International Conference on

The Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation

BOOK OF ABSTRACTS

Ensuring Safety and Enabling Sustainability

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Atoms for Peace and Development

International Conference on the Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation: Ensuring Safety and Enabling Sustainability

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BOOK OF ABSTRACTS

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ORAL PRESENTATIONS

SESSION 2.2: OVERARCHING CONCEPTS OF ENSURING SAFETY AND ENABLING SUSTAINABILITY

IAEA CN-318/5

Addressing sustainability considerations in strategies for nuclear decommissioning

Author: Simon CARROLL[1]

Co-author: Deborah OUGHTON

1 Vattenfall

Decommissioning is typically undertaken on the basis of planning and assessment to ensure safety, protection of workers and the public, and protection of the environment. While these are well-established aspects of nuclear decommissioning, additional considerations relating to issues of sustainability are receiving ever increasing attention. However specific sustainability considerations tend to be framed either within the rather narrow and limited context of improving the sustainability of how particular decommissioning activities are undertaken, or diffusely within overarching organizational sustainability strategies with rather vague connections to the practice of decommissioning.

This paper will argue that the current conceptual approach to nuclear facility decommissioning is a fundamental limitation and that a reframing is necessary if sustainability is to be genuinely addressed. When we talk about nuclear decommissioning, we are usually referring to the final phase of a once-through nuclear facility life cycle. This paper will suggest a wider framing of the issue, so that from the outset considerations of how and to what extent a facility and its equipment will be reused should be embedded in design and construction, and that future use of a site will be integrated into development plans. Embedding decommissioning within a more cyclical conceptual framework would enable broader and deeper engagement with sustainability and circular economy considerations systematically throughout the life cycle.

It is suggested that the current interest in advanced reactor designs and SMRs offers an ideal opportunity to begin to implement a new more sustainable and circular approach to nuclear decommissioning already at the design stage. Current initiatives to address sustainability in decommissioning of the current fleet of nuclear facilities should be strengthened and intensified with the aim of testing and refining circular economy approaches and inform design choices for the next generation of facilities.

IAEA CN-318/320

Reimagining the nuclear cycle as a circular economy: challenges and opportunities

Author: Matthew CLARK[1]

1 Hopegill Associates

Taking the UK as a case study, we have seen a massive shift away from disposal in dedicated radioactive waste repositories (1). This has been achieved through improved sorting and segregation, metal recycling and volume reduction through incineration, but most significantly by diversion to non-nuclear disposal facilities.

Dedicated radioactive waste disposal capacity is a precious resource and so these achievements should not be underestimated. Available capacity for disposal of UK LLW has been extended by decades as a result. However, as landfill capacity becomes increasingly scarce and unacceptable to the public, there remains much work to be done.

Reducing the nuclear industry's reliance on disposal is a difficult challenge for technical and societal reasons, including cost. To address this issue, creating a circular economy will be essential and this may best be achieved within the industry. To do this we cannot rely on thinking about what to do with waste, we need focussed action at the "front end" with designers, engineers and programme delivery professionals actively seeking out opportunities to reuse materials. We will also need to design in repairability, refurbishment and remanufacture (2), which in turn will require a change in the approach to specification within the industry.

The industry's entirely appropriate focus on safety can be a barrier to material reuse, which is partly seen in specifications. Addressing this issue will require careful consideration to balance the needs of safety with the benefits of increased material reuse within the industry. Whilst this may seem a challenge, the nuclear industry has for a long time had a "cycle" mindset and this presents a great opportunity to reimagine the nuclear cycle as a fully sustainable one for current times.

References

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2. Ellen Macarthur Foundation, the butterfly diagram: visualising the circular economy (https://ellenmacarthurfoundation.org/circulareconomy-diagram)

IAEA CN-318/194

Sustainable remediation in Brazil: Development, controversies, and future perspectives

Authors: Juliana FREITAS[1], Stela SANTOS COTA[2]

1 Universidade Federal de São Paulo

2 CDTN/CNEN

Contaminated sites management started being implemented in a more structured form in Brazil mainly in the 90's. Since then, the management strategy and techniques have evolved significantly. For example, a site-specific risk-based approach was developed to define remediation goals and new remediation technologies were developed and are applied worldwide. However, more recently, it became apparent that the application of remediation techniques might have significant environmental impacts, such as waste generation and gases emissions, besides having a high demand for energy and resources. Consequently, the idea of sustainable remediation started permeating the contaminated sites sector. In this paper we aim to present and discuss how the concept of sustainable remediation started appearing in the Brazilian context and controversies involved in its introduction and application. For example, initially there was a concern that the concept would be used to justify a non-action approach, resulting in higher exposure risks. Currently, there is an ongoing discussion on which levels should the remediation achieve, considering the need to restore impacted systems, the sustainability of the intervention actions and risks involved. Finally, we will present our perspective on the possibilities and opportunities to apply the concept of sustainable remediation, and the points that need further development.

IAEA CN-318/351

USA NUCLEAR REGULATORY COMMISSION: ENSURING SAFETY AND FOSTERING SUSTAINABILITY THROUGH RISK-INFORMED COMPLIANCE PERIOD FRAMEWORK FOR ANALYSES OF RADIOACTIVE WASTE DISPOSAL

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1 Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards

The United States Nuclear Regulatory Commission (NRC) Low-Level Radioactive Waste Management (LLRWM) Program continues to make progress with allowing for the safe use of nuclear technology and nuclear materials for industrial and medical uses while sustainably increasing disposal options for higher activity wastes. The NRC is undertaking a rulemaking to modify its low-level waste disposal regulations that will allow for near-surface disposal of Greater-than-Class-C (GTCC) waste and depleted uranium, which can be similar to intermediate level wastes. The NRC's approach to maintaining safety and sustainability involves requiring licensees to perform technical analyses of the wastes proposed for disposal in a risk-informed, graded manner. Use of site-specific technical analyses balances the need to increase waste disposal options while protecting future generations from potential releases of radioactivity from long-lived radionuclides disposed in the near surface. The NRC plans to implement a graded compliance period framework of shorter duration of analyses required for typical low-level waste and a longer duration of analyses for waste streams containing significant quantities of long-lived radionuclides. The NRC staff has compiled research from the international community to determine the appropriate durations for each type of waste. Implementing this risk-informed compliance period framework will ensure that licensees evaluate protection of the member of the public as well as an inadvertent intruder, thereby fostering sustainability for future generations. This paper will highlight the NRC's approach to balancing safety and sustainability through the use of a risk-informed compliance period framework.

IAEA CN-318/144

Circular economy in nuclear industry, through the prism of Material and Waste Management

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According to the IAEA's definition, a circular economy is a policy in which resources are kept in reuse or recycling for as long as possible, retrieving the maximum value from them, then recovering and regenerating products and materials at the end of each lifecycle. It is an approach focused on delivering positive society-wide benefits by limiting waste production and preserving natural resources.

The objective of this paper is to illustrate the application of circular economy principles within the nuclear industry and particularly in the waste management and decommissioning activities. In this regard, this paper will address the necessary conditions (regulatory, social, industrial, economic and environmental) to deploy circular economy, its expected assets as well as its benefits and outcomes.

The paper will also provide some perspectives of the different challenges to be addressed in order to increase the efficiency and better acceptance within the nuclear industry of the reuse and recycling principles on which circular economy mainly relies.

In the frame of waste management and decommissioning activities, the commonly recognised driving principle is waste hierarchy. Based on this latter, the paper will demonstrate how, over the last decades, the worldwide nuclear industry gathers international experiences to improve waste management and decommissioning to implement circular economy in its activities.

Consequently, taking advantage of the increase of decommissioning projects and induced materials and waste, nuclear operators have developed specific methodologies to:

- Significantly reduce the amount of type, nature and volumes of ultimate waste to be disposed of in order to preserve raw or rare resources.
- Implement reuse and recycling principles since the design phase in new nuclear projects as well as in maintenance and dismantling activities in all of them.
- Increase the importance and relevance of characterization items (skills, labs, methodologies…) to enhance the volumes of generated materials devoted to proper reuse and recycling.
- Identify the various criteria enabling sustainable strategies: cost efficiency, environmental aspects, social acceptance, regulatory constraints, available technologies as well as R&D needs and young generations attractiveness.
- Foster innovations to reduce secondary waste or improve nuclear facilities' design.
- Promote circular economy and sustainability within the nuclear industry activities through some identified remaining challenges to be addressed.

Relying on the above-mentioned items, the paper will be strengthened with evidence and case studies currently implemented in global nuclear industry. The paper will further promote international cooperation in the strive towards circular economy.

Last but not least, the paper will illustrate how the implementation of circular economy in the entire nuclear lifecycle will enable to increase the credibility and relevance of global nuclear industry as a sustainable low-carbon energy source.

SESSION 3.1: MANAGING THE INTERRELATIONSHIPS IN POLICY, STRATEGY, LEGISLATION, AND REGULATION

IAEA CN-318/175

The proposed regulatory approach to NORM management in Brazil

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1 Comissão Nacional de Energia Nuclear – CNEN

Developing policies, strategies and an adequate regulatory framework for NORM residue management is a challenge for many countries, including Brazil. Industries that generate NORM residue must undertake actions aimed at recycling and reusing materials, whenever possible, or for disposal when no further use of waste is foreseen. To make the circular economy a feasible option to the industries it is necessary to have an appropriate regulation considering the principles of sustainability. The new updated Brazilian Basic Safety Standard, currently in final stages of approval, took an important step in this direction. The regulation was reviewed focusing on a dose criterion to be met for exemption and/or clearance of such materials in specific cases encouraging recycling and reuse solutions or disposal in conventional landfills. Based on Brazilian BSS, NORM related industries are considered Existing Exposure Situations and depending on the characteristics of the NORM residues and the associated levels of risk, a graded approach based on the 1mSv/y dose criterion was considered to define different levels of regulatory control. Although classified as existing exposure situation, regulatory requirements foreseen for the planned exposure situation can also be applied.

IAEA CN-318/173

The Regulatory Framework for the safety of nuclear applications Role in achieving the Sustainable Development Goals in Cuba

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The Sustainable Development Goals (SDGs) approved in 2015 during the World Summit on Sustainable Development, without being legally binding, require countries that adhere to the 2030 Agenda to adopt them as their own by establishing National Frameworks for their achievement.

Cuba endorsed these principles; however, there was already a legislative framework applicable to the safety of radioactive facilities, currently in force, practically in its entirety and under review, as may have happened in other countries.

The Regulatory Framework analysis (more than 30 legal bodies), carried out by comparing the Objective of each legal body, with the SDGs of interest to the Conference, allows to ensure that all these legal bodies contribute to the achievement of any of the SDGs of interest to the Conference, many of them, to various SDGs and those related to radioactive waste management and unsealed sources handling, support the implementation of about 50% of these. The best supported SDGs by legal bodies are, in order, SDGs 9, 17, 3 and 12.

It is advisable to intensify the processes of updating the Regulatory Framework in terms of safety and radiological and nuclear protection towards the maximum completion of the corresponding elements to facilitate the adoption of the SDGs by each country.

IAEA CN-318/319

Canadian Regulator's application of lessons learned in updating the regulatory framework to incorporate sustainability into decision making

Author: Sarah WATT

Co-author: Kevin ROSS[1]

1 Canadian Nuclear Safety Commission

As Canada's nuclear regulator, the Canadian Nuclear Safety Commission (CNSC) has modernized its regulatory framework to take into consideration past practices, and lessons learned to enhance safety while allowing flexibility to adapt to and support emerging technologies. The updates included life cycle management, planning of decommissioning activities and end states as early as possible and in the design phase for new facilities, to ensure alignment with Canada's waste policies and international best practices.

The CNSCs regulatory framework ensures safe decommissioning and remediation with consideration for the protection of the environment for future generations. The modernized regulatory framework also contains requirements for emerging projects, such as Small Modular Reactors, at the design and planning stages. Requirements have been introduced into the framework for licensees to have in place a waste management plan before moving into operations, and a consideration of the decommissioning strategy and its end states at the planning and design phases. CNSC representatives will provide specific examples to demonstrate the lessons learned from Canada's historical projects, and how these have contributed to the modernization of the framework.

IAEA CN-318/177

Ensuring Safety and Sustainability for Nuclear Decommissioning in Norway

Authors: Ian BARRACLOUGH[1], Kristine Valberg NYEGAARDEN[1], Yngvild SAUGE[1]

1 DSA, Norway

The focus of Norway's nuclear activities is in transition, from operating research reactors to decommissioning nuclear facilities and managing the associated radioactive waste. New facilities will be needed to support decommissioning and for management of the wastes. Both the decommissioning of old facilities and development of new facilities will need to be carried out safely, but both will also lead to an increased focus on sustainability. This in turn will depend on the coordinated application of different legislation, to continue ensuring safety and environmental protection while building in sustainability from the planning stage.

This paper will elaborate on of the most important regulatory instruments for ensuring sustainability in the Norwegian regulatory framework. This includes the environmental impact assessment (EIA), which will identify significant impacts on the environment and society and ensure public participation and sufficient stakeholder involvement.

Another important regulatory instrument is the Pollution Control Act (PCA) which applies to radioactive pollution and radioactive wastes. There is a need to further examine the links between the EIA, PCA and other relevant regulatory instruments for nuclear site operation and radioactive waste disposal, such as the license/SAR. The EIA and the PCA will contribute to Norway achieving the SDGs.

SESSION 3.2: MANAGING THE INTERRELATIONSHIPS IN POLICY, STRATEGY, LEGISLATION, AND REGULATION (CONT'D)

IAEA CN-318/193

Analysis of the regulatory framework and the interrelations between safety and sustainability during the back end of nuclear fuel cycle facilities

Author: Erika FUHR

This paper aims to describe the interrelations between the regulatory framework of the Nuclear Regulatory Authority (ARN) and the sustainable development objectives (SDGs 2030) towards the back-end of nuclear fuel cycle facilities, as well as the perspectives and challenges. In addition, experiences will be presented from the regulatory oversight framed in the national legislation, intern policies of ARN and its strategic planning and international cooperation related to the fulfilment of the SDGs 2030.

The paper points out regulatory safety requirements, taken from the current regulations and aligned with the SDGs 2030, the development by facilities to implement technologies and procedures that allow optimizing processes that aim to minimize radioactive waste and releases.

A graded approach to regulatory verifications activities will be evaluated, considering the classification of the facilities and their associated radiological risks that may impact on the workers, the public and the environment. The justification of the practices and the principles of optimization of radiation exposures will be taken into account.

Responsibilities of the interested parties involved in the licensing processes for the back end of nuclear fuel cycle facilities and their influence on decision-making considering economic, social and environmental factors will be described.

Finally, this paper will bring conclusions and opportunities for improvement to be addressed in terms of updating the regulatory framework concerning the integration of the concepts of safety and sustainability.

IAEA CN-318/282

Planning for decommissioning from an early stage

Authors: Sofia LUQUE[1], José Luis REVILLA[1], SUSANA SOLIS[1], Inmaculada SIMÓN[1]

1 Consejo de Seguridad Nuclear (Spain)

The Spanish framework for regulatory control and supervision of the decommissioning projects carried out up to date, has posed a challenge that has derived in the acquisition of a vast regulatory experience in this subject.

This experience has been essential in the process of regulatory harmonization in Europe through the WENRA association, and, as a result, the Spanish Nuclear Safety Council (CSN) has issued the Safety Instruction IS-45 "Instruction on safety requirements during the design, construction and operation phases of nuclear facilities and fuel cycle facilities, to provide for their dismantling and, where appropriate, their dismantling and closure". This Instruction regulates one of the first lessons learned; the need for a preliminary decommissioning plan long

before the end of the operating life of these facilities, to provide for a safe and sustainable decommissioning process.

This plan aims to minimize environmental impacts, optimize waste management, and promote sustainable practices throughout the decommissioning process.

IAEA CN-318/287

The UAE Nuclear Legislation Framework: Radioactive Waste Management and Spent Fuel Management

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1 Federal Authority for Nuclear Regulation, United Arab Emirates

The infrastructure of the UAE Nuclear Programme has been established with the "Policy of the State on the Evaluation and Potential Development of Peaceful Nuclear Energy" issued in 2008. The Policy aims to develop and regulate the nuclear sector towards peaceful purposes of nuclear energy, as well as the Federal Law by Decree No. 6 of 2009 "Concerning the Peaceful Uses of Nuclear Energy" that had established the Federal Authority for Nuclear Regulation (FANR) as the independent safety, security, and non-proliferation regulator.

The paper will present the regulatory framework including the licensing and oversight activities of licensees and facilities, especially those related to radioactive waste management such as the Natural Occurring Radioactive Material (NORM) Waste Treatment and Disposal Plant, in line with the Policy's objectives of management and disposal of spent fuel and radioactive waste. FANR regulations provide the requirements for the licensing of nuclear facilities, radiation protection, management of radioactive waste and spent fuel in nuclear facilities, among other regulatory elements.

The paper will present sustainability in the regulatory processes specifically for radioactive waste management where FANR has maintained its strategic objective of developing sustainability of the UAE regulatory infrastructure through regulations in line with the IAEA Safety Standards and the best international practices. In addition, how the national radioactive waste policy will be shaped to meet the future demands and sustainability (spent fuel management, radioactive waste management, etc.).

IAEA CN-318/243

Nuclear Waste Services – Developing a sustainability strategy that ensures safety and enables sustainability

Author: Daniel BUNN[1]

1 Nuclear Waste Services

Introduction: At Nuclear Waste Services, our purpose is clear: to make nuclear waste permanently safer, sooner. And we want to become the 'one-stop shop' for nuclear waste management and disposal solutions in the UK. As an organisation, we want to deliver this in the most sustainable way possible. We have created a sustainability policy that outlines six key principles to ensure we deliver this ambition.

The challenge: We need to create a sustainability strategy that enables us to act as a sustainable organisation while maintaining our core nuclear safety and security principles. We need to be able to focus on key sustainability topics that are the most significant to our organisation and deliver them in a coordinated way.

Our approach: We need to make sure that our strategy represents the views of our stakeholders, and when we focus on areas, we know that we are focusing on the areas that matter. We have developed our understanding through materiality assessments with various stakeholders, such as our workforce, communities, leadership, and the waste community.

The output: By completing these materiality assessments, we can shape our sustainability strategy to ensure we focus on the key topics. The output of these assessments showed that our stakeholders think safety and security are key to sustainability, and by working with our colleagues in safety, we have been able to shape a sustainability strategy that can deliver on our sustainability priorities while ensuring nuclear safety is at the core of our strategy.

Summary: This paper will describe the output of the sustainability materiality assessments completed. It will highlight the key topics that have emerged from each stakeholder group and how these topics will be developed into the Nuclear Waste Services sustainability strategy.

IAEA CN-318/26

Improvement Of the Regulatory Framework in The Field Of Radioactive Waste Management In The Republic Of Armenia: Challenges In Implementation of Radioactive Waste Management Program, Policy, And Strategy

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Co-author: Armen AMIRJANYAN (AA)

1 Nuclear and Radiation Safety Center" CJSC

The Republic of Armenia has been using the nuclear energy and technology for peaceful purposes in power generation, agriculture, medicine, industry, and research, for over five decades. However, despite its benefits, the management of generated radioactive waste poses a significant challenge that require a comprehensive approach to ensure both safety and sustainability. The radioactive waste from both historical and current periods, including the waste expected from the decommissioning of the Armenian Nuclear Power Plant, needs effective management to avoid long-term environmental risks without imposing an unnecessary burden on future generations.

This article examines the interrelationships between policy, strategy, legislation, and regulation in ensuring the safe management of radioactive waste in Armenia. It discusses the challenges in achieving a balance between safety and sustainability while creating or improving the regulatory framework.

Additionally, the article discusses the use of international best practices and the application of the International Safety Standards, along with the selected Directives of the European Commission, to establish a safe and sustainable framework for managing the radioactive waste.

SESSION 5.2: MANAGING THE INTERRELATIONSHIPS BETWEEN SAFETY AND SUSTAINABILITY IN DECISION-MAKING

IAEA CN-318/147

Application of AGILE project management methodology in R&D to ensure the safe and sustainable disposal of legacy waste

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1 ONDRAF/NIRAS

ONDRAF/NIRAS plans to build and operate a surface disposal facility for the low-level radioactive waste in Dessel. The licensing process is underway and should lead to a construction and operation license by mid-2023. The construction of the disposal facility could start in 2024 and its operation could be expected in 2027.

The license (and the safety report) will set the conditions that the waste must respect to ensure a sustainable and safe disposal. Besides radiological limits, physico-chemical criteria are also defined. Indeed, the waste can't unduly affect the performances of the Engineer Barriers that play a major safety function and can't perturb the expected evolution of the disposal system.

One of the main challenges is to ensure the disposability of the legacy waste. To achieve this goal an AGILE project management methodology is applied to perform in an iterative way the R&D and to develop in an incremental way solutions allowing a safe and sustainable disposal of this waste. With this methodology, the R&D works could be turned into first solutions that could be quickly deliver allowing not to prevent the construction and operation of the surface disposal facility. The further optimization of the solutions will still continue allowing future developments in order to keep the highest levels of safety standards.

This paper will describe the application of the AGILE project management methodology with the example of the development of solutions allowing the disposal of potentially swelling waste, such as the concrete waste sensitive to ASR (Alkali-Silica-Reaction) and DEF (Delayed Ettringite Formation) reactions.

IAEA CN-318/250

Applying a life cycle environmental perspective to the development of radioactive waste treatment technologies

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Environmental life cycle assessment (LCA) is a standardised approach to evaluating and improving environmental sustainability in a holistic manner and has been applied quite extensively to nuclear energy generation life cycles. However, there are very few examples of LCA being used to ensure more sustainable radioactive waste management. This presentation will begin by considering the prior use of LCA in this field and the potential benefits of its application, before focusing on work conducted as part of the EU/Euratom-funded PREDIS project which has applied LCA and the methodologically related approach of life cycle costing (LCC) to a variety of novel treatment options for metallic, organic, and concrete package waste streams. This has been conducted in close collaboration with partners across Europe to identify candidate waste forms and pre-treatment methods and to coordinate data collection processes, which will be outlined. Subsequent LCA has been conducted using Sphera GaBi software with input from the Ecoinvent 3.9 database. The presentation will draw on this work to analyse cases of specific waste treatment techniques and to illustrate how LCA can be used to ensure that new waste treatment processes in the nuclear sector are designed with sustainability in mind from the outset.

IAEA CN-318/252

NESSAT: Providing a technical-economic assessment toolbox for a more integrated waste management policy

Authors: Luc VAN DEN DURPEL[1,] Aliki VAN HEEK[1]

1 Nuclear-21

The Nuclear Energy Systems Strategy Assessment Toolbox (NESSAT), is a comprehensive toolbox for evaluating the long-term safety, environmental impact, and sustainability of nuclear energy systems, developed by Nuclear-21, an expert cabinet consultancy focused on nuclear newbuild support, nuclear resource and waste management and sustainability. NESSAT utilizes advanced modeling techniques and data analysis to assess the entire life cycle of nuclear power, from mining to waste disposal and decommissioning. It helps decision-makers analyze waste management options, such as storage, reprocessing, and geological disposal, considering factors like volume, radioactivity, costing and – of increasing importance- (financial) risks as part of the waste fund provisioning. NESSAT also incorporates a set of sustainability indicators to evaluate the environmental, social, and economic impacts of nuclear projects. By optimizing decision-making processes and providing insights for improvement, NESSAT ensures the implementation of sustainable practices in the nuclear energy sector. Overall, Nuclear-21's NESSAT toolbox is a valuable resource for stakeholders involved in nuclear energy planning and policy-making, enabling them to make informed decisions regarding waste management, safety, and the overall sustainability of nuclear energy systems. A few selected examples of applications of NESSAT will be presented.

IAEA CN-318/264

A Blind Spot of Sustainable Development - Integration of Radioactive Waste Accumulation into the Planetary Boundary Framework

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The Sustainable Development Goals are the cornerstones of the United Nations' 2030 agenda for sustainable development. However, efforts to achieve these goals must be conducted within the ecological capacity of our planet, defined by the framework of planetary boundaries. Climate change, one of nine identified boundaries, requires a rapid decarbonization of global energy systems, for which nuclear power, as low-carbon technology, is often considered. However, nuclear fission has long lasting anthropogenic impacts through the production of highly radioactive waste, which must be isolated from the biosphere for several hundred millennia. To date, there is no deep geological repository in operation, but the radioactive waste stockpile continues to accumulate due to ongoing operation of nuclear power plants, posing an increasing challenge to its safe management. As radioactive waste is currently insufficiently addressed within the planetary boundaries' framework, this paper proposes to incorporate radioactive waste as a control variable for the boundary named "novel entities". For this purpose, possible control variables will be defined, and their suitability will be assessed by three criteria (feasibility, relevance, and comprehensiveness) following the approach of Persson et al. (2022). This implementation will support environmental policy makers to formulate more comprehensive decisions on sustainable development while emphasizing the need for increased efforts in radioactive waste management and waste reduction.

IAEA CN-318/171

Embedding sustainability into decommissioning: participative systems mapping

Author: Tracy BRAITHWAITE[1]

1 Environment Agency

There is growing interest in using systems thinking to addressing complex challenges. Managing the UK's nuclear legacy in a sustainable way presents a significant and complex challenge that requires assessment of socio-economic and environmental impacts in the management of risks and considerable lifetime costs. This brings significant challenges to decision-makers as they seek to identify long term solutions that reconcile competing interests.

The Environment Agency is collaborating with the Nuclear Decommissioning Authority and the Department for Energy Security and Net Zero on a project to demonstrate the value of systems thinking to stakeholders. The aim of the project is to develop an integrated systems map that will support decision making in decommissioning.

The systems map is framed around the United Nations Sustainable Development Goals (SDGs).

The approach is designed to facilitate collaborative exploration of the whole decommissioning system, identify issues and how they interact. The nodes and connections on the system map model the decommissioning system and can be used to explore how decisions and changes may affect the system's contribution to the SDGs.

IAEA CN-318/179

Sustainability and taking a systems approach - an environmental regulator's perspective

Author: Karl LITTLEWOOD[1]

1 Environment Agency

It is vital that we take an integrated systems approach to embed sustainable development in decisions taken throughout the nuclear lifecycle. As the decommissioning of the UK's earliest reactors proceeds towards final decommissioning, restoration plans and decisions need to respond to wider social and environmental considerations. Nuclear operators also need to deliver against their corporate environmental and social responsibilities. Approaches that enhance public value, engage local communities, consider intergenerational equity, enhance environmental protection, and mitigate and adapt to climate change, are needed. These changes require a culture that places sustainable development goals at the centre of decision making.

For sustainable remediation to be effective, planning should consider the impacts beyond the site boundary, the value of assets, and the eventual use of the site. Sustainability is a principal goal of remediation and should consider factors such as safety, cost, environmental impact, legal compliance, and other socio-economic impacts. Integration, collaboration, and communication is necessary if we are to avoid the potential for unintended negative impacts.

The Environment Agency has been working on innovative ways of achieving these aims. This paper sets out our expectations for identifying and addressing environmental outcomes and considers lessons from work with nuclear operators.

SESSION 5.3: MANAGING THE INTERRELATIONSHIPS BETWEEN SAFETY AND SUSTAINABILITY IN DECISION-MAKING (CONT'D)

IAEA CN-318/316

Sustainability – a multidimensional challenge in the nuclear industry

Authors: Lasse KYLÄKORPI[1], Karin PETRINI[1]

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1 Vattenfall AB

2 Vattenfall

Sustainability in nuclear power is linked to many sustainability aspects, and these sustainability aspects have different significance in the different phases of nuclear power.

For example, during the front-end particular focus and attention is given to consideration of certain aspects (e.g. human rights, biodiversity, health & safety (H&S),etc.); whereas during operation other aspects are central (e.g. nuclear safety, stakeholder involvement, radiation protection, etc); and the emphasis shifts again during back-end to another set of aspects (long-term radiation safety, environment, H&S, etc.).

For these different phases, different sets of actors also have the main responsibility and different groups of stakeholders have requirements and expectations.

This means that the sustainability work for a responsible "utility" is multidimensional. It is important in every part of the life cycle and across the business to focus on the right issues, collaborate with relevant actors and identify the right measures and tools at the right time. It is also essential that decision-making at any particular stage is supported by awareness of the sustainability implications at all phases. This requires development of an integrated framework, with appropriate skills, tools, and methods to support data gathering, analysis and decision-making throughout.

This paper will describe Vattenfall’s efforts to further develop a multidimensional sustainability framework for its nuclear activities.

IAEA CN-318/215

Environmental remediation and waste management following a nuclear accident

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1 IRSN

In the context of the French Steering Committee for the management of post-accidental situations (CODIRPA), IRSN studied environmental remediation strategies and waste management options following a major nuclear accident, in order to allow a sustainable living environment in affected zones.

The work consisted in (i) modeling a major accident impacting urbans territories, agricultural land, and forests (Figure 1), (ii) simulating several remediations strategies and (iii) estimating waste volumes, efficiency and workforce associated with the strategies, using tools developed by IRSN and based on feedbacks from Chernobyl and Fukushima accidents. It also capitalized knowledge on a typology of environments, which might require differentiated remediation approaches. Its main outcomes are to underline the impact of the choice of a remediation strategy on waste volume and nature, as well as to identify the main difficulties associated with waste management in the event of a major nuclear accident in France. Overall reflections on possible evolutions of the French waste management system are finally given. One of the main perspectives of the work is to include other factors, such as social acceptability, in order to lead multi-stakeholder and multi-criteria analysis to support decision-making.

IAEA CN-318/293

Managing interrelationships between safety and sustainability in decision-making: SITEX. Network activities

Authors: Valéry DETILLEUX[1], Nadja ZELEZNIK[2], Alexis GEISLER-ROBLIN

1 Bel V

2 EIMV

The Brundtland report defines 'sustainable development' as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs". By considering this vision in addition to the dynamism of the Aarhus convention, the SITEX.Network (Sustainable network for Independent Technical EXpertise on radioactive waste management), a cooperative network involving several international Technical Safety Organizations, regulators, and Civil Society Organisations, promotes the articulation of sustainability with a certain framework for pluralistic decision-making about safety aspects of radioactive waste management. An application developed by SITEX.Network is the 'PEP serious game' (Pathway Evaluation Process). It offers to its players (from several types of actors, not necessarily with a technical background) a diversity of created scenarios of events, with a need of discussions, decisions, and clarification in order to reach a certain safe and sustainable terminus, regarding a specific strategy for long term radioactive waste management. The dynamism offered by this type of interactions and their interesting results led SITEX.Network to further investigate enlarged and intergenerational approaches about Safety Culture, notably with the open characteristics of intergenerational safety assessment. This opens to SITEX.Network wide horizons of future studies about Safety Case temporal evolutions.

IAEA CN-318/254

Incorporating Land Use Considerations into The Cleanup Of A Complex Nuclear Site In Canada: An Integrated Approach

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Co-authors: Rachel CHENNETTE[1], Scott CLEMOW[1], Luc ROBITAILLE[1], Samantha SCOTT[1], Grace SNELL[1]

1 Canadian Nuclear Laboratories

Canadian Nuclear Laboratories (CNL) has made great strides toward the development of a safe and sustainable approach to the progressive decommissioning, remediation, and revitalization of the Chalk River Laboratories (CRL) site.

Through the establishment of the Land Use Program, focus has been put on incorporating science-based principles and proactive, effective stakeholder and Indigenous engagement into robust site-wide planning for decisions on environmental clean-up and future land use. Safety is integrated into the Land Use Program through the adoption of risk-based exposure and dose objectives for non-radiological and radiological contamination which are used to model screening and clean up criteria to be targeted during planning and execution of environmental remediation.

The overarching output of the Land Use Program is an Overview Decommissioning and Cleanup Plan for the site. This iterative plan provides a strategic approach to the decommissioning and remediation of CRL's buildings, infrastructure, and contaminated lands, while integrating these plans with sustainability goals and other site priorities and projects, such as site revitalization and the availability of future waste management and disposal options. The plan will continually evolve to incorporate new information, lessons learned and feedback from stakeholders and Indigenous communities as clean up progresses.

IAEA CN-318/314

NDA Value Framework - Our touchstone for sustainability

Author: Markku KOSKELAINEN

To ensure transparency when comparing and assessing options, the Nuclear Decommissioning Authority (NDA) has established an approach together with our stakeholders to valuing the delivery of our decommissioning mission, recognising that value comes in many forms, such as: an improved environment, hazard reduction, social amenities, money, or employment. These values have been gathered together as a Value Framework.

The NDA Value Framework is not a decision-making process; but a set of decision-criteria against which performance of options for the delivery of our decommissioning mission can be assessed. Applying the Value Framework ensures that the decisions consider the value that each option would deliver in relation to a range of different decision-criteria and offers a way to present a rational assessment of the advantages and disadvantages of each option. Applying the Value Framework in our decision-making processes means:

• never compromising on safety or security

• taking full account of our social, economic, and environmental responsibilities

• putting the three pillars of sustainability and social value at the heart of the decisions we make.

Many of the decision-criteria in our third iteration of the NDA Value Framework remain unchanged, but we have simplified and improved the NDA Value Framework with renewed focus on making the link between the decision-criteria and sustainability reflecting both the ambition of stakeholders involved in nuclear decommissioning and the aspirations of wider UK government policy.

SESSION 6: BUILDING CAPACITY FOR ENSURING SAFETY AND ENABLING SUSTAINABILITY

IAEA CN-318/196

Global method to Attract, Develop and Retain Talent at Andra

Author: Fabrice PUYADE[1]

1 ANDRA

Andra is facing Human Resources (HR) issues with the crucial question of long-term projects, societal acceptance with regards to (for example) the size, duration, and multidisciplinary challenges of Cigéo project. Andra must permanently plan years ahead to hold on to its attractiveness, identify and develop potentials, retain its employees, while preserving acquired knowledge.

To that end, a "5 circle" (5C) method is developed:

1- By remaining attractive on a tight job market facing a lack of engineers and technicians linked to the appetence for professions in the nuclear industry.

2- By becoming a competitiveness hub and a center for the emergence and development of talent.

3- By institutionalizing a program of forward planning and systematic development of the agency's human capital, whose aim is to build tailored, high added value career paths.

4- By increasing the accountability effect.

5- By deploying an ambitious Corporate Social Responsibility (CSR) approach.

The paper will present the HR policy implemented at Andra to deal with the major challenges the Agency is already facing, and which will extend over several decades.

IAEA CN-318/327

Developing Capacity for Nuclear Decommissioning: The Nigeria Experience

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Considering the growing number of nuclear facilities entering permanent shutdown, it is crucial to review lessons learned and adopt best practices to ensure effective decommissioning, dismantling, and remediation. The key to successful decommissioning lies in having competent personnel involved in the process. Therefore, organizations responsible for future decommissioning projects must prioritize the development and implementation of robust human resource management practices, policies, and training programs for all stakeholders involved. The Nigeria Research Reactor-1 (NIRR-1) is a low-power reactor located at the Centre for Energy Research and Training (CERT) in Ahmadu Bello University, Zaria. After operating for 12 years with Highly Enriched Uranium (HEU) fuel, it underwent partial decommissioning to mitigate proliferation risks by converting the fuel to Low Enriched Uranium (LEU). The decommissioning process was preceded by rigorous trainings and drills facilitated by the International Atomic Energy Agency (IAEA) and the US Department of Energy (DoE). The decommissioning preparation began with training personnel on spent fuel characterization and transport cask design and thereafter, operators were trained to be proficient in core removal and package loading operations, while the radiation protection team received comprehensive training on emergency preparedness and response. Security measures were strengthened by assembling a team comprising university guards from CERT and personnel from Nigeria's armed forces, including the police, customs, and immigration. Thanks to the extensive training and drills conducted on and off-site, the decommissioning process was executed efficiently despite Nigeria's security challenges. However, valuable lessons were learned during the preparatory phase as internal personnel transfers within the university affected trained administrative staff and security guards, leading to duplicated efforts, increased costs, and delays in implementation. Furthermore, the sustainability aspect was overlooked during the personnel training as none of the trained personnel were on internship or fellowship, which implies that none would be available to bring their experience to bear on the next decommissioning project. This will necessitate significant investment to train a new workforce. Overall, the Nigerian experience emphasizes the importance of capacity building for nuclear decommissioning and highlights the need for comprehensive training programs, considering personnel sustainability, and effective coordination among stakeholders.

IAEA CN-318/299

Overview Of Sustainable Management of Radioactive Waste in Tanzania

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1 Tanzania Atomic Energy Commission

Tanzania has established a radioactive waste management regime in the country to ensure sustainable management of radioactive waste management withing a country. These efforts include safe and effective management of radioactive waste while protecting public health and the environment. One of the notable sustainable approaches is the establishment of the Central Radioactive Waste Management Facility (CRWMF). The CRWM was commissioned in 2005 and stores radioactive waste from various nuclear application in medical, industrial, and research activities. Facility guidelines and procedures for safe handling and storage of radioactive waste have been established to ensure protection of workers, environment, and the public in general. The updating of national inventory of radioactive sources within the country is regularly done and 31 disused radiation sources have been conditioned and secured for Long Storage through an IAEA supported project of Spent High Activity Radioactive Sources (SHARS) in September 2009.The review of legal framework infrastructures for the management of radioactive wastes has also been done to accommodate the requirements of International basic safety standards. Tanzania has made huge achievements in establishing training programs through its research and development department on management of radioactive waste, comprehensive inventories of both in use and disused radioactive sources, capacity building for professionals through academic and professional courses and the improved collaboration with local and international partners including the IAEA for various technical cooperation programs. Tanzania is also envisaging the use of bore hole technology as a long-term solution for management of radioactive waste management. Despite the achievements, the lack of infrastructure and limited technical expertise for conditioning of radioactive waste, and high cost in security management are some of important challenges.

