BACKGROUND PAPER

INTERNATIONAL ATOMIC ENERGY AGENCY

ADDRESSING RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT FOR SUSTAINABLE ENVIRONMENTAL AND SOCIAL PROTECTION

Welcome Letter

Dhifan Kemal Akbar

Greetings delegates! Hailing from Indonesia, I am currently studying Mechanical Engineering. I was always interested in energy-related issues and I am now focussing my studies on advancing renewable energy technology. I really like joining MUN as it is more than just simulations, caucuses and resolution papers. It will give you an experience that makes you discover your hidden talents, and allow you to meet people who share the same interest as you, giving you the opportunity to pursue projects in the future. It can also lead to achievements you never knew were possible. So, don't hesitate to get involved as it will be my highest pleasure to assist you in this unique endeavour.

Annika Würfel

Dear Delegates, my name is Annika Würfel, and I am one of your chairs for the IAEA Council in TEIMUN 2022. I am a political science student from Germany. I am delighted to have the opportunity to chair a conference for the first time. Despite the fact that I live near the border to the Netherlands, I am still excited exploring the Netherlands and of course meeting you all! Our topic is a global issue that will be more and more important in the future. Many stakeholders see radioactive waste as a critical issue due to the potential hazards for human health and the environment. The goal of our debate will be to determine an effective radioactive waste management to ensure the protection of human health and the environment now and in the future.

Jan Willem Leeuwma

Welcome to you all! I'm proud to be one of your chairs. I'm Jan Willem Leeuwma and I am from The Netherlands. As a History student I love to step in on this subject and have a focus on subjects from the past with the consequences of today. The MUN world is still very new for me as I have just joined in a couple of years ago. But nothing to be scared of as I know to chair and keep you all in line. Come prepared and show the best of yourself. We are all going to make this a MUN we will never forget. Make this debate as radioactive as our topic.

Introduction

Since the early 20th century, research and development in the field of nuclear science and technology has produced a wide range of applications in research, medicine, industry and nuclear power. These practices generate waste that must be managed to ensure the protection of human health and the environment now and in the future, without placing undue burden on future generations. Radioactive waste may also arise from the processing of raw materials containing naturally occurring radionuclides. A safe radioactive waste management requires an effective and systematic approach within each country's legal framework, defining the roles and responsibilities of all relevant parties.

Radioactive waste occurs in a variety of forms with very different physical and chemical characteristics which can be in gaseous form, in liquid form, or in solid form. Radioactive waste has long been recognized as a potential hazard to human health. Related to future generations these hazards may include potential radiation exposure, economic consequences and the possible need for surveillance or maintenance.

Fundamental safety approaches for the management of radioactive waste are based on international experience. In the Radioactive Waste Safety Standards (RADWASS) series of publications, the IAEA integrates this experience into a coherent set of fundamental principles, standards, guides and practices for achieving safe radioactive waste management.[1]

The objective of radioactive waste management is to deal with radioactive waste in a manner that protects human health and the environment, imposing undue burdens on future generations. Responsible radioactive waste management requires the implementation of measures that will afford protection of human health and the environment since improperly managed radioactive waste could result in adverse effects to human health or the environment.

Effective management of radioactive waste considers basic steps in the radioactive waste management process as parts of a total system, from pre-treatment through disposal. It should take the implications of transportation into account. Storage of radioactive waste involves monitoring the radioactive waste so that isolation, environmental protection and monitoring are provided.

In recognition that international co-operation is playing an increasingly important role in the development and implementation of national radioactive waste management programmes, the IAEA developed the Waste Management Database (WMDB). The purpose of the WMDB is to provide a mechanism for the collection, archival and dissemination of information about radioactive waste management in Member States. The WMDB contains information on national waste management programmes, activities, plans, policies, relevant regulations and waste inventories. The information is provided by Member States and is compiled and stored by the Agency.[2]

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[1] International Atomic Energy Agency. (1992). *Radioactive Waste Safety Series (RADWASS) Programme.*

[2] International Atomic Energy Agency. (2018). *Regulations for the Safe Transport of Radioactive Material.*

Problem Specification

Most countries have made progress towards developing national policies, strategies, and programmes for the management of spent fuel and radioactive waste that are consistent with international recommendations. The requirements of the Euratom Waste Directive harmonise the approaches and reporting in EU Member States, particularly in Europe.[3]

In the majority of countries, public acceptance of spent fuel and radioactive waste management remains a challenge. This is especially true for disposal facilities, where a lack of acceptance has stymied progress. Efforts to improve openness, transparency, and public participation have been stepped up. Local acceptance has been successfully achieved in the cases where progress has been reported. There has been notable progress in Finland, where a licence for the construction of a deep geological repository for spent fuel was granted in 2015; as well as in France and Sweden, which have selected sites for their deep geological repositories and are proceeding with the licensing process.