SESSION 8.2: INTEGRATING THE VIEWS OF SOCIETY INTO DECISION-MAKING CONSIDERING TECHNICAL, ENVIRONMENTAL, SOCIAL, AND ECONOMIC FACTORS

IAEA CN-318/334

Content

Author: Jonathan OLIVER[1]

1 IDOM Nuclear Services

Wider society´s viewpoint is an important consideration to ensure the continued support of peaceful nuclear power generation. History shows that lack of public support has influenced political decisions and impeded projects. With that in mind these abstract focuses on how the views of society could affect, and be implicated in, the decision-making process within the field of radioactive waste management (RWM).

Our recently published European Commission sponsored study on radioactive waste classification schemes in the European Union, that partly involved a public survey, found that 82% of respondents thought all radioactive waste was dangerous. It is significant considering many stakeholders are seeking public consultations as they aim to develop projects such as deep geological disposal facilities for high-level waste. Public opposition to such projects could impact important decisions such as siting etc.

One example has been provided on how the views of different stakeholders interact with an array of factors that influence the implementation of nuclear technologies applied to RWM. The study´s findings could be further advanced by elaborating on an assessment of currently applied classification schemes and whether there would be any benefit in implementing a holistic approach to classification.

IAEA CN-318/358

Consent-Based Siting: Fostering Community Support For Australia's First Deep Geological Repository Project

Author: Nate SMITH[1]

1 TELLUS Holdings Ltd

Gaining community support is crucial for the successful implementation of a deep geological repository (DGR) project, particularly in the context of Australia's first venture into this domain – The Chander Project. The Chandler Project will be licensed to accept international low level radioactive waste and also international chemical wastes and Tellus is approaching the signing of an indigenous land use agreement for this project. The paper highlights the significance of adopting a consent-based siting approach to secure community involvement and acceptance in the development of Australia's DGR. It outlines the key principles and strategies of the consent-based siting approach and emphasises its potential to build trust, foster transparency, and ensure the long-term viability of the project. The consent-based siting approach emphasises the involvement of local communities in the decision-making process, recognising their rights, concerns, and knowledge. It acknowledges that the selection and establishment of a DGR site require the support and cooperation of the affected communities, who play a crucial role in shaping the project's future. The paper presents a practical framework for implementing the consent-based siting approach, encompassing various stages, from site identification to project approval and implementation. The framework emphasises early engagement and transparent communication as fundamental pillars. It advocates for open dialogues, public consultations, and active participation of stakeholders to ensure their voices are heard and considered. The paper also highlights the importance of providing accurate information about DGR technology, safety measures, and the long-term benefits it offers, thereby addressing concerns and dispelling misconceptions. Furthermore, the paper emphasises the significance of incorporating indigenous knowledge and perspectives in the development process, respecting the cultural, spiritual, and environmental values of indigenous communities. By integrating indigenous knowledge systems and engaging in meaningful consultation, the consent-based siting approach promotes a mutually beneficial partnership with indigenous communities, fostering a sense of ownership and collaboration. The adoption of a consent-based siting approach in Australia's first DGR project offers numerous advantages. It ensures that the project aligns with the values, aspirations, and expectations of the local communities, promoting social acceptance and minimising opposition. By actively involving the affected communities, the approach enables the identification of potential site-related issues and facilitates their integration into decision-making processes and mitigation strategies. Tellus' framework, cantered around community engagement, transparency, and inclusivity, provides a roadmap for building trust, securing community support, and ensuring the long-term success of the project. By embracing this approach, Australia can foster meaningful collaboration, address concerns, and create a shared vision for the safe and sustainable management of radioactive waste, establishing a solid foundation for future radioactive waste initiatives in the country.

IAEA CN-318/212

Global justice as a cornerstone of Agenda 2030 and its importance in the evolution of a safety culture in remediation, decommissioning and waste management

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1 Federal Institute for Geosciences and Natural Resources (BGR)

The 17 SDGs set out in the 2030 Agenda are based on the recognition that the eradication of poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable prerequisite for sustainable development. All countries and all actors will implement this plan in partnership, which is based on the Universal Declaration of Human Rights, the international human rights treaties, the Millennium Declaration, and the 2005 World Summit Outcome" and on "full respect for international law".

Never before in the history of international relations have world leaders committed to joint action and efforts under such a comprehensive and universal political agenda, expressing that international or global justice is becoming more and more relevant given the extent to which global inequality and poverty are undermining the SDGs.

Past United Nations strategies and practice in international relations reflect the priority given to security (and some specific economic issues such as trade) in the architecture of the postwar international legal system. The Millennium Declaration opened a new chapter in the development of the international order and opened the door to new approaches to global justice that focus on economic and social issues that had been left behind in the previous traditional United Nations approach to international relations.

Given the historical evolution of the international safety culture for the back end of the nuclear fuel cycle, the question is whether the change described above is also reflected in the way safety standards are currently developed and applied by the relevant international organizations and the international community that champion this safety culture? And is the current safety culture a rigid, absolute, non-negotiable framework, or given the role of global justice in the 2030 Agenda, is there room for maneuver that can be explored through more participatory mechanisms in the context of its development and application?

There is no universal answer to this question, as even the back-end aspect of the nuclear fuel cycle is still quite diverse: waste management and decommissioning are usually in the hands of commercial operators, while the remediation of orphaned sites is often a responsibility of governments. With regard to the application of Agenda 2030 strategies, the degree of international influence on sustainability aspects in the back end therefore varies.

This paper examines whether there is ample evidence that the development of the international safety culture for the back end of the nuclear fuel cycle has broken away from the traditional UN approach to international relations and the extent to which aspects of global inequality and justice – in line with Agenda 2030 - have taken hold. Based on the experience of the author, special emphasis is placed in this context on the specifics of remediation of existing exposure situations.

IAEA CN-318/353

Engaging for Success: Port Hope Area Initiative Activities

Author: Casey MCLELLAN[1]

1 Canadian Nuclear Laboratories

The Port Hope Area Initiative (PHAI) represents the Canadian government's response to the community-requested solution for the cleanup and local, long-term, safe management of historic low-level radioactive waste, in the municipalities of Port Hope and Clarington, located in Southern Ontario. The waste is the result of the radium production and uranium purification activities of the former Crown Corporation, Eldorado Nuclear Ltd., and its private sector predecessors. With funding of CAD $2.6 billion from Atomic Energy of Canada Limited, Canadian Nuclear Laboratories is implementing the PHAI to remediate and safely store more than 2M cubic metres of waste deposited in various ravines, waste disposal facilities and interim storage locations in both communities, as well as approximately 1,200 private properties in the urban area of Port Hope. Long-term waste management facilities including dedicated wastewater treatment plants and multi-layered aboveground storage mounds have been constructed in both communities to receive the remediated waste. The presentation will highlight project accomplishments including the successful completion of the Port Granby Project in 2022 and ongoing engagement with Indigenous communities and organizations, stakeholders, and the public, as well as the responsive nature of the project to challenges faced.

IAEA CN-318/224

Evolution of radioactive waste management in France

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Co-author: Olivier LAREYNIE[1]

1 French Nuclear Safety Authority

Within the EU, recycling of waste from nuclear facilities is a common practice used by Member States by implementing "clearance levels" under certain conditions for conventional applications, pursuant to the Directive of December 5, 2013. In France, only one facility, operated by Cyclife, allows the recycling of metallic materials by melting of metal scrap, in the nuclear sector only.

Reutilisation conditions are regulated by the French Public Health Code. Until 2022, its Article R. 1333-3 prohibited the use of materials or waste from nuclear activities, potentially contaminated by radionuclides, in the manufacture of consumer goods and building materials.

While decommissioning of nuclear facilities increases in France, a large volume of very low-level waste (VLLW) will be generated in the next few decades, in particular metal waste.

A public debate held in 2019 in preparation for the 5th issue of national radioactive waste management plan (PNGMDR) confirmed the need to develop new VLLW management solutions. In early 2022, as a result of a process involving all stakeholders, new regulations were issued allowing the recycling of VLL metal waste in the conventional sector.

The paper will provide details on stakeholder engagement regarding the management of VLLW in France, focus on the decision to recycle certain type of VLL metal waste, and on provisions developed to address public expectations regarding VVLW management.

SESSION 8.3: REGIONAL AND INTERNATIONAL COOPERATION FOR ENSURING SAFETY AND ENABLING SUSTAINABILITY

IAEA CN-318/211

ASN's experience on regional and international cooperation concerning deep geological repository

Author: Viviane NGUYEN[1]

1 ASN

In accordance with its commitments towards developing the sustainable and responsible use of nuclear energy, France is one of the most advanced programs for deep geological disposal of radioactive wastes. This project, Cigéo, is the outcome of more than 25 years of R&D, 3 laws passed in 1991, 2006 and 2016, and 2 nationwide public debates held in 2005 and 2013.

The French radioactive waste management agency, Andra, submitted Cigéo' s construction permit application in January 2023, thereby achieving a major step in the project development.

Because of their unique nature, DGR is the subject of much international discussion and shared experience around the world. ASN has participated in several discussions including AIEA WGs, WENRA, DGRRF and bilateral exchanges.

In 2016, the ASN requested a review of Cigéo Safety Options Report by the IAEA, with a view to benefiting from the expertise and feedback of international experts with experience on similar programs.

The proposed document includes details of the shared international feedback acquired by ASN and focuses on the implementation of this review, the main conclusions of the expert team and shows how this review will provide additional information for the review of construction permit applications.

IAEA CN-318/317

Supporting safe sustainability, through enabling cross border radioactive waste treatment facilities and services.

Author: David OXBERRY[1]

1 Studsvik Limited

IAEA Safety Standards and Euratom Council Directives provide the basis for the underlying legal and regulatory framework in radioactive waste management and decommissioning. This enables a framework for radioactive waste treatment within countries which are underpinned by local considerations and national policies. To further the safe advancement of waste treatment, we have embarked upon a project to establish and clarify the benefits and added value of a more aligned and harmonised regulations and standards for prioritised topics related to radioactive waste handling, including shared processing facilities. The project name is HARPERS (HARmonised PracticEs, Regulations and Standards in waste management and decommissioning) which is funded under Euratom research and training programme 2021-27 under grant agreement No 101060028.

The HARPERS project has a two-phase approach: the first phase involves engaging with Stakeholders to assess needs and pros/cons for harmonisation and to identify priority areas for deeper analysis. The second phase will pursue deeper engagement with Stakeholders to further assess the highest ranked priority areas in the three technical Work Packages.

Work Package 3 (WP3) of HARPERS project is focused on addressing the most important conditions and opportunities for promoting Cross Border Radioactive Waste treatment facilities and Services.

For the prioritisation of needs and opportunities for Cross Border facilities and service considerations, a detailed list of topics (challenges/needs - related to harmonisation of practices, regulations and standards) has been developed. Topics were clustered into 4 main categories and discussed with interested external stakeholders during dedicated on-line workshops conducted in January and February 2023.

Criteria for the prioritisation of topics, based on drivers relating to societal impacts, actor-specific impacts, scientific impacts, and financial impacts, have been developed and discussed during the workshops too.

The outcome will focus on the development of 3-4 priority topics which will then be further investigated with a view to identifying recommendations, barriers, actions and opportunities to provide improvements in the cross-border services or facilities needed for radioactive waste treatment.

This exciting project brings together learning and experience from all organisational types from European and International countries. A blend of inputs from these differing perspectives provides us with a unique opportunity to bring about safe radioactive treatment. This uplift presentation will strike a chord with IAEA participants by drawing together the needs/challenges identified by the project, and how they are crucial to safe waste treatment demonstrates our commitment to a sustainable nuclear community.

IAEA CN-318/241

Radioactive Waste Management for Small Amounts of Wastes – Results from the EURAD ROUTES Project

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2 SURO

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The ROUTES work package (WP) is one of two strategic studies WPs within the ongoing European Joint Programme on Radioactive Waste Management (EURAD). ROUTES objectives are to provide a framework for Member States to share methodology, experiences, and knowledge in the radioactive waste management (RWM) considering waste from its origin to disposal. Two tasks within the ROUTES WP are specifically dedicated to solutions for small amounts of waste, both focusing on pre-disposal management as well as on disposal options. A target group for these RWM solutions are so-called small inventory member states (SIMS). Due to the small amounts of wastes of multiple physical and chemical forms, large-scale treatment facilities and disposal solutions together with existing infrastructures are not economically feasible. In this paper the results from the work gathered in multiple workshops discussing potential disposal options for SIMS together with the data acquired for predisposal management routes will be presented. It will provide an overview of the methodologies used for the identification of suitable waste management routes and will summarise the main outputs of the tasks achieved to date.

IAEA CN-318/240

Advancing sustainability practices through innovation in LILW pre-disposal radioactive waste management: outcomes from the Euratom PREDIS project

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1 VTT Technical Research Centre of Finland

2 National Nuclear Laboratory

The collaborate Euratom R&D project Pre-disposal of Radioactive Waste Management (PREDIS, 2020-2024, 23.7 M€) has numerous dimensions that are focusing on improving sustainable practices when handling low- and intermediate-level radioactive waste (LILW). This presentation will share how the project's innovations on treatment and condition of metallic, organic, and concrete package waste streams is striving to minimize wastes that require higher classes of geological final disposal, by supporting the waste hierarchy. Technical examples will be given where the end user community of industry has identified areas where improvements could be made in treatment and conditioning also with more sustainable materials, such as geopolymers as replacements of traditional cement-based binders. The presentation will give examples how life cycle assessment approaches have been applied to show the environmental impact of such waste treatment and processing technologies. The impact of the project results to adapting safety and sustainability in Member States' policies and regulations will be covered, with examples of evolution of waste acceptance criteria to account for new materials used in waste conditioning.

The PREDIs project community of 47 expert organisations from 17 European countries is striving to bring innovation and better practices to the community, directly impacting the Member States' practices in holistic waste management practices. This linkage between sustainable practices needs arising from decommissioning as well as final disposal is highlighted via the recently developed Strategic Research Agenda, in collaboration with the European Joint Programme on Radioactive Waste Management, EURAD.

SESSION 10.1: REGIONAL AND INTERNATIONAL COOPERATION FOR ENSURING SAFETY AND ENABLING SUSTAINABILITY

IAEA CN-318/288

Utilizing international cooperation in the development and sustainability of the UAE Nuclear Program

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1 Federal Authority for Nuclear Regulation, United Arab Emirates

As a member state of the IAEA since 1976, and as a nuclear energy producing nation since 2021, the UAE Nuclear Programme has seen remarkable growth in the past years which has owed to the international cooperation especially with the IAEA. The paper will highlight the lessons learned through the IAEA peer review services, advisory missions, and Review Meetings of Contracting Parties to the Joint Convention.

The UAE currently has multiple ongoing projects including the Barakah Nuclear Power Plant, the first to be built and operated in the UAE and in the Arab World, consisting of (4) APR-1400 technology reactor units in Al-Dhafra region of the Abu Dhabi Emirate, as well as promising projects in other elements of the nuclear fuel cycle including radioactive waste management. The UAE heavily invests in the nuclear industry for economic and environmental welfare.

The UAE will be hosting COP28 this year as nations come together to find solutions for climate change. The paper will present the practical solutions provided by the emerging UAE Nuclear Programme that supports the initiative announced by the UAE President to designate the year 2023 as the ‘Year of Sustainability’ to inspire collective action through a nationwide commitment towards sustainable practices and foster international collaboration to address challenges.

IAEA CN-318/135

EURAD: A European collaboration towards safe radioactive waste management and sustainable knowledge

Author: Louise THÉODON

Co-authors: Tara BEATTIE, Paul CARBOL, Bernd GRAMBOW, Elisabeth SALAT, Kurt SMITH, Piet ZUIDEMA

The European Joint Programme on Radioactive Waste Management (EURAD), gathering 115 RWM organisations across 23 countries (including both large and small inventory programmes) was launched in 2019 to help the Members States in developing and implementing their national R&D programmes for the safe long-term management of their full range of radioactive waste. One declared ambition of EURAD is also to ensure the sustainability of the knowledge by both developing the existing knowledge base and enhancing knowledge management transfer between Member States, generations, and organisations.

EURAD updated, early 2023, its Strategic Research Agenda, which identify the activities of joint interest between the Colleges: European Waste Management Organisations, Technical Safety Organisations and Research Entities, where there is added value at the European level, compared with conducting activities at the national level. Relying on the interactions of the Colleges, acknowledging their different function and independence, EURAD develops Knowledge Management for maintaining, sharing and transferring the knowledge and capabilities.

One aspiration is that EURAD could evolve to be the go-to place to structure and organize RWM competence, know-how and capabilities on a European scale, which includes the School for RWM as a platform for training future experts and interconnects them through communities of practices.

IAEA CN-318/311

Role of Regulatory Authorities in Cross Cutting Dialog on Risk Management at Complex Situations

Author: Malgorzata SNEVE[1]

1 Norwegian Radiation Protection Authority

Achieving stakeholder recognition of the role of nuclear technologies in delivering United Nations sustainable development goals is significantly dependent upon building confidence in the safety of radioactive waste management, decommissioning, environmental protection, and remediation.

A major regulatory issue of particular interest is how to achieve a balance between:

• the need for regulatory flexibility that allows adaptation of regulations to a wide variety of prevailing and evolving circumstances, and

• the need to provide precise and detailed requirements and criteria that give clarity to and confidence in the safety standards.

It is also recognised as important not to deal separately with the transition from operational to decommissioning status; dismantling activities; site remediation; waste treatment; waste transport; interim storage, and final disposal. There are very strong strategic, technical and stakeholder linkages. An integrated methodology, supported by an appropriate regulatory framework, is needed to provide clear goals in a step-wise process that may take years to complete. This is especially important at complex sites. By complex, we mean sites that comprise: facilities in development or operation, with others in decommissioning; long-standing contaminated areas; and old disposal areas. Among the complexities is the proportionate management and regulation of other hazards arising alongside the radiological.

This paper will describe recent developments in the area, based on shared national experience from the DSA's bilateral regulatory cooperation programs with Ukraine and other countries, as well as DSA's engagement with the IAEA's EUCAS program, and NEA expert groups. The paper will conclude with recommendations for continuing international cooperation.

IAEA CN-318/191

Multinational disposal solutions require alignment of policies, strategies, and legislation and regulations

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A key challenge that is often ignored in new nuclear planning is ensuring that there are credible safe, secure, and sustainable paths towards implementation of final disposal facilities for the spent fuel and high-level waste produced. Especially for small or new nuclear power programmes, multinational repositories (MNR) can be a way forward. But national policies, strategies, legislation, and regulations must be sufficiently aligned in the partner nations sharing a common disposal facility to allow for successful implementation. Currently, the situation in each of these areas vary significantly between countries. At the uppermost policy and legislation levels, some countries are specifically opposed to MNRs solutions, leading them to have total bans on import or export of radioactive wastes. Several European countries have regulations or legislation banning import of radioactive wastes but are silent on the issue of export. However, many countries are on record as being interested in pursuing a "dual track" approach which keeps open the options of a national disposal facility or participation in an MNR. Clearly, all such countries should ensure that their national policies and regulations would allow the latter.

But progress towards implementation of an MNR requires more than only declaration of policies. A national strategy and programme including specific activities devoted to furthering MNR initiatives is also required. Moreover, with the emergence of implementable MNR projects, alignments of national legislation and regulation will increase in importance. An MNR used by several countries should obviously have to satisfy the safety goals and regulations of the individual countries and these are currently not totally aligned. National nuclear regulatory bodies must clearly demonstrate their independence and hence are often resistant to acknowledging any overarching authority so that the harmonisation of regulations and legislation can prove challenging. Encouragingly, the increasing support of nuclear power, which could lead to many SMRs being deployed worldwide, has recently led to increased cooperation between national regulators harmonising reactor licensing. At the back end, however, the harmonisation of radioactive waste management regulations and legislation has been less emphasised.

For a multinational repository to function safely and securely, the user nations will ultimately also have to align numerous operational processes and engineering issues e.g., agreeing site selection criteria, unifying waste acceptance criteria, coordinating logistics and timing of transports, finding consensus on facility inspection, agreeing arrangements for transfer, or sharing of future liabilities. To pursue the goal of high-level alignment of policies and strategies,

ERDO aims to facilitate multinational discussions between government officials responsible for back-end policy and regulations in their home nations.

IAEA CN-318/192

ERDO Programme for enhancing international cooperation the back-end of the fuel cycle

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1 COVRA and ERDO Association

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For nuclear power to be accepted as a sustainable technology, some key requirements must be fulfilled. These include developing waste disposal solutions that are technically and societally accepted. A safe and responsible solution for radioactive waste is also a requirement for other nuclear applications. The ERDO Association is the only entity devoted entirely to enhancing international and regional cooperation aimed satisfying these requirements. ERDO and its predecessor organisations, Arius and the ERDO Working Group, have focused for the last two decades on organising constructive initiatives to encourage multinational efforts to ensure that all countries that generate radioactive wastes that need to be disposed of in a deep geological repository will have access to such a facility. The ultimate objective of ERDO is to establish one or more concrete projects for the implementation of the multinational repository (MNR), but, as this paper will illustrate, ERDO has expanded its activities to include also projects aimed at enhancing cooperation in pre-disposal treatments of radioactive wastes. In its overarching roadmap leading to eventual establishment of an MNR, ERDO follows two paths: a top-down approach encouraging countries to cooperate at the policy level and a bottom-up approach involving technical R&D projects. The present paper will summarise the technical cooperation between member countries in ERDO, and also between ERDO and other international organisations such as the IAEA, the NEA, the EC and IFNEC.

Currently, around half of the 27 Member States of the EU have expressed interest in the potential option of a shared MNR. Given the growing interest in expanding or introducing nuclear power globally, emergence of a credible MNR project might significantly counter potential public or political opposition based on assertions that “the waste disposal problem” remains unsolved.

IAEA CN-318/321

The Euratom project MICADO with its innovative procedure for the characterization of Nuclear Waste Packages

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All over the world the nuclear waste management is always part of the public debate. Independently from the origin of the waste, the main concern is the radiological emission and the impact on human health and the environment. The inexistence of a standardized characterized procedure of nuclear waste types and packages, a country dependent legislation with own definition of waste categories and activities do not help to have a comprehensive and homogeneous overview of the situation and an efficient management and treatment. Moreover, there is often the necessity to perform the characterization of large amount of legacy waste because of lost or not complete information, or required analysis of a large amount data that are not always promptly accessible.

The MICADO project started under the H2020 Euratom call aiming to demonstrate the feasibility to improve the characterization of nuclear waste packages. This is done with a toolbox of up-to-date and novel gamma and neutron detection technologies, working as modular elements, and a digital software platform used as a base for the digitalization of detector information and the off-line analysis for the uncertainty assessment. The procedure was defined to reduce the measurement time in each step and being able to select the required detection technology avoiding multiple unnecessary measurements of the same waste package. The combined data analysis fuses different measurement results to extract information not available by the individual systems and reduces the individual uncertainties. This aspect is extremely important as a possible solution to the problem of having a satisfying and reliable categorization of the waste package activity of complex cases as high density waste drums or the request for the free release. The software platform also aims to reduce operator costs and improve the ALARA principle, decreasing the time spent on field by the operators and promise a simple and easy data control on historical basis of all the already characterized waste packages. This work summarizes the final results obtained by the project that was concluded last February. It will be presented the final status of the project, tests performed in real life and almost real-life configurations and the future plans for the industrialization of the systems.

SESSION 10.2: INTEGRATING THE VIEWS OF SOCIETY INTO DECISION-MAKING CONSIDERING TECHNICAL, ENVIRONMENTAL, SOCIAL, AND ECONOMIC FACTORS

IAEA CN-318/350

U. S. Nuclear Regulatory Commission Stakeholder Engagement in The Radioactive Waste and Decommissioning Programs: Ensuring Safety and Enabling the Sustainability

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The United States Nuclear Regulatory Commission (NRC) Low Level Radioactive Waste Management (LLRWM) and Decommissioning Programs continue to make progress to decommission and remediate the commercial complex nuclear facilities and legacy sites and fulfil the "Sustainability Promise" to make as many former nuclear sites as possible available for unrestricted reuse. NRC follows procedures for rulemaking that require engaging the public as part of revising current or developing new regulations. NRC regulations require the NRC to hold public meetings to obtain comments from the public, stakeholders and interested parties. At decommissioning sites, especially commercial nuclear power reactors, the NRC encourages the site owner to sponsor or support local or state organized decommissioning Community Advisory Boards (CAB). As an independent regulator, NRC cannot be a member of the CAB but is frequently invited to provide information on the regulatory process, technical issues, and inspection findings. As required by the 2019 Nuclear Energy Innovation and Management Act by the U.S. Congress, in July 2020, the NRC provided a Report to the Congress on the Best Practices for Community Advisory Boards at Nuclear Power Plants. In order to complete the report, NRC held 11 public meetings to gain insight into CABs. Along with the conclusions in the best practices report, this presentation will provide NRC perspectives and experience for engaging with interested stakeholders regarding safety in low level waste regulations and decommissioning programs.

IAEA CN-318/209

Factors Influencing Generation Z and Millennials on the Acceptance of Nuclear Power Plant in a developing country: An Extended Theory of Planned Behavior

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The Nuclear Power Plant (NPP) is recognized as an efficient and clean energy source, offering great potential for achieving carbon peaking, carbon neutrality, and affordable electricity in developing countries such as the Philippines. However, public acceptance remains the major obstacle hindering the sustainable development of NPP in these nations. Understanding the perceptions of different generations is crucial, especially as Generation Z and Millennials are considered the future of the 21st century. This study investigates the acceptance of NPP among these specific generations and extends the Theory of Planned Behavior by integrating perceived risks, safety, and benefits. Utilizing Structural Equation Modeling, a theoretical model is established to examine the impact of perceived benefits, perceived risks, subjective norms, attitudes, perceived behavioral control, and intention towards NPP acceptance. The research findings revealed that perceived behavioral control, subjective norms, risk, safety, and benefits significantly influence the acceptance of nuclear energy, while attitude has a notable negative impact. Notably, Millennials and Generation Z exhibit a higher perception of benefits over risks associated with NPPs. This study pioneers the investigation of NPP acceptance among Generation Z and Millennials, providing valuable insights for formulating acceptance strategies, particularly in developing countries where NPPs are being considered.

IAEA CN-318/232

Feedback from technical dialogue set up with civil society on HLW & IL-LL waste management in France

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1 Anccli

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In France, deep geological disposal has been chosen as the reference solution for the management of high-level waste and intermediate level long-lived waste (HLW&LLW). With this in mind, the National Agency for Radioactive Waste Management (Andra) is developing a project for an industrial geological disposal center (Cigéo).

Taking into account the high technical and societal challenges of this project, the National Association of Local Information Committees (Anccli), the Local Information and Oversight Committee (Clis) of the Bure research laboratory, and the Institute for Radiation protection and Nuclear Safety (IRSN) have set up a technical dialogue since 2012. This dialogue allows:

i) civil society to increase its technical skills in the objective to participate in public decision-making

ii) and IRSN to make its expertise more robust by integrating the concerns and questions of civil society.

The paper will present the objectives, the actions implemented, the lessons learned and the main results of this technical dialogue.

IAEA CN-318/227

PREDIS: Example of how stakeholders can impact an R&D project and maximize their benefits – leading to increased safety and improved sustainability in radioactive waste management

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The PREDIS project targets the development and implementation of activities for pre-disposal treatment of radioactive waste streams other than nuclear fuel and high-level radioactive waste.

In order to focus on the needs of stakeholders and end users, interaction with them is foreseen at different levels, on different topics and at different moments in time. One example of the impact of stakeholder engagement is the interactive process of writing the strategic research agenda (SRA). The baseline SRA focused on the consolidation of the existing published SRAs, while the revised 2nd edition SRA document has been developed based on the needs of PREDIS and the End User Group (EUG). The SRA will guide R&D in the coming years, to ensure maximal benefit for the end uses.

PREDIS has now reached 119 registered stakeholders from 29 countries, covering 4 continents. Stakeholders and end users have been invited for more than 20 public events such as webinars and the projects annual meetings, where they could interact directly within the technical WP's. This interaction, which is still on-going, directs the project to ensure maximum impact and utilization of the results, which will improve safety of radioactive waste management and enables sustainability.

IAEA CN-318/10

Attaining Sustainable Development through the Application of Radioactive Sources and Safe Management of the Waste Therefrom

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Health, industry, and agriculture are three key areas of the Ghanaian economy where applications of nuclear/radiation technology have the potential to turn around the fortunes of the country. Effective applications reduce reliance on carbon-emitted technologies and thereby establish trajectory for sustainable development and greener environment. Attainment of the IAEA's Milestone-1 of the nuclear power installation framework demonstrates Ghana's commitment to the programme which promises to yield sustainable power generation, enhanced radioactive waste management facility, a robust gamma irradiation facility etc. In spite of these potential benefits, significant public acceptability of the programme is key to its success. As a result, the Ghana Nuclear Power Programme Organisation (GNPPO) is charged with the responsibility of engaging and taking the views and insights of the stakeholders of which, the public is an integral part for decision-making. Prevailing views and concerns of the Ghanaian society borders on waste management, safety, and sustainable environment which are being addressed and released to the public through the GNPPO's Quarterly Newsletter. In this regard, the Radioactive Waste Management Centre is strategically enhancing its logistical and human resources to ensure the safe and secure management of radioactive waste generated in Ghana from all sources of radioactive/ nuclear applications.

SESSION 11: APPLICATION OF THE CONCEPT OF CLEARANCE: PRACTICAL EXPERIENCES

IAEA CN-318/308

EURATOM HARPERS Project Phase 1 Overview

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IAEA Safety Standards and Euratom Council Directives provide the basis for the underlying legal and regulatory framework in radioactive waste management and decommissioning. However, their implementation can vary from country to country as they are adapted to local considerations and national policies.

The HARPERS project aims to establish and clarify the benefits and added value or possible disadvantages of more aligned and harmonised regulations, practices and standards in decommissioning and radioactive waste management. The project will support the activities of the European Joint Programme on Radioactive Waste Management (EURAD), Pre-disposal Treatment of European Radioactive Waste Streams (PREDIS) and Stakeholder-based Analysis of Research for Decommissioning (SHARE) projects. HARPERS connects with the wider European Community through, e.g., SNETP, IAEA, NEA, DigiDECOM, IGDTP, ENSREG and encourages interaction between different national programmes.

Identifying relevant regulatory differences and assessing the rationale for these differences and establishing the potential for their harmonisation relative to cross border services/facilities, moving to a circular economy and implementation of advanced technologies are the primary focuses of the HARPERS. The high-level benefits of more aligned and harmonised regulations are related to 1) greater business opportunities, 2) better understanding between diverse groups serving wider markets, 3) improved cost efficiency, 4) waste minimisation, 5) improved final disposability of waste. Realisation of these high-level benefits would contribute to enhancing the overall safety and economics of the nuclear sector.

IAEA CN-318/341

Safe Handling, Treatment, Clearance, And Recycling of Contaminated Metals from Nuclear Installations

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Treatment of contaminated metals by melting in Sweden started 1987 as a joint initiative by the licensee at that time (Studsvik) and the regulators in Sweden. One year later, the first treatment campaign for international licensees took place. Since 2016, the metal treatment facility in Sweden is owned and operated by Cyclife Sweden AB, a company within the EDF Group.

Already from the first day, safety has been the priority within the facility as well as for the associated services. Over the years the facility and the operations have expanded, and the capabilities developed. Even though the main objective with the facility is to treat metals aiming for clearance, there could be some radiological risks that needs consideration. However, the main safety risks are associated with the transport of large and heavy components, working at height when doing disassembly as part of the treatment process and not at least the risks related to metal melting and the handling of residues to which most of the radioactivity are concentrated.

Another safety aspect relates to the clearance and safe recycling back to the conventional industry of the metals treated regarding the process of release from regulatory control. A robust process with integrated physical and administrative barriers is fundamental to secure safety and stakeholder confidence.

The paper will present a typical process from the disassembly of a large and contaminated component until the metals have been recycled into new products, to the benefit of the society. It will also provide a comparison with other approaches for the management of contaminated metals from a safety perspective. The paper will also provide an overview of the mitigation process for the major safety risks related to handling and processing of large, contaminated components. The gained experience will be shared in a few case studies.

The applied processes contribute to sustainability and a circular approach by promoting safe management solutions aiming for reuse and recycling of valuable metals along with waste minimisation.

IAEA CN-318/115

Clearance Benefits and Inputs for Safety and Sustainability

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One of the main safety principles for radwaste management is minimization of radwaste. This goal except of minimization of radwaste on the stage of their generation could also be benefited by effective implementation of methodologies and procedures of release of waste and materials from regulatory control. This approach will allow to minimize the volume of radioactive waste which require further conditioning, storage and/or disposal and thus will optimize the whole radwaste management system for ensuring safety. From the other hand this also is beneficial because the valuable materials are returning back to economically reasonable use which lead to resources save. All these achievements are the positive factors for enabling sustainability of nuclear safety use activity and for overall sustainable development.

IAEA CN-318/137

14 years Implementing Clearance in Argentina

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In Argentina, on the year 2009, Generic Clearance Levels based on the IAEA Safety Standards Series RS-G-1.7 (2004), and the Document Safety Series N°44 (2005) of the IAEA, were adopted by resolution of the Directors Board. On the year 2011, the first regulatory guide (AR 08 rev 0) addressing the main concept of clearance and the necessary recommendations for its implementation was published. Since then, the Nuclear Regulatory Body provided many workshops and training courses to users of radioactive materials of different facilities, such as Category I and II facilities, as well as operators of NPP´s. The main objective of these workshops was to train the facilities´ personnel on the importance of implementing clearance, as part of the radioactive waste management system, emphasizing on the minimization of waste allowing sustainability and adequate management of resources. As it was a new concept, it had to be explained and accepted by users and operators.

During the 14 years since the concept of clearance was first incorporated into the regulatory standards, much has happened and evolve. In this sense, it is worth mentioning that the Regulatory Guide has been updated several times, based on the new GSR part 3 (2016), in order to include the concept of conditional clearance and incorporate surface generic clearance levels. In addition, many clearance authorization requests were received from different radioactive facilities, including facilities form the nuclear fuel cycle.

This paper summarizes the history of the implementation of the clearance concept throughout the years in the country, focusing on some examples of clearance requests received and how they were addressed, fostering sustainability.

Key words: Clearance; minimization of waste, sustainability, management of resources.

IAEA CN-318/91

Derivation of conditional clearance limits for the disposal of NORM waste from O&G industries in hazardous waste landfills.

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The waste streams generated by O&G industries contain activity concentrations of naturally occurring radionuclides above the generic level for clearance of material. Availability of disposal solutions for the waste generated by the E&P operations and from the decommissioning activities would allow for the safe and eventually cost-effective management of such materials. The use of safe and cost-effective solutions for NORM disposal meets various UN Sustainable Development Goals such as water and land use and sustainable cities. The ongoing development of an action plan for NORM streams in accordance with updated regulations in Brazil has provided a step forward towards the sustainable management of NORM waste, as it establishes a more appropriate dose criterion to be met for the clearance of such residues in specific cases without incurring any undue risk of exposure to the public and the environment. A potential solution for the NORM O&G waste is its disposal in industrial landfills, which have requirements already applied to many types of non-radioactive hazardous waste. The aim of this paper is to present a derived activity concentration range for such waste to allow for its safe disposal at an industrial landfill, considering a post-closure safety assessment using RESRAD software.

SESSION 12: INTEGRATION OF SAFETY AND SUSTAINABILITY IN MANAGEMENT OF RADIOACTIVE SOURCES

IAEA CN-318/221

Sustainable management of disused sealed radioactive sources (DSRSs) in Malaysia: Borehole disposal

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Effective and safe management of disused sealed radioactive sources (DSRSs) is essential in ensuring sustainability in radioactive waste management particularly in countries without extensive nuclear power program like Malaysia. Malaysia is adopting borehole disposal as an approach to manage its Category 3-5 DSRSs wisely and safely and at the same time promoting sustainability of the environment and economy. The final disposal of the DSRSs managed to remarkably resolve most of the issues associated with the accumulation and storage of DSRSs that the country had been facing for the past 40 years. Longer-lived and higher radioactivity sources such as Am-241, Cs-137, Sr-90, Kr-85 and Co-60 were the main inventories disposed into the borehole. Post-closure safety assessment indicated that the borehole disposal facility is effective in providing safe solution for the disposal of the DSRSs, with a maximum dose rate of 10 magnitudes lower than public dose limit of 1 mSv/y received by human 450,000 years after the disposal. With its small footprint of approximately 300 mm, the borehole disposal resulted in low land usage and impact. During its construction, very minimal environmental intrusion and damage were involved. The borehole disposal system implemented contributes to circular economy not only in terms of reducing radioactive waste and its associated risks to human and the environment but also promoting other economic activities for example recycling of uncontaminated shielding parts for other applications. Additionally, the implementation of borehole disposal is more cost-effective than other disposal options for Malaysia that has limited amount of radioactive waste. Expertise and experience as well as resources such as the mobile tool kit facility (MTKF) acquired serve as invaluable long-term sustainable assets to be shared with other countries interested in the same purpose.

IAEA CN-318/210

Radioactive Waste Management in Nepal

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In Nepal, radioactive sources are primarily used in the medical field. The Radioactive Substances (Utilization and Regulation) Act of 2020 became effective in July 2020, and the Radioactive Substances (Utilization and Regulation) Rules of 2022 were approved in August 2022. These developments have paved the way for the establishment of a regulatory body responsible for managing radioactive waste. They also include provisions for requirements and standards for radioactive waste management based on the International Atomic Energy Agency's (IAEA) Safety Standard.

Chapter 9 of the Radioactive Substances (Utilization and Regulation) Act of 2020 deals with provisions related to radioactive waste management. Article 36 prohibits the importation of radioactive waste into Nepal. Article 37 outlines the licensee's responsibility for the safety and security of radioactive waste, including its disposal in an approved location or mechanism as specified by the regulatory body. Article 38 addresses the export of radioactive waste with the permission of the regulatory body, in accordance with relevant international obligations along the export route. Article 39 contains provisions for safety and security, including the formulation and implementation of necessary standards to protect human health, animals, and the environment from the adverse effects of radioactive waste.

Chapter 7 of the Radioactive Substances (Utilization and Regulation) Rules of 2022 pertains to provisions regarding radioactive waste management or disposal. Article 37 classifies radioactive waste, while Article 38 explains the provisions for the disposal of radioactive waste. Article 39 outlines the duties and responsibilities of license holders with respect to the management of radioactive waste.

The establishment of a radiation regulatory body in Nepal has been long overdue, but there are positive signs that its work is in progress for managing radioactive waste through the Nuclear Materials Management Division of the Ministry of Education, Science & Technology of Nepal. Despite the challenges of establishing a regulatory body and ensuring the availability of competent experts, Nepal is making progress in the management of radioactive waste, including high-activity radioisotopes. Various IAEA Technical Projects are currently underway, focusing on strengthening regulatory efforts through training, expert missions, equipment donations, and support in the development of rules, regulations, and standards. Additionally, the United States Department of Energy's Office of Radiological Security (ORS) has expressed its interest in assisting Nepal with the management of disused radioactive sources.

IAEA CN-318/257

Approaches in the Sustainable Management of Radioactive Waste and Disused Sealed Radioactive Sources in Zimbabwe

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Sealed radioactive sources have been used in medical, research and industrial applications in Zimbabwe for socioeconomic development as is the case globally. Low level and intermediate waste and disused sources are generated from these practices every year albeit limited capacity to manage waste. Radioactive waste remains a topic of real concern with stakeholders and the public and the country set out measures to implement effective and safe solutions for the sustainable management of radioactive waste. The country has a return to supplier policy as a requirement for all import of sources. When they become disused, sources are stored at respective facilities pending return to manufacturer. To date the country has over 300 disused sources stored within the licensed holders with the facilities failing to return them to suppliers, these are still under regulatory control. They could not be returned to supplier because they are either legacy sources that were imported before existence of the regulatory body, damaged sources, failure to identify documentation and the supplier or because of the high cost of sending them back. Further, medical waste and other low-level waste from research and industry have been managed by individual waste generators. Noting the vulnerability of such arrangements and the challenges of the return to supplier policy Zimbabwe set out to create a lasting solution to the management of disused sealed radioactive sources and radioactive waste. This include the setting up of a centralized radioactive waste management facility with the assistance of the International Atomic Energy Agency, the facility shall be operationalised in the fourth quarter of 2023. An interim facility that resembles the centralized facility was established to ensure safe management during the phase of establishment of the centralized facility. To ensure sustainability government has proposed through review of the Act establishment of a waste management fund as levied in the licensing fees of the sources to ensure adequate funding of waste management operations and also for remediation measures.

IAEA CN-318/323

Demonstration of the Stability of the Engineered Barrier System of the Borehole Disposal System for the Disposal of Disused Sources in Ghana

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Borehole disposal system (BDS) is the first of its kind in the world and currently, Ghana and Malaysia are the two countries that are exploiting the implementation of this disposal system. The safety of this disposal system over long time relies mainly on the engineered and natural barrier systems. Therefore, confidence in the ability of the BDS to provide containment of the radionuclides for the requisite timescale rests on an adequate understanding of the behaviour of the engineered barrier system on the host environmental conditions. It is for these reasons that, in this study, the stability of the engineered barriers was demonstrated to assess their impact on the long-term safety of the BDS.

IAEA CN-318/12

Safe Management of Radioactive Waste in Syria

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1 Atomic Energy Commission of Syria

The study spotlights radioactive wastes management in Syria based on the National legislation Decree No. 64 and the Prime Minister Decree No. 134. Historical and new wastes at the user premises were collected and temporary stored at the central radioactive waste management facility, where they were processed to meet the International Safety Standards.

Scales originated from decontamination of equipment used in production of oil & gas contain mainly 226Ra and 210Pb with activity concentrations up to 3000 and 1800 Bq g-1, respectively, in addition to chemical impurities. A treatment strategy was consolidated to safely isolate and contain scales based on incineration, compacting with 25 tonnes and cementation. Processing gave weight loss ca. 30% preserved confinement of radionuclides content and chemical hazards and ensured stabilization. The final packages comply with the safety requirements of radioactive waste for transportation and long-term storage. Historical wastes were segregated, characterised, and safely treated case-by-case basis. Aqueous and organic effluents contained 137Cs and 90Sr were processed using selective ion exchangers, such as KU 2×8 & KB-4P2, according to the safety case and radiation protection programme. The effluents were then discharged into the environment when radiological impact and chemical hazard of the released materials are acceptable.

The work enables to draw a sustainable strategy for safe and secure management of radioactive waste, which implies protecting people, society and the environment against ionizing radiation and avoid imposing undue obligations and burdens on future generations.

SESSION 13.1: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN REMEDIATION OF SITES AND MANAGEMENT OF NORM

U.S. DOE Office of Legacy Management - Beneficial Reuse of Environmentally Impacted Sites

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1 U.S. Department of Energy Office of Legacy Management

The US Department of Energy (DOE) Office of Legacy Management's (LM's) mission is to fulfil DOE's post closure responsibilities and ensure the future protection of human health and the environment. LM incorporates safety and sustainability into the planning process early and continually throughout project life cycle, which results in resilient sites that support the communities affected by DOE's historic activities. This paper will present case studies dealing with two specific sites, the Fernald Preserve, Ohio, Site and Las Colonias Park in Grand Junction, Colorado, that showcase LM's holistic approach and how LM's projects and programs support sustainability and resilience, while at the same time ensuring the safety of the public, employees, and stakeholders. Each case study will detail how LM implements unique solutions, including site-specific institutional controls, to ensure the long-term safety resilience and sustainability of its sites.

IAEA CN-318/249

Why should NORM be regulated under the existing exposure situations concepts to enable sustainability?

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Sustainable development involves environmental, social, and economic dimensions. Radiological Protection System recommended by ICRP includes the optimization principle that considers economic, social, and environmental factors. Therefore, if safety regulation uses this principle as a driving force a perfect relationship between safety and sustainability would be reached, improving resource use and environmental protection. Exposure due to NORM is considered by ICRP as an existing exposure situation (EES), but not adopted as such by IAEA, therefore certain regulators control such exposures as planned exposure situation (PES). Although optimization should be applied to all types of exposures situations, in EES it is the driving force within a range of reference levels corresponding to acceptable values of risk; in the case of PES, the optimization has a secondary role below a value of risk too low to permit the acceptability of nuclear facilities. This conservative approach can impact the industrial sector, resulting in unjustifiable control. Brazil has many NORM-related industries, and the revision of the Brazilian Basic Safety Standard is proposing a graded, pragmatic, and flexible approach, considering ethical values. This allows safety to be related to sustainability without neglecting radiation safety. This paper will discuss all these issues using Brazilian BSS as a study-case.

IAEA CN-318/46

Radiological characterization, risk assessment and selection of preferred remedial option for the Veselivske legacy trench site in Ukraine

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The trench-type Veselivske radioactive material burial site in the Kirovograd Region of Ukraine near Kropyvnytskyy city was created in 1988 in a former clay quarry to store the waste materials originating from the clean-up of an accident involving two disused industrial 137Cs sources. The institutional control over the site has weakened over decades, and as a consequence the burial site suffered from unauthorized intrusion in 2017, which resulted in dispersal of radioactive materials from the trenches. Results are presented from remedial assessments aimed at bringing the Veselivske site into a radiologically safe condition, which were accomplished in 2021-2023 with the support from the Norwegian Regulatory Authority (DSA). The project included historic data collection, radiological characterization, risk assessment and selection of the preferred remedial option using a multicriteria decision analysis framework, including consideration of socio-economic and sustainability factors. The selection of remedial options was carried out in consultation and information exchange with Kropyvnytskyy city authorities and national regulatory bodies. Weighting of radiological risks to public and workers, remedial costs, waste management aspects and other relevant criteria suggests that the preferred remedial option consists in establishing an engineered soil cover above the disturbed trench area with elevated radiation levels. This remedial option allows for certain types of use of the remediated site but with restrictions on soil works (for example, as a solar farm, a storage area for goods, etc.) and ensures safe long-term (estimated time frame of 100 years) in situ storage of radioactive materials in trenches, assuming that the site operator will supervise the site and maintain the integrity of the soil cover.

IAEA CN-318/340

Effort on Recycling of Removed Soil Arising from Off-site Decontamination Activities in Japan

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Since shortly after the accident of the Fukushima Daiichi NPS in 2011, Japanese Government (mainly the Ministry of the Environment, Japan (MOEJ)) has made continuous effort on off-site remediation projects.

The whole-scale decontamination activities and the large-scale transportation activities to the Interim Storage Facility (ISF) have been completed by March 2022, except for the Restricted Areas.

As a result of the activities, a large volume of removed soil and waste have been generated, and more than 13 million m3 of removed soil and waste (the most part is removed soil) have been transported into the ISF.

The stored soil and waste are supposed to be transported from the ISF for final disposal outside Fukushima Prefecture by March 2045.

It is, however, regarded as unrealistic to find out the place for final disposal of all the stored soil, therefore the MOEJ has promoted recycling of removed soil to reduce the volume of the soil for final disposal in the future.

The MOEJ has implemented a couple of demonstration projects using removed soil to ensure its safety from technological point of view, and also has implemented policies to earn trust and build public understanding.

In this presentation, progress made and issues to be addressed will be presented, including the new framework between the IAEA and the MOEJ.

IAEA CN-318/354

CGULS Activities in Central Asia and expansion to Africa

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1 IAEA - Division of Radiation, Transport and Waste Safety

Since the mid-1940s, uranium mining and processing activities have been conducted in Central Asia, primarily in the regions intersecting the Kyrgyz Republic, the Republic of Kazakhstan, the Republic of Tajikistan, and the Republic of Uzbekistan. After the cessation of these activities in the 1990s, numerous uranium legacy sites emerged, comprising abandoned mining and milling facilities, waste rock and ore dumps, tailings piles and ponds. These sites present significant environmental and public health risks due to physical, radiological, and toxicological hazards associated with the remaining contaminated materials. The lack of means and safety requirements for sustainable remediation poses a challenge for Kyrgyzstan, Tajikistan, and Uzbekistan, leading to a call for international support from the International Atomic Energy Agency (IAEA). To address this challenge, the IAEA established the Coordination Group for Uranium Legacy Sites (CGULS) in 2012, aiming to facilitate cooperation among the affected Member States and organizations involved in regulatory control, managing and remediating these areas contaminated by past practices and activities.

Building upon the collaborative efforts, the remediation of uranium legacy sites has made significant progress in Central Asia. With joint efforts of CGULS, the European Bank for Reconstruction and Development (EBRD), the European Commission, and other donors, successful remediation has been completed in certain sites in Kyrgyzstan and Tajikistan. The work and targets are described in Strategic Master Plan, which is updated every 5 years.

Building on its existing infrastructure and Central Asian experience, CGULS plans to launch CGULS Africa, expanding its support to other countries in need of safety infrastructure for successful implementation of remediation efforts. This expansion aims to transfer expertise, foster cooperation and promote safe management of uranium legacy sites in several African countries.

The presentation will include examples of activities completed and planned within the CGULS aiming at ensuring safety of remediation projects, protection of the public and the environment, knowledge and capacity building in Central Asia. Synergies with other international initiatives will be provided. The authors will also present the plans and current activities for expanding the gained experiences to selected African Member States ensuring safety and sustainability of remediation activities.

IAEA CN-318/184

The management of the legacy of radium-production in Belgium: a roadmap to long-term management solutions

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Belgium was from 1922 till 1977 a major radium-producer by extraction from natural ores. This production was situated on the site of the former Union Minière, now UMICORE, in Olen.

Since 1977, decommissioning of production facilities and remediation activities were conducted: radium-contaminated materials and soils were brought on landfills and in storage facilities, but these are only temporary solutions. The challenge remains to come to final disposal solutions for all radioactive and non-radioactive wastes.

The last years the tools have been developed and put in place to meet the challenge:

- A methodology to define long-term management solutions for the various categories of radium-contaminated waste on the basis of contamination levels;
- A roadmap to develop and decide on all remediation and disposal projects; focus in the first phase (2021 – 2024) is on the completion of the legal and regulatory framework for the remediation and disposal projects, including a national policy for a dedicated shallow-depth disposal facility for radium-contaminated radioactive waste;
- A structure of collaboration and communication with the main actors involved and with the federal and regional governments and local stakeholders.

With this roadmap we are at the beginning of a long path to final disposal solutions (decades), but by focusing now on the legal and regulatory elements and collaboration structures we establish solid foundations.

SESSION 13.2: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN DECOMMISSIONING

IAEA CN-318/349

An Overview of The U. S. Nuclear Regulatory Commission Decommissioning Program: Progress Towards Fulfilling the Sustainability Promise

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1 Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards

The United States Nuclear Regulatory Commission Decommissioning Program continues to make progress to decommission and remediate the commercial complex nuclear facilities and legacy sites and fulfilling the "Sustainability Promise" to decommission and make the former nuclear sites available for unrestricted reuse. Since promulgating the 1997 License Termination Rules to regulate the decommissioning of nation's commercial nuclear facilities, nearly 80 complex sites, including 12 power reactors have completed decommissioning and licenses terminated for unrestricted use. Substantial progress is also being accomplished to complete the remediation of legacy sites. Since 2013, eleven (11) power reactors have permanently ceased operations and entered decommissioning status. Most of the newly shutdown plants were expected to enter a significant dormancy period or safe storage, however, many of the utility operators have chosen to move directly to active decommissioning. As of October 2022, the power reactor decommissioning program has increased significantly to 26 units with 18 being in various stages of active decommissioning. The current trends are to contract the decommissioning work to a decommissioning company or transfer the licenses to decommissioning companies willing to assume financial risks and technical responsibilities to decommission the sites. This presentation will provide an overview of the U.S. decommissioning program, the status of the reactor decommissioning program, legacy site remediation and improvements to the regulatory framework, and the reuse of formerly licensed sites that demonstrate the US commitment to the nuclear sustainability promise.

IAEA CN-318/111

Good Practices and Future Development Prospects of Nuclear Decommissioning in China

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1 Profile of CNNC Environmental Protection Co., Ltd.

Nuclear decommissioning is an important component of advanced nuclear technology systems. Since the 1990s, China has made positive progress in reducing risks of old nuclear facilities and supporting sustainable development of nuclear energy through decommissioning, accumulating a wealth of good practice experience. This report focuses on the top-level capability industrial layout of China's decommissioning work over the past 30 years, key project construction and operation, and radiation environment restoration. It highlights the integrated decommissioning capability layout of China National Nuclear Corporation's environmental protection subsidiary and the good practices of projects such as the solidification of radioactive liquid waste and the remediation of naturally occurring radioactive waste in fairy cave (Shenxiandong). The report also proposes future prospects and initiatives for global decommissioning technology research and development, international cooperation, and promoting the development of the nuclear decommissioning industry.

IAEA CN-318/75

Embedding sustainability into nuclear site decommissioning strategy and site restoration delivery – An example from the Winfrith Site in the UK

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1 Magnox Ltd

The Magnox Winfrith site, located in Dorset UK, is a former nuclear research facility that hosted 9 experimental research reactors, including the Steam Generating Heavy Water Reactor, and numerous laboratories supporting nuclear research.

The current decommissioning plan is to remove the two remaining reactor cores and deliver the optimised approach to decommissioning and waste management to a next land use suitable for public access.

Magnox has incorporated UN Sustainable Development Goals into strategic decision making on waste management and decommissioning. The optimisation process seeks to balance the benefits and detriments of short-term impacts against long term risks to define the preferred approach to decommissioning and includes input from the local community.

Optimisation assessments have identified examples that support on-site disposal of low-level radioactive waste (concrete structures) and removal (discharge pipeline) as preferred strategies.

The impacts and risks from the proposed on-site disposals are assessed in accordance with the UK Regulatory framework, including the Environment Agencies guidance on radioactive substances disposal.

The on-site disposals sit in wider context of restoration of the Winfrith site which will support biodiversity net gain and local water quality improvement.

Key lessons learnt in the process include involving stakeholders in decision making on technical issues and engineering justification of legacy structures.

IAEA CN-318/87

Sustainable Decommissioning of The Iraq Destroyed Irt-5000 Research Reactor

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1 Ministry of Environment

The IRAQ IRT-5000 Soviet designed research reactor was seriously destroyed during the Gulf war 1991 the records and operation documents, candidates for decommissioning, were lost. It has been identified as the largest, most complex facility with the highest radiological significance, which has lost its containment of radioactive materials and has an increased potential for large scale contamination of the environment. Accordingly, the work was developed for the risk management methodology associated with the decommissioning strategy options for the destroyed IRT-5000 research reactor. The work plan was linked with three phases. Phase one considers the radiological survey and investigation of the destroyed IRT-5000 based on the Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM). Phase two focuses on the Probabilistic Risk Assessment, in order to identify, analyse and evaluate the risk associated with the Iraqi decommissioning project. The last phase considers the assessment of the radiological impact of the IRT-5000 radionuclide inventory on humans and environment. In conclusion, this paper suggests that the state of the destroyed reactor is not safe to keep untreated. The treatment, however, must consider straight scenario considerations criteria to the public and environment in compliance with safety and land uses criteria.

IAEA CN-318/180

Lessons learned from the design and implementation of nuclear liquid waste treatment installations – perspectives from a license holder and a service provider

Authors: Martin LERCHE[1], Wenzhong ZHANG[1], Antti KETOLAINEN[1]

1 Fortum Power and Heat Oy

Liquid waste is generated throughout the lifetime of any nuclear installations. To ensure minimal environmental impact, liquid waste management typically involves treatment steps where the volume of the radioactive waste is reduced, the physicochemical reactivity is stabilised, and the migration boundary is established. Initiatives of a new nuclear liquid waste treatment installation can originate from nuclear new build, from renewal of aged facilities, from new treatment needs (e.g., when shifting towards decommissioning stage), and from technical upgrade for a safer and more cost-efficient process. Fortum Power and Heat Oy (Fortum) is the license holder of Loviisa nuclear power plant (VVER-440, Finland), where the liquid waste treatment system renewal is currently underway. In addition to being an operator and license holder, Fortum is an active service provider that design and implements liquid waste treatment projects internationally. In this presentation, we share several key lessons learned from our recently completed and ongoing projects with a deep understanding across the system delivery boundary. A feasibility study based on strategy is an entry point for any design and implementation project. However, the focus of the feasibility study tends to be centred around finding a viable technical solution. Lesson learned #1 is that the emphases of the feasibility study shall be put on defining project lifecycles and boundary conditions, cost impact analysis which includes final disposal cost consequences, and technical feasibility with a wider range of solutions. When entering into the design and implementation phase, lesson learned #2 is that sufficient amount of resources are recommended to be reserved for piloting and design modifications. As the needs and boundary conditions are highly site-specific, optimising even a turn-key treatment solution might bring significant benefits. Open, customer-centric communications and project management is the #3 lessons learned, especially between the license holder organisation and the service provider organisation. Challenges are tackled together when the license holder's needs are concretely understood, and overall waste routes taken into consideration in an early stage. The last lessons learned (#4) is that owner organisations are recommended to implement a holistic fleet level approach and to consider the deployment of mobile systems used in multiple sites over a longer period of time.

IAEA CN-318/125

Bulk radioactive residuals from cyclotron decommissioning in the Netherlands: an opportunity for recycling through conditional clearance

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1 Dutch Institute for Public Health and the Environment

The European and worldwide accelerator park is aging, and increased decommissioning activity is foreseen in the near future. Cyclotron usage results in activation of cyclotron parts and concrete bunkers. The aims of this project were to substantiate cost estimates for radioactive waste storage and to identify potential savings and recycling opportunities through conditional clearance.

Information on cyclotron characteristics was obtained from operators. Data on specific activity in materials after cyclotron decommissioning was obtained from literature. Only bulk material - including metals originating from the magnet coils and yoke, as well as the reinforcement bars of the concrete and the inner 50 cm of all bunker concrete – was included. Estimates of activated mass were based on dimensions of representative cyclotrons and bunkers. Materials were judged likely to qualify for conditional clearance when the clearance-weighted sum of present specific activities was below 100.

Total yield of radioactive waste for all Dutch cyclotrons was estimated at 4000 – 7000 tonnes of bulk material. Corresponding storage costs at the Dutch Central Organisation for Radioactive Waste (COVRA) would amount to 40 to 70 million euros. More than 90% of bulk material was found likely to qualify for conditional clearance after 5 years post-shutdown. Modern Dutch cyclotrons operate at higher currents than cyclotrons reported on in decommissioning literature; studies must be performed to examine the effect on radioactive waste yield.

SESSION 14.1: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN MANAGEMENT OF RADIOACTIVE WASTE

IAEA CN-318/149

Final disposal of nuclear wastes in Finland – ensuring safety effectively

Author: Olli NUMMI

Co-authors: Antti KETOLAINEN, Otso MANNINEN

In Finland, the waste producer has the responsibility to manage the nuclear wastes produced, including the final disposal. The Finnish nuclear power companies dispose their own low and intermediate level wastes (LILW) in the repositories located at the nuclear power plant sites at Loviisa and Olkiluoto. Having the whole chain from waste production, handling, transportation, and disposal of the LILW within a single organisation has proven to be a straightforward and cost-effective way to manage and dispose of the nuclear waste produced. The disposal of spent nuclear fuel at Olkiluoto is managed by Posiva, a company which is jointly owned by the both power companies.

An existing disposal solution promotes sustainable use of nuclear energy in near future, but also protects the environment after the repository closure. However, implementing and demonstrating a safe disposal consumes resources and therefore creates a challenge for sustainability. A balance between (long-term) safety goals and effective utilisation of resources has been established using a graded approach, where both the repository depth and engineered barriers are adjusted to the radioactivity content of wastes. The disposal plans are also periodically reviewed taking into account the results and uncertainties of the most recent long-term safety case. These are also considered in the on-going R&D-program to ensure safe and effective disposal.

IAEA CN-318/54

First approach comparing cement and geopolymer as solidification matrixes for radioactive waste using Life Cycle Assessment

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Radioactive waste must be properly immobilized to reduce the migration potential of contaminants and facilitate the waste's handling from storage to disposal. Cement is the most common matrix for low-level waste, but new technologies are emerging, such as alkali-activated materials, called "geopolymer". Geopolymers have been considered as an immobilization matrix for radioactive waste due to a range of benefits, like less emission of greenhouse gases when compared to cement, good mechanical properties and resistance to fire and acids. Some authors compared both materials using Life Cycle Assessment (LCA) Methodology for construction purposes. LCA Methodology is a tool for studying environmental aspects and potential impacts on the life of a product by the combination of software and databases to calculate different environmental impacts. The comparison of both matrixes for their use in radioactive waste immobilization is not reported in the literature yet. The global warming has been globally discussed and this discussion needs to enter in the nuclear area. This work aims the comparison between cement and geopolymer using the LCA Methodology, to evaluate if geopolymer is a more sustainable alternative to cement for radioactive waste immobilization. This study may lead to new formulations for geopolymer to assure its sustainable characteristics.

IAEA CN-318/162

Radioactive waste management during CNE life extension and sustainability consideration

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Embalse Nuclear Power Plant (CNE NPP) is a CANDU type reactor with pressure tubes type, loaded with natural uranium fuel, and moderated and cooled with heavy water. It is located in the province of Córdoba, Argentina.

Before accomplished its first cycle of operation, the Government, according to the national Law N° 26566 (in 2009), declared of national interest the life extension of CNE and determined that NA SA was the entity in charge of the project.

In that sense, in order to extend the plant life for another 25 years of full power operation as well as to increase the electrical power, during the refurbishment outage different design changes were introduced to improve safety. The main activities that were carried out consisted of changing pressure tubes, the steam generators, the process computers, and the repowering of the plant.

From the sustainable development point of view, it stands out not only the commitment to minimize the generation of radioactive waste and not exceed the estimated volume of waste generated, but also the process of citizen participation through a Public Hearing which granted the social environmental license. In this manner, stakeholders representing the local community, the provincial and the national interests were able to express their vision on this vital project. The understanding of the need to reduce the effect of global warming due to the burning of fossil fuel to produce electricity was a great achievement.

At the beginning of 2019, CNE was reconnected to the electricity grid at full power.

IAEA CN-318/19

Recycle And Reuse of Nitrate Bearing Radioactive Liquid Waste in Uranium Refining Facility

Author: Shrishma PAIK (Scientific Officer)

Co-authors: S K SATPATI, A K SINGH

Technologies for the management of radioactive waste has been constantly upgraded based on R&D activities and operating experience with a view to minimise the release of activity to the environment, reduction in the volume of waste disposed, its recycle and reuse and to lower the radiation exposure to the operating personnel. An important effluent coming from uranium refining operation is ammonium nitrate solution as Ammonium Di-Uranate Filtrate (ADUF) during refining process of uranium for fuel fabrication. The significant volume of nitrate solution needs to be processed after decontamination for efficient effluent management. Since present day safety and environmental issues are becoming increasingly stringent, the discharge of nitrate bearing effluent is now turning out to be much more serious concern. Hence, for achieving a cost-effective waste management, it would be a novel approach to recycle this effluent and explore the utilisation of this waste product in other processes or applications.

Efforts have been made to utilise this effluent for volume minimisation by recycling it in uranium processing routes itself. The effluent ammonium nitrate was recycled as a strippant for stripping uranium from loaded solvent (30% TBP) during solvent extraction in place of De-Mineralized (DM) water. Extensive studies were performed to find the optimum stripping conditions through counter current batch simulation for quantitative and qualitative uranium recovery. Plant scale implementation of the process leads to almost 40% reduction in the volume of nitrate waste and its effective utilization in the in-situ process. Thus, the value addition by such kind of improvisation in these waste recycling strategies with scientific inputs, has made a wholesome contribution towards the mitigation of the challenging problem of the nitrate waste management in uranium refining plant.

IAEA CN-318/242

UK Integrated Waste Management Programme - Driving Sustainability into Radioactive Waste Management

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Introduction: Foundational work has been undertaken by the UK's Integrated Waste Management Programme (IWMP) to understand the current and aspirational future state of sustainability practice in radioactive waste management in the UK, and to establish a common perspective across the nuclear sector. This paper will describe the gap and the response to deliver the necessary thought-leadership in waste and tools for change and how sustainable practices can be driven throughout the radioactive waste management while ensuring safety is maintained.

The waste challenge: The UK has over 4 million cubic metres of radioactive waste still to be recovered and managed to clean-up the UK's historical nuclear sites, and a new generation of nuclear power stations is set to be built requiring ongoing waste management capability.

A coordinated approach: The IWMP has been established to enable improvements in the management of waste from the nuclear sector to optimise and accelerate decommissioning and remediation, and to support the UK Government's Net Zero greenhouse gas emissions and wider sustainability commitments. The IWMP is made up of a wide range of stakeholders including waste producers, regulators, and government. It also involves service and supply chain providers; access to a robust radioactive waste management supply chain being one of the key enablers of optimized safe and sustainable waste management in the UK.

The baseline: As part of the baseline study on sustainability in radioactive waste management, the IWMP engaged with personnel from across the industry (ranging from individuals supervising the sort and segregation of waste to staff in procurement functions and our safety community). A clear appetite and desire to act more sustainably was evidenced, together with a lack of knowledge and understanding on the 'how to' in relation to people's own area of work and ways of working.

The response: The IWMP has established a Sustainability Programme to collectively drive forward the marbling of sustainability through radioactive waste management and the people capability and infrastructure that underpins it. Working together with industry stakeholders, the programme is working towards turning words into meaningful action, resources, and tools.

Summary: This paper will describe the baseline-study findings and roadmap for change, aligned to key UN Sustainable Development Goals. It will also showcase some of the tools developed to date to support industry stakeholders on their journey to embed sustainability within their organization while maintaining safety throughout the management of radioactive waste.

IAEA CN-318/263

Practical Safety and Sustainability decisions in Australia's Radioactive Waste Facilities

Author: Duncan KEMP[1]

1 ANSTO

This paper will cover the implementation of sustainability initiatives and the practical decisions which have to be made for radiation safety. There are times when the decision has to be made between safety and sustainability; times when there are compromises and times when they are congruent. Safety requirements will always play a larger role in these decisions, and sustainability decisions have to work within the safety requirements. When manufacturing radiopharmaceuticals, the patient safety requires single use items which come in contact with the radioactive material, generating a lot of waste; whereas for other items such as transport containers, cleaning tools and PPE there is the ability to decontaminate these items and re-use them. This reduces the environmental impact of the process, reduces wastes for disposal however it slightly increases the radiological risks due to the decontamination steps. The design of facilities and sustainability programs have interactions which need to be agreed. The recycling of waters from the reactor cooling circuits requires greater use of electricity, land, and people, however, reduces water use which is important in a country like Australia. The placement of solar panels on radioactive waste stores increases safety risks as people have to access the solar panels, and all the support structures create penetrations through which rain and debris can enter the storage facility. The conditioning of wastes into as small a volume as possible, including via Synroc processes and reprocessing of used fuel, reduces the environmental impacts as well as the cost of disposal. The design of buildings for decommissioning activities, including floor coverings and compartmentalisation of the construction techniques can improve the life cycle impact of the facility. There are separate regulators in Australia for environmental protection and radiation protection, with both working in parallel to assess all submissions focussing on their area of expertise. Some international techniques are not socially acceptable within Australia and lead to less efficient technologies being chosen, with incineration of solid wastes being continually rejected by Australian communities.

SESSION 14.2: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN REMEDIATION OF SITES AND MANAGEMENT OF NORM

IAEA CN-318/244

Perspectives and challenges for sustainable post-remediation management of uranium legacy sites in Portugal

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The exploitation of radioactive ores in Portugal initiated after the discovery of the first radium deposit in 1907 and was developed until the early nineties. Since 2001, the Portuguese State committed with the environmental remediation of all mining legacy sites in Portugal, including 62 radium and uranium legacy sites. After two decades of remediation 45 radioactive mining sites are remediated, 8 are undergoing remediation (in 2023) and 9 are planned to be remediated until 2030.

Despite the use of safe and complex remediation technologies, it is necessary to ensure the continuous post-remediation management activities to ensure the long-term protection of the people and the environment and the sustainable use of the remediated areas.

This paper will present the main perspectives and challenges for the sustainable use of the remediated legacy sites in Portugal, such as the use for energy production, for scientific or research and development activities, for remining or for touristic activities. It will also discuss the challenges related with the implementation of post-remediation management activities and institutional controls, such as end use and resource restrictions, but also to ensure the continuous monitoring, maintenance, groundwater remediation, records and knowledge preservation and other post-remediation activities.

IAEA CN-318/129

Remediation of Radiologically Contaminated Sites in Georgia

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1 Agency of Nuclear and Radiation Safety

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Georgia develops its capability to conduct remediation of radiologically contaminated sites. The main following factors should be considered to ensure sustainability of issue:

- Upgraded legal base
- Equipment used for remediation activity
- Building capacity and;
- Develop national radioactive waste management system

The country intensively upgrades its legal base (including laws, national BSS and other legal requirements). New mobile laboratory was put in operation to conduct on site investigations. Based on the conducted gap analyze new training program was developed for young specialists. The new facilities design is developing under EU support.

The most important radiologically contaminated site in Georgia is s.c Anaseuli site situated at the in Ozurgetu district in Western Georgia. The site was operated by former Scientific-Research Institute of Tea and Subtropical Plants. The site is surrounded by agriculture fields and village houses. The site remediation is important reach UN sustainable development goal N3 and N12. Based on the conducted investigation #d dynamic model of the site contamination is elaborated. The remediation was started based on the gained data. Together with other experts special matrix was developed on CIDER meeting to assess the effectiveness of the remediation activity, which was used for Anaseuli case.

IAEA CN-318/109

U.S. DOE East Tennessee Technology Park: A Model for Sustainable Cleanup

Author: Albes GAONA[1]

1 US DOE

At the U.S. Department of Energy (DOE) East Tennessee Technology Park (ETTP), the DOE Office of Environmental Management's (EM) vision is to transform a community liability into a safe and sustainable asset. EM is tasked with cleaning up the legacies of the Manhattan project, by demolishing contaminated facilities and remediating contaminated soils and groundwater. As a result, that work is altering the landscape and creating new opportunities for economic redevelopment, historic preservation, and conservation for future generations. After nearly two decades of work, employees have cleared away more than 500 buildings and are nearing completion on soil remediation. Land was returned to a natural state through native grass and wildflower reseeding projects. Environmental stewardship practices played an important role, including recycling and reuse initiatives, greenspace creation, and renewable energy generation. EM has also transferred nearly 1,300 acres to the community for industrial development. That land is now home to more than 20 businesses and multiple solar arrays producing more than 1.2 MWh of electricity annually. Areas at the site are also part of the Manhattan Project National Historical Park. The completion of this first-of-a-kind cleanup project serves as a model for future sustainable and safe environmental cleanup projects.

IAEA CN-318/156

Remediation and Retrieval of Legacy Radioactive Waste Stored at Sewaqa Site in Jordan

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2 Jordan Atomic Energy Commission

The Radioactive Waste (RW) stored at Sewaqa legacy site was of particular concern to Jordan Atomic Energy Commission (JAEC) since its storage conditions does not meet some of the applicable national legislation requirements and internationally recognized safety standards on safety and security of RW. In order to eliminate these deficits and to achieve full compliance with the requirements of the national legislations, the stored RW from the Storage pit at Sewaqa site were retrieved, reconditioned and repackaged into new 200 L drums and transferred to the Centralized Storage Facility (CSF) at JAEC headquarter for long term storage. The used remediation procedures as well as the safety and security measures that were employed while executing the RW retrieval and remediation are described. No incidents or accidents occurred during the project's implementation and sources were successfully moved to the CSF. The safety and radiation protection aspects pertaining the implementation of retrieval and removal of RW stored at Sewaqa site were fully employed. Security measures involving the implementation of the Security Plan were enforced and well employed. The retrieved RW was accepted for long term storage at the CSF and added to the national inventory of the CSF.

IAEA CN-318/338

Commitment to Long-Term Stewardship: An Overview of Safe and Sustainable Management and Reuse of Legacy Sites

Authors: Bud SOKOLOVICH[1], Tania TAYLOR

1 US Department of Energy, Office of Legacy Management

The operations of the Department of Energy, Office of Legacy Management, are trans-hemispheric. The Office of Legacy Management is charged to protect human health and the environment at 102 sites in over 30 states and territories, from Puerto Rico in the Caribbean Sea to Amchitka Island, Alaska, in the Bering Sea. The Office is the caretaker or steward of the legacy sites that played a critical role in America's nuclear history. As such, its commitment to sustainable long-term stewardship is at the core of everything it does, beginning the moment the Office takes over a legacy site and continuing throughout long-term management efforts. This discussion re-views the long-term stewardship undertaken by the Office of Legacy Management in recent years. It describes the necessary components of an effective program, including the protection of human health and the environment, beneficial reuse, record keeping, monitoring remedial activities, stakeholder engagement, and international collaboration. The topic explores engagements with local communities, state and local governments, and tribal nations across numerous mediums to educate and inform the public of ongoing stewardship activities. Finally, the discussion includes current efforts to assess risks associated with climate change and to incorporate measures to increase climate resiliency of legacy sites. It is hoped that this discussion will convey the importance and commitment required of long-term stewardship.

Established in 2003, the Office of Legacy Management continually evaluates how potential environmental changes may impact the approach to monitoring, inspection, and maintenance at the sites. Its scope has grown from 30 in 2003 to 102 sites today, and the number will continue to increase to 125 by 2030. The organization comprises approximately 80 federal employees and 500 contractor partners including geologists, hydrologists, engineers, physical scientists, and other professionals to ensure long-term environmental protection. It includes actuaries, financial managers, and procurement specialists to provide for retired contractor pension payments and post-retirement benefits. Certified realty officers and property specialists manage federal property and information technology specialists and records professionals to capture, safeguard, and share information. Historians and public participation specialists help facilitate engagements with stakeholders and governments. Finally, there are human resource and administrative staff to support personnel and work-flow needs.

The Office operates using five key components or goals. The Office protects human health and the environment; makes legacy and environmental clean-up records accessible to the public and future generations; funds pensions and post-retirement benefits for over 10,000 former contractor workers and their spouses; manages land and facilitates beneficial reuse of closed sites; and ensures meaningful involvement by all stakeholders, especially tribal and local community members in all long-term stewardship activities.

In keeping with the theme of this year's 5th International Mining Symposium, "Re-thinking Mining Remediation, Innovative Approaches Towards Sustainability", it is important to review

how the Office of Legacy Management shapes the future of legacy sites through its commitment to safe and sustainable long-term stewardship.

IAEA CN-318/188

Implementation of Nuclear Knowledge Management Program on Radioactive Waste Management

Author: Hade ELSAYED[1]

1 Egyptian Atomic Energy Authority

Nuclear power remains an important option for many countries to improve energy security, provide energy for development and fight climate change. The greenhouse gas emissions from nuclear power plants and are much smaller than those associated with coal, oil and natural gas, and the routine health risks are much smaller than those associated with coal. The nuclear power generation constitutes the intermediate phase between the front- and back-ends of the nuclear fuel cycle. But there are in this intermediate phase routine releases of radionuclides to the surrounding environment in liquid and gaseous forms. A major environmental concern related to nuclear power is the creation of radioactive wastes such as uranium mill tailings, spent fuel from the reactors, and other radioactive wastes. These materials can remain radioactive and dangerous to human health for thousands of years. Radioactive wastes are subject to special regulations that govern their handling, transportation, storage, and disposal to protect human health and the environment from the hazards of radioactive elements.