In a number of countries, funding waste management and decommissioning activities continues to be a challenge. Through contributions to dedicated waste management and decommissioning funds, effective systems for spent fuel and radioactive waste from current nuclear power production have been established, but funding for decommissioning older reactors, as well as for remediation and management of legacy sites and waste, remains a challenge, especially when the original owner or operator no longer exists. In these instances, funding frequently becomes the state's responsibility and must compete for funding with other priorities.

To avoid repeating the creation of unfunded legacy sites in the future, states considering nuclear energy or building new reactors are increasingly considering future requirements for spent fuel and radioactive waste management, as well as eventual decommissioning, as a condition of licensing the new reactors. They are bolstering policies, strategic planning, and financial systems to ensure that future waste management and decommissioning requirements are met adequately. Such policies and systems are being developed in areas where they do not yet exist.

For many decades, peer reviews have been an integral, albeit generally voluntary, part of planning, implementing, and evaluating radioactive waste, spent fuel, and decommissioning programs worldwide. They are still used to develop and improve national programs and are now required in a number of countries under a variety of legal instruments, including the Euratom Waste Directive.

QARMAs

1. What are the challenges related to safety and security during the transport of nuclear

[3] Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, Official Journal of the European Union, No. L199, Publications Office of the European Union, Luxembourg (2011).

and radioactive material and their interface?

2. How can member states ensure and foster better research development strategies to sustainably handle radioactive waste and spent fuel management?
3. How can geological challenges be considered in planning for disposal in order to ensure an environmentally safe long-term radioactive waste isolation?

Explanatory Section per QARMA

QARMA 1

a. Background of the Problem

The transport of nuclear and radioactive material is a crucial moment. It involves moving products that are essential for public health, manufacturing, agriculture and energy production. More than 20 million shipments occur per year globally, in air, on seas, on railways and roads.

To facilitate, both the national and international exchange of good and appropriate practices for the safe and secure transport of nuclear and radioactive materials, challenges related to safety and security during transport, and their interface must be identified in order to develop appropriate transport infrastructures. Recent experiences with Covid 19 can therefore serve as LessonsLearnt.

The development of robust, effective and appropriate transport safety and transport security infrastructures, either separately or combined, is to be considered as a challenge for Member States, in areas of (1) development and implementation of a national legal regime; (2) development of transport safety and transport security regulations; (3) establishment of a competent authority at national level that has the legally delegated or invested powers to issue authorizations, perform compliance monitoring; and (4) development of competencies of the authority to achieve the sustained delivery of effective regulatory oversight.[4]

b. Recent Developments

Regulations which aim to govern the safe transport of radioactive material have been developed and maintained at the international and national levels for more than six decades. The IAEA has initiated work on establishing enhanced measures to ensure security in the transport of all radioactive materials, including the so called nuclear fuel cycle materials. The overall guidelines are the Model Regulations which contain a basic security level for the transport of all dangerous goods as well as additional requirements for an enhanced security level for goods defined as 'high consequence dangerous goods'. International standards and requirements are sometimes supplemented by national requirements. However, it does not appear that much effort

[4] International Atomic Energy Agency. (2021). *International Conference on the Safe and Secure. Transport of Nuclear and Radioactive Materials.*

has been devoted to harmonising requirements between national jurisdictions. Different standards and requirements between national jurisdictions can add complexity and can create more confusion and misinterpretation, and can potentially act as a disincentive to transport service providers.[5]

c. Relevant Actors

Managing radioactive waste involves many actors at various stages, including operators, regulators and a range of stakeholders. Stakeholders vary from country to country depending on the specific issue under consideration or the specific stage of a facility's life cycle or the RWM programme in the country.

A proactive role is played by international organisations such as IAEA, INTERPOL, UNODC, UNICRI, EUROPOL, WCO, ICAO or UN Initiatives when they organise groups which try to develop new initiatives or ideas. These groups are sometimes very formalised, examples being the Radioactive Waste Management Committee (RWMC) or the Performance Assessment Advisory Group (PAAG) of the NEA or the Waste Safety Advisory Committee (WASSAC) of the IAEA. In addition, influential activities are undertaken by the International Commission on Radiation Protection (ICRP), which develops, independently of national governments, guidelines on radiation protection that are then adopted into most bodies of national legislation.

d. Past International Approaches

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention) is the international framework providing guidance for developing and implementing a nuclear waste management program to contracting parties.

In order to deal with radioactive waste in a manner that protects human health and the environment now and in the future without imposing undue burdens on future generations, internationally agreed principles were established. The IAEA Safety Fundamentals Principles are the following: Principle 1: Protection of human health. Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health. Principle 2: Protection of the environment Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment. Principle 3: Protection beyond national borders. Radioactive waste shall be managed in such a way as to assure that possible effects on human health and the environment beyond national borders will be taken into account. Principle 4: Protection of future generations. Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today. Principle 5: Burdens on future generations. Radioactive waste shall be managed in such a way that will not impose

[5] International Atomic Energy Agency. (2022). *Status and Trends in Spent Fuel and Radioactive Waste Management*.

undue burdens on future generations. Principle 6: National framework. Radioactive waste shall be managed within an appropriate national legal framework including clear allocation of responsibilities and provision for independent regulatory functions. Principle 7: Control of radioactive waste generation. Generation of radioactive waste shall be kept to the minimum practicable. Principle 8: Radioactive waste generation and management interdependencies. Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account. Principle 9: Safety of facilities. The safety of facilities for radioactive waste management shall be appropriately assured during their lifetime.[6]

QARMA 2

a. Background of the Problem

Research and Development (R&D) on spent fuel and radioactive waste is a crucial part that a country possessing radioactive material should always continue to pursue. Usually, R&D programmes are executed by a wide variety of entities ranging from holding companies, facility operators, regulators, and even independent entities such as educational institutions or research laboratories.