Nuclear Knowledge Management at the project, organizational and national levels is an integrated and systematic approach applied to all stages of the knowledge cycle, including its identification, sharing, protection, dissemination, preservation, and transfer. Knowledge management systems support nuclear organizations in strengthening and aligning their knowledge. Knowledge is the nuclear energy industry's most valuable asset and resource, without which the industry cannot operate safely and economically. In the organizational context, nuclear knowledge management supports the organization's business processes, and involves applying knowledge management practices. These may be applied at any stage of a nuclear facility's life cycle: research and development, design and engineering, construction, commissioning, operations, maintenance, refurbishment, and lifetime extension, decommissioning and waste management.

Here in this paper, we will perform the implementation of nuclear knowledge management program on radioactive waste management.

IAEA CN-318/201

Optioneering and optimisation of solutions for On-Site Disposition to ensure safety and enable sustainability

Author: Arun KHUTTAN

In 2018, the Guidance on Requirements for Release [from the Radioactive Substances Regulation] was published by the combined Environment Agencies of the United Kingdom. This is also known as the GRR. The GRR gives the provision for an operator to optimise final solutions to allow release from the RSR and includes options such as those shown in Fig 5 (taken from the GRR).

To aid the optimisation process, a model has been developed which considers several factors, aligned with the NDA Value Framework, and which considers elements of sustainability. These can be broken into the main pillars of sustainability.

Social

- Risk to public (from transport)
- Risk to workers (on-site and transport)
- HGV movements and disturbances to local communities

Economic

- Cost (using the inbuilt cost model)

Environmental

- CO_2 emissions (including from concrete use, HGVs etc)
- Material use / re-use (volume)
- Land / area for reuse

The proposed oral presentation would cover how this model specifically ‘ensured safety’ by using inputs from control measures (e.g., dose limits, transport controls), whilst optimising solutions to be as sustainable as possible from a variety of perspectives, including the consideration of views from local stakeholders.

SESSION 15.1: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN DECOMMISSIONING

IAEA CN-318/69

The challenge of balancing safety, environment, and sustainability in the nuclear industry

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1 Society for Radiological Protection/Sellafield Ltd

It is widely accepted that the nuclear industry contributes to the United Nations Sustainable Development Goals (UNSDGs) through the production of clean, low-carbon energy. However, wider sustainability opportunities within the construction of nuclear facilities are less well recognised.

Further, in an industry that embraces safety, finding a balance between safety, environment, and other sustainable outcomes can be challenging. For example, focusing on increasingly low radiation doses requires additional mitigation measures that can have wider societal and environmental impacts.

At Sellafield Ltd, finding the balance between sustainable outcomes while managing its nuclear legacy is vital to achieving its mission of creating a clean and safe environment for future generations. In pursuit of this mission, a fleet of waste treatment buildings and stores are required, creating one of the most complex construction portfolios in the world. From a societal perspective, the local borough is highly dependent on the site for employment. Therefore, managing the historic nuclear legacies requires balancing social, economic, and environmental factors to manage the creation of future legacies i.e., contributing to the totality of the UNSDGs.

The presentation will explore examples from Sellafield on how the nuclear industry can balance safety and the environment with other sustainable outcomes.

IAEA CN-318/304

Experiences, Challenges and Prospects in Decommissioning Nuclear Fuel Cycle Facilities in RSA

Author: Amanda MBHELE[1]

Co-author: Christopher MELANE[1]

1 Necsa

South Africa began decommissioning work in the mid-1990s when the country abandoned its historical nuclear program, which included uranium enrichment. These historical facilities are situated in Pelindaba at the South African Nuclear Energy Corporation site. A total of 36 facilities have been categorised as historical facilities and are currently in the process of going through the last stages of the decommissioning process. There have been several facilities that have been successfully decommissioned and have been repurposed for non-radiological operations. There have also been a great number of facilities that have been retained under Care and Maintenance (passive safety) while they wait to be repurposed or removed from regulatory oversight. Many of these facilities were built between the 1960s and the 1980s without considering the decommissioning process or the waste streams generated during the decommissioning process. As a consequence of these, several challenges and valuable lessons were learnt.

This paper aims to discuss the current status and prospects of decommissioning nuclear facilities in South Africa. Additionally, this paper will highlight significant wins and challenges that were faced during the process of decommissioning. In this article, the deficiencies in the decommissioning regulatory framework and governance are briefly discussed.

IAEA CN-318/336

Decommissioning Of Indonesia's Triga Mark II Reactor: Safety and Waste Management

Author: Renaldy SARAGIH[1]

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The construction of nuclear reactors in Indonesia is moving towards a new phase marked by the decommissioning of nuclear reactors in Indonesia, namely Triga Mark II with the concept of waste and safety development. Indonesia has three reactors, all of which are research reactors for research. The Triga Mark II reactor began operation in 1965 in Bandung, West Java. Decommissioning of course concerns the age and consideration of the assessment of the safety factors of reactors that are more than 50 years old. The decommissioning of Triga Mark II confirms that Indonesia is focusing on its nuclear power management. Careful planning and increased cooperation among authority holders will be carried out. In the past decade, Indonesia's nuclear landscape has undergone significant changes with the organization of comprehensive risk and safety assessments ('government regulation'). The successful decommissioning of the Triga Mark II reactor plays an important role in determining the sustainability and safety guarantees and protection of Indonesia's nuclear power utilization as well as the challenges of building the first power plant reactor.

IAEA CN-318/297

How nuclear decommissioning can be made compatible with a net zero carbon trajectory

Author: Nicholas BARRON[1]

1 Arup

Nuclear derived power features heavily in the strategies of most nations to decarbonise electricity production and industrial processes. It is widely accepted and documented that nuclear generation has a very low carbon intensity when used for electricity production and similar logic can be used to extrapolate this to non-electric applications. These studies have principally focused on accessing lifetime emissions associated with the construction, operation and decommissioning of modern Generation III/III+ and IV systems. The carbon intensity of legacy nuclear facilities, including Generation I reactors, that were developed and commissioned between 1950 and 1960 are less clear cut, given existing decommissioning, waste storage and disposal strategies. It is not a surprise to note that the carbon intensity of dealing with this legacy is dominated by construction and demolition activities – and is carbon emitting, particularly within the strict nuclear safety setting of the industry. While research is ongoing, the decarbonisation of common construction materials (concrete and steel) is difficult, with limited proven and commercial scale technology that can be implemented within the constraints of current regulatory and industry practice in the timeframe required.

In general, current decommissioning plans are pushing long term disposal and site end states further into the future, adding significant carbon to the industry through interim storage and long quiescence periods. Understanding the whole life carbon of decommissioning relative to the net zero by 2050 timeline and the diminishing national carbon budgets, is necessary to support the no-regrets policy decisions. Also, decommissioning of the legacy facilities could set the precedent for future nuclear decommissioning and waste management activities. In this systems-thinking context, there is a risk that a high carbon decommissioning sector jeopardises the low carbon credentials of the nuclear energy generation – and hence credible decarbonisation pathways adopted by many countries. Thus, it is important to address these challenges now.

Arup has co-authored the PAS2080:2023 and its decarbonisation principles that considers the Net zero carbon transition at the systems-level. For example, global Decommissioning Missions are sacrosanct – but it must fit in the time and carbon budgets that are set at national and international levels. Thus, every asset must, on a systems level, be compatible with the net zero transition of the system that it is part of.

This paper will discuss common decarbonisation challenges associated with decommissioning of legacy facilities and waste disposal with a very fixed net zero milestone of 2050. In addition, it will provide a view on the suitability, or otherwise, of prolonged interim storage as a means to defer final disposal to the far future. Noting associated national and global decarbonisation trajectories. It will also discuss worked decarbonisation examples in action and explore opportunities for the need to prioritise nature-based solutions in managing carbon, including the role of land use change (site end states) in increasing climate resilience and hence reduce the carbon for hard infrastructure provision and avoided disruption; but also enhance the carbon sequestration potential.

IAEA CN-318/140

A resilience-based approach to safe and sustainable nuclear back-end management

Author: Kristina GILLIN[1]

1 Vysus Group

Experience to date has shown that planning for nuclear decommissioning, waste management and site remediation is associated with major uncertainties. This includes assumed reactor shutdown dates, which sometimes change significantly on short notice. Another example is assumed in-service dates of planned waste disposal facilities, for which long delays or project cancellations have become commonplace – an indication that the current paradigm is unsustainable.

The uncertainties regarding timing of major milestones mean that decommissioning plans tend to be based on assumptions that will not hold and, hence, likely are suboptimal. In addition, the timeline uncertainties translate into an increased risk of emergent issues that might have safety implications. By viewing nuclear decommissioning, waste management and site remediation through a sustainability lens, the impacts that such uncertainties may have can be mitigated.

In this paper, the uncertainties regarding timeline and their potential safety impacts will be explored by applying resilience thinking – a key concept within sustainability research. Cornerstones of what a resilience-based approach to nuclear back-end management would entail will be shared and discussed.

IAEA CN-318/356

The NEA's Decommissioning Costing Activities and its Implication to Sustainability

Author: Heather BARTON (EGCDL Bureau member)

Establishing reliable cost estimates is an essential element of decommissioning project planning. Cost, time, and quality are all drivers for decision-making and high-quality costing data is desirable to assess the economic viability of projects. Quality cost estimates are an essential key enabler to ensure that safety and sustainability are embedded in decisions. The identification of sustainable solutions is closely interwoven with the costing of any solution and practical approaches to achieve harmony between finances and sustainability should be leveraged.

The Nuclear Energy Agency's Expert Group on Costing for Decommissioning of Nuclear Installations and Legacy Management (EGCDL) will present a paper focussed on its mandate to foster the exchange of information, knowledge, and experience between members on cost estimation, such that there is an increase in the credibility of cost estimates. Developed tools to achieve this will be presented; in addition, identified good practices and challenges will be discussed. Progress on the practical approaches that can be taken to improve economic considerations that feature in sustainability and safety decisions in decommissioning will be explored. The paper will encourage dialogue between the safety and sustainability communities and cost estimators such that an appreciation of the costing role in holistic decision-making is recognised.

IAEA CN-318/278

Proportionate Regulatory Control for Nuclear Sites in the Final Stages of Decommissioning

Author: Penny DUNBABIN[1]

Co-author: Adam SHARMAN[1]

1 UK Department for Energy Security and Net Zero

In the UK, nuclear sites are regulated by the Office for Nuclear Regulation (ONR) and the relevant environment agency [1]

In the early stages of decommissioning of a nuclear reactor, the spent fuel and higher activity wastes are removed and stored securely elsewhere, resulting in radiological hazards on the site falling by over 99%. In the final stages of decommissioning and clean-up, hazards and risks fall to the point that regulation under the nuclear site licensing regime and application of the nuclear third-party liability regime are no longer warranted.

The 2023 Energy Bill proposes to align procedures for ending nuclear third-party liability with international recommendations [2] and to amend processes to end or vary a nuclear licence. At the end of the licence, the Health and Safety Executive will take on responsibility for regulation of health and safety. Environmental regulation will continue for years or decades after the end of the nuclear licence.

References

1. Environmental regulation is devolved to Parliaments in Scotland, Wales, and Northern Ireland. The relevant environment agency is the Environment Agency in England, the Scottish Environment Protection Agency in Scotland, and Natural Resources Wales in Wales – there are no nuclear sites in Northern Ireland.
2. OECD Nuclear Energy Agency Steering Group, 2014, “Decision and Recommendation of The Steering Committee Concerning the Application Of The Paris Convention To Nuclear Installations In The Process Of Being Decommissioned

SESSION 15.2: PRACTICAL EXPERIENCES IN INTEGRATING SAFETY AND SUSTAINABILITY IN MANAGEMENT OF RADIOACTIVE WASTE

IAEA CN-318/21

Site selection's role at a sustainable radioactive waste repository project: a Brazilian experience

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1 Centro de Desenvolvimento da Tecnologia Nuclear – CDTN

The implementation of a radioactive waste repository is especially important to countries that have a nuclear program or wants to be a newcomer nuclear country, as it testifies the correct management of the large amount of radioactive waste generated in several nuclear related activities.

In Brazil, the site selection process is guided by CNEN Standard NE 6.06, which establishes minimum requirements for the process of selection and choice of sites for repositories for low and intermediate-level radioactive waste to ensure the safe containment of these materials. Regarding this Standard, the achievement of as much UN sustainable development goals as possible is an important milestone to ensure such a robust and technically flawless infrastructure that must last so long with minimum environment impacts.

The site selection phase is therefore one of the most important steps of a repository's planning when one defines which sustainability milestones must be achieved by locating the repository in a suitable and safe place, especially concerning water and land resources.

This paper aims to illustrate how the Brazilian site selection procedures were aligned to the most relevant UN sustainable goals for a national low and intermediate level repository.

IAEA CN-318/230

Advancing the Integrated Management of Contaminated Sites: Frameworks and Tools

Author: Catrinel TURCANU[1]

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The importance of stakeholder participation, and the consideration of the broader social, environmental, and economic sustainability aspects in decisions concerning decommissioning and environmental remediation (D&ER) is increasingly recognized. More encompassing and inclusive approaches to decision making are thus needed. While retaining a focus on safety, these should include also other elements of sustainability, eventually making use of innovative frameworks and tools.

The IAEA MAESTRI project (Management Systems Supporting Environmental Remediation Projects) aims at developing a structured decision framework that considers, in an integrated manner, the different dimensions and activities relevant to the proper management of sites contaminated by ongoing or past activities, or that hosted nuclear facilities. With the view of bringing these sites to sustainable end-states of beneficial use, MAESTRI will provide practical guidance for the integrated management of contaminated sites, including:

- considerations underlying decisions on D&ER (e.g., institutional, environmental, safety, technical, economic, social, ethical).
- sustainability assessment of site management options (i.e., the social, economic, and environmental aspects); and
- application of evaluation tools to support a transparent, consistent, comprehensive, and inclusive decision-making process.

The project recognizes that participation of societal stakeholders should be an integral part of the site management process, leading to better decisions and enhanced human well-being.

A first step in MAESTRI was a review of frameworks, approaches and tools used in the decision-making processes related to environmental remediation. The aim was to identify the state-of-the-art and remaining gaps and articulate a series of proposals relevant to decision-making for D&ER projects.

Results show that social and ethical dimensions are underdeveloped in terms of clear frameworks and indicators that can be used in decision-support tools, partly due to the context-sensitive and complex operationalization of related aspects.

Furthermore, the sustainability frameworks developed for D&ER in non-nuclear fields, or for community development, provide insights and tools that should be applied to D&ER in the nuclear field.

Notwithstanding other contributions to the eventual decision, multi-criteria decision aid allows tackling the multidimensional nature of D&ER options in an effective way. Specifically, social multi-criteria evaluation is designed to support public policy processes where both quantitative evidence and qualitative data such as stakeholders' input, conclusions, or evaluations, as well as scientific and expert advice, play important roles. It can integrate in a consistent way the various criteria (technical, social, environmental, economic), against which the D&ER options should be assessed and compared. However, clear, and accessible guidance is needed on specific methodological aspects, as well as modalities for enhanced interaction with stakeholders.

MAESTRI also connects with circular economy principles. In the particular case of remediation, it implies re-thinking remediation from a limited perspective of harm reduction to one involving value creation, for instance by bringing land, to the extent possible, to recreational, industrial, agricultural, or nature conservation use.

Considering the path forward, MAESTRI holds a clear vision, stating that decision processes need to be more comprehensive and aligned with sustainability objectives. D&ER should be seen within the wider outreach of environmental management, encompassing all the stages and dimensions relevant to this process.

IAEA CN-318/359

The Deep Borehole Disposal Method and An International Demonstration Project Proposal for Australia

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Deep borehole disposal (DBD) is a promising concept for the safe and long-term disposal of radioactive waste. This paper presents a proposal for a demonstration project located in Western Australia, highlighting the potential of the concept as a viable solution for the management of radioactive waste; this is in context of Tellus receiving indigenous approval for a DBD project and being in process of finalizing development approvals to start this project in connection with its proposed partner CSIRO (funding pending). DBD involves the emplacement of waste in deep, stable geological formations, providing multiple barriers for containment and isolation. By utilising the geological stability and impermeability of deep boreholes, DBD offers enhanced safety and security while minimising environmental impact. The proposed demonstration project aims to assess the feasibility of DBD in the Australian context. Western Australia possesses geological conditions suitable for deep borehole disposal, making it an ideal location for this demonstration. The project includes three key components: site selection, engineering design and comprehensive safety analysis. Site selection involves geological surveys to identify appropriate rock formations capable of providing sufficient isolation and containment. Engineering design focuses on borehole construction, waste emplacement, and monitoring systems, ensuring the integrity and stability of the disposal system. The safety analysis includes risk assessment, long-term performance evaluation, and contingency planning. The demonstration project will serve as a valuable opportunity to engage stakeholders and the public, fostering transparency and addressing concerns related to waste disposal. It will provide valuable insights into the technical, environmental, and socio-economic aspects of implementing DBD, enabling informed decision-making for future management strategies and waste management initiatives in the country. Furthermore, this project will contribute to the broader international dialogue on safe and sustainable disposal options for radioactive waste, promoting knowledge sharing and collaboration. The DBD concept, with its inherent safety features and potential for deep geological isolation, offers a promising approach to addressing the challenges of radioactive waste management. The paper outlines the deep borehole disposal concept and presents a proposal for a demonstration project in Western Australia, demonstrating the feasibility and potential of DBD as a long-term solution for the safe disposal of radioactive waste.

IAEA CN-318/265

Planning LILW disposal facility in Slovenia in a sustainable way

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1 Agency for Radwaste management, Slovenia

Planned Slovenian disposal facility for low and intermediate level waste (LILW) will be situated in Vrbina in municipality Krško. Slovenia will with final disposal of radioactive waste ensure a safe environment for present and future generations. The disposal concept is a near-surface silo which is first of its kind in the world. It is a combination of well-known surface and underground disposal concept. Containment and isolation of the waste is provided by various engineered and natural barriers. Multiple barrier approach is considered, therefore the failure in an engineered barrier will not have an impact on people and the environment because of the presence of other barriers. First engineered barrier is a metal drum containing the wastes, second is a N2d concrete container, third barrier is a silo and the last is a low permeable geological surrounding. Concrete used for the container and the silo will be high performance concrete whit long durability. Free spaces between containers and containers and the silo wall will be filled with backfilling grout and after the closure all the free spaces, the shaft and the drainage system of the silo will be sealed with the backfilling concrete. At the top the concrete will be covered with thick layer of clay. Thus, after the closure, the silo will become a monolithic structure.

The architecture of the hall above the silo considers the acceptability of construction for local community and environment. Considering reusable construction, the planned hall above the silo is envisioned to be used for another location if a new silo will be built. The same vision is planned for the crane located above the silo, used for waste disposal. After the construction, the surrounding environment will be greened with local plants and trees. This will establish a new habitat for plants and animals and ensure a sustainable future of the facility in connection to the environment. After the closure and a period of 300 years of an institutional control, the place will be put to unlimited use to the local community.

IAEA CN-318/342

French Low-Level Long-Lived repository project: ensuring sustainability from the early stages

Author: Sonia GUILLOT

Co-author: Virginie WASSELIN

In France, Andra, the national radioactive waste management agency, is in charge of developing long-term solutions for all types of radioactive waste. Application of graded approach principles for the disposal of Low Level-Long Lived waste category (i.e., for graphite and radium-bearing waste) have specific environmental and safety concerns. Intermediate depth repository options have been engineered by Andra for several years and a community in Aube district (East France) volunteered to host the project. At the current "feasibility" stage of the project, Andra decided to carry out an environmental diagnosis of the community site to:

• Identify compartments and areas where environmental specific values should lead to their early exclusion of the siting process.

• Collect and structure initial information on the sensitivity of potential sectors to give robustness to the "avoid/reduce/compensate" strategy,

• Pre-assess and analyse the impacts on all environmental sensitive components (land use, water, air, biodiversity, landscape, economic activities including agriculture and forestry...) at construction, operation, and post closure phase of a disposal facility

Coupling safety analysis with environmental studies at the earliest stage of the project gives a strength and robustness to the systematic identification, sorting and specification of project requirements. It also steers the project development by identifying when project iterations would be needed to ensure a step-by-step refinement of the disposal solution for this category of waste.

IAEA CN-318/355

Geopolymer as a potential sustainable technology for a safe radioactive nuclear waste management: Design, synthesis, and characterization

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Proper radioactive waste management is one of the critical issues for a successful and safe nuclear application. Engineered or technical barriers to contain such waste should be performed with the objective of ensuring adequate safety and protection of both the environment and the human health. Cementitious materials have been widely utilized as a solution for radioactive waste disposal. Nonetheless, this technique presents numerous technical challenges, particularly regarding long-term durability. One of the main concerns revolves around the possibility of these cementitious materials to degradation over time, potentially leading to the release of radioactive contaminants. One of the promising materials that can be used as an alternative cementitious material is geopolymers. These emerging materials can offer high encapsulation capacity, durability, and lower CO2 emissions, making it a sustainable and eco-friendly solution compared to conventional Portland cement-based materials. This study aims to assess the physical and chemical barrier effect of geopolymer material on leaching behavior of cesium and strontium. Phosphate mining waste rocks and metakaolin were used as aluminosilicate agents. Microstructure, structure analysis and thermal analysis were performed using Scanning Electron Microscopy (SEM), energy-dispersive X-ray spectroscopy (EDAX), X-ray Diffraction (XRD), Fourier Transform InfraRed (FTIR),) and Thermogravimetric Analysis (TGA). The long-term leaching performance of simulated radioactive cesium and strontium from geopolymers was evaluated according to ANSI/ANS-16.1, which showed that the diffusivity of cesium and strontium in geopolymer specimens was significantly lower than in Portland cement by a factor of 103 and 106, respectively, demonstrating significantly improved immobilization performance. A pilot plant design with a details structure design have been proposed as a potential project for intermediate and low-level nuclear waste immobilization.

POSTER PRESENTATIONS

POSTER SESSION 1: OVERARCHING CONCEPTS ON ENSURING SAFETY AND ENABLING SUSTAINABILITY

IAEA CN-318/1

National Strategy and Planning for The Safe and Sustainable Management Of Radioactive Waste And Spent Nuclear Fuel

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1 Nigeria Atomic Energy commission

Nuclear technology applications have been on the increase in Nigeria. The use of radioactive materials in the fields of research, medicine, industry, agriculture, commerce, education, and defense; as well as the extraction, processing and combustion of raw materials containing Naturally Occurring Radioactive Materials are among the most prominent. Other emerging activities include the development of nuclear reactors for research and electricity generation purposes. These activities generate radioactive wastes, which contain materials that emit ionizing radiation, and have been recognized as a potential hazard to human health and the environment since the beginning of the 20th century. The safe management of these radioactive wastes is, therefore, essential for the protection of human health and the environment, in the present and future.

The Nigeria Atomic Energy Commission has developed the National Radioactive Waste Management Policy as well as the Nuclear Fuel Cycle Policy to express the intent of Government to manage radioactive waste and spent nuclear fuel in a safe, secure and sustainable manner to safeguard public health and the environment. As a follow up to these policies, a set of strategies were developed for the management of radioactive wastes arising. The general viewpoint is that the management of radioactive waste involves the reduction to as low as reasonably practicable and justifiable. The most preferred approach in the management of radioactive waste are ‘delay - decay’, ‘dilute-disperse’ and to concentrate the waste and contain the radionuclides in it by means of a waste matrix and waste container followed by disposal in an appropriate disposal facility designed to provide adequate isolation from the immediate environment.

While the Policies describe intent, the Strategy describes the “how to” and provides the framework for how radioactive waste management will be performed in the country. It also provides for process development and identifies competencies needed and how they will be provided. It elaborates waste management methods for all waste types and prescribes use for communicating with the public and governmental authorities.

Among those, in terms of safety, security and environmental protection, one of the main requirements imposed by the Government of Nigeria to all waste generators, is to manage radioactive waste in a manner that protects human health and the environment, now and in the future.

The financial requirements for the implementation of the strategic plan for safe, secure, and sustainable management of radioactive waste and spent nuclear fuel comes from the Radioactive Waste Management Fund.

IAEA CN-318/59

Legacy Sites, Addressing the Past and Ensuring the Future

Author: Wafaa MOSTAFA (Prof Dr)

The rapid development of commercial and military uses of radioactive material from the early 1900's, peaking in the period from 1950's to 1980's has led to the development of many radiological and nuclear facilities worldwide. In many countries, these facilities were built and operated before the regulatory infrastructure was in place to ensure that they were effectively decommissioned, and their operating sites returned to beneficial use at the end of their operational life. The legacy from this under-regulated build up is that many countries now have partially remediated or abandoned contaminated facilities or areas where spills or accidents have occurred leaving behind long-lived radioactive and toxic residues that pose substantial environmental and health concerns.

The main target of this review study paper is to manage legacy sties in different places around the world, and to avoid the creation of new ones, strong and independent regulatory supervision is seen as a critical factor. This requires clear recognition of the separate responsibilities of operators and regulators.

Biodegradation is the use of a biological process such as microorganisms to accelerate the elimination of environmental pollution (such as an oil spill). Biodegradation is an environmentally friendly method when it comes to oil spills as it breaks down into harmless substances like carbon dioxide and water…. Social, cultural, and economic factors also influence management decisions and, increasingly, the engagement of stakeholders is seen as an integral part of the overall process of legacy site management.

We have to realize that the environment is our responsibility, and we have to work hard in keeping it clean and protecting it from any hazardous materials. It is for these reasons, mentioned that conducting research in the field of biotechnology is very important to discover new ways to clean the environment.

Since legacy circumstances are difficult to anticipate, it is not possible to provide regulations in advance that will be effective in all future cases. Some caution is needed to avoid prescription that could mitigate against the optimized solution in particular circumstances. However, it should be possible to set up in advance procedures and plans, including the role of regulators and all other stakeholders, to address legacies as they are recognized or arise. A similar lesson has been recognized with respect to planning for waste management after major accidents (NEA, 2016). This process should include how legacies can be recognized in a legal context, so that responsibilities can then be exercised within a proper regulatory framework.

IAEA CN-318/84

An Analysis of Achievements and Challenges in the Implementation of Regulations and Policies to Gain Safety and Sustainability of Radioactive Waste Management in Indonesia

Author: I Made ARDANA[1]

1 BAPETEN

The utilization of nuclear energy to support achieving Indonesia's four pillars of sustainability (social, economy, environment, and law and governance) is increasing yearly. Such utilization will produce radioactive waste, which requires exceptional management. Several regulations and policies have been established as references for radioactive waste management. In Indonesia, radioactive waste is mainly generated from operating three research reactors and using radioactive material and sources in the health, industrial, and research facilities. This literature review presents an overview of achievements and challenges in implementing several regulations and policies to improve radioactive waste management's safety and sustainability in Indonesia. Several achievements have been obtained, including establishing a centralized radioactive waste management organization, IPLR-BRIN, and its national inventory. This paper also presents challenges in managing radioactive waste related to the issue of developing sustainable storage and disposal facilities in terms of site and sustainable maintenance of facilities. In addition, as an archipelagic country, Indonesia needs to give attention to the safety and security aspects of radioactive waste during transport, including improvement of coordination between related parties. The analysis results show that implementing regulations and policies for radioactive waste management presents various challenges for regulators and operators to ensure that radioactive waste management in Indonesia remains safe, secure, and sustainable.

IAEA CN-318/86

Reconstruction of Legal Politics on Radioactive Waste Management in the Framework of Strengthening Sustainable Development

Author: Dwihardjo RUSHARTONO[1]

1 BAPETEN (Indonesian Nuclear Energy Regulatory Agency)

Indonesia is committed to achieving the Sustainable Development Goals (SDGs) targets and this has been manifested in various legal politics, including in the establishment of legislations and regulations. Since the SDGs have complex goals that do not only focus on economic growth, but also ensure environmental preservation, social welfare, and peace. In addition, as one of the countries considered pioneers in the implementation of the SDGs, Indonesia has become a reference for countries at the Asia-Pacific region as well as at the international level. On the other hand, the problem of radioactive waste management in Indonesia still has problems in achieving optimum solutions. The strengthening of legislations and regulations related to radioactive waste and spent fuel has been implemented, but on the other side, it is still necessary to decide legal politics for radioactive waste management. However, at the same time there is legal politics in the establishment of national policies as outlined in the omnibus law (Law No. 11 of 2020 on Job Creation). The purpose of establishing an omnibus law is to overcome all forms of regulatory constraints currently being experienced by Indonesia so that regulations shall be simplified, amended, or revoked in number. This is important, considering that regulations that have multiple interpretations can have an impact on Indonesia's weak competitiveness in the global arena. There are special provisions in the Job Creation Law changing legal politics in the management of radioactive waste in Indonesia, namely the issues of authority and institutions. Previously, Law No. 10 of 1997 gave BATAN (Indonesian National Nuclear Energy Agency, the promoting agency of nuclear energy) centralized responsibility for managing radioactive waste. By Law No. 11 of 2020 on Job Creation, BATAN had no authority for high and long term radioactive waste repository. However, on the other side, there is no document that normatively and specifically develops a national policy in setting up a strategy for radioactive waste and spent fuel. The approach used is normative juridical research or normative legal research which is research aimed at finding and formulating legal arguments through an analysis of the subject matter. The main problem of this can be found in the conclusion that there should be regulatory tools and the compliance with the international standards that have become best practices and common practices related to the principles of good regulation. In addition, there is unclear boundaries of institutional authority, including coordination mechanisms. This solution requires reforming elements related to policy formulation as well as legislations and regulations so that the establishment processes will be able to produce higher quality and more proportional legislations and regulations. It is necessary to carry out various establishment of policies for the short, medium, and long term, especially in structuring strategies for the management of radioactive waste and spent fuel.

IAEA CN-318/100

Romanian regulation on the safety of radioactive waste management and decommissioning, considering factors that enable sustainability

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1 National Commission for Nuclear Activities Control (CNCAN)

This paper describes the Romanian regulatory framework for the safe management of radioactive waste and decommissioning in order to ensure safety and sustainability. The pyramidal regulatory framework is governed by nuclear law and consists of safety and licensing requirements on pre-disposal and disposal of radioactive waste and spent nuclear fuel as well as safety requirements on decommissioning of nuclear and major radiological facilities. Fundamental Regulations on Safe Management of Radioactive Waste and Safe Management of Spent Fuel describes the principles of safe management of radioactive waste as well as safety requirements ensuring long term sustainability. The release from regulatory control of materials and building resulted from authorised practices and natural sources practices are described. Furthermore, for safety and sustainability, Romanian legislation has regulations for the monitoring of environmental radioactivity in the vicinity of a nuclear or radiological facility and regulations on limiting the release of radioactive effluents in the environment.

IAEA CN-318/106

National Regulatory Requirements and Practices for Radioactive Waste Management, Decommissioning and Environmental Protection – Ensuring Safety and Enabling Sustainability

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1 PNRA

Despite significant global contribution of nuclear power in achieving safe, reliable, and low carbon energy needs, challenges pertaining to ensuring safety and enabling sustainability in radioactive waste management, decommissioning and environmental protection are not insignificant. On behalf of Government of Pakistan, Pakistan Nuclear Regulatory Authority (PNRA) promulgated "National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel in Islamic Republic of Pakistan", in 20I8. This policy outlines responsibilities of Government of Pakistan, nuclear power program owner i.e., Pakistan Atomic Energy Commission (PAEC) and nuclear regulator i.e., PNRA in areas of radioactive waste management, decommissioning and spent nuclear fuel management. In addition to national policy, PNRA has also issued national regulations on Decommissioning of Facilities using Radioactive Material i.e., PAK/930 which delineates general requirements applicable to decommissioning and covers specific requirements such as strategy, planning, funding, conduct and completion of decommissioning. This paper discusses Pakistan national regulatory framework, requirements, policies, and strategies pertaining to radioactive waste management, decommissioning, spent nuclear fuel management and environmental protection and how combined efforts and practices in these areas contribute towards sustainability, now and for future. National policy adopted strategies and national regulations are discussed to draw interrelationships between safety and sustainability by considering factors such as social, economic, and intergenerational repercussions and environmental impact.

IAEA CN-318/132

Radioactive Waste Management – National Programmatic Perspectives in North Macedonia

Author: Gordana NIKOLOVA

Current situation with the management with the radioactive waste in North Macedonia, and programmatic perspectives for future.

IAEA CN-318/138

Review of Safety Assessments for Radioactive Waste Storage facilities

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1 Nuclear Regulatory Authority

Radioactive Waste Management standard AR 10.12.1 of the Nuclear Regulatory Body from Argentina, held on the year 2016, requires that radioactive waste storage facilities need to develop a safety assessment, prior to operation, in order to ensure safety among the lifecycle of this facilities and guarantee that radiation protection measures to the public and the environment are accomplished, as well as dose limits and constraints.

Given the national broad nuclear power plan and the large amount of radioactive facilities and activities in the country, there are several radioactive waste storage facilities already constructed, and it is expected that more will be constructed in the near future to provide capacity for all the radioactive waste generated. As some of these facilities were constructed prior to the update of the standard, they didn´t have a specific safety assessment associated independent of facility safety case. In views of improving and regularizing this situation, since 2018 the regulatory body has been requiring operators, to fulfil with the requirement of the mentioned standard and to develop the Safety Assessment including scenarios for normal operation and accidental conditions of the storage facilities located within their sites.

During 2019, an instructive of the content of the safety assessment was developed by the Radioactive Waste Management Control Section of Nuclear Regulatory Authority, in order to facilitate to operators, the process of preparation of the documentation needed to perform the safety assessment.

This paper addresses the regulatory review process for the safety assessment of these facilities, emphasizing on the creation of a multidisciplinary group to evaluate the documentation, the radiation protection measures, and dose limits and constraints taken into account and the scenarios considered.

IAEA CN-318/154

Measures of Iran Nuclear Regulatory Authority in support of the sustainable development

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1 Iran Nuclear Regulatory Authority

Iran Nuclear Regulatory Authority (INRA) as the national regulatory body has been working to improve its regulatory functions toward sustainable development goals. In this regard, INRA requires license`s applicants for the radiation facilities and activities to provide, as appropriate, a justification plan, a radiological environmental impact assessment, a report of seismic studies and a report of geotechnical studies in the siting process and a radiation protection program including individual monitoring, workplace monitoring, a system of inventory, an emergency plan and physical protection. INRA has a training strategy for individuals involved in radiation activities in which the education, training and competence of any individual proposed by the licensee are assessed. In addition, INRA supervises and controls the safe management of radioactive waste, and in this regard, it has recently developed the "Safe Management of Radioactive Waste" regulations. In recent years, owing to the needs and problems of industry in finding suitable radioactive sources and the storage risk of disused sealed radioactive sources, INRA has issued authorization for the reuse of disused sealed radioactive sources with the purpose of reducing radioactive waste. Moreover, by establishing and maintaining a system of inventory as a part of the regulatory approach, all sealed radioactive sources are accounted at all stages from the production to waste. Besides, through the establishment of an online portal monitoring system at ports of entry, INRA is now able to detect contamination of goods with radioactive substances with a much high speed and accuracy. In addition, all the decommissioning requirements of a radiation facility are recently incorporated into the revised regulations by INRA. The activities carried out by INRA which leads to reduction in radiation detriment will improve safety and human health and protect the environment, thus enabling the sustainable development.

IAEA CN-318/168

Stakeholder engagement in the decommissioning of a uranium mine in Brazil

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The Caldas Decommissioning Unit (UDC), belonging to Nuclear Industries of Brazil (INB), was the first uranium mine in Brazil that operated from 1977 to 1995. Currently, actions are carried out to mitigate environmental impacts and recover degraded areas under supervision by regulatory bodies (Ibama and CNEN) and other civil society representatives.

There are several challenges in decommissioning, including stakeholder engagement. The lack of public acceptance stands out due to society's little knowledge of the nuclear issue. Still, the role of regulatory bodies is hampered by gaps in Brazilian legislation. For this reason, actions have been developed to bring together the stakeholders, involving communication with society and licensing regularization. Environmental education and social communication programs were implemented with the aim of increasing dialogue and knowledge among the population. Regarding the licensing process, several actions have been developed with the regulatory bodies, with an emphasis on the creation of the Decommissioning Commission. Furthermore, all decommissioning activities are described in the action plans, which have been presented to regulatory bodies and others.

Therefore, it is expected that there will be improvements in the public's perception, an approximation of regulatory bodies, and more effective participation of stakeholders in decision-making in relation to decommissioning actions.

IAEA CN-318/214

New regulatory framework for Radioisotopes Production in Brazil – Decommissioning aspects

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1 CNEN/Brazil

The decommissioning stage is a challenge in licensing nuclear and radioactive installations worldwide. The decommissioning of radioisotope production facilities can generate tons of long-lived radioactive waste, requiring specific procedures for dismantling, demolition, packaging, and managing the radioactive waste generated. In Brazil, advances in the area of radioisotope production resulted in the publication of a recent regulatory framework for radioisotope production facilities with cyclotron accelerators, in which the decommissioning stage was considered from the construction stage, aiming at cost and radiological environmental impacts reduction, and sustainability. The regulatory framework establishes that, from the beginning of the project, a preliminary plan for withdrawing from the operation and adequate financial resources to cover the costs associated with the decommissioning, including the management of waste arising from this operation, also considering a possible premature decommissioning of the facility. Furthermore, the project must describe the removal layer for decommissioning, computational estimates for the activation of concrete and equipment components, and justify the constructive aspects chosen about radiological impacts and complexity for future decommissioning. The assessment of factors related to decommissioning in the pre-operational stages of the licensing process is an excellent regulatory approach aimed at sustainability and cost reduction in the decommissioning of radioisotope production facilities.

IAEA CN-318/220

HARPERS Project Phase I - Methodology to identify needs and priorities in issues related to harmonised practices, regulations, and standards in waste management and decommissioning

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The 3-year HARPERS project aims to establish and clarify the benefits and added value of more aligned and harmonised regulations, practices, and standards in decommissioning and radioactive waste management between EC Member States. The project focuses on the following themes i) cross border services/facilities, ii) moving to a circular economy and iii) implementation of advanced technologies.

The project output will be a series of position papers that will provide clear guidance regarding different impacts (technological, business, economic, societal, etc.) identified for a selection of prioritised topics identified in relation to the themes above. The consolidated outputs can be used to inform (future) strategic research agendas (and updates).

For reasons of pragmatism for the short time frame of the project, the project will only focus on a limited set of identified priority topics which serve as case studies. The identification of the priority topics was conducted in 4 steps. First a broad gap analysis was performed on identified relevant documents (69 documents analysed) which provided a solid basis of possible issues/topics. Secondly (in parallel), a stakeholder community was built (300 organisations contacted). Thirdly, a series of webinars were conducted with registered stakeholders to engage with them on the outcome of the gap analysis in order to further fine tune identified priority areas. In the 4th step, the outcome of the workshops was carefully evaluated to narrow down to a limited list of priority topics that will be further analysed within the 2nd Phase of project.

IAEA CN-318/280

Possibilities and challenges of RWM with regard to Civil Society interactions

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Civil Society (CS) experts involved in the ROUTES (Waste Management routes in Europe from cradle to grave) work package of the EURAD programme , together with Radioactive Waste (RW) technical experts, have investigated how the pillars of the Aarhus Convention together with a broader understanding of Transparency and Public Participation (T&PP) can be transposed into Radioactive Waste Management (RWM) in the establishment of RW facilities, primarily geological disposal repositories, in different national contexts. Criteria for T&PP in the development of RW facilities are proposed, based on the EC Radioactive Waste and Spent Fuel Management Directive, the Aarhus Convention and the CS BEPPER report focusing on Broad Framework for Effective Public Information and Participation in Environmental Decision-making in RWM. In this perspective, the possibilities and challenges of RWM in Large Inventory Member States and Small Inventory Member States are analysed with regard to interactions with CS, drawing on various exchanges between the CS experts and experts from RW management organisations, RW technical support organisations and RW research entities within ROUTES, including the last exchange at a workshop held at Nuclear Engineering Seibersdorf GmbH in Austria in May 2023, where contrasting examples of CS engagement approaches in LIMS and SIMS were compared.

IAEA CN-318/143

Abstract of presentation of Lithuanian legislative framework on decommissioning of nuclear facilities

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1 State Nuclear Power Safety Inspectorate

Ignalina INPP has two units with RBMK-1500 reactors. Unit 1 was shut down in 2004 and Unit 2 – in 2009. Pursuant to the provisions of the Law on Nuclear Safety the Ignalina NPP Units operation licences are valid as long as nuclear fuel is there. All spent nuclear fuel is removed from the Unit 1 and Unit 2 storage pools to a dry storage facilities in 2022.

The State Enterprise Ignalina NPP (thereinafter – SE Ignalina NPP) during transition period from operation to decommissioning undertake activities to prepare for decommissioning as well as building necessary infrastructure for radioactive waste management. Implementation of a number of dismantling and decontamination (D&D) projects related to equipment no more needed started at this transition period as well. State Nuclear Power Safety Inspectorate (thereafter – VATESI) developed legislative framework allowing to proceed dismantling activities within the frame of operational licence. Hence, authorisation of decommissioning activities is implemented by the granting of the licence for decommissioning as well as granting permissions for individual dismantling and decontamination projects.

Safety evaluation is a key issue for authorisation of decommissioning activities. Aspects of a safety assessment for granting of decommissioning licence as well as authorisation of dismantling and decontamination projects (e.g., overview of content of safety analysis reports) based on examples from Ignalina NPP decommissioning projects to be presented.

VATESI established procedures for authorization of release of buildings and site from regulatory control, including site and buildings investigation process and required VATESI agreements on radiological characterization programmes and reports. Main aspects of this process to be presented.

IAEA CN-318/256

Public perception and acceptance of nuclear energy in Turkey: An empirical analysis based on Twitter

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Public opinion is an important factor regarding success of nuclear energy policy implementation in a country, and existing literature focusing on determinants of public opinion emphasizes trust in a variety of stakeholders, perceived risk and perceived benefits as the path leading to acceptability. However, until recently most of the studies were dependent on surveys or interviews. In order to fully grasp views of society in the matter we must look into big data with help of social media. The novelty of this study lies in the quantitative analysis of Twitter data in Turkey by identifying a panel of subscribers for a specific time interval, observe the relation of opinions with being located near power plants, being exposed to NGO and political party views via sentiment analysis and network analysis. What are the main aspects of public perception of nuclear energy? Are there variations for different stage and locations (Mersin, Sinop and Tekirdağ in particular where power plants are expected to be)? Are there any influencers in the nuclear power topic network? Are there any significant differences in perception among subscribers due to being exposed to NGO/influencer/political party activity on Twitter that should lead to alliance strategy locally or nationally?

POSTER SESSION 2: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN MANAGING RADIOACTIVE WASTE AND NORM

IAEA CN-318/116

Lu-175 in PET Detectors – Impact on Medical Image and Legal Remediation Issues

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1 Center for Nuclear Medicine Cli9nical Center of Serbia

Introduction: The most PET devices contain scintillation crystals based on lutetium - LSO or LYSO. Lutetium Lu-175 is incorporate with radioactive Lu-176 (abundance 2.6%; T1/2= (3.56±0.07) ×1010 years; β- radiation (Emax=596keV), followed by three simultaneous γ-ray emissions (energies: 88, 202 and 307keV)). Taking into account long half-life, lutetium activity could be considered as constant - 52.61±0.36Bq/g.

Objective: The objective is to estimate the amount of radioactive lutetium in Siemens Biograph 40 64 PET-CT device, potential impact on the diagnostic information and to emphasize the importance of remediation, to protect environment.

Methods: Based on the dimensions of the crystal, mass number and the total number of crystals, it was estimated the share of isotope Lu-176 in the overall mass, and the associated radioactivity.

Results: According to the device technical specification, it was determined the detector size and calculated the mass of detector unit - 2,368g. Furthermore, there are 169 crystals per detector block and 144 detector blocks, which leads to the total detector mass - 57627g, from which the share of Lu-176 is 1150g. Hence, there is ring distributed radioactivity of about 60.5kBq.

Conclusion: Natural radioactivity of lutetium poses no problem in clinical PET imaging (excitation activities ~100MBq, energy threshold 350keV), but could have influence on the QC examinations with low activities, with Ge-68 point source (activity ~5kBq), and potentially at the end of dynamic studies using C-11 or O-15. After replacement of the detector block or termination of device exploitation, the proper disposal is mandatory.

IAEA CN-318/120

The First Nuclear Security Plan for Nuclear Medicine Departments in Serbia

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Introduction

The new national legislation in Serbia envisages site security plan for a nuclear medicine facility.

Although we have two years to comply with regulations, as the largest nuclear medical institution in Serbia, we tried to implement the appropriate project as soon as possible. Probably due to the low risk, from a nuclear security point of view, relevant issues have not been addressed in the literature by now.

Security targets

Radioactive sources in nuclear medicine are the second and primary third category sources, by both relevant approaches to categorization (activity coefficient or application). Primary security targets are I-131 and Lu-177 capsules for radionuclide therapy, with individual activity of around 7,4 GBq. Considering short half-life, 99mTc/99Mo, with activity in the range 10-30 GBq, brings less security danger. On the other hand, calibration phantoms with long half-life and small dimensions, such as Cs-137, deserves attention, although their activities are in the range 5-200 MBq (adequate storage at the end of period of use in the nuclear facilities of Serbia is mandatory).

Security risk issues

Summarized, the greatest risk is from high activities in capsules for radionuclide therapy and from relatively long-lived radioisotopes in calibration phantoms. The hospital environment is favourable for potential sabotage, and such activities, if successful, would, at the very least, lead to the cancellation of the clinical program and unwanted attention and image in the media.

Optimization

The imperative that is imposed is to achieve defense in depth and balanced protection, with small investment, considering primary nuclear security within the hospital - Gamma knife, as well as merging with other types of security, such as data and fire issues, sharing the infrastructure.

Security response

What if the security system is triggered and there is reason to believe an incident is in effect? It is essential, after shortly confirming the necessity, to ensure adequate interaction with the police in order to respond promptly - a series of meetings were held with the police and a

system was defined for their response to be professional - specially in sense of radioactivity, fast and efficient.

Conclusion

This is the first approved and rounded security plan for nuclear medicine in Serbia.

Overall approach externally and internally raised the level of safety culture.

IAEA CN-318/133

Management of low activity radioactive waste (TORTA II)

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Co-author: Jessica BANDEIRA DE MELO CARVALHO PASSOS

Among the actions aimed at the decommissioning of the Caldas Decommissioning Unit (UDC), branch of Nuclear Industries of Brazil (INB), there is the management of TORTA II, a low activity radioactive waste. This material originated from monazite processing was brought from São Paulo unit, which was decommissioned in the 1990s. There are approximately 13,000 tons of waste packed in 40,000 drums stored in sheds and semi-buried concrete silos.

Currently, UDC has been improving the waste management in order to guarantee the protection of human health and the environment. Among these actions, the overpacking operation and infrastructure improvements in the sheds stand out. Several occupational radiological controls are being adopted such as the use of personal protective equipment, special clothing, and detectors to control radiation exposure. Other projects involve civil works of the new access control, the renovation of existing shed and the replacement of the semi-buried silo roof.

Among the possible solutions, one is this sale of this material to companies interested in recovering elements such as uranium, thorium, and rare earths. Through all the improvements being made, this material will be stocked safely and properly until the definitive solution is adopted.

IAEA CN-318/139

Application of the JRODOS system and the probabilistic weather data sampling model in the Probabilistic Safety Assessment Level 3 for nuclear installation

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1 National Centre for Nuclear Research

Probabilistic Safety Assessment (PSA) Level 3 assesses the risk for public that can be caused by the spectrum of possible accident scenarios involving any nuclear installation. Level 3 PSA estimates the frequencies of off-site consequences for public health and environment, including economic consequences attributable to the set of radiological release categories and corresponding source terms determined in the PSA Level 2 analysis. Obtaining the above values is based on using appropriate meteorological data basing on existing knowledge and assessment of the effects of a potential release. These methods that are now widely used should be improved by adopting the latest computational techniques and the lessons learned from the accident in Fukushima Daiichi. This publication proposes an advanced probabilistic model for sampling weather conditions basing on the estimated multidimensional probability distribution, which is obtained from long-term measurement data. The JRODOS system was used to calculate the transport of radionuclides in the atmosphere and the dose values. Thanks to using a more robust model of generating meteorological data, PSA L3 results become more transparent and comprehensive, but also easier to identify different negative scenarios and their effects.

IAEA CN-318/148

Evaluating the sustainability of sites for nuclear facilities under the effects of climatic changes on variability of the effective dose to the representative person

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The radiological environmental impact assessment, as part of the safety evaluations for authorizing nuclear facilities, in addition to the characteristics of the planned radioactive releases and information on members of the public distribution and habits, requires the knowledge of the meteorological variables which are relevant for the estimation of doses to the representative person. Climatic changes, which may happen in relative short periods, introduce and additional source of uncertainties. Presently, when weather anomalies are being observed more frequently, it is necessary to evaluate the impact on the doses of such anomalies. This has motivated LARE to reevaluate the effective dose (ED) under the hypothesis of weather annual variability, and to compare with the results using climatological averages. Among the variabilities considered, the estimated ED only showed some deviations in relation to the rainfall. The effects of rainfall variability are limited to distances up to 5 km from the source. Within this distance, for the rainier scenarios, the wet deposition causes more radionuclides to become available over the surfaces, increasing the ED in relation to the estimations using mean values. The opposite is observed on the drier scenario. Beyond 5 km, the two extreme scenarios behave similarly to the mean. Despite the deviations observed, doses in all the scenarios remained much lower than the dose criteria established, warranting the site's sustainability. This work is part of the expert recommendations of a recent IAEA mission.

IAEA CN-318/157

Experience of decommissioning RADON-type legacy storages of solid radioactive waste

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1 TVEL

INTRODUCTION

Decommissioning of nuclear and radiation hazardous facilities refers not only to nuclear power plants, but also to a wide range of specific facilities including storages of radioactive waste.

The paper describes Rosatom's experience in decommissioning of RADON-type legacy storages of solid radioactive waste.

1. COMPOSITION OF RADON-TYPE STORAGE

Section 1 describes typical composition of RADON-type storage on the example of the facility located in Murmansk.

1. TYPICAL COMPOSITION OF RADON-TYPE STORAGE
   Section 2 includes major causes leading to RADON-type storages decommissioning. This includes loss of leak-tightness due to natural degradation of engineering barriers and modification of legislation on radioactive waste management that took place in 2011.
2. EXPERIENCE OF RADON-TYPE STORAGES DECOMMISSIONING
   Section 3 describes the experience of RADON-type storages decommissioning.
3. CASES
   Section 4 covers some cases of RADON-type storages decommissioning. These include Murmansk facility and Leningrad facility (a branch of Federal Ecological Operator). Cases include information on the facilities and decommissioning scope that was carried out.

CONCLUSION

Accumulated experience of RADON-type legacy storages decommissioning may serve for consideration during planning of further projects of similar nature, thus potentially saving financial resources and leading to shorter duration of such projects.

IAEA CN-318/226

Final characterization and Supervision by National Regulatory Body under Site Restoration Plan in Sites after Dismantling Nuclear Power Plant (Jose Cabrera site case)

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The authorization process of a NPP in Spain follows the different stages of these facilities: construction, operation, dismantling and decommissioning. For the dismantling authorization, the licensee is required to send several documents, including the Site Restoration Plan (PRE), which defines the activities to meet the radiological criteria that lead to release (total or partial, with or without restrictions) of the site, including final status survey, based in the site final radiological characterization.

The CSN, Spanish nuclear regulatory body, has published two Safety Guides (GS) related to PRE. GS 4.2 describes the content that must be included in this document and in the final status survey, while GS 4.3 recommends a methodology to verify the radiological situation for release of the site. These Safety Guides stablishes criteria for supervision by the CSN.

The evaluation process of PRE document is analysed from the point of view of the final radiological characterization, taking into account the application of those Safety Guides, though the presentation of Jose Cabrera NPP case, the first to complete all phases of this type of facility in Spain. PRE is currently carrying out in this site, once final version of the document was approved by CSN in June 2022.

IAEA CN-318/238

The role of international cooperation on estimation the erosion rate and decreasing uncertainties in radioactive waste management safety assessment

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The effect of erosion on the long-term safety of the Anarak, Iran near surface disposal facility was one of the main issues considered during the safety assessment and design process. Therefore, the measurement of the erosion rate considered as one of the common projects with IAEA and Hungarian experts who have worked on the issue of erosion before. The various techniques have been studied for estimating erosion rates, and the necessary techniques were chosen in accordance with site conditions. A rainfall simulator that can be used to develop different scenarios was built and has been used in various tests based on different rainfall intensity, slope and soil structures. This device's establishment and tests have greatly aided in evaluation the rates of erosion and penetration for safety assessment and designing proposed covers for trench. International cooperation in this area led to a decrease uncertainty in erosion rate and an improvement in the accuracy of the data used in the safety assessment. This cooperation helped to gain more confidence regarding the design and long-term safety of waste disposal trench covers, which is a sign of the impact of international cooperation on sustainable development in the long-term management of radioactive waste.

IAEA CN-318/261

Enhancing Radiation Safety on NORM Management at Tin Industry to Increase Sustainable Production

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Indonesia is the second largest tin producer in the world, so this industry is one of the industries that influences Indonesia's incomes, especially in Bangka Belitung Islands Province. As is commonly known, the tin industry produces Naturally Occurring Radioactive Mineral (NORM) in its production process, so it requires a proper management from mining, processing, and smelting. The tin industry in Indonesia consists of large companies, medium companies, small companies, and micro companies. With the company levels from large to micro companies, the radiation safety management is very different. From the research conducted in 2019 to 2021, the radiation safety on average is still weak and several recommendations have been made for improvement, such as raw material handling methods, processing methods, product handling and residue handling which can be in the form of interim storage, re-processing, or disposal. Several things have been done to improve this safety, namely conducting radiation safety socialization to stakeholders, holding workshops, applying existing regulations, and making efforts to change regulations according to international recommendations and current conditions in Indonesia. The impacts of safety on sustainable production of tin industry would be discussed in the paper. By improving radiation safety, the sustainability of tin production in Indonesia will be even better, both from an economic, social, and environmental perspective.

IAEA CN-318/25

Sustainability in Safety for Borehole Disposal of Disused Sealed Radioactive Sources: Malaysian experience

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Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. It should be balanced between economic growth, environmental protection, and societal wellbeing. The development of safe, sustainable, and societally acceptable strategies for borehole disposal of DSRS is essential. Boreholes disposal of DSRS reduces safety and security risks and enables their efficient management. In order to ensure the disposal of DSRS into borehole is not harmful to the public and the environment, the safety case and safety assessment are vital. Furthermore, sustainability of the safety is very critical to guarantee protection of worker, the public, the environment, and future generation. To ensure sustainability of the safety is achieved, several actions shall be engaged which include borehole technology, site selection, borehole design, disposal container design, capsule design, selection of material for disposal container and capsule, type of cement used in borehole, welding technology, type of radionuclides to dispose of quality assurance and public acceptance. This paper will enlighten what actions had been taken to ensure the sustainability in safety for Malaysia first borehole disposal of DSRS.

IAEA CN-318/34

Legislative Framework towards Safe Management and Disposal of Disused Sealed Radioactive Sources: Nigeria's Experiences, Challenges and Prospects

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Nuclear technology is applied in numerous sectors of the Nigerian economy ranging from petroleum industry, Industrial sector, health sector, mining, agricultural sector, security screening, education, and research, to handle many socio-economic challenges in a way that is beneficial to the public. The legislative framework for regulating the possession and application of nuclear technology in Nigeria is the Nuclear Safety and Radiation Protection Act No. 19 of 1995 (the Act), which establishes the Nigerian Nuclear Regulatory Authority (NNRA) as the only Competent National Authority saddled with the responsibility for nuclear safety and radiological protection regulation in Nigeria. The Act clearly establishes the requirement that mandates operators of nuclear and radiological facilities towards ensuring safe utilization, management and disposal of disused sealed radioactive sources thereby ensuring public and environmental protection from unjustified radiation exposure and contamination arising from such practices. The NNRA provides regulatory oversight on all facilities utilizing radioactive sources and ionizing radiation generating equipment in Nigeria thereby ensuring safe management after use in line with radiation protection standards. This presentation highlights Nigeria's Experiences, Challenges and Prospects towards Safe Management and Disposal of Disused Sealed Radioactive Sources after their useful life.

IAEA CN-318/92

Integrating the views of society into decision-making considering technical, environmental, social, and economic factors

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1 CODDAE

We first retain the concept of stakeholder is used to designate any individual or group who contributes to the implementation of a project or who are the beneficiaries or who share the risks of the project.

Studies on radioactive effects and impacts concern in particular contamination, environmental degradation, risks related to the contamination of natural resources, etc.

As a result, to implement a nuclear project, taking into account the points of view of the surrounding populations (stakeholder) are essential to not only ensure its acceptability, but also its sustainability.

The involvement of the community will influence the optimization of protection and security and can identify other traditional techniques used to detect the level of contamination with a view to their modernization.

Several projects were unable to achieve their long-term objectives because the points of view of the beneficiary company were not taken into account, which motivated the introduction of the results-based approach in the new term of the design of development projects.

IAEA CN-318/114

Building policy, strategy, and regulation to ensure the radiation safety of waste containing radionuclides of natural origin management

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1 State Nuclear Regulatory Inspectorate of Ukraine

Today, in Ukraine on the sites of oil and gas production industry enterprises, significant volumes of radioactively contaminated waste have been collected (pumping and compressor pipes, slurries, bulk waste etc.). The levels of surface contamination or specific activity of this materials exceeds the levels of release of radioactive materials from regulatory control.

Ukraine faces the task of development the State strategy and radiation safety system on management of naturally occurring radioactive material (NORM) and waste containing NORM (NORM-waste).

The development and implementation of Policy and Strategy for management of NORM and NORM-waste will allow to ensure protection of workers, public & environment during the generation, accumulation, decontamination of equipment contaminated by NORM and NORM-waste) and disposal of NORM-waste that generated.

POSTER SESSION 3: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN MANAGING RADIOACTIVE WASTE

IAEA CN-318/2

Creation of a Disposal Facility for the Very Low-Level Radioactive Waste at the Rooppur Nuclear Power Plant (RNPP)

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1 Bangladesh Atomic Energy Regulatory Authority

The first condition for the development of a country is uninterrupted power supply. In the world from the ancient period strongly bonded among economics, environment, and energy. Energy security is the most important for any country's national security, standards of living, strong economics etc. As a long terms sustainable energy supplies the Government of Bangladesh contracted with Russians government to set up two units of nuclear power plant at the Rooppur region of the country. But it is big challenge for the country to maintain the radioactive waste. There are four types of radioactive waste generate from nuclear power plants. Such as High level, Intermediate level, Low level and Very low-level radioactive waste. This paper considers the construction of an interim storage facility for a very low-level waste (VLLW) at the Rooppur Nuclear Power Plant (RNPP) site. Given information on the formation and handling of VLLW at the Rooppur NPP. Presented characteristics of the disposal facility for VLLW with a approximately volume of 11,500 m3. In the nuclear power plant use fresh fuel UO2. But when it is burnup, then produce different types of radioactive chemical element. In this paper these different types of elements were identified by the program GETERA.

IAEA CN-318/3

Radioactive Wastes from Decommissioning of The RTC Of JSC “Foton”

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1 Institute of Nuclear Physics AS RU

Decommissioning of the Radiation-technological (RTC) site of the JSC «FOTON» including 2 gamma facilities and IIN-3M pulse liquid fuel research reactor occurred in 2015-2019. During decommissioning 46 twenty-liter plastic containers with very low dose rates from reactor cooling system were transported to the Institute of Nuclear Physics for reprocessing at AQUA facility. Solid radioactive wastes including 6 oversized containers with reactor tank and other reactor systems and 456 metallic two-hundred-liter drums and 2 big-bags with wipes were transported to the National repository (Republican Radioactive Waste Disposal Facility - RRWDF). Special storage for the radioactive wastes from the RTC site was built at the RRWDF with the capacity of 976 cubic meters.

IAEA CN-318/8

Decades of personnel and environmental safety in the management of radioactive waste facility in Ghana for a sustainable socio-economic development

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1 Ghana Atomic Energy Commission

Nuclear science and technology have contributed immensely to the socio-economic development of Ghana, especially in medicine, industry, agriculture, and research. The provision of effective protection to occupationally exposed persons, the public, and the environment underpins the successful management of radwaste, thus the need for this study. Twelve years (2011 – 2022) of personnel and environmental radiological data from the centralized radwaste facility shows that the mean annual average radiological data ranged from 0.07 – 1.06 µSv/h. The decay store of the facility which contains scrap metals from dismantled disused sealed radioactive sources (DSRS), and low-level wastes from Ghana's Research Reactor exhibited the highest mean annual average dose rate of 1.06 ± 0.92 µSv/h. The range of the mean annual average personnel dose equivalent is 0.41 – 2.07 mSv which is below the ICRP limit of 20 mSv. Principal component analysis indicates that the dose equivalent is primarily influenced by the radiation associated with the outer wall surface of OFF-3, LAB, and washroom where no DSRS are stored. This implies that the dose equivalents are not essentially attributable to the radiation exposures of personnel during operations at the facility where DSRS are stored. Therefore, the existing radiation protection measures at the facility are effective.

IAEA CN-318/31

Pre-operational radiologic monitoring program of Türkiye's first open pit rare earth element mining and processing area.

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1 Turkish Atomic Energy Authority

Facilities that will carry out rare earth element (Thorium and Uranium) extraction, processing and storage activities are considered in the scope of nuclear facility. For this reason, the founder carries out an environmental radiological monitoring program for a period of 1 year to determine the background radiation in the environmental environment in and around the mine site. Then, it submits the report of the pre-operation environmental radiological monitoring program to the national Nuclear Regulatory Authority (NRA) for approval. As it is known that, this practice is carrying out in other countries in the world in a similar way with some differences. In this study, information about encountered difficulties and practical experiences regarding with preparation, application and evaluation phases of radiological monitoring programme is given in a flow chart. At the end of one year, on-side dose calculation was made for the mine site and surrounding settlements.

IAEA CN-318/35

Regulatory Control on the Disposal of Naturally Occurring Radioactive Material (Norm) Waste Produced from Petroleum Industry in Malaysia For Safety and Environmental Sustainability

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Crude oil and its products and waste from petroleum industry containing naturally occurring radioactive materials (NORM). Human activities in the petroleum industry namely extraction, processing crude oil and natural gas activities generated significant number of wastes containing NORM. In addition, the specific radioactivity of these NORM waste may be enhanced due to technological and human activities, which eventually may pose potential environmental and health risk. This will require continuous attention by monitoring and surveillance during the disposal process in the petroleum industry. Typically, there are two types of NORM wastes generated in this petroleum industry such as oil sludge and scale. From the year 2019 till year to 2020, Malaysia had disposed 157 ton of NORM wastes from the petroleum industry. Depend on specific radioactivity in the uranium and thorium contents, NORM wastes with specific radioactivity above 1 Bq/g need to obtain approval from regulatory authority before disposal. Then, those NORM wastes will be transported and incinerated in an incinerator by the licensed facilities. This study presents the regulatory control of the disposal of NORM waste produced from typical petroleum industry for safety and environmental sustainability. In conclusion, the regulatory control of the disposal of NORM waste produced from petroleum industry is warranted for radiation protection towards legislative compliance in ensuring safety of the public and workers and the protection of the environment.

IAEA CN-318/36

A Portable Low Level Waste Incineration System of China Institute for Radiation Protection

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There are three sets of fixed-site pyrolysis incineration facilities for low-level combustible solid waste in China at present. They can realize the waste disposal in nuclear base but can't meet the actual needs for many departments and units with less combustible solid waste production. In addition, conventional fixed-site incineration facilities also have problems of relatively high construction and operation costs, excessive operating personnel, and complex management procedures, leading to the limitations of its application and popularization. In response to this situation, the China Institute for Radiation Protection has developed a portable low-level combustible waste incineration test device by reducing needless equipment and designing compact and integrated layout. It has many advantages such as compact equipment, portable transportation, small footprint, simple operation and maintenance procedures and low construction costs, which can achieve the goal of multiple-sharing and local-disposal of low-level combustible waste. Up to now, a set of portable incineration test device with 1:1 scale has been developed and verified reliably. Furthermore, the development of the second-generation portable incineration engineering test device has also been carried out.

International Conference on the Safety of Radioactive Waste Management,

IAEA CN-318/39

Site Selection Procedures at the Initial Stages of The Implementation of DGR Programme in Lithuania – Lessons Learned

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1 Ignalina NPP

2 Lithuanian Geological Survey

During the assessment of potential geological Formations according to suitability for the deep geological repository (DGR) the positive and negative screenings of Lithuanian territory were performed. The criteria for the negative screenings have been covered protection zones of wellfields protection zones, European Natura 2000 areas, cities, areas of mineral deposits, formation thickness smaller than 50 m, depth of formation less than 200 m, paleo-incisions penetrating the pre-Quaternary succession, areas with an area larger or considerably smaller than 10 km2. After eliminating the unfavorable regions according to the above-mentioned criteria, 110 potential areas have been identified covering all the geological formations selected as a potential formation for the DGR (Crystalline basement, Cambrian and Triassic clay, Permian evaporates) during the previous investigations carried out in years 2005-2020.

In regard to the positive screening procedures the territories potentially suitable for DGR construction shall be assessed under the following selection criteria: geological suitability, socio-economic and general safety criteria. The determination of the geological criterions was based on IAEA and EU regulatory documents and application of best practices from advanced DGR countries also strongly considering the peculiarities of the geological and tectonic structure, seismicity, geomechanical and hydrogeological characteristics of the host rocks and the subsurface processes occurring in the territory of Lithuania. The geological criteria established by Lithuanian geological survey were divided in two main groups: 1) a set of criterions ensuring the reliable stability of DGR; 2) a set of criterions for sufficient physical isolation of a DGR from biosphere. Taking into account the above-mentioned criteria and availability of the geological data, the geological criteria have been defined for the selection and ranking procedures for all 110 previously identified sites comprising the potential geological formations. After the screening it was determined that from 110 previously identified areas, 31 areas should be eliminated based on geological criteria. At present, all remaining 79 areas are considered as potentially suitable for the further studies. Based on the analysis of the geological data the rather limited suitability of Permian evaporites in Lithuania (salt rocks and anhydrates) has been identified and, accordingly, these Permian formations were excluded from the set of the potential areas to be further investigated.

The social-economical analysis has provided a methodology, criterions, and guidance for the rating of the potential sites of DGR from this perspective.

Permian evaporates has been also confirmed by results of the general safety analysis of the potential areas of DGR in Lithuania.

A combined analysis of all three (e.g., social-economical, geological and safety characteristics) studies will be carried out to substantiate a decision towards the furthermore detail geological

investigations aimed in final determination of the most suitable DGR sitting locations (likely 3-5 potential sites).

IAEA CN-318/41

Immobalization Of Spent Resin Using Palm Oil Fuel Ash (POFA) Supplemented Cementitious Material

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The spent resin from the effluent treatment process and operation of the TRIGA PUSPATI reactor is one of the low level radioactive wastes managed by the national radioactive waste management centre at the Malaysian Nuclear Agency. This waste cannot be stored in its original form for a long period of time to avoid the radiological impact on humans and the environment. The spent resin used is Amberlite IRN 150 type, a spherical-shaped absorbent resin. Current work investigates the compatibility of palm oil fly ash (POFA) as the supplementary cementitious materials in the immobilization of spent resin in a cementitious matrix. POFA, an organic waste material from palm oil mills, has similar characteristics as other industrial supplementary cementitious materials normally in use. Other desirable features of POFA are low density and hardens quickly with minimal use of water. Therefore, the aim of the current work is to determine the optimum ratios of cement, POFA, and resin for the robust and durable radioactive waste immobilization system. The performance of the matrix system can be tested by compression tests following ASTM C-39/C39M-09a standards with maximum application stress of 2000kN. Characterization methods such as Field Emission Scanning Electron Microscope (FESEM), X-Ray Diffraction (XRD) Spectrometer, and CHNS analysis will be performed on the samples, hydrous or anhydrous to complement the mechanical data with a morphological and structural understanding of the system. Therefore, through this study, if the system can satisfy the waste form performance requirement in strength, waste loading, and slow leaching, the potential of POFA as an alternative supplementary cementitious material can be explored.

IAEA CN-318/50

Gamma radiation- induced synthesis of polyaniline/CuWO4 nanocomposite for potential sorption of Cobalt-60 and Cesium-137 from aqueous solutions

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The release of cobalt-60 and cesium-137 in the environment is considered dangerous pollutants. In this concern, the present work deals with gamma radiation-induced synthesis of novel polyaniline/CuWO4 (PANi/CWO) nanocomposite adsorbent and estimating its potential adsorption capacity for cobalt-60 and cesium-137 from aqueous solution. The crystallite size of pure CWO NPs and PANi/CWO nanocomposite is found in the nanoscale range. Also, SEM images and XRD results confirmed the successful preparation of PANi/CWO nanocomposite. Further, the elemental mapping images proved that all entire elements were homogeneously distributed over the PANi/CWO nanocomposite. Besides, the adsorption experiments were conducted separately to investigate the adsorption behavior of cobalt-60 and cesium-137 by PANi/CWO nanocomposite. Adsorption processes have also been performed, and numerous factors, including medium pH, contact time, initial metal ion concentration, and temperature, have been tested. Batch experiments were done to get the optimum conditions for removing cobalt-60 and cesium-137. Four Kinetic models were investigated, indicating that the adsorption process of cobalt-60 and cesium-137 onto PANi/CWO nanocomposite is controlled by chemisorption and intra-particle diffusion. Four equilibrium isotherm models were investigated, revealing that the adsorption process is a monolayer and multi-layer process on a heterogeneous surface. The negative (ΔHo) value suggested that this study's removal of cesium and cobalt has an endothermic behavior, whereas the positive (ΔSo) value proved that the examined system is random. The effect of temperature was investigated, and the calculated thermodynamic parameters indicated that the removal of cobalt-60 and cesium-137 by PANi/CWO nanocomposite has an exothermic behavior.

IAEA CN-318/51

Conceptual Design of Transportation Container for Radioactive Waste Fission Product Molybdenum Capsule

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2 BATAN

It is a necessity that the use of nuclear technology will generate radioactive waste that has a low to high radioactivity range. Molybdenum radioisotope production by fission process in the reactor carried out by PT INUKI produces stainless steel capsule waste with a dose rate of about 1 Sv/hour. To ensure the safe operation of facilities at PT INUKI, the waste must be managed by sending it to the radioactive waste management facility belonging to the Directorate of Nuclear Facility Management (DPFK). Adequate transport containers are needed to contain radiation and ease of handling of the waste in order to ensure safety in its transportation. The transport container was designed using Micro Shield software with input data derived from a survey that had been carried out on stainless steel capsule waste inside the PT INUKI hotcell. In this modeling, several choices of shielding materials are used to achieve optimization in terms of cost and technicality in the field. The combination of iron-lead-iron material is considered more optimal with a smaller thickness, namely 0.4cm-10cm-0.5cm respectively. With the choice of material and thickness, the modeling results have met the requirements for the dose rate for transport, which is a maximum of 2 mSv/hour.

IAEA CN-318/55

Evolution of Approaches to Calculation Justification of Long-Term Safety of Radioactive Waste Disposal Facilities in the Russian Federation

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In 2004, the IAEA published the results of the international project ISAM (Safety Assessment Methodologies for Near Surface Disposal Facilities (NSDF)) [1], which was devoted to current approaches to safety assessment and the calculation tools used. In the ISAM project as a perspective approach to the NSDF long-term safety assessment the use of the compartmental modeling was considered.

Using compartmental modeling SEC NRS has carried out long-term safety assessments of Radon-type long-term storage facilities for radioactive waste, tailings and other similar nuclear legacy facilities. The experience of using compartmental modeling pointed to its fundamental drawback, which is associated with obtaining excessively conservative results due to a significant simplification of the engineered barrier systems of radioactive waste disposal facilities (RWDF) and the geological environment. In particular, when using compartmental modeling it is impossible to consider some features of engineered barrier, topographical relief, the presence of flooding factors, geological heterogeneities such as tectonic disturbances, regional hydrogeological conditions, real paths of radionuclides migration.

In accordance with the legal and regulatory acts of the Russian Federation, based on the results of the long-term safety assessment the choice of RWDF site, engineered barriers system, and radioactive waste acceptance criteria should be justified. Consequently, over conservatism can lead to mistakes in RWDF site selection, underestimation of RWDF useful capacity, excessive costs of engineered barriers system, and errors in determining doses of public exposure.

Currently, there are computer programs that can be implemented to RWDF long-term safety assessments based on a realistic approach, in which the initial data, model parameters and boundary conditions are confirmed by field data and experimental studies. In such case, it is reasonable to use modern computer programs that allow developing three-dimensional grid models based on numerical methods of finite elements, finite volumes or finite differences, allowing to consider a wide range of processes occurring in the disposal system, real paths of radionuclide migration, geological heterogeneities and exact geometry of RWDF elements. A successful example of the use of such computer programs in SEC NRS is the work carried out in 2017 - 2019, on the calculation justification of the long-term safety of unique and technically complex radioactive disposal facilities in the Russian Federation - deep well injection disposal facilities for liquid radioactive waste, as well as on the development of NSDF models for independent regulatory assessments.

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IAEA CN-318/65

Cost Benefit Analysis of Liquid Radioactive Waste Treatment Methods

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Along with the development of nuclear technology, such as nuclear reactors, comes the potential to produce radioactive waste. One of the wastes from the operation of a nuclear reactor is liquid radioactive waste, which must be treated properly to ensure environmental safety. Liquid radioactive waste treatment can be done in various ways, such as by evaporation and ion exchange. Evaporation is the treatment of liquid radioactive waste by evaporation using steam, while ion exchange is the treatment of liquid radioactive waste by exchanging the cations or anions in the waste. From the two methods of liquid radioactive waste treatment, it is necessary to carry out a cost-benefit analysis in order to achieve efficient and cost-effective liquid radioactive waste treatment. Cost-benefit analysis can determine an optimum method by combining aspects of safety and sustainability. In the aspect of safety, the potential dangers of the two methods of treating liquid radioactive waste Whereas in the aspect of sustainability, the energy requirements required from both liquid radioactive waste processing methods.

IAEA CN-318/68

Radiological characterization of radioactivity around nuclear facilities

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Summary. The main objective of this work is to characterize the different compartments of the environment, by considering samples of air, soil, and fresh water, in order to protect the environment and the public from the harmful effects of ionizing radiation, and to control the reference level of natural and artificial radioactivity. Soil samples were taken in various undisturbed areas of the Draria Nuclear Research Centre (CRND). Air samples were collected using high flow air sampling pumps. Water samples were taken from various locations by GPS. samples collected and packaged are analysed by direct counting by gamma spectrometry in a reference laboratory. The results obtained clearly show that the level of radioactivity measured remains stable with a normal level of natural radionuclides in soil samples. As for artificial radioactivity, it is represented by traces of 137Cs in the soil, probably resulting from nuclear tests since 1945, and/or the Chernobyl accident.

This characterization strengthens and upgrades the real-time environmental monitoring system.

Keywords: Radioactivity, 137Cs, Air, Soil, water, gamma spectrometry.