On the current status quo, most research is focused on the development of technology for repository construction and operation such as but not limited to waste handling, tunnel isolation, operation management as a whole, and even as complex as predisposal management issues, which if none of them is developed could have a significant impact on the safety aspect and sustainability concern. Any changes made to the reactor design or even the small modular reactors would require the whole framework of spent fuel and radioactive waste management to be revisited and revised. Thus, countries would have to think of a strategic way for R&D to keep ahead of advancement and navigate management to be as efficient as possible.

Moreover, countries are intensifying R&D to assess risk on future performances. This is an effort to prevent unwanted negative outcomes and take corrective action. Examples of this case can be taken from the Fukushima Nuclear Disaster in 2011. Fortunately, R&D in regards to post-accident recovery has taken place and specific technology to handle the crisis was already built assisting the recovery faster and more securely, limiting damages to spread even further.

Additionally, countries began to undertake studies to reduce the volume and potential hazards. For example, the research is to find a solution to separate actinides that would help in reducing the hazards relating to spent fuel management and disposal storage. Other research has a similar goal however with different approaches by trying to transmute and partition in addition to recycling uranium or plutonium for a longer fuel cycle that eventually helps reduce spent fuel and could reduce the radiotoxicity of

[6] International Atomic Energy Agency. (1995). *Principles of Radioactive Waste Management Safety Fundamentals, Safety Series*.

the final waste. However, a lot of these R&Ds are still in the early development phase making it difficult for countries or any entities to estimate the actual benefits.

In another part of the R&D, storage for radioactive waste is currently under development. However, it is expected to take decades until a breakthrough would emerge due to its complex nature. Currently, to compensate for the long R&D, the AEA has developed regulatory provisions and technical measures for temporary safe storage of radioactive waste. Hence, the future challenges are clear. Delegates are expected to visit the current regulatory provisions and technical measures, then analyse for any room for improvement.

b. Recent Developments

There are a lot of current coordinated research projects under the IAEA, whether it is to develop a standardised framework for radioactive waste logistics and management or to reduce the radiotoxicity of the waste. The outcome of the projects is to give knowledge to member states in regards to the required material for advancement and provide implementable management systems. Some examples of current coordinated research projects are as follows.

Economic Evaluation aims to produce a systematic report on the best methodology obtained by analysing the back end of the fuel cycle. The current progress of the research is at the stage of obtaining valuable data in regards to the cost of the open fuel cycle in comparison to the close fuel cycle. The further result is expected to draft recommendations of implementable spent fuel management.

The World Nuclear Association (WNA) is currently working with an expert working group relating to the sustainable development of spent fuel management in holding a platform for all relevant stakeholders to share their ideas on the back end of the fuel cycle. The expert working group gives insight into the problem by giving out a recommendation as well as providing information on effective spent fuel management.

A global approach aims to understand the whole picture of where, how, and how each member state is doing in regards to their spent fuel and radioactive waste management.

c. Relevant Actors

Relevant actors cannot be strictly categorised as most of them collaborate and cross-role with each other. For the sake of the explanation, an analysis of relevant actors could be explained in two ways.

Country-specific R&D are those member states who are actively running R&D programmes. These countries include Canada, France, Sweden, Switzerland, the UK, and the USA. These countries heavily invest in research to focus on gaining experience of technological advancement and operation while also understanding the long-term

safety aspect of the fuel cycle to draft a better-spent fuel and radioactive waste management. The research under these member states is done both individually and in a collective effort. The collective effort is usually done to save costs.

The European Union follows their own directive of the Euratom Waste. Joint programmes, reports, and multinational collaboration are working on large scale projects on radioactive waste and spent fuel management. Some of the project under the EU is as follows, (1) Characterization of Conditioned Nuclear Waste for its Safe Disposal in Europe), (2) Thermal Treatment for Radioactive Waste Minimization and Hazard Reduction (THERAMIN), (3) Full-Scale Demonstration of Plugs and Seals (DOPAS), (4) Joint Programme on Radioactive Waste Disposal (JOPRAD), and many others.

Other bodies such as the Organisation for Economic Co-operation and Development (OECD), and the National Environment Agency (NEA) where their programmes run relating to waste decommissioning are also considered significant to the development of the sustainable implementation of spent fuel and radioactive waste management.

d. Past International Approaches

The IAEA champions