IAEA CN-318/72

Sustainability Aspects in Radioactive Waste Management in Lithuania

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Ignalina NPP has been permanently shut down and is currently in the decommissioning phase. Decommissioning activities, besides dismantling projects, also include construction and operation of treatment, storage, and disposal facilities for radioactive waste. Before the start of decommissioning activities, licenses and permits for the implementation of a certain activity shall be obtained from regulatory bodies and public administrations. Licenses and permits are granted based on the submitted studies, reports and other documentation that justify safety as well as demonstrate sustainability aspects of the planned activity. The aim of safety analysis is to demonstrate that the planned activity or radioactive waste management facility meets safety and regulatory requirements. The format and content of the safety analysis report presented either in the national regulations or IAEA safety guides do not set direct requirements to consider sustainability aspects. However, other documents that are obligatory, for instance, the Environmental Impact Assessment (EIA) Report, cover a wide range of such aspects as potential direct and indirect impacts on public health, flora and fauna, air, water, climate, social-economical, biodiversity, etc. About twenty radioactive waste management projects in Lithuania have been harmonized with authorities, public and other relevant parties and passed EIA procedures.

IAEA CN-318/88

Treatment of low level radioactive waste containing 134Cs radionuclide using modified natural clay

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Safe treatment of radioactive waste containing Cs-134 is the aim of this work, it includes;

1. Introduction

2. Experimental

2.1. Preparation of sorbent material

2.2. Characterization of the prepared material

2.3. Sorption experiments

2.3.1. Effect of pH on the treatment process

2.3.2. Effect of contact time and concentration

3. Results and Discussions

3.1. Characterization of the prepared material

3.2. Effect of pH on the treatment process

3.3. Effect of contact time at different concentrations

3.4. Equilibrium isotherm

3.5. Comparison of sorption capacity of cesium onto different materials

4. Conclusion

IAEA CN-318/89

Sorption of Radioactive 60Co and 137Cs in low level radioactive waste onto crosslinked Crown ether Polymeric Composite

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IAEA CN-318/103

A Proposal Study for Storage and Disposal of Low-Level Radioactive Waste in Salt Cavities of Anatolian Region, Türkiye

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In this study, it is given a proposal on storage and disposal of low-level radioactive waste in salt cavities of Anatolian region in Türkiye. First, in the study, general information about radiation and nuclear facilities and radioactive waste management in Türkiye are given. Until August 2018, Turkish Atomic Energy Authority (TAEK) was the regulatory body of Türkiye. After that time, the regulatory activities of TAEK have been transferred to the Nuclear Regulatory Authority (NDK). Thus, NDK has undertaken the regulatory activities concerning facilities (including nuclear power plants), devices, substances and activities related to nuclear energy and ionizing radiation as the regulatory authority of Türkiye. Türkiye does not operate any nuclear power reactors at now. But WWER-1200 type reactors are under construction in Mersin Province under the agreement signed with the Russian Federation in 2010. Nuclear fuel loading to this facility, which will be Turkey's first nuclear power reactor to generate electric energy, was announced on April 27, 2023, by President of Republic. Concurrently, the radioactive materials and radiation devices are used to many beneficial applications such as medicine, industry, energy production, agriculture, and research in Türkiye. The waste generated during the operations of nuclear power plants and from the use of radionuclides in medicine, industry and research is managed routinely and disposed of, usually, in near surface disposal facilities. As increasing numbers of nuclear and radiation facilities reach the end of their useful lives and are decommissioned, the need to make additional arrangements for the management and disposal of the associated waste is being recognized both in terms of creating extra disposal capacity and of developing new types of disposal facilities. In this scope, one of the possibilities for the disposal of radioactive waste products is its underground storage in space formed within deposits of rock salt. Second, this study contains information concerning the characteristics of rock salt, its occurrence in Anatolian region of Türkiye, and the underground space resulting from mining operations such as salt cavities in Çankırı, Kars, Yozgat, Nevşehir, Kırşehir and Erzurum cities. A proposal consideration is then given to the feasibility of using such space for low-level radioactive waste disposal in salt cavities.

IAEA CN-318/107

Methodology for deriving criteria for the acceptance of cellulose-containing waste throughout a low-level radioactive waste repository

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The Republic of Korea has been operating a low- and intermediate-level radioactive waste disposal site since 2015. Recently, the issue of the impact of isosaccharinic acid (ISA), a type of complexing agent, on the migration of radionuclides has emerged as a factor for the safety of the repository. ISA is a cellulose-derived material that is highly adsorptive to radionuclides, which can be an important consideration for the long-term safety of a repository. This study analyzed the current status of cellulose-related regulatory requirements and acceptance criteria in Korea. In particular, an advanced case (Sweden) was analyzed. To analyze the phenomenon of nuclide migration by cellulose, we designed experiments on the solubility and adsorption of radionuclides depending on the concentration of cellulose and elaborated an experimental design for the degradation rate of ISA caused by cellulose, which will be directly affected as a complexing agent. The total amount of ISA available for disposal in the derived disposal facility was then finalized.

IAEA CN-318/23

Experiences Of Integrating Safety and Sustainability of Radioactive Waste Management of Nuclear Medicine Facilities in Kenya: Case Study of Kutrrh

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Medical application of radioactive isotopes in nuclear medicine is gaining popularity in Kenya. Kenyatta University Teaching Research and Referral Hospital (KUTRRH), which is one of the national hospitals in Kenya, is currently using radioactive isotopes such as Flourine-18(F-18) from the installed cyclotron within the hospital, technetium-99m (Tc-99m), Iodine-131(I-131) and Iridiam-192 (Ir-192) for diagnostic and therapeutic applications. This paper demonstrates the hospital's approach in integrating safety and sustainability in managing radioactive waste generated in Nuclear Medicine Department. The hospital has in place Radiation Protection System, Air Compressing Station and Liquid Waste System that guarantees safe and sustainable disposal of unused radioactive material and objects contaminated with it. The installed Radiation Protection System provides real time monitoring of radioactivity levels in the facility and in ventilation exhaust. The Air Compressing Station collects and stores radioactive air from inside hot cells and fume hoods during radiopharmaceutical production. Once the stored radioactive air has decayed, it is discharged in the extraction conduit of the laboratory general ventilation. The automated Liquid Waste System allows collection of radioactive liquid waste from the hot toilets and hot sinks into decay tanks. This system controls a three-ports valve and water supply and informs staff on radioactive liquid status of tank level, radiation level and valve position. For RAW in the form of vials, syringes, needles, cotton swabs, contaminated gloves, and absorbent materials which are low level waste and with short half-lives are stored in lead shielded containers in designated radioactive waste rooms for a minimum period of about 10 half-lives until the residual activity attains background radiation for disposal.

IAEA CN-318/57

Implementing Safety Performance Indicators in the Radioactive Waste Management Facility: Methods, Results, and Challenges

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1 BATAN

Implementing Safety Performance Indicators in the Radioactive Waste Management Facility: Methods, Results, and Challenges. This paper provides an overview of the implementation of safety performance indicators (SPIs) in the National Radioactive Waste Management Facility operated by the National Research and Innovation Agency of Indonesia. The national radioactive waste management facilities discussed in this paper consist of a radioactive waste treatment facility and interim storage for nuclear spent fuel. The PDCA cycle is used to tailor the method to the organization's specific needs, and SPIs are used to assess the effectiveness of safety functions. Generally, SPIs are established to achieve zero accidents, occupational safety, as well as environmental and public safety resulting from the operation of a radioactive waste management facility. From the operation of the RWM Facility, it is hoped there were no accidents resulting in death or permanent disability, and the incident rate was within the acceptable limit. In addition, the maximum dose received by each individual radiation worker must not exceed the dose constraint that has been set. In terms of the radioactive activity released into the atmosphere and waterbodies, both facilities were within the allowable limits. The SPIs are an indicator set every year, reviewed, and improved based on the results achieved in the previous year. However, there were some challenges with changes in organization and policies that impacted the implementation of safety functions. The authors provide suggestions for future improvements based on their evaluation of the strengths and weaknesses of the implementation of safety functions. The findings have implications for the management of radioactive waste in the future, particularly in managing changes in organization and policies.

IAEA CN-318/73

Information system integration on radioactive waste management in Indonesia

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1 BAPETEN

Different radioactive waste data in Indonesia are currently managed by different information systems (IS). The different IS has led to data islands, inaccurate radioactive waste data, and ineffective radioactive waste management. A literature study on information system integration in radioactive waste management in Indonesia has been conducted by qualitative approaches. The main goals are to provide information and challenges on the existing radioactive waste IS in Indonesia, provide solutions to integrate radioactive waste IS, and arrange the integration plan from the government institution's perspective. The study identifies that: some radioactive waste ISs have data duplication, while others have unidentified data or data gaps; IS integration has been in the national strategy and policy plan, however the stage is still premature. The IS integration includes five level choices are classified, i.e., system specification, system-user, islands of technology, organization, and socio-organizational. In conclusion, some challenges identified are bureaucracy capacity, limited resources, technical problems, and different processes owner and data types. The study suggests that the suitable IS integration type is the island of data integration. Organizational integration was not chosen as it might compromise the specialization of each stakeholder. Steps that need to be taken by stakeholders are also proposed to develop the integrated radioactive waste IS architecture in Indonesia.

Keywords: radioactive waste, information system, integration, national strategy, and policy

IAEA CN-318/122

Safe energy management for sustainable nuclear energy

Author: Sibel GEZER (Ph.D. Eng)

Many factors contribute to the ability of any society, whether industrialized or developing, to achieve sustainable development, one of the most important is a supply of energy resources that is fully sustainable. Naturally, for a society to attain or try to attain sustainable development, much effort must be devoted not only to discovering sustainable energy resources, but also to increasing the safety of processes utilizing these resources.

Globally, temperatures have increased to about 1.1 degrees Celsius above pre-industrial levels, and the past seven years have been the warmest on record, according to the World Meteorological Organization (WMO). However, warmer temperatures are just the beginning of the story.

The way shown how the IAEA collaborates with governments and researchers around the world to bring climate solutions to fruition and bolster the capacity of communities to tackle the challenges they face. Good data is the basis of sound decisions. Scientists and decision makers rely on IAEA data to measure climate change. The reference materials for greenhouse gases are the global standard and are used to quantify, trace and identify emission sources. Together with the World Meteorological Organization we are working to expand the use of isotope measurements for greenhouse gases across Africa, Asia and the Pacific, Europe, and Latin America and the Caribbean.

In mitigation, nuclear energy has played a central role. Over the past five decades it has avoided the release of more than 70 gigatons of carbon dioxide. Globally, more than 400 reactors still supply the world with about a quarter of its low-carbon energy and today around 30 countries are considering or embarking on new nuclear power programmes. Nuclear energy already plays a crucial role in mitigating climate change and providing energy security. In these pages the International Energy Agency’s executive secretary elaborates this point.

Nuclear science and technology have for decades been crucial parts of the climate change solution, both in mitigation and adaptation. It is clear the world needs more low-carbon energy and more opportunities to adapt. That means the world needs more nuclear.

IAEA CN-318/218

Research on the management of MTR Spent fuel in the DMN-CAB-CNEA

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1 Comisión Nacional de Energía Atómica – Argentina

The RA-3 research reactor was inaugurated in 1967 to cover the Argentinean demand for medical radioisotopes [1]. The spent fuels from this reactor have been stored in wet conditions in CAE facilities, in the past at the DCMFEI deposit and currently in the FACIRI deposit [2].

There are three proposals for the management research reactor spent fuels [2]:

- Uranium isotopic dilution for use in light water power reactors.
- Return to the country that supplied the enriched uranium when this possibility exists.
- Isotopic dilution conditioning for final disposal in the deep geological repository.

That will be defined when the country defines its nuclear fuel cycle.

In our Uranium Laboratory of the Nuclear Materials Department (LU-DMN) located in the Bariloche atomic centre, we worked on proposals for the conditioning and immobilization of these types of spent fuels by isotopic dilution and ceramization [3, 4], the addition of glass to the ceramization process [4], and glasses matrices for immobilization [5]. The proposal of this presentation is to show some of our research lines in the context of the nuclear fuel cycle of the Argentina nuclear energy sector, and in particular the results of the Cerus Project (Ceramization of radioactive elements in sintered uranium).

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IAEA CN-318/190

Gap analysis and implementation of international projects in countries developing nuclear and radiological waste management capacities

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The international aid is often the only option for countries developing nuclear capacities, including to apply modern methods in the field of radioactive waste management (WM). The fact that almost all radioactive and nuclear waste from the former Yugoslavia is located in Serbia, was recognized by the European Commission (EC) and the IAEA, which supported the strengthening of capacities in the field of radiation safety and security in Serbia with several cooperation projects.

The task of the contracts signed under the European IPA 2008 project, was decommissioning the old storage facility in Serbia, meaning the proper processing and conditioning of rad-waste, and further storage in the brand new storage facility built by the Serbian Government. One of the most important condition for the successful completion of the work was the operational license for the Waste Processing Facility (WPF). However – this facility is not operational, even eight years after signing the contract. The initial decision with respect to WPF, supported at the time by IAEA experts and domestic decision-makers – was to rearrange the existing facility initially built for another purposes, to cover the present needs. Nonetheless, the project is somehow "frozen" since the early beginning; and there is no any sign that its status will change soon.

It is important to note that same is observed in another ongoing EC project signed in 2019, which in a great extent depends on the rearrangement and licensing of the WPF. Very likely one could expect again delays and extensions, without a clear vision when the work might be completed. And clearly – this is certainly neither resulting in safe improvements nor a sustainable situation.

The author believes that this situation could have been avoided, by using a proper gap analysis which would easily recognize the reasons that hindered the implementation of the projects supervised and supported by the IAEA. Such an analysis should be performed by the IAEA experts, with assistance of the European contractors (for abovementioned projects) and Serbian authorities. The results should indicate acceptable solutions to Serbian authorities and accelerate the implementation of the EC/IAEA projects in Serbia. Such an approach could also help to other MS with similar issues in the predisposal nuclear and radiological waste.

POSTER SESSION 4: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN ENVIRONMENTAL PROTECTION AND REMEDIATION

IAEA CN-318/6

Baseline data of radioactivity and radon mass exhalation rate in soils and phosphate rocks of a prospective phosphate mining area in Hinda district, Republic of Congo

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The present study aims to establish a baseline data of natural and artificial radioactivity in soil and phosphate rock samples collected in a prospective phosphate mine of Hinda district. Samples were measured using an HPGe gamma spectrometer. The mean activity concentrations (Bq kg ^{1}) for 238U, 235U, 226Ra, 232Th, 40K, and 137Cs in soil are 94.87, 12.29, 47, 17, 43, 1 and 1370.23, 40.16, 922, 70, 103, 7 for phosphate rock samples, respectively. The obtained mean values were found to be lower than the world mean values for soil samples excepted for 226Ra, and higher for phosphate rock samples. 222Rn activity concentration (Bq kg ^{1}) and 222Rn mass exhalation rate were determined in soil and phosphate rock samples. The radiation hazard indices associated to natural radioactivity were also calculated and found to be lower than the world mean values for soil samples and higher for phosphate rock samples. Strong correlations were found between 226Ra, 222Rn activity concentrations and 222Rn mass exhalation rates. Based on these findings, soils from prospective phosphate mine are not recommended for construction purposes. Also, phosphate rocks highly contribute to the contamination of the study area. Therefore, in order to protect the population, the recommendations were drawn to strengthen the environmental protection in this mining area during the operation phase of the mine. Precautionary measures such as continuous verification of dose level in the study area are necessary.

IAEA CN-318/11

Application of RESRAD and ERICA tools for safe and sustainable gold mining in Nigeria

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Gold mining in Nigeria has had a significant socioeconomic impact, contributing to the country's GDP, and providing employment opportunities. However, the sector has also been associated with radiological health risks. The government has implemented policies to regulate the sector, but challenges remain in terms of sustainability because the policies are less pragmatic considering the economic realities of the country. In this study, state-of- the- art computational tools - RESRAD ONSITE, RESRAD OFFSITE and ERICA were applied to a typical representative artisanal goldmining area in Nigeria, in an attempt to assess radiological and ecological risk to guide policy makers towards sustainable gold mining decisions. Results indicated that the total doses and cancer morbidity risks for an offsite resident farmer is within the radiation basic safety limit, while for onsite resident farmers they were greater than the limits. For non-human biota conservation, the hazard quotient was estimated and found to be less than unity, and the total dose rate per organism was less than the screening dose of 10μGy h−1, which demonstrated that the risk is acceptably low. It was concluded that risk communication and sensitization will ensure sustainable mining.

IAEA CN-318/15

Safety and Environmental Protection during Interim Storage of Spent Nuclear Fuel

Author: Mohamed SHAAT

Interim storage is a system for temporary storage of spent nuclear fuel for a period from initial removal from the reactor until reprocessing or direct ultimate waste disposition.

The causes of spent fuel degradation as fuel/cladding interaction, oxidation and hydration, thermo-mechanical properties and radiological source term will be discussed.

To minimize the oxidation rate of the uranium dioxide, the following measures will be considered: (a) establishing time limits for exposure of fuel pins, (b) using inert environments in leak tight containers to limit access of oxygen to the fuel, and (c) maintaining wet storage of fuel until sufficient decay to limit decay heat. Degraded fuel should be canned and stored within an inert environment that ensures fuel integrity and safety functions.

As a case study the radiological source term, gamma ray and neutron emission rates at high burn-up of VVER-1200 spent fuel assembly will be calculated and analyzed based on the safety limits and environmental protection during extended interim storage using SCALE/ORIGEN-ARP code.

IAEA CN-318/303

Legal regulation of subsoil use relations for the construction and operation of geological facilities for the radioactive waste disposal in the Russian Federation

Author: Iuliia TROFIMOVA

Co-authors: Ruslan SITDIKOV, Mikhail POLUYANOV

The disposal of radioactive waste is inextricably linked with the issues of subsoil use and legal regulation of subsoil use relations.

To ensure long-term safety and reliable isolation of radioactive waste at a subsoil site for radioactive waste disposal, it is necessary to obtain the sufficient geological information.

In the Russian Federation, the procedure for the use of subsoil and the requirements for geological studying, complex rational use and protection of subsoil are established in the Law of the Russian Federation of February 21, 1992, N 2395-1 "On Subsoil".

The Law "On Subsoil" establishes that the use of subsoil can only be carried out if there is a special state permit in the form of a license for subsoil use and in accordance with the approved project documentation that has passed the necessary expertise and approvals.

The subsoil legislation also establishes the stages of geological exploration, which in general can be correlated with the roadmap steps for geological disposal projects. At the same time, the results of each stage of geological exploration are subject to special geological expertise and are issued in the form of geological reports that are different from safety case reports.

The article will consider the issues of legal regulation of subsoil use in the radioactive waste disposal, including licensing, geological exploration, creation of underground research laboratories and organization of subsoil monitoring in accordance with the goals of sustainable development in terms of subsoil rational use and protection.

IAEA CN-318/95

An industrial pilot phase to accompany the development of the French HLW and ILW-LL DGR Cigéo

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1 ANDRA

The development of Cigéo, the French deep geological repository project, is organized in several successive phases. The first years of the repository construction and operation corresponds to the “industrial pilot phase” (Phipil).

The principle of a “Phipil” was adopted by Andra following 2013 Public Debate on the project. This is a cautious approach proposed by Andra for the stepwise construction and startup of this new type of industrial facility. Since 2016, the “Phipil” has been a legal requirement enshrined in the environmental code (article L. 542-10-1).

From the technical standpoint, the Phipil main objective is to consolidate, under actual repository and industrial operation conditions, Cigeo design and safety demonstration, and to test the reversibility of the disposal process.

From the governance standpoint, the Phipil constitutes for public and all stakeholders a knowledge acquisition phase for refining their requests on their participation and involvement to Cigeo industrial operation. It will enable them to work more effectively on the preparation and follow-up of the decisions to be taken during this phase and to gradually prepare those to be taken afterwards. Results of the Phipil will feed a law establishing the conditions of development and operation of Cigeo on a longer run.

IAEA CN-318/105

Demonstrating Safety through Environmental Monitoring around Nuclear Installations in Pakistan

Author: Nazia SALEEM

Co-author: Adeel AFZAL

Nuclear Installations may release radioactivity into the environment under normal operation in the form of gaseous or liquid effluent. Monitoring of environmental and food samples in the vicinity of these installations during operational stage and estimation of radiation doses to public is therefore imperative to ascertain the impact of plant operations on public health and environment. Accordingly, samples of soil, water, aerosol, food etc. are collected and analyzed on gross alpha/beta counter, gamma spectrometry system and liquid scintillation analyzer to quantify the potential anthropogenic radionuclides released into the environment. The analysis results reveal the minor traces of 137Cs in few soil samples which could be attributed to global fallout due to past nuclear accidents. Moreover, Tritium is found in few water samples and activity concentration values are well below the guideline level of 10,000 Bq/L for drinking water, specified in PNRA Regulations-PAK/904 (Rev.01). In addition, gross alpha and beta activity concentration values in water samples are found well below the WHO recommended screening criteria for gross alpha and beta in drinking water samples. The operator's environmental monitoring data is also verified through this study. It is concluded that environmental protection is ensured during operational stage of Nuclear Installations in Pakistan.

IAEA CN-318/121

Experience of the environmental radiological sustainability approach in medical practice with ionizing radiation

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Environmental sustainability, complementing the economic and social in health services, specifically in the use of ionizing radiation in medical practices, is a determining premise in the success of this activity. In this process, besides the exposure of the patient and occupationally exposed personnel, the alteration of the environmental dose rate is unavoidable, due to the management of radioactive sources, both in operating conditions and in disuse, and the specific activity in the releases into the environment of radioactive solids, liquids, and gases.

Present work exposes how it is managed in a sustainable way, at a General Hospital where the modalities of medical practice with ionizing radiation are applied; Radiotherapy, Nuclear Medicine and Radiodiagnosis, adequately the environmental radiological impact, related to the radioactive sources used and discharges into the environment.

The quantitative estimation of the behavior of the radiological component of environmental sustainability is carried out through environmental indicators based, fundamentally, on what is established in this regard in the applicable national regulations and that meet the criteria of effectiveness for indicators, recognized in practice.

This approach makes it possible to perform a comparative assessment at different moments of the quantitative status of the indicators and thus monitor the behavior of the radiological component of the environmental impact of the facility within the effort to consolidate the sustainability of the medical care activity with radiation.

IAEA CN-318/170

Radon Matters in Environmental Remediation

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Radon is the largest contributor to radiation doses for the worldwide population. Reducing radon levels indoors is one of the initiatives of Europe's Beating Cancer Plan. While exposures vary greatly among individuals, people living in areas affected by past uranium mining and milling, or other NORM related activities are particularly at risk.

NORM-contaminated legacy sites often comprise abandoned ponds of processing waste (slurry or sludge) and heaps of solid residues, both of which pose a threat to human health and the environment when not properly remediated. In cases where houses or other constructions have been built in those sites, their occupants might be inadvertently exposed to high levels of radon coming from the Ra-226 bearing waste.

To avoid this type of situations, reclamation of the sites for uses that entail building (residential or industrial) may be regarded as incompatible with any on-site confinement solutions. The practical difficulties to find viable valorization or off-site disposal options for the bulk volumes of residues may result in sites remaining unremedied for many years, thus negatively impacting the livelihoods of nearby communities.

Despite the above, there is a major upside when managing radon risk: architectural solutions are very effective at mitigating radon entry into buildings and can achieve great dose reductions at very limited cost while avoiding waste generation. Numerous building codes worldwide include provisions to achieve radon-resistant constructions. But standard solutions might not work, or even aggravate the problem, in complex settings, such as legacy sites, where buried contamination and structures and piles of residues favour advective or convective transport of radon gas. To design optimal architectural or engineering mitigation measures for buildings and/or the soil, a site-specific study is required.

The key tool for this approach is radon numerical modelling. However, the development of numerical models remains challenging due not only to the complexity of the processes governing radon generation, transport, and entry and accumulation into buildings but also to the high number of parameters that need to be accounted for. Moreover, important difficulties remain in site characterization and monitoring of radon-related variables and parameters, which would ideally be used as inputs or validation of the numerical model.

In order to contribute to the development of radon modelling in support of sustainable land remediation, an R&D project was promoted by the Spanish Nuclear Safety Council. Three different buildings and their surrounding areas have been monitored for a period of one year, and two different numerical modelling strategies have been applied to reproduce indoor radon levels:

- A dynamic multi-compartment model (RAGENA code), developed in the late 90s and adapted to incorporate the experimental data, including parameters related to the soil-building interface.
- A CFD (computational fluid dynamics) model (based on the COMSOL Multiphysics software package) capable of solving radon transport equation by finite elements and of reproducing complex geometries with the required spatial resolution.

In this presentation the main results of the modelling exercises will be summarized, including consideration of the main challenges in the experimental determination of the most critical parameters.

IAEA CN-318/186

Radiological Impact Assessment of Radon in An Earthquake Prone Area: A Case Study of Weija -McCarthy Hill in Ghana

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1 Ghana Atomic Energy Commission

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We are surrounded with radiation, which is an essential component of our surroundings. Natural radiation flux is the main source of non-medical human exposure to ionising radiation. For the purpose of evaluating indoor air quality and researching the possible harm to human health, measurements of the radon gas 222Rn in the environment are crucial. After smoking, radon exposure is regarded as one of the major risk factors for lung cancer. Type of geology, indoor air quality, cracks, and building materials all affect the environmental radon concentration. Using LR-115 Type II strippable detectors, this study was conducted to measure the indoor radon levels in homes within an earthquake-prone area. The results show that the activity concentration of radon ranges 50.89 Bqm-3 to 365.65Bqm-3 with a mean value of 186.51 Bqm-3. The results of the study showed that the geogenic radon potential is strictly linked to the geological setting of an area in terms of the radon source, radon migration pathways (faults and fractures), and the mechanism of radon exhalation from soil gas to the atmosphere and indoor environment. In conclusion most of the investigated homes had radon concentration above the WHO recommended value of 100 Bqm-3 and risk communication on radon to populace implemented.

IAEA CN-318/296

Pre controlling of the discharge of liquid (or other forms) radioactive waste effluents Regulatory Control for discharge of liquid radioactive effluents

Authors: Mustafa MAJALI[1], Buthaina ALAMERI

1 FANR

The criteria and options for the selection of appropriate technology for either discharge of liquid radioactive effluents directly or concentrate and store for decay is an important regulatory decision due to the potential for increased exposure, associated costs, and the complexity of technical and environmental considerations.

An effective model can be used to estimate and evaluate the impact of liquid radioactive effluents before discharge. The production source term (P) was used by assuming that the production is constant and continuous over time. The build-up activity (A(T)) will depend on the total removal rate (K). The increase or decrease in activity concentration relies on the volume of water body when the effluent reaches the environment. This model demonstrates and provides the regulatory decision-makers with a straightforward method to ensure that the selected option will meet the exemption criteria, confirm the radiation risk is sufficiently low as not to warrant any further control and inherently safe. In addition, the model would ensure that selected option has no additional impact on environment and public exposure and has no regulatory concern with no appreciable likelihood of scenarios that could lead to a failure to meet both without any regulatory concerns or control issues.

IAEA CN-318/229

Full System Decontamination of the primary circuit at Doel 3 NPP: safety assessment by the regulatory body

Author: Valéry DETILLEUX[1]

Co-authors: Nicolas DRUET[1], Alain GEENS[1], François HENRY[1], Nathan LEMAHIEU[2], Jeroen MERTENS[1], Cédric NAZÉ[2]

1 Bel V

2 AFCN

According to the law for nuclear phase out in Belgium, the third unit of the Doel NPP (referred to as "Doel 3") was permanently shut down in September 2022 after 40 years of operation. Doel 3 entered in so-called Post Operational Phase, during which the licensee prepares notably its safe dismantling. Among these preparation activities, the licensee performed a chemical Full System Decontamination (FSD) of the Doel 3 primary circuit, including several auxiliary circuits (e.g., the chemical and volume control system). This activity mainly aimed at decreasing the radiation exposure of the workers during the future dismantling activities. The preparation and the realization of the FSD was a challenge for the licensee and Bel V, notably because it was the first FSD on a PWR unit in Belgium. The current paper will introduce the FSD performed by the licensee, present the approval process applied by the regulatory body, and the associated safety assessment performed by Bel V. This assessment consisted of several pillars, i.e., the justification of the FSD from the ALARA point of view, the safe and sustainable management of the generated radioactive waste (on the short and longer terms) and the management of radiation protection and hazards during the FSD. This assessment required interrelationships between several stakeholders, for instance with the waste management organization for the aspects related to the management of the generated radioactive waste. The main lessons learned for future FSD projects will be presented.

IAEA CN-318/202

Experiences on Environmental Radiological Monitoring for Nuclear Emergency Exposures Situations, resulting from field exercises: lessons learned and proposals for improvement with a sustainability perspective

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1 Autoridad Regulatoria Nuclear (Argentina)

2 Nuclear Regulatory Authority

The Nuclear Regulatory Authority of Argentina (ARN) establishes and supervise the application of the national safety standards, including those to maintain an appropriate level of protection for people, the environment, at present and for future generations, from the harmful effects of ionizing radiation. Moreover, according to the national legal framework, ARN has responsibilities to cover the intervention for emergency exposures situations, in cooperation with operators and other national agencies. At the ARN's Division for Intervention in Radiological and Nuclear Emergencies (SIERYN), EPR tasks are carried out in order to avoid and mitigate adverse consequences for health and the environment in case of an emergency, including environmental monitoring.

As part of these preparedness for response activities, SIERYN performs environmental radiological monitoring tasks for emergency situations, trough the involvement in the Nuclear Emergency Exercises organized by the operator of the Argentinean NPPs (Embalse NPP and Atucha Nuclear Complex) and supervised by ARN.

This paper will develop the following aspects:

- Description of the experiences of aerial, ground vehicular and ground on foot Environmental Radiological Monitoring applied for nuclear emergency situations, and carried out in the proposed scenarios of the nuclear power plant emergency plan application exercises.
- Case study analysis, identifying strengths and difficulties observed.
- Proposal for improvements and future actions to be developed in the SIERYN, in order to ensure and provide a correct management for decision making in the event of a possible and/or real emergency, proposing protective measures focused on sustainable solutions justified under the premise that they are harmonious with the environment, natural resources, society and that contemplate risk tolerability.

IAEA CN-318/277

Ranking of nuclear facilities by assessing potential radiation impact on the environment

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This research proposes a systematic method to assess and compare nuclear reactor units and other facilities in regard to their potential environmental impact in case of accidental releases. The strategy employed involves computing the radioecological risk, which accounts for the likelihood of an accident, the quantity of radioactive substances that could be discharged, and the influence of such release on the environment.

The tree layer of a pine forest was used as a reference natural community to assess the effects of radiation exposure. The tree layer has been selected as an ideal indicator of changes in the environment, due to its high sensitivity to such occurrences. By employing the radiation exposure index, the researchers aim to accurately characterize the effects of radioactive fallout resulting from these accidents.

Through the implementation of the method, the research team has managed to assess the risk levels of a diverse range of reactor units. This includes such designs like the VVER-1000, VVER-1200, PWR-890, BWR-1412, and EPR-1600. The subsequent radioecological ranking allowed for a comprehensive comparison of these units in terms of their impact on the reference natural community.

Notably, the findings of the study highlighted the VVER-1200 reactor, a new generation design, as the safest option concerning the potential risks posed to biota. This result showcases the positive advancements in reactor technology and reinforces the importance of prioritizing safety measures and innovations in the nuclear power industry.

Overall, this research contributes valuable insights into the field of nuclear power and provides a robust framework for assessing and comparing reactor units, enabling informed decision-making and risk mitigation strategies within the industry.

IAEA CN-318/301

Determination Of the Limits of Geochemical Background of Groundwater in The Riacho Das Vacas Sub-Basin

Author: Josilene SILVA ROCHA DONATO

Groundwater plays an important role in meeting SDG 6, supplying or complementing the demands for drinking water, especially in scenarios of scarcity of surface water. In certain regions, there are geological anomalies that can give groundwater concentrations of elements above the legislated limits for human consumption or for other uses. Anthropogenic activities can also result in contamination that can make certain uses unfeasible. Differentiating what is natural and anthropic alteration is of paramount importance to outline guidelines for the management of water resources. This research aims to determine what are the natural background limits in the Riacho das Vacas sub-basin, inserted in a region with the presence of natural uranium anomalies and where a mining company that processes this mineral is located. Through statistical evaluation of the results of 46 wells, monitored in the study area between 1998 and 2018, it was preliminarily verified that the upper background limit for uranium is 0.023 mg/L. This value is between the maximum limit allowed for human consumption established in CONAMA Resolution No. 396 and that of Ordinance GM/MS No. 888.

IAEA CN-318/309

Methodology for environmental impact assessment of uranium mining enterprises

Author: Samat KAIRAMBAYEV

JSC National Atomic Company “Kazatomprom” ("Kazatomprom” or “the Company”) is a national operator of the Republic of Kazakhstan for the import-export of uranium, rare metals, and nuclear fuel for nuclear power plants. The Company fully embraces the values of the United Nations Agenda for Sustainable Development, recognizes the importance, and adheres to all 17 Sustainable Development Goals (SDGs). In the field of environmental protection, it contributes to the achievement of goals such as SDG 6 “Clean water and sanitation” and SDG 15 “Life on land” as well as accepts responsibility and takes measures to access and preserve biodiversity in the presence region.

Kazatomprom is a public company, and reporting on nature conservation and environmental measures should be done in accordance with the legislation of the Republic of Kazakhstan, as well as in line with the principles of sustainable development (ESG) and the requirements of global reporting (Global Reporting Initiative, GRI). However, in compliance with the legislation of the Republic of Kazakhstan, the environmental impact assessment and the reporting of potential impacts should be conducted according to the methodology and include information on the sources of environmental data.

The impact assessment should be carried out with the aim of developing measures to reduce the level of anthropogenic influence on environmental objects. To achieve this, it is necessary to differentiate the factors of industrial activity impact based on identified markers of uranium production facilities from other negative factors, such as natural background and other anthropogenic activities, including agriculture, other industrial production, transportation, and the livelihood of the local population.

To achieve this, the work should be conducted to analyze all types of emissions generated during the production activities of the industrial enterprise. Based on this analysis, factors, potential pathways, and markers of impact on environmental objects such as atmospheric air, atmospheric precipitation, groundwater, soil, vegetation, and animals are identified. The article provides a methodological description for assessing the state of each environmental object.

The presented Methodology for assessing the impact of industrial activities on the environment enables the development of effective measures to reduce the impact and provides recommendations for updating internal regulatory documents in the field of environmental protection. Additionally, visualization and mapping of the results of ecological studies facilitate perception, data analysis, and the development of measures, allowing for the assessment of the state of environmental objects through long-term studies.

The JSC NAC “Kazatomprom” program for environmental and social research enables enterprises to organize their activities on a continuous basis in accordance with a risk-oriented approach and generate environmental and social reporting in compliance with the legislation of the Republic of Kazakhstan and the provisions of GRI standards. According to these standards, the results of environmental studies are made available for review and discussion by various stakeholder groups.

POSTER SESSION 5: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN MANAGING RADIOACTIVE WASTE AND NORM

IAEA CN-318/269

Updating the ANRDR: sustaining safe practice in the face of an expanding radiation industry in Australia

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1 Australian Radiation Protection and Nuclear Safety Agency

Radioactive materials find frequent use in many aspects of industry and research; however, it is vital to ensure the safety of the radiation worker during their use. One area of concern is the aggregate dose received by a worker across their career, which may be difficult to track due to changing employers, industries, and personal and professional details. This information is vital for effective decision-making about worker safety and roles.

Due to Australia's rapidly evolving nuclear industry, the sustainability of existing procedures for tracking dose are likely to be challenged. Australia had previously implemented a national dose register for uranium mine workers in 2011 that expanded to included occupationally exposed Commonwealth employees in 2017, but with the expansion of Australia's nuclear industry, the need to extend this system to a truly national and industry wide system has taken on a new sustainable focus.

The present work will briefly present the background of Australian National Radiation Dose Register (ANRDR), its existing successes, and some of the challenges in the expansion of it from a limited scope to a truly industry-wide register which will be sustainable for the future.

IAEA CN-318/302

Uranium Bearing Material Processed for Source Material Content: Radioactive Waste or Not?

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1 U.S Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) has export/import authority over nuclear material including radioactive waste. Often jurisdictional guidance is requested and with technical analysis, a decision is rendered to an interested applicant or member of the public. In the last several years, the NRC received requests from tribal nations requesting the NRC to use its authority under 10 C.F.R. §2.202 to order conventional uranium recovery facilities, not to import radioactive materials into the United States without a specific import license. The reasoning – the processing of uranium bearing materials for its source material content constitutes a recycling process generating radioactive material for disposal. The NRC has long recognized that processing uranium-bearing feed material for its uranium content is a legitimate nuclear fuel cycle activity regardless of motivation, profit, or market-oriented factors, as referenced in "In the Matter of International Uranium (USA) Corporation, CLI-00-1, 51 NRC 9 (2000)". This precedent demonstrates that uranium bearing material can be processed for its source material content and has long been regulated and treated under both domestic and import regulations as alternate feed material within the nuclear fuel cycle and not as radioactive waste.

IAEA CN-318/305

Contaminated Area Management Plan for a Mining and Milling Uranium Facility – Preliminary Results

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1 Industrias Nucleares do Brasil

Uranium Concentration Unit (URA) is a facility which belongs to Indústrias Nucleares do Brasil (INB), in which uranium mining and milling activities are carried out to produce ammonium diuranate (ADU) as uranium concentrate. As a result of operational activities at the URA, environmental radiological impacts generated by unusual events such as infiltration of liquids into the soil due to failures in the waterproofing system were perceived.

In order to understand the extent of the impact generated and to propose mitigating actions, it was necessary to prepare a management plan for the contaminated area, which consisted of the following steps:

a) Diagnosis of the area based on documentary evaluation;

b) Updating the conceptual model of contamination based on the diagnosis;

c) Elaboration of a work plan, including:

I. Necessary confirmatory and/or detailed investigation steps;

II. Proposition of emergency containment actions that can be adopted.

The work was carried out seeking to comply with the specific resolution of the Brazilian National Council for the Environment (CONAMA) for the management of contaminated areas.

IAEA CN-318/310

HARPERS Project – Identification of priority needs and opportunities for promoting Circular Economy when managing materials and waste arising from nuclear decommissioning

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The 3-years Euratom HARPERS (HARmonised PracticEs, Regulations and Standards in waste management and decommissioning) project aims to establish and clarify the benefits and added value of a more aligned and harmonised regulations and standards for prioritised topics related to decommissioning and radioactive waste management between EC Member States.

One of the technical themes included in the HARPERS project is focused on addressing the most important conditions and opportunities for promoting Circular Economy approaches when managing materials and waste arising from nuclear decommissioning across Europe.

The first year of the project was dedicated to the identification of the priority areas for Circular Economy considerations. A detailed list of topics (challenges/needs - related to harmonisation of practices, regulations and standards) has been developed and a series of workshops were organised to engage with external Stakeholders in order to further discuss and fine tune the identified priority areas.

During the workshops sustainability and waste minimization were indicated as the main reasons why Circular Economy is important for nuclear decommissioning and radioactive waste management. A lot of attention was also given to Stakeholder trust and public perception. Recycling and reuse and Clearance were indicated as the most important themes to be further studied within HARPERS project to deeper analyse the challenges associated with regulatory discrepancies and regulatory constraints. Protection of citizens and environment, economic renewal and growth and public trust and confidence were selected as the main drivers for implementing Circular Economy principles.

The outcomes of the workshops were carefully evaluated and a methodology for prioritisation was developed to arrive to a limited list of priority topics that will be further analysed within the 2nd phase of the project.

IAEA CN-318/331

Identification of opportunities for standardisation and collaboration to accelerate the demonstration and adoption of advanced technologies to enhance nuclear decommissioning and radioactive waste management

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The Euratom Harpers project aims to identify potential opportunities to enhance the implementation of nuclear decommissioning and the associated radioactive waste management through the adoption of a more harmonised approach, increased collaboration, and shared/common practices. The project focuses on three areas: (i) cross border services, (ii) circular economy and (iii) the adoption of "advanced technologies". This paper relates specifically to the adoption of advanced technologies.

In the context of the Harpers project, advanced technologies include a wide range of technologies covering new nuclear specific developments, emerging technologies and technologies matured in other sectors but not yet widely deployed in the nuclear sector. The technologies considered in the first phase of the project were identified through a structured gap analysis based on evaluating a wide range of data from existing research and development agendas and end user engagement. The subjects identified were grouped into three broad areas: 'Waste Treatment', 'Digitalisation' and 'Robotics and Automation'. Fifteen subtopics were identified in these categories ranging from artificial intelligence and digital twins to smart decontamination. This paper describes the identification and prioritisation of these opportunities.

In the next phase of the programme, position papers will be developed based on a more detailed analysis of three short-listed (prioritised) topics, and dialogue with technologists, industrial end users and other stakeholders.

IAEA CN-318/333

Promoting Safety, Sustainability, and Innovation: Responsible Utilization of Radioactive Waste and By-products for a Circular Economy

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Integration of safety, sustainability, and innovation has become a critical imperative in today's world. This ideology is closely linked to the responsible utilisation of radioactive waste, decommissioning, and environmental protection. However, this does not only involve waste generated during the decommissioning of nuclear power plants but also by-products from other energy sectors like fly ash originating from coal and biofuel combustion, which can sometimes be contaminated with radionuclides like 137Cs. Research shows that the implementation of fly ash as a partial cement replacement can divert it from traditional waste streams, reduce airborne emissions and demand for virgin materials as well as improve the structural integrity of the materials manufactured with such by-products. This idea can be further expanded to include the reuse of cementitious materials left over after the decommissioning of nuclear power plants for various civil engineering purposes. The potential applications could be radioactive waste immobilization, road construction or the manufacturing of reinforced concrete sleepers. When handled and implemented appropriately, such utilisation of radioactive materials would not pose considerable risk to human health or the environment. In conclusion, while fostering innovation, such utilization practices would also promote sustainable industrialization as well as the stride towards the circular economy.

IAEA CN-318/343

Implementing Rays of Hope (RoH) initiative and enabling sustainability: hopes and challenges of a light

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The global annual cancer burden is expected to grow especially on low- and middle-income countries, where over 70 % of cancer deaths are expected to occur, and these countries do not hold adequate facilities and equipment and human resources in this area.

The IAEA Rays of Hope initiative, that aims globally to build, or strengthen cancer tools treatment in terms of access and equity by using nuclear sciences and technology, by the way appear as key point for contributing to the fulfilment of the UN Sustainable Development Goal number 3 related to ensuring good Health and well-Being for people by reducing between other, premature mortality from non-communicable diseases.

The assistance provided by the IAEA during the last decades has enabled Senegal and many other countries to establish or strengthen safe, secure, and effective radiations in radiotherapy, radiology, and nuclear medicine capabilities in terms of provisions of requirements; training and advises.

Despite this support of IAEA, and the hope drawn in the RoH initiative, it is essential for Senegal and the countries having similar characteristics in terms of management approach and coordination of the technical cooperation, to pay attention on some central elements to ensure a full success of the RoH.

A study based on look back of lessons learned of specific frame of the past years technical cooperation with IAEA combined with descriptive review of national coordination of multisectoral projects and programs urge to give particular attention on the three challenging aspects: - the information and reinforcement of high decision making; - A plan of staffing allied of training and capacity reinforcement provided by the IAEA; - adding in the coordination of projects civilian servant as co-coordinator or assistant for reporting directly to ministry and supporting the regulation and safe use of radiations.

The impacts of the consideration of these aspects will help to reduce the time of implementing of objective or sustaining gain received on the projects to increase traceability and immutability and to maximize benefit from end users and beneficiaries. These impacts are also and important point for commitment increase of financing; cost sharing contribution of the direct national sectorial managers.

IAEA CN-318/158

Rehabilitation Of Hot Spots, Creation of Safe Areas for The Population of Albania Through Sustainable Development

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Albania after the Second World War was gradually transformed from an agrarian country to an industrial-agrarian country until the end of the 90s, where the largest works of Albanian industry were built, such as: a steel plant in Elbasan capable of processing over 1 million tons iron ore, a large oil refinery, the development of the chrome, iron-nickel and copper mining and processing industry; other plants for the production and processing of chemical fertilizers, bitumen, cement, bricks, light industry and processing plants; etc. With the change of the system after the 90s, the industry in our country stopped production, creating many hot spots for the environment.

In Albania, 16 priority hotspots have been identified, spread over the entire territory of the country with a total area of about 255.5 ha. The main pollutants in these hotspots depend on the activities carried out such as: Various toxic chemicals; Batteries containing Pb (lead); Fe-Ni dumps; Cyanide; Residues of Ferro - Chromium; Ammonium; Wastes of mines containing copper; mining waste; Pesticides; residues of Cu, Fe, Cu FeS2 (copper, iron, chalcopyrite); Nitric acid, nitrogen gases, ammonium fertilizers, ammonium nitrate, etc.

IAEA CN-318/262

Conceptual Design of The Mobile Tool Kit Facility for Conditioning of Disused Sealed Radioactive Sources Category 3-5 In Thailand

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The use of nuclear and radiation technology is currently widespread in Thailand, particularly in the fields of industry, research, and agriculture. Most of the applications for nuclear and radiation technology often involve the use of sealed radioactive sources (SRSs). SRS contains radioactive material that is permanently sealed in a capsule or closely bound and in a solid form. When SRSs are no longer in use, they are declared disused and managed as radioactive waste. The Radioactive Waste Management Center (RWMC) is responsible for the centralized collection, transport, conditioning, and storage of Disused Sealed Radioactive Sources (DSRS) in Thailand. The objective of conditioning DSRS is to ensure safe and separate from the environment and to prevent general public exposure for a specified period of time. Besides, it is recognized that conditioning DSRS will minimize the risk associated with them. The new innovation of waste packages is more suitable for handling, transport, storage, and/or disposal. In 2022, RWMC designed and developed the Mobile Tool Kit Facility for Conditioning of Thailand (MTKF-TH-01) to perform conditioning of DSRS categories 3–5. The basic idea was (i) to establish a workplace area for conditioning DSRS for categories 3–5, (ii) to build a flexible and movable workplace for moving to another building in the future, and (iii) to perform DSRS conditioning for new operators training. The MTKF-TH-01 is designed to consist of two containers (2.25 m x 3.20 m x 2.40 m) and is divided into three main areas: (i) reception and technical area; (ii) working and dispatch area; and (iii) dress change and contamination control area. In addition, radiation safety, health safety, security, and emergency assessment are implemented according to IAEA guidelines and Ministerial Regulations. The generic safety assessment and operational procedures were conducted for MTKF-TH-01. The design and development of MTKF were supported by the Thailand Science Research and Innovation (TSRI) budget.

IAEA CN-318/20

Environmental Radiological Monitoring, Decommissioning and Remediation of Uranium Mine Sites of Arlit, Niger

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The uranium production began in Niger with Société des Mines de l'Air (SOMAIR) in 1971, then the Compagnie Minière d'Akouta (COMINAK) in 1978. At this time, there are no laws, regulations and guidance regarding radioactive wastes management, health, safety, environmental protection, decommissioning and remediation. This situation leads to the storage of several million tons of radioactive residues and waste rocks from uranium mining and milling in open air near the mining cities of Arlit and Akokan during several years. The presence of these potential contamination sources can have negative impacts on people and the environment. Currently COMINAK uranium mine is under decommissioning and remediation phase. In addition of these two companies, there are la Société des Mines (d'Azelik) SOMINA and IMOURAREN which started mining in 2008 and 2009 respectively, but they are currently shut down. Two new uranium mining licenses were also granted in 2016 and 2020 respectively to the Compagnie Minière de Madaoula (COMIMA) and la Société des Mines de Dasa (SOMIDA) which is in the phase of development. In recent years, Niger has put in place a legislative and regulatory framework to regulate mining in general and uranium mining in particular.

Keywords: laws, regulations, waste rocks, residues, contamination sources, decommissioning and remediation

IAEA CN-318/216

Safety and sustainability considerations in the operation management of spent nuclear fuel interim storage facilities in Indonesia

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Indonesia has stored spent nuclear fuels (SNFs) from operational of G. A. Siwabessy Multipurpose Reactor (GAS-MPR) in the interim storage for spent fuel (ISSF). SNFs, as high-level radioactive waste, are stored in a pool of water that requires structures, systems, and components (SSC) according to the safety requirements of non-reactor nuclear installations. ISSF operations are inevitable from generating radioactive waste, and sustainable solutions for radioactive waste management are necessary to achieve sustainable development goals. This paper presents operating experience in safe management of the radioactive waste and the efforts towards sustainability at the ISSF operation by ensuring safety of the SSC, the worker, and the public; minimizing the formation of the radioactive waste; and monitoring effluent into the environment. The method used is performed by identification of the systems or processes at the ISSF focused on process that generate radioactive waste followed by an evaluation of the safety performance of these systems. Major considerations in it are protection of workers, people and the environment, minimization of waste, and safety of the facility. The results of this study summarize the efforts that have been made such as minimization of contamination, application of risk-informed approach, minimization of leaks and spills, detection of leakage, avoidance of the release of contamination, periodic review of operational practices, provision for early detection of leakage and contaminant migration. This study also proposes several points of change in the limits of system operating conditions after evaluation to optimize sustainability and safety. The results also show that the radioactive waste from spent fuel storage pool operations can be minimized after further safety evaluation such as performance of the purification system, etc. Furthermore, the radioactive waste that can be minimized includes radioactive waste in the form of spent resin purification systems, filter waste used for purification and cooling systems, liquid radioactive waste, HEPA filter, and doubtful effluent. Low and intermediate levels of radioactive waste from ISSF operations will be sent to the radioactive waste installation (RWI) located on the same site and managed by the same agency. This paper also presents the optimization of safe and efficient management and minimization of radioactive waste throughout the entire life cycle, from cradle to grave.

IAEA CN-318/219

Challenges of radioactive waste management in nuclear medicine facilities in Kenya

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In the last ten years, Kenya has embraced nuclear medicine for both diagnostics and therapy in various health facilities. This has been part of the National Cancer Control Strategy. The number of nuclear medicine centers has increased from 3 in 2012 to 8 in 2022. Two of the facilities operate cyclotrons for the production of the F-18. The practice leads to the generation of low and medium levels of radioactive waste. This paper intends to share with the international community the challenges related to the generation and management of waste, including regulatory challenges and steps taken by the industry to address them.

IAEA CN-318/251

Initial stage of the Lithuanian Deep Geological Repository project

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“Development Program for Decommissioning of Nuclear Power Facilities and Radioactive Waste Management for 2021–2030” (hereinafter - the Program) was approved by the Resolution No. 76 of the Government of the Republic of Lithuania on 3 February 2021.

The Program establishes that the only sustainable final method of disposal of spent nuclear fuel and other long-lived radioactive waste, that can be considered at the moment, is their placement in a deep geological repository.

State Enterprise Ignalina Nuclear Power Plant (hereinafter - INPP) was appointed as the institution responsible for the implementation of the Deep Geological Repository (hereinafter - DGR) project in Lithuania.

Currently, following the recommendations of the IAEA "Experience in selection and characterization of sites for geological disposal of radioactive waste" (IAEA-TECDOC-991, Vienna, 1997), INPP is carrying out the initial stage of the conceptual planning project - site selection.

At this stage, studies and evaluations are carried out to select the DGR location. Based on the results of these activities, INPP will plan further implementation of the DGR.

At present, studies have been carried out to develop criteria for selecting a site for the DGR:

- “Determination of geological criteria for the suitability of the geological environment for the Deep Geological Repository of the radioactive waste “, 2022;
- "Social and economic evaluation for selection of potential region for Deep Geological Repository", 2022;
- “Final report on detailed analysis of formations potentially suitable for the construction of the Deep Geological Repository of the radioactive waste and prioritisation of potential sites according to the main geological (suitability) selection criteria”, 2023;
- “Safety-related criteria for Deep Geological Repository construction in Lithuania", 2023;
- “Comprehensive assessment of the results of the studies carried out in the Deep Geological Repository project”, 2023.

Considering importance of their proper performance for the successful implementation of the entire project, Lithuania in October 2022 requested the IAEA Artemis mission to provide an independent international evaluation of the studies carried out by Lithuania regarding the development of DGR site selection criteria.

Based on the above-mentioned criteria and evaluations, the most promising potential DGR sites for further research will be identified.

The planning and implementation of the initial stage of the Lithuanian Deep Geological Repository project, the involvement of independent IAEA experts, experience gained, and lessons learn may be relevant for other institutions planning to develop national DGRs.

IAEA CN-318/268

Radioactive Waste Management and A Quality Management System in Thailand

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The Thailand Institute of Nuclear Technology (Public Organization)-Radioactive Waste Management Center (TINT-RWMC) is the institution responsible for the management of radioactive waste generated from nuclear and radiation applications in industry, research, and agriculture in Thailand. RWMC is a service at a national level that includes the collection and transportation of radioactive wastes to centralized waste management facilities, where they are characterized, segregated, treated, conditioned, and stored. The services provided by the Radioactive Waste Management Section (RWMS) and the Radioactive Waste Technology and Development Section (RWTDS) are accredited under ISO 9001. The quality of RWMC's performance in operation in carrying out its important role in environmental protection is assured by implementing the environmental management system according to ISO 14001. The ISO 14001 certificate represents a permanent commitment of RWMC to implement and improve the environmental management system and to include environmental aspects in all its activities, especially in performing the public service. Radioactivity Measurement Laboratory service on analysis of water (surface water, wastewater, drinking water) radioactivity (Gross alpha, Gross beta, 3H, 60Co, and 137Cs) of RWMC control by ISO 17025. In addition to a quality management system, the RWM services of RWMC are following IAEA guidelines and ministerial regulations, including always internal and external audits from outside agencies and regulators. Therefore, the quality management system is an efficient tool of RWMC to demonstrate that adequate measures are in place for RWM to ensure the safety of RWM activities and continual improvement.

IAEA CN-318/272

Progress On the Establishment of The Centralised Interim Storage Facility in Response to Spent Fuel Management Sustainability In South Africa

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South Africa's Spent Nuclear Fuel (SNF) is generated from Eskom's only two 1 840 MWe nuclear power reactors at the Koeberg Nuclear Power Plant (NPP) and from Necsa's only one research reactor (SAFARI-1) at the Pelindaba nuclear research site. The establishment of the Centralised Interim Storage Facility (CISF) follows recent reports from the power utility Eskom who runs the NPP at Koeberg that there is limited space for storing SNF on site. Moreover, the lifetime of the NPP has been extended to 2045 which implies that with time, constraints on storage at reactor site will be increased. However, the long-term storage will be established for all the nuclear reactors in the country.

The South African Radioactive Waste Management Policy and Strategy of 2005 recommends that South Africa must adopt the strategy of storing SNF away from the reactor in an above ground dry CISF, followed by a final disposal in a Deep Geological Repository (DGR). The CISF is envisaged to be built off site at the Vaalputs only Radioactive Waste Disposal facility. The facility will be sustained into time with continuous monitoring of radiation in lieu of the DGR for ultimate disposal. Management of SNF still pose a great challenge with many member states not yet having facilities for the final disposal of SNF and associated High Level Waste (HLW), mainly due to the economics associated with developing such required facilities. The project is still at a developmental phase with the feasibility study undergoing a review. It has been established that the project is lacking funds and human resources. The paper outlines the current progress, challenges, and plans for the establishment of the CISF in South Africa.

IAEA CN-318/142

Radioactive Waste Management in Kenya

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Radioactive wastes pose a significant impact on health and environment, and their health risks in low and middle-income countries like Kenya are an important public health concern. On account of numerous social and economic benefits derived from the use of radioactive materials there has been a perceptible growth in the use of radioactive materials in Kenya. Our key objective in radioactive waste management is to ensure that the radiation exposure to an individual (Public, occupationally exposed worker, Patient) and the environment does not exceed our prescribed safe limits... The Central Radioactive Waste Processing Facility was established and officially commissioned on 18th March 2022 to carry out radioactive waste safety operations in the Country. Management of low and intermediate level radioactive wastes is already being implemented. This paper accentuates radioactive waste management methods being adopted by the Centre to manage radioactive waste in Kenya.

IAEA CN-318/76

Storage and Disposal modalities of Radioactive Waste in one of Tunisian NM departments

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In nuclear medicine departments, diagnostic and therapeutic procedures carried out generate radioactive wastes. These wastes are an inevitable result of the use of radionuclides in unsealed form.

All liquids, gloves, or syringes etc.., used in diagnosis or therapy, considered as contaminated material must be managed safely. Within healthcare establishments, clear and strict protocols are therefore followed according to the nature of the waste in accordance with radiation protection standards.

In addition, particular attention should be paid to the waste that may be produced by patients outside the nuclear medicine unit, in particular when they are cared for by other healthcare establishments in order to provide them with information necessary for the collection and disposal.

Nuclear medicine department of Salah AZAIEZ Institut, dating from 1970, currently has three diagnostic unities (conventional imaging-PET-CT and RIA) and a therapeutic unity (metabolic radiotherapy using iodine 131). It is equipped with 2 storage rooms dedicated to liquid and solid radioactive waste.

Substances delivered to the department are of different types: ready-to-use radioactive packages (I131, MIBG-I1123.), products from industrial cyclotrons (18-FDG) and technetium (molybdenum) generators which will be used to prepare radiopharmaceuticals in hot room and whose activity delivered per week is around 20 GBq for a medium-sized department (approximately 4500 examinations/year).

We illustrate the different procedures adopted by our department for the management of its radioactive waste.

IAEA CN-318/183

Occupational exposure in the management of radioactive waste in Syria

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1 Syrian Atomic Energy Commission

Introduction

Workers managing radioactive waste may be exposed to an important amount of radiation depending on the characteristics, radioactivity, and processing procedures of the waste. In Syria, a Radioactive Waste Management (RWM) facility was established, at the Syrian Atomic Energy Commission, to deal with the radioactive waste in the country.

Materials and Methods

Many radiation practices are carried out in the RWM facility and dealing with various types of sources: Co-60, Cs-137, Ra-226, Ir-192, Am-241, Sr-90, The workers in the RWM are monitored using Harshaw TLD with two chips in the card, Harshaw TLD chips for extremities, and Harshaw TLD manual reader Model 4500. Whole body doses [Hp (10)] for 14 workers were recorded every two months from 2006 to 2022. Introducing recycling of disused sealed sources into the facility implied the measuring of extremities equivalent doses [Hp (0.07)] using finger ring dosimeter.

Results

The figure shows the cumulative recorded Hp (10) during the respective period of work for each worker. The average annual dose for all workers was below 1.8 mSv. The maximum recorded personal dose, during one monitoring period, was 3.3 mSv for worker 5. The measured extremities doses for each practice, usually not frequent, were below 3 mSv.

Conclusion

The recorded whole body and extremity doses were significantly below the recommended dose limits (20 mSv and 500 mSv per year, respectively). This proves that the radiation protection program followed by the staff of RWM facility complies with the radiation protection requirements and assures safe management of radioactive waste according to ALARA principle.

IAEA CN-318/146

Preparation of the safe and sustainable disposal of LLW in the future surface disposal facility in Belgium

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1 ONDRAF/NIRAS

ONDRAF/NIRAS plans to build and operate a surface disposal facility for the low-level radioactive waste in Dessel. The licensing process is underway and should lead to a construction and operation license by mid-2023. The construction of the disposal facility could start in 2024 and its operation could be expected in 2027.

The license (and the safety report) will set the conditions that the waste must respect to ensure a sustainable and safe disposal. Besides radiological limits, physico-chemical criteria are also defined. Indeed, the waste can't unduly affect the performances of the Engineer Barriers that play a major safety function and can't perturb the expected evolution of the disposal system. Cellulosic substances, sulphates, chlorides, ASR (Alkali-Silica-Reaction) and DEF (Delayed Ettringite Formation) reactions constitute the main sources of potential perturbations.

To ensure the absence of perturbations and to allow the safe and sustainable disposable of the waste a disposability program was defined. This program is illustrated in the following figure. The different steps are the establishment of conformity files, development of filling plans, realization of (non)-destructive controls to confirm the disposability of the waste and definition of measures to allow non-conform waste. The disposability program considers the legacy waste for which missing information as to be collected as well as future waste for which additional measures should be taken to ensure the production of conform waste. The disposability program will be described in this paper.

IAEA CN-318/77

The Establishment of A 5-Year Roadmap to Respond to Challenges in Controlling Radioactive Waste Management in Indonesia

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Radioactive waste is an essential aspect of using nuclear energy in Indonesia. The volume of radioactive waste that requires management is highly dependent on the utilization of nuclear energy. As residual material from activities using radioactive material, radioactive waste does not benefit facilities that generate it. Hence, there is a potential that radioactive waste needs to be appropriately managed, leading to the violation of the regulation. BAPETEN, as a Regulatory body, is mandated to establish a roadmap for solving problems related to radioactive waste management. The problems faced at this time, there need to be a roadmap to resolve the potential that radioactive waste needs to be properly managed, which can lead to the violation of the regulation. The final result of this paper is to establish a 5-year roadmap in radioactive management by identifying issues related to more effective regulatory control by identifying several issues related to radioactive waste management. The issues include the safety infrastructure, the organization, and human resources, the documentation of waste management, the records and reports on waste generated or managed, and the origin of radioactive waste. Coordination meetings, focus group discussions, interviews, or inspection results do the method for obtaining the results of this paper. By identifying the existing issues and establishing the roadmap for controlling radioactive waste management in Indonesia, BAPETEN will be able to find its best approach to controlling radioactive waste management more effectively.

IAEA CN-318/202

Experiences on Environmental Radiological Monitoring for Nuclear Emergency Exposures Situations, resulting from field exercises: lessons learned and proposals for improvement with a sustainability perspective

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1 Autoridad Regulatoria Nuclear (Argentina)

The Nuclear Regulatory Authority of Argentina (ARN) establishes and supervise the application of the national safety standards, including those to maintain an appropriate level of protection for people, the environment, at present and for future generations, from the harmful effects of ionizing radiation. Moreover, according to the national legal framework, ARN has responsibilities to cover the intervention for emergency exposures situations, in cooperation with operators and other national agencies. At the ARN's Division for Intervention in Radiological and Nuclear Emergencies (SIERYN), EPR tasks are carried out in order to avoid and mitigate adverse consequences for health and the environment in case of an emergency, including environmental monitoring.

As part of these preparedness for response activities, SIERYN performs environmental radiological monitoring tasks for emergency situations, trough the involvement in the Nuclear Emergency Exercises organized by the operator of the Argentinean NPPs (Embalse NPP and Atucha Nuclear Complex) and supervised by ARN.

This paper will develop the following aspects:

- Description of the experiences of aerial, ground vehicular and ground on foot Environmental Radiological Monitoring applied for nuclear emergency situations, and carried out in the proposed scenarios of the nuclear power plant emergency plan application exercises.
- Case study analysis, identifying strengths and difficulties observed.
- Proposal for improvements and future actions to be developed in the SIERYN, in order to ensure and provide a correct management for decision making in the event of a possible and/or real emergency, proposing protective measures focused on sustainable solutions justified under the premise that they are harmonious with the environment, natural resources, society and that contemplate risk tolerability.

IAEA CN-318/228

Assessment of the mechanical stability of dams surrounding the uranium mill tailings in France

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Uranium mining in France led to the production of more than 50 million tons of mill tailings which are currently disposed in 17 facilities, many of which relying on dams. Given the long-lived nature of the main radionuclides present (mostly radium and uranium), the associated risks will persist over time scales of the order of tens of thousands of years. Since no provision can reasonably be envisaged to guarantee, in the absence of maintenance, the mechanical strength of the dams over a period of more than a few hundred years, the objective is to seek an objective life duration of a thousand years for these facilities.

A methodology was developed by a pluralistic group to clarify the issues involved and to propose an approach to evaluating the long-term mechanical stability of the dams. As such, their resistance shall be assessed considering the facilities' evolution in time, by taking into account normal conditions as well as potential natural hazards (heavy rainfall, earthquakes) and high water levels in the dams induced by a cessation of maintenance of the drainage systems. The risks of liquefaction, internal erosion and external erosion shall also be analyzed. At the end of the evaluations, reinforcement actions can be decided.

POSTER SESSION 6: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN MANAGING RADIOACTIVE SOURCES AND NORM

IAEA CN-318/13

Utilisation of the IAEA BDC Scoping Tool and AMBER Modelling for Post Closure Safety Assessment for a Proposed Borehole Repository of Disused Sealed Radioactive Sources in Ghana

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1 Ghana Atomic Energy Commission

The IAEA BDC Scoping Tool and AMBER Modelling were employed in the post-closure safety assessment of a proposed borehole disposal facility in Ghana. The borehole disposal facility is to be constructed to dispose of disused sealed radioactive sources in storage. Based on the hydrogeology and geochemical characteristics of the proposed site, results obtained from the IAEA BDC Scoping Tool revealed that the borehole and its components were efficient in offering acceptable safety to the disposal system and the environment. Considering the evolution of the borehole and the reference site, further assessment using AMBER Modelling was carried out to assess the safety that would be provided by the borehole and its components. Farmers were assumed as the receptors of the exposed dose in the AMBER Modelling. Results from the AMBER calculations revealed that, the borehole and its components were able to provide satisfactory safety for the disposal system if the borehole design functioned as envisaged. Also, in an unlikely event that there are defects in the borehole components, viz, the source capsule and disposal container, satisfactory safety was achieved.

IAEA CN-318/18

Experience and lessons learned by the SSE “Radon Association” on the remediation of radioactively contaminated areas

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1 State Specialized Enterprise "Association "Radon"

In Ukraine collection and storage of radioactive waste originating from the use of radiation sources in medicine, science and different industries are performed by State Specialized Enterprise “Radon Association” (SSE “Radon Association”). SSE “Radon Association” also performs maintenance, radiation monitoring and control of storage sites for radwaste resulting from decontamination and sanitary treatment of vehicles (SSR/VTS) after the Chornobyl accident, which are located outside the exclusion zone in the Kyiv, Zhytomyr, and Chernihiv regions.

Within implementation of international technical assistance project of the European Union U4.01/12D the decontamination waste storage site “Pisky-1” located in Pisky village in the Ivankiv district of the Kyiv region was selected as a pilot facility for taking remediation measures.

The international consultant developed a technical decision on activities for “Pisky-1” pilot facility remediation and safety analysis report. Experts of SSE “Radon Association” performed comprehensive radiological survey of this facility using equipment obtained under the project.

SSE “Radon Association” completed process activities on remediation of “Pisky-1” pilot facility. After retrieval of decontamination waste and confirmation of reaching remediation criteria for end state “Pisky-1” location was remediated to natural conditions.

IAEA CN-318/22

Roles and Responsibilities of Regulatory Body in Licensing Decision for Naturally Occurring Radioactive Materials (NORM) milling facility

Author: Iyu Lin TENG (SCIENTIFIC OFFICER)

In Malaysia, the atomic energy activities are controlled by the Department of Atomic Energy (Atom Malaysia), the regulatory body established under the Atomic Energy Licensing Act 1984 (Act 304). The atomic energy activities including the irradiation facility, non-destructive testing activities, gauging, research and education as well as the Naturally Occurring Radioactive Materials (NORM) facilities. Under the Act there are several Regulations and Orders to explain more details regarding the requirements. Licence applications are required to fulfil the general and technical requirements under the Act 304. For the licensing of the naturally occurring radioactive materials (NORM) milling activity, the application together with all of the technical supporting documents will be assessed by the Atom Malaysia provided all other related approval had been granted by other relevant agencies such as local authorities and Department of Environment. There are 3 parts of licensing for NORM milling facility, which is siting licence, construction licence and operation license. Operation license is divided to 2 stages, which are Temporary Operating License and Full Operating License. For siting license, the applicant should submit the background monitoring data which is recorded together in a document called Radiological impact Assessment (RIA) for at least 6 months of data. In another hand, the applicant had also subject to the Department of Environment requirement to submit the Environmental Impact Assessment (EIA). During construction license, the plant design should be endorsed by the Professional's Engineer (PE) approved by the government. The operation license will be started with 2 years temporary operating license and after the full assessment, the licence will be renewed to full operating license.

IAEA CN-318/24

Holistic Approach in Regulatory Control on The Disposal of Norm Residues from Rare Earth Industry into The Permanent Disposal Facilities (Pdf) For Environmental Sustainability

Authors: Thieng Kui NGU, Suhana JALIL, Iyu Ling TENG

Naturally Occurring Radioactive Materials (NORM) consist of materials with enriched radioactive elements found in the environment namely uranium, thorium, and potassium and any of their decay products, such as radium and radon. NORM occurs in geological formations and enhanced NORM can be created by industrial activity. In Malaysia, examples of industries that may be of concern include among industry, petroleum industries, rare earth processing facility and titanium dioxide production. One of the world's largest, rare earths processing facility outside China commenced operations in Pahang, Malaysia in the year 2012. Operation rare earths processing facility soon gained national public interest since the processing facility refined rare earth element from lanthanide concentrate which originate from outside Malaysia and producing NORM residues or very low-level radioactive residues named as Water Leaching Purification (WLP). In the year 2011, the Malaysian Government received International Atomic Energy Agency (IAEA) review mission as an international independent expert review on radiation safety aspects of this rare earth refining plant. Again, a second IAEA review mission had been carried out during year 2014. In the year 2020, the Malaysia Government request the rare earth processing facilities to build a permanent disposal facility (PDF) for the disposal of WLP as one of the license conditions for renew operation license. In year the 2022, the rare earth processing facilities successfully gain license and start to construct the PDF for WLP disposal. This paper presents detail study on the holistic regulator control on the disposal of NORM residues from rare earth industry into the PDF for safety and environmental sustainability as well as the challenges experiences during construction.

IAEA CN-318/28

Assessment Of Occupational and Public Exposure from Tin Mineral Processing Industries in Jos – North Central Nigeria

Author: Isa SAMBO

Any mining operation or other industrial activity involving a mineral or raw material has the potential to increase the effective dose received by individuals from natural sources, because of exposure to radionuclides of natural origin contained in or released from such material. Mining and processing of tin ores has been going on for over 100 years in Jos and its environs. Twenty-Six (26) Tin processing industries were visited to assess occupational and public exposure using Thermoluminescence Dosimeters (TLDs) for an assessment period of twelve months. The maximum effective dose at the workplace was assessed to be 69.94mSv, the maximum effective doses for the workers assessed to be 1.58 mSv per year and 22.02 mSv for the public for the period. The values obtained for the workplace and the public were above the limits stipulated in IAEA GSR Part 3 while the effective dose for the workers were within limits. The doses at the workplace and the pubic are very significant. Therefore, radiation protection measures are needed in tin processing industries to protect workers and the public.

IAEA CN-318/29

Applying Graded Approach in The Sustainability of Management of Naturally Occurring Radioactive Material Residues in The Oil and Gas Industry in Nigeria

Author: Isa SAMBO

The law governing the use of radioactive material in Nigeria is the Nuclear Safety and Radiation Protection Act No.19 of 1995 which provides for the establishment of the Nigerian Nuclear Regulatory Authority (NNRA). The NNRA applies graded approach to ensure effective regulatory control of different facilities and activities with radiation sources. Naturally Occurring Radioactive Material (NORM) arising from oil and gas production are controlled by ensuring that the prospective oil and gas fields are authorized by the NNRA before commencement of operations. Issuance of authorization is subject to meeting safety requirements commensurate with the radiation risks associated with the activity. This guarantees sustainability of management of NORM Residues in the Oil and Gas Industry in Nigeria. This paper therefore outlines NNRA's regulatory processes for such an activity and the lessons learned.

IAEA CN-318/30

Assessment and Licensing Point of View Towards Borehole Disposal Facility in Malaysia

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Malaysia is one of the rapidly developing countries using ionizing radiation from radioactive material, especially in research, industrial and medical applications. The use of these radioactive materials in various applications over time has led to the accumulation of radioactive waste called Disused Sealed Radioactive Sources (DSRS). These DSRS started to accumulate from the 70s until today, and up to date approximately more than 12,000 units of DSRS belong to Category 1 to Category 5 according to the International Atomic Energy Agency (IAEA) Safety Standards Series No. RS-G-1.9 Categorization of Radioactive Sources was generated and stored in the National storage facility located at Nuclear Malaysia Agency. Thus, Malaysia is currently dealing with the management of these large amounts of DSRS and the measure to manage it properly. Since 2011, the government of Malaysia approved the construction of a Borehole Disposal Facility proposed by the Nuclear Malaysia Agency as the ultimate solution to the large amount of DSRS. The development of this project also received full support from the government of Malaysia and financial assistance from the IAEA and the government of Canada. In the evaluation process of the Borehole Disposal Facility construction, the Department of Atomic Energy (Atomic Malaysia) as an atomic energy regulatory body had made several assessments before issuance of the license to this project under the provision of the Atomic Energy Licensing Act 1984 (Act 304) which provides the requirements and control of the atomic energy activities in Malaysia. The evaluation includes reviewing and endorsement of the technical and non-technical documents, assessment visits to the project site with the relevant stakeholders, discussions with the expert during the IAEA expert's mission, discussions with the project proponent as well as reviewing consideration of the findings from the public engagement and awareness activities. The Borehole Disposal Facility in Malaysia is actively under development and is the pioneer, therefore it will gain attention from all over the world in the perspective of assessment and licensing procedures and also the operation of this facility.

IAEA CN-318/44

Safe Management of Disused Scelled Radioactive Sources in Morocco

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Practically every country in the world uses radioactive sources; the radiation they emit can be used for beneficial purposes in many areas of development. Once these radioactive sources have reached the end of their useful life, they must be carefully managed in order to guarantee safe management solutions without losing sight of the permanent requirement to protect present and future generations and the environment from risks presented by this waste.

The approach adopted by CNESTEN in collaboration with the International Atomic Energy Agency (IAEA) to set up a system for processing sealed radioactive sources Category 3 waste is the dismantling of these sources, while respecting the safety requirements and ensuring the conditioning and storage of this Sources under prescribed safety conditions. The process of dismantling is planned and executed safely to minimize the risks of radiation exposure to workers and the environment. the dismantling process is carried out with appropriate equipment and procedures in place to minimize the risk of exposure to radiation and ensure compliance with regulations and standards. The main steps of this approach will be developed in this present work.

IAEA CN-318/60

Development and Challenges to Improve Nuclear Knowledge Management and Safety Culture

Author: Wafaa SALEM **(Prof)**

Today, there is universal acceptance of the significant impact that management and organisational factors have over the safety significance of complex industrial installations such as nuclear power plants. Many events with significant economic and public impact had causes that have been traced to management deficiencies. The report on the TMI-2 accident underlined the importance of problems associated with the management, organization, an institutional structure. The Chernobyl accident is an example of multiple institutional, organizational, and management flaws, identified as determining contributors to the accident. In developing safety management methodologies, they should be based on scientific analyses to identify and understand the individual causes involved and their effects. We should focus on the importance of this approach to safety management using the potential of human behaviour and management sciences. While technical performance at nuclear power plants has benefitted from the significant improvement in the knowledge of materials, equipment, and systems performance, etc. there has not been a similar general improvement of management practices. For many years it has been considered that managing a nuclear power plant was mostly a matter of high technical competence and basic managerial skills. The field of nuclear technology has been dominated by hard sciences Some degree of frustration also became apparent after earlier research efforts.

In high-risk industrial environments such as nuclear power plants, chemical factories, railways or the aircraft industry, people in charge of work organisation tend to be engineer-technicians of a very homogeneous scientific background. For a number of decades, engineers have structured the organisation of high-risk industries. This has been achieved in a highly technical-bureaucratic fashion through successive reforms and as a result of fairly unilateral thinking. The resulting organisational innovations are hardly ever submitted to external criticism, let alone reliability assessments (of the organisation itself). No diagnosis is ever attempted. Organisations are generally modified, adjusted, and amended, without any prior justification or debate. Most of these changes are implemented top-down and yet the way they reach the bottom suggests that there is much variety in the way reforms are received, understood, and really implemented.

The objective of this study is the development of new methods to increase and improve knowledge management for the safety of nuclear power plant operation focusing on commercial nuclear power plants that are intended for electrical power generation from a safety point of view, knowledge management, human performance, and organisational factors perspective.

IAEA CN-318/61

Chornobyl NPP Cooling Pond: Decommissioning

Author: Oleksandr NOVIKOV

According to "Feasibility Study of ChNPP Cooling Pond Decommissioning," the radiological and ecological conditions have been monitored throughout the water level lowering period (2014-2023).

Cooling pond design

ChNPP cooling pond (CP) was created by constructing the artificial embankment on the right bank of the Prypiat River. It was commissioned along with start-up of Power Unit 1 in 1976.

Radioactive contamination

According to the estimates, the total content of radionuclides in the CP before 1986 accident was the following: 137Cs – 77.7 GBq, 90Sr – 1.5 GBq.

The 1986 accident changed the situation drastically. Due to radioactive aerosols and fuel particles falling on the surface, the pond was exposed to extremely high contamination. In addition, about 5,000 m3 of extremely contaminated water was discharged into the pond from the primary circuit of the damaged reactor, fire fighting water and other process systems of the plant.

Based on the assessments, the current contamination levels of the pond are in the order of: 137Cs – 260 TBq, 90Sr - 54 TBq.

Water level and direction of groundwater flow

Following the shutdown of the last operational power unit, it was not reasonable to continue using the pond. Creation of the CP, as well as measures performed in 1986, raised the groundwater level in the adjacent area, which resulted in flooding of a part of existing foundations of radiation-hazardous facilities and radioactive waste storage sites. It led to spending additional costs for pumping out and treatment of radioactively contaminated water from the bottom premises of the Plant.

Monitoring of surface layer of the atmosphere

In order to ensure radiation protection of personnel and environment, radiation situation is being monitored from the start of water level lowering and drying of bottom areas of CP. The monitoring points were selected along the pond perimeter towards places of personnel presence.

Monitoring of groundwater

Monitoring of groundwater, change of water level, radiation and chemical conditions is being carried out at the observation wells located at the enclosing dam.

Monitoring of geobotanical changes within the dried sections

Formation of stable vegetation cover at the dried bottom sections is the factor which reduces danger of erosion processes, and the factor which retains entry of radioactive aerosols into the surface layer of the atmosphere due to wind transfer from the pond area to the adjacent areas.

During the growing season the dried areas are being visually inspected to reveal the soil erosion development. Once such sections are identified, a decision is made on the necessity to implement engineering measures.

Monitoring of hydrobiological changes

Hydrobiological observations during lowering of the CP water level are being performed seasonally by the Institute of Hydrobiology of the NAS of Ukraine. Hydro physical, hydro chemical, hydrobiological and bacteriological parameters are being monitored at sampling points along the CP water space and in lakes.

Ecosystem changes of the CP are being analyzed based on data of spatial and quantitative distribution of aquatic organisms.

IAEA CN-318/70

Ensuring safety and sustainability in managing legacy and remediation radioactive waste

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In the interests of consistence with the principles of sustainable development – of not passing undesirable burdens to future generations – it is essential that the effective radioactive waste management system also covers legacy waste and waste generated during remediation activities (remediation waste). In Belarus this waste categories include about 1000 m^3 of old institutional waste, now having status of long term stored waste and more than 400 thousand tons of waste, arisen from clean-up activities in the areas, affected by the Chernobyl Accident.

In order to adopt a truly sustainable strategy for management of the waste there had been a step-by-step decision-making process, which, in addition to the safety aspects, required consideration of economic, societal, and environmental factors. The process included detailed safety assessment of the waste potential radiological hazard, update of regulations, and "mutual learning" by and from all stakeholders.

The paper is intended to show how in Belarus, over the last three decades, the approaches and the strategies for the management of the legacy and remediation waste have been developed and rethought, and what sustainability challenges in the area are being considered today.

IAEA CN-318/97

Viability of the sustainable valorization of the dicalcium phosphate residues: towards the safe management of NORM residues

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Like many other industries, decommissioning a dicalcium phosphate production facility generates different waste streams. Generic wastes include dismantled equipment, contaminated soil, a mixture of soil and sludge, scale, and other miscellaneous materials. Residues generated in the dicalcium phosphate production consist of sludge of undissolved phosphate rock, SiO2 and fluoride compounds such as CaF2. When simultaneous calcium chloride production occurs at the same facility, another type of sludge is formed, mainly composed of Mg $(OH)^2$.

The conventional dicalcium phosphate production process involves reacting the phosphate rock with acid sulphuric to produce phosphoric acid. Several methods and modifications are used to separate fluoride – an undesirable impurity in the production process; iron; aluminium; magnesium; manganese impurities, and silica. Fluorspar is on the EU's Critical Raw Materials (CRMs) list and therefore is one of the materials considered crucial to Europe's economy. The CRMs form a solid industrial base, producing various goods and applications used in everyday life and high-tech industries. Reliable and unhindered access to certain raw materials is a growing concern within the EU and across the globe.

A critical aspect of the potential valorisation or recycling of these residues comes from the presence of radionuclides. Among the radionuclides that may be present in the sludge are U-238, U-234, Th-230, Ra-226 and Pb-210. The IAEA Safety Standards No. SSG 60 (Section 6) elaborates on strategies for NORM residue management, including exemption and clearance. In addition, the Safety Report N. º 49 addresses the Radiation Safety Basis for the Management of NORM Residues (Section 4).

This work intends to study the viability of the valorization of dicalcium phosphate residues by developing a methodology to evaluate the potential use of these residues as a source of CRMs and as secondary resources, for example, to manufacture sulfur polymer concretes.

The first step is to develop a detailed characterisation protocol of the dicalcium phosphate residues: radiological, physical-chemical, and mineralogical. The protocols should also include natural leaching tests and studies on the geotechnical and mechanical properties (laboratory-scale tests). The second step is to compile the existing valorization processes with similar residues from the bibliography. The results will define possible applications of these residues as CRMs sources and as secondary resources from the technical characteristics and define exposure scenarios, pathways and dose calculation from the safety and radiological protection point of view.

IAEA CN-318/64

Assessment of the Implementation of Reuse and Recycle of Disused Sealed Radioactive Sources to Reduce Radioactive Waste in Indonesia

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Reusing and recycling Disused Sealed Radioactive Sources (DSRSs) is an option for managing radioactive waste implemented in Indonesia. This study explores the implementation of recycling and reuse of DSRSs in Indonesia by analyzing regulations, reports, procedures, and IAEA publications. Based on Indonesia's radioactive waste management regulation (GR No. 61 in 2013), the executing body has to assess the possibility of reusing and recycling DSRSs. DSRSs must be tested in the laboratory to check the leakage and contamination of the capsule, including the physical check. Although this process can reduce waste, the safety of radioactive sources must be ensured for use and transport. The reused/recycled DSRSs' compliance with transport requirements is also questioned. Although IAEA encourages reuse and recycling as an alternative to DRSR management, the standard for the test of DRSRs is not available yet. The joint convention reports show that some countries (such as Albania, Argentina, Australia, Bulgaria, China, France, and so on) implement the reuse and recycling of DSRSs. However, specific information about the test for the certification process is not available. Therefore, IAEA should provide standards or guidelines to support the state in establishing reused and recycling DSRSs to reduce waste and benefit the economy and environment.

IAEA CN-318/164

Development Of Radioactive Contamination Control and Radiation Monitoring Systems in Belarus: Contribution of The Chernobyl Catastrophe Consequences Overcoming Experience

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The accident at the Chernobyl nuclear power plant in 1986 set a number of tasks for Belarus to overcome the consequences of the Chernobyl disaster and predict emergency situations at nuclear and radiation hazardous facilities, including through the creation and development of systems for controlling radioactive contamination and radiation monitoring in the country. A special place is given to monitoring on the territory of the Polessky radiation-ecological reserve - a unique object in terms of the tasks to be solved.

Belarus is the first country in the world that faced the need to overcome the consequences of the Chernobyl disaster in the absence of relevant experience. The country has become a pioneer in the creation of systemic radiation monitoring and control. Its experience and created technologies are used by other states, the work of the Polessky Radiation and Ecological Reserve contributes to the study of the impact of radiation on environmental ecosystems.

Subsequent incidents demonstrated the importance of having systems for controlling radioactive contamination and radiation monitoring: "…a comprehensive and well-coordinated program of long-term environmental monitoring is needed in order to determine the nature and extent of the radiological impact on the environment at the local, regional and global levels" (Director of the IAEA in the report on the accident at the Fukushima nuclear power plant).

The work carried out by Belarus in the field of radioactive contamination control and radiation monitoring makes a significant contribution to improving emergency preparedness and response, which should be actively used by countries implementing their first nuclear programs.

IAEA CN-318/200

The Role of Nigerian Radioactive Waste Management Facility Centre on The Safety and Sustainable Use of Radioactive Sources in Nigeria

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Sustainable use of nuclear science and technology depends on the safe use of nuclear materials throughout their life time. This includes the safe management of radioactive waste, environmental protection (including control of radioactive releases), the safe decommissioning of nuclear facilities, and the remediation of contaminated areas. Nigeria generates radioactive waste through numerous activities such as the operation of nuclear Research Reactor, medical facilities, research facilities, and industrial processes. This work looks at the management of radioactive waste at the Radioactive Waste Management Facility Centre (RWMF) in Zaria and conditioning of Disused Sealed Radioactive Sources (DSRS) for the safety and sustainable use of nuclear Science and Technology in Nigeria.

IAEA CN-318/253

Financial Provisions for Management of Radioactive Waste and Disused Sealed Radioactive Sources in Zimbabwe

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1 Radiation Protection Authority of Zimbabwe

Radioactive waste management is a critical element of radiation safety and security and the cradle-to-grave management of sealed radioactive sources. When sources become disused, they are no longer of economic value to the licensees, even though they still require appropriate management. Zimbabwe has a number of challenges associated with the management of disused radioactive sources, including failure to send sources back to supplier after they have become disused, legacy sources that were brought in before the onset of the Regulatory Body as well as limited financial resources. To manage this challenge, government has constructed a centralised radioactive waste management facility to be operationalised in 2023. Further, the Radiation Protection Amendment Bill has provided for the establishment of financial mechanisms through a waste management fund for the management of radioactive waste and disused sources. The objective of the Fund is to hold such levies as shall be prescribed in trust for the purpose of enabling the repatriation, management, storage, or disposal of radioactive sources previously in the custody of an authorised person who by reason of insolvency or any other event is incapable of discharging his or her obligations to repatriate, manage, store, or dispose of the sources concerned. This shall ensure Zimbabwe has resources in place to ensure the cradle to grave management of sealed radioactive sources imported into the country and radioactive waste. The Fund shall ensure resourcing of the centralised waste management facility as well as an operation to manage legacy sources. The IAEA has also provided the Regulatory Body with expertise in developing a financing model for operationalisation of the centralised waste management facility.

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IAEA CN-318/313

Radiation safety analysis of the management of radioactive sources from lightning rods

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The paper presents the radiation safety analyses of the management of radioactive sources coming from lightning rods. Such management of sealed sources is part of activities on their planned dismantling and decommissioning activities of old radioactive waste storages in Serbia where dismantled lightning rods are stored. Since these sources cause a large contribution to the radiation dose, the results of the analyses are of primary importance for identifying the potential radiation hazard in order to achieve minimization of operator exposure and the release of radionuclides into the environment. Available data on the production of lightning rods during the 1970s were used, as well as data from operational logs on the receipt of dismantled lightning rods. The methodology used for the analysis of the contribution of direct exposure to ionizing radiation from sources during the planned operations was verified through several experiments. This radiation safety analysis includes reference photon flux calculations based on Monte Carlo simulations and the use of conversion factors for equivalent and effective dose rates according to ICRP-74 and ICRP-116 standards. For the analyses, geometric models were developed for known packages with radioactive sources from the lightning rods for different situations related to the location of sources.

IAEA CN-318/185

Progress towards the demonstration of deep borehole disposal

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2 Deep Borehole Demonstration Center

This paper provides an update to progress towards the end-to-end demonstration of deep borehole disposal for radioactive waste, following the research study presented at the IAEA International Conference on Radioactive Waste Management in November 2021.

In 2021/22, Deep Isolation and the University of Sheffield conducted a study of international stakeholder views from across the regulatory, policy and waste management communities on the benefits, opportunities, and challenges of deep borehole disposal (DBD). Four out of five research participants said that they would welcome greater international collaboration on DBD, with the highest priority being a full-scale, non-radioactive demonstration of the technology.

Based on this feedback, Deep Isolation has helped to convene an initial group of government and industry partners to establish an independent, non-profit organization: the Deep Borehole Demonstration Center, established on 1 December 2022. This paper outlines the multi-year, phased program of work that these non-profit aims to deliver, with the primary objective to advance the maturity of the safety case for deep borehole disposal and the technical readiness levels of the disposal concept.

Work has already started on this program, with an initial canister lift test in February 2023 using standard oil and gas equipment. This paper sets out latest progress and plans by the growing number of government, regulatory and private-sector organizations that are joining as Members of the Deep Borehole Demonstration Center.

IAEA CN-318/234

Application of Monte Carlo modeling based – PHITS code to DSRSs management in Cameroon

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The Management of Radioactive waste generated from nuclear and radiation applications has become a worldwide issue as nuclear waste is a dam of several radionuclides with different half-lives, activities, and characteristics. The only well-used solution up to date is the long-term storage and disposal after its status of "waste" is confirmed. The disposal solution may incur the burden of the current generation onto the future ones. To be properly managed according to the regulations in place, Radioactive waste should be characterized, and the appropriate geometries should be used for its long-term storage in Cameroon since the final management option is not yet prescribed by regulations. In this regard, mathematical and numerical tools such as Monte Carlo methods have been developed to perform the safety evaluation of the waste package and to test its performance. This research project describes the extension of the use of Monte Carlo simulation to properly manage radioactive waste, mainly in developing countries with low incomes. It thus deals with 137Cs disused sealed radioactive sources (DSRS) managed in Cameroon with the assistance of the International Atomic Energy Agency (IAEA). Some applications to neutron and gamma-disused sealed radioactive sources are highlighted as case studies. Since Monte Carlo methods are used to simulate the transport of particles, especially photons, electrons, and neutrons through matter and to obtain the detection system response, it is appropriate to be used during the research and development phase, while the DSRSs are under use before their disuse and classification as radioactive waste. The Particle and Heavy Ion Transport Code System (PHITS) was used to perform the Monte Carlo simulation in the present work and the result of the GEANT4, FLUKA, and MCNP are to follow. The main outcomes are waste package geometry optimization and the comparison of experimental data compared to Monte Carlo modeling has been done to demonstrate the effectiveness of MC simulations.

IAEA CN-318/187

Radiological Environmental Impact Assessment in Scenarios of Expansion of a Nuclear Facilities Site

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In addition to the well-known benefits of nuclear facilities, such as the energy generation and radiopharmaceutical production, the population surrounding a nuclear facility site experiences other benefit. For example, the population benefit from jobs creation and the associated academic development. There is also a growth in the surrounding cities. The good standards for environmental protection applied in the nuclear industry contribute to foster the sustainable use of the environment and its resources. For example, conducting prospective radiological environmental impact assessments, establishing discharge limits to protect humans and the environment, optimizing the level of protection balancing the potential very low radiation risk following "ALARA" principles, considering economic, societal, and environmental aspects. Moreover, environmental monitoring is a direct measure of the level of populational and environmental protection, validating the assessments. In this sense, environmental monitoring closes the loop of sustainable use of nuclear energy. This work analyzes the recent improvement in the methodology, as recommended by an international expert required to the IAEA under a Brazilian Technical Cooperation project and presents the results of the dose assessment on individuals from public surrounding a nuclear complex, considering the current annual average releases and the possible expansion of facilities that can take place in the future.

POSTER SESSION 7: PRACTICAL APPLICATION OF ENSURING SAFETY AND ENABLING SUSTAINABILITY IN DECOMMISSIONING AND MANAGING RADIOACTIVE WASTE

IAEA CN-318/108

Design and Development of Performance Test Facility of Final cover for Near-surface Disposal Facility

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In this study, the function and purpose of the disposal cover, which is an engineering barrier installed to isolate the disposal vault of the near-surface disposal facility for radioactive waste from natural/man-made intrusion, and the design details of the demonstration facility for performance verification were described. Disposal cover consists of multiple layers of heterogeneous materials such as sand, clay, and gravel. Cover is aimed at delaying the release of radioactive material into the natural environment as long as possible and isolating radioactive waste from human life for as long as possible. he Demonstration facility was designed in a partially divided form to secure the efficiency of measurement while being the same as the actual size of the surface disposal facility to be built in the Intermediate & low-level radioactive waste disposal site of the Korea Radioactive Waste Agency (KORAD). In this study, the design and construction methods of a test facility were described to demonstrate the performance of a disposal cover that isolates a surface disposal facility from nature. In addition, the design and construction method of monitoring technology that can monitor the safety of engineered barriers in real time by measuring information such as moisture, temperature, and slope safety in real time was also explained.

IAEA CN-318/118

Sustainable Development of Unified State System of Radioactive Waste Management in Russian Federation

Author: Tatiana RAKITSKAYA

In 2011, the Russian Federation adopted Federal Act No. 190-FZ "On the RWM…", which significantly changed the concept of RMW in the country. The paper provides a description of the Unified State System of RWM (USS RWM) in the Russian Federation, organised in accordance with the new Federal Act, and the 10-year history of its formation.

The paper is highlighting the:

- Changes in the activities and the management of radioactive waste area, which were introduced in 2011 by Federal Act No. 190-FZ.
- Complexity of the national waste management system in a country with a long history of the nuclear industry, accumulated problems and at the same time implementing a large-scale program for the construction of new facilities and the development of nuclear technologies. Principles of organizing activities in accordance with the new Federal Act, which ensure the sustainability of RWM in the long term.
- The experience of integrating safety and sustainability in practice using novel approaches and taking a lifecycle approach.
- The experience of integrating safety and sustainability in all the different stages of implementation of radioactive waste management.

IAEA CN-318/126

Operational safety measures taken during dismantling and conditioning of neutron and low activity disused sealed radioactive sources in Cameroon

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Under supervision of the International Atomic Energy Agency (IAEA), neutron and low activity disused sealed radioactive sources (DSRS) have been dismantled, conditioned and safely and securely stored within the Cameroon centralized storage facility. Safety measures implemented allow on to dismantle and to load DSRS in two retrievable capsules which have been transferred to the shieldings and then the whole has been transferred to the drums (200l drum for low activity gamma sources and 100l drum for neutron sources). Drums have been locked, sealed, and labelled according to the measured dose rates at 1 meter. Security measures within the centralized storage facility included delay and detection measures as well as the response procedure. During the dismantling operations, wipe tests were carried out on the source supports and leads to the conclusion of non-contamination. The contamination was measured using a handheld contamination monitor (RadEye B20). The measured values which were within the interval [0.21-0.46] Bq/cm2 are less than the limit value of 4 Bq/cm2 from which contamination of source supports may be suspected. Safety measures taken contribute to improve security through the use of adequate seals and lock mechanisms. In addition, the robust and heavy drums used increase the difficulty for an adversary to remove or sabotage the packages. During operations, NRPA carried out individual dosimetry monitoring of international experts and other involved persons. OSL dosimeters have been used to perform individual dosimetry of workers under ionizing radiation during the whole process. Low radiation dose of 0.05 mSv can be measured with OSL dosimeter that was used to control effective dose received by each exposed person. Another advantage of OSL technology is the possibility of proofreading. A total of 12 dosimeters were distributed to workers. These dosimeters were collected at the end of operations and the exposure radiation dose of each involved person was measured and recorded.

IAEA CN-318/134

Assessment of Moroccan natural additions impact on the cementation process quality of the spent and radioactive ion exchange resins: strength and 134Cs leaching resistance and morphological structure

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The present work is undertaken within the general framework of radioactive waste management. It concerns the optimization of used and radioactive ion exchange resins cementation. The study aims to develop the quality of IER cemented form. It also proposes to increase the IER loading. Referred to the formulation with 8.3% of IER adopted at the nuclear study center of Maamoura (CENM), Morocco. The investigation of the impact of the addition of local and natural materials in cementitious IER formulation has been realized. They are local red clay (MA), limestone and marly limestone. Cemented forms prepared with 8.3% and 12% of IER loads were compared to those of 12% of IER loading prepared with 4% of additions and (4% - 12%) of MA. Mechanical strength, porosity, 134Cs leaching, morphological structure development were assessed. The cementitious process conformity was studied using the diffusion coefficient and leaching index. The obtained results show that MA has improved the quality of IER cemented forms. Compared to the CENM formulation, the formulation with 12% of IER and 10% of MA allows improving the mechanical strength and the porosity by 137% and 14%, respectively. It leads decreasing conditioning cost and the final waste volume by 30%.

IAEA CN-318/160

Improvement of Regulatory Framework on Radioactive Waste Management Facilities in Korea

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In Korea, as radioactive waste management facilities have gone into full operation, the regulatory body has been revising the Nuclear Safety Act (NSA) to introduce several practices to radioactive waste management facilities including Periodic Safety Review (PSR) to ensure that the safety regulation framework related to assessment and obligation during operation is consistent with international standards. Considering the findings of IAEA IRRS mission and overseas precedents, the NSA is revised to lay a legal basis in 2021 for a PSR to be performed every 10 years by a radioactive waste management facility before the time comes when the first PSR needs to be performed. Major revisions to the NSA include the obligation of the operator to conduct a PSR and submit the results and the authority of the regulatory body to order corrective or supplementary measures when the results of the PSR or follow up actions are not sufficient. Another significant revision to the NSA is to establish a regulatory procedure related to termination of operation (decommissioning of radioactive waste treatment or storage facilities, closure and post-closure institutional control of disposal facilities), with consideration of characteristics of each facility, so as to be prepared for termination of operation of a radioactive waste management facility. The NSA is to be revised in such ways to obtain a regulatory approval for decommissioning of a radioactive waste management facility and to clearly define a procedure and a list of documents to be submitted along with an application for decommissioning approval. Additionally, a closure procedure for a radioactive waste disposal facility, etc. which cover approval for closure, documents to be submitted when an application is filed is to be defined. Through these legislative changes, it is expected that a regulatory framework for all stages of the life cycle of a radioactive waste management facility will be established.

Keywords: Radioactive Waste Management Facilities, Periodic Safety Review, Decommissioning, Post-closure Institutional Control, Regulatory Framework

IAEA CN-318/166

Plasma Treatment of a Simulated Low-Level Radioactive Waste

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According to PNGRR (2020), 90% of the radioactive waste produced in Argentina is low-level waste. Since these materials occupy a lot of space, treatment techniques have been developed to manage them efficiently. One of these techniques is thermal plasma gasification, which involves heating up waste in a special oven using ionized gas. The process's high temperatures enable the treatment of a wide range of materials, resulting in a volume reduction of nearly 100% (Ojovan, 2011). This work presents an experiment on gasification by thermal plasma using a simulated low level radioactive waste (SLLW) to analyze its volume reduction and reaction products. The experiments were conducted at Nuclear Materials Department (CNEA) (Pullao, 2021; Rivero, 2017). The SLLW had an initial volume of 9000 cm^3, consisting of nitrile gloves, laboratory paper, and chemical compounds of stable metals Co, Sr, Cs, and Ce to simulate the presence of radioisotopes Co-60, Sr-90, Cs-137, and Ce-144. The volume reduction obtained was 99.6% (34.4 cm3), and the ashes inside the reactor contained Co, Sr, Cs, Ce, and Cl, along with crystalline phases CuCl, Cu_2O, ZnO, TiO_2, $CuSO_4$, CuO, ZnS, and $TiZn_2O_4$.

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IAEA CN-318/178

Experimental study on the characteristics of radon cover in waste landfills

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Waste from resource extraction industries contain uranium and thorium decay chain radionuclides. One important radiological impact of these wastes is the release of radon into the atmosphere. Therefore, prediction/evaluation of radon flux and effectiveness of different covers are the major elements in radiation protection, long-term safety aspects, and to model radon release to the environment for final assessment of radiological impacts and required remediation actions [1,2]. The authors designed a measurement system by short-time accumulation technique based on transient-diffusion method and the validity of the laboratory model to quickly estimate the radon release from soils, diffusion coefficient, and the effect of covers was investigated [3]. It was observed that after 0.5 m and 1 m clay cover layer with diffusion coefficient (1.78±0.24)×10-6 m2 s-1, the measured radon flux density from bare waste, 1.05±0.23 Bq m-3, decreases by a factor of 1.7 and 2.8, respectively, to 0.61±0.12 Bq m-3 and 0.37±0.06 Bq m-3. Concerning to the measured radon diffusion length, the radon flux reduction factor increases to 10 for 1.6 m clay cover layer. The results show that the effectiveness of the studied cover layer is 3, which is similar to theoretical and experimental results in uranium tailings pond [4].

IAEA CN-318/101

Transition from operation to decommissioning of NPP units in the Russian Federation on the example of units 1 and 2 Leningrad NPP

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Transition from operation to decommissioning of NPP units in the Russian Federation on the example of units 1 and 2 Leningrad NPP

1. Introduction

In Russian Federation in operation -11 NPPs (36 power units), Total - 30.5 GW. NPP produced over 20% of all power generated in Russian Federation. At 2022 – 9 power units are shut down for decommissioning, of which: 2 NPP – at decommissioning stage (decommissioning license granted); 7 NPP– at decommissioning preparation stage. By 2032, 17 power units are to be shut down for decommissioning.

2. Regulatory Framework

- Federal Law on the Use of Atomic Energy No. 170-FZ (∑ ~ 16 Federal laws and decrees)
- Safety Rules for Decommissioning of a Nuclear Power Plant Unit, NP-012-16 (∑ ~ 19 Codes/ Rules and Safety Guidelines)
- "Rosatom" Concept of Nuclear Facilities Decommissioning
- "Rosenergoatom" Concept of Power Units Decommissioning
- Leningrad NPP Concept of Power Units Decommissioning
- Programs of Leningrad NPP Power Units Decommissioning (individually for each Unit)

3. DECOM Preparation Stage

Rationale for "immediate dismantling" selection:

- Lower costs
- Higher radiation and technical safety
- Possibility for the NPP workforce retention

4. Prospects

- Development, try-out, implementation, and improvement of new technologies for uranium-graphite reactors decommissioning;
- Extension to other NPPs;
- Personnel training in new technologies and techniques;
- RW interim storage and processing;
- Waste decontamination, fragmentation, and conditioning facility.

IAEA CN-318/174

A 3D digital-based training system of safety assessment to reduce exposure and prevent accidents during decommissioning of nuclear facilities

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To simulate several scenarios of decommissioning process, testing environments have been designed on a virtual reality. A lot of scenarios were developed in 3D virtual environments to evaluate through simulation. The assumption on testing of the training system is that the worker's falling accident rises during installation of cavity pool seal. The performance test of the training system is shown in below figure. Once the subject puts the HMD on his head, he can look at the cavity pool seal lifted by a crane. The one subject starts to go down from the upper floor to the below cavity pool, the other subject supports the moving of the one subject. The other subject plays a role in supporting the one fallen subject in case of an accident. At this time the working time and radiation exposure of the subject are for the first time measured. During installing and checking of the cavity lines around the cavity pool seal, an accident of the one worker's falling takes place. The other subject observing the moving of the one subject goes down to the accident spot on a ladder and both of them gets to the upper floor. In the end, the accumulated working time and radiation exposure of the subjects are measured and displayed on the HMD in first mode and on the monitoring device in third mode.

IAEA CN-318/208

IRT-1 Research Reactor Decommissioning: Preliminary Plan

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The Tajura Nuclear Research Center (TNRC) has two reactors, one of them with a power of 10MWth and the other Critical Facility Stand with a power of 100W within operation for 41 years, the status of the research reactor is extended shutdown since 2013, for these reasons, the decommissioning plan it became important. The preliminary decommissioning plan consists of actions and steps required as well as the strategies to be adopted for the shutdown of the facility under the technical and administrative, seeking the safety, of health workers and the public, and minimizing environmental impacts.

This work aims to develop a preliminary plan for decommissioning the research reactor, considering the technical documentation of the system (SAR-Safety Analysis Report), the existing rules of the Libyan Atomic Energy Establishment, as well as regulatory instructions and recommendations of the IAEA.

IAEA CN-318/267

NORM management: Decommissioning of offshore oil and gas pipeline infrastructures

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Naturally occurring radioactive materials (NORM) are a class of contaminants found in offshore oil and gas reservoirs around the world and may form contamination products including scales and sludges in topside and subsea infrastructure (e.g., pipelines). These facilities are coming to the end of their life in many jurisdictions around the world, which will require decommissioning. The risk that NORM from these sources present in the marine ecosystems is not yet understood meaning that decisions made about decommissioning may not deliver the best outcomes for such environments. It is known that during the decommissioning process, marine ecosystems are at risk from both physical damage and the release of scale contaminants.

Both operators and regulators will need to make a final decision using a graded approach regarding the decommissioning needs for such facilities, addressing the level of impact and risk associated with the proposed decommissioning solution. Factors to consider may include ecological and environmental impacts, financial costs, human safety, the political and regulatory environments, and social licence. This paper considers NORM-contamination products in oil and gas systems, results of emerging Australian research in marine radioecology related to decommissioning practices and identifies key research priorities for the future.

IAEA CN-318/276

Safety and Security Requirements during the Decommissioning of Nuclear Facilities

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There are large numbers of research reactors and many more small nuclear facilities utilizing radioactive material, some of which are coming to the end of their operating lives and will require decommissioning. These nuclear facilities were built in many States, and the extent of local nuclear experience varies widely. Although the radioactive source terms within research reactors and other small nuclear facilities are expected to be less in radioactive inventory than in larger facilities, small nuclear facilities may still pose significant radiological and other risks, due to ageing and other issues. Many Factors affecting the choice of decommissioning strategy such as: financial requirements, human resources, safety, security, spent fuel and waste management infrastructure limitations. Decommissioning of such nuclear facilities may be made more difficult due to limitations in the availability of the necessary resources. The resources required for decommissioning are varied in nature and go beyond simply numbers of people or amounts of available funding. This paper discusses the safety and security requirements during the decommissioning of nuclear facilities.

Keywords: decommissioning, safety and security, radioactive waste

IAEA CN-318/9

Safety assessment of radiological characterization in decommissioning of a nuclear facility or waste management processes

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Radiological characterization activities represent an important part of the decommissioning project of a nuclear installation or waste management processes. These are continuous activities over the lifetime of the mentioned processes, being carried out repeatedly due to the fact that radiological characterization activities are necessary in their many phases. It is a good practice to manage aspects like people, safety, environment, quality, etc., especially when radiological characterization activities are made in-situ. Significant personal exposure can be recorded when in-situ measurements or sampling activities are done in unfamiliar area or when the radiation levels are poorly known or unknown. An optimization process of radiological characterization activities must be carried out (e.g. detailed considerations regarding the sampling type and place, specific analysis or techniques will be used, cots, time spent, etc.) so that adequate measures can be put in place to protect the safety of workers during decommissioning or waste handling operations.

This paper present good practices related with safety in radiological characterization activities done during the decommissioning of a nuclear facility or waste management processes.

IAEA CN-318/74

Korea Radioactive Waste Management Status and Future

Author: Sungwook HONG[1]

1 KORAD

1. Status of Radioactive Waste Management in Korea

   There are 25 nuclear power plants in Korea, and their power generation capacity is 24,650 MW [1]. Nuclear power generation is essential, and the amount of radioactive waste generated by NPP is increasing every year. Therefore, safe management of radioactive waste is necessary.

2. Gyeongju Low and Intermediate-Level Radioactive Waste Disposal Facility

   In 2005, Gyeongju was selected as the final site through the participation and voting of local residents during the site selection process [2]. L&ILW first disposal facility's disposal capacity is 100,000 drums. 1st stage's disposal facility type is Underground silo type and was completed in 2014 [3]. 2nd Stage's disposal type is shallow land disposal type. The capacity of 2nd Stage's disposal facility is 250,000 drums and was completed in 2023 [4].

3. HLW Management Policy and Plans

   The Korean government issued a basic plan [5] on HLW management in 2016 built upon recommendations from the Public Engagement Commission on Spent Fuel Management (PECOS). The basic plan contained development of a deep geological repository, generic underground research laboratory (URL), and an interim storage facility.

   The Government issued the 2nd Basic Plan [6] on HLW Management based on the recommendations by various stake holders.

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IAEA CN-318/274

Improving The Safety Culture as A Mechanism for Achieving Sustainable Development Goals on The Example of NAC Kazatomprom JSC

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NAC Kazatomprom JSC (hereinafter – Kazatomprom, Company) is the national operator of the Republic of Kazakhstan for the import and export of uranium, rare metals, nuclear fuel for nuclear power plants and fully shares the values of the UN Sustainable Development Agenda. The Company recognizes the importance of all 17 SDGs and, as part of its activities, make every effort to make a feasible contribution to their achievement. One of the key tasks aimed at achieving the Company's sustainable development goals is to ensure the health protection and occupational safety of personnel, environmental protection and radiation safety (hereinafter - HSE). In order to solve these tasks, Kazatomprom has built an appropriate organizational structure, developed, and implemented mechanisms to achieve goals at the strategic level.

Kazatomprom uses a number of mechanisms aimed at increasing the level of awareness, competence and interest of employees and managers; conscious compliance with safety requirements; ensuring transparency and openness in the field of HSE. The Company has developed and successfully implemented a system for identification and registration of Unsafe Conditions (UC), Unsafe Actions (UA), Near Miss incidents; a procedure for conducting Behavioral Safety Audits, Risk Assessment, blocking hazardous energy sources (Lock-out/ Tag-out), stopping unsafe work (STOP Card), as well as interaction with contractors. Moreover, an internal and external communication system in the field of HSE has been established, as well as an employee motivation system has been built. Therefore, the development of a safety culture in Kazatomprom is aimed both at achieving a zero level of injuries and at reducing the negative impact on the environment, in this manner ensuring the sustainable development of the Company.

Currently, Kazatomprom has launched an information system in which the collection, storage, monitoring and analysis of HSE indicators is carried out. Automation of HSE processes allows Company to do more in-depth data analysis and take effective measures to prevent any risks. At the same time, the further development of the HSE management system and the pursuit of zero on HSE indicators will require further improvement of the safety culture, increasing of the automation level and necessary competencies of personnel.

IAEA CN-318/213

Spent Fuel Management in Slovakia

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Peaceful use of nuclear energy began in Slovakia in 1972. Currently, four VVER 440 units are in operation in Slovakia, one unit is in the commissioning phase. By the mid-1980s, spent nuclear fuel (SNF) was being shipped to the USSR. In 1986, a pool-type interim spent fuel storage facility (ISFSF) was put into operation. In 2000, the ISFSF was seismically upgraded, and its storage capacity was increased.

Currently, all SNF is stored after cooling in at-reactor pools in ISFSF. Since the full project storage capacity of the ISFSF will be reached at the end of 2024, a decision was made to build a new dry storage capacity. The project started in 2015, the first spent nuclear fuel will be placed in the new storage in the second half of 2023.

In new storage SNF will be stored in special canisters of 85 SNF assemblies. Due to planned long period of storage of SNF (up to 100 years), higher requirements for seismic resistance were applied during the design than the requirements set for the site. After completion the ISFSF will be protected against the fall/attack of an airliner.

Currently, the JAVYS (Nuclear and Decommissioning Company) is working on a project of a deep geological repository, the expected term of putting the repository into operation is the year 2065.

IAEA CN-318/247

Radioactivity in wastewater from the phosphate industries in Tunisia

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The Tunisian phosphate industry processes large amounts of phosphate ore (8 Mton/year, 20) for a wide range of applications: the production of phosphoric acid, fertilizers, and others. Water is one of the essential elements in phosphate enrichment process in Southern Tunisia. After being used, most of this wastewater is returned to the environment. This study focused on discharges from phosphate industries in Gafsa-Metlaoui basin. The phosphate industries generate several hazardous and radioactive in wastewater. Effluent samples were collected from these industries; analyses were carried out for the water from the phosphate washing units in the basin of Gafsa. The 234U/238U activity ratio were determined by alpha spectrometry in water and sludge and the results were compared with other studies in worldwide.

IAEA CN-318/281

In-situ Characterization Technology Development for Clearance Verification of Radioactive Waste from Nuclear Decommissioning

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During decommissioning of nuclear power plants, a large amount of metallic radioactive waste is generated. If it can be confirmed that the residual activity of radioactive waste is below the clearance level, it can be managed as general or industrial waste. For accurate and conservative evaluation of radioactive metal waste, in-situ characterization technology was developed. A value below the clearance level was found to be accurately measured through minimum detectable activity measurement. To evaluate the error according to the shape, spot, and nuclide of the sample, MCNP simulation was performed. A comparison of the measured value and the MCNP value showed an error range of 0.1–7.7%. Even if the radioactivity measurement value of metal waste shows contamination at the same level of radioactivity, the resulting value is different depending on the material and spot, making correction necessary. In order to evaluate this variation, the density correction factor according to the sample material and spot was evaluated. A conservative methodology was developed by calculating the simulation error and the density correction factor. For accurate evaluation, a 3D camera, plastic scintillation detector, NaI (Tl) scintillation detector, and MCNP simulation were applied to present a technique that can confirm a below clearance level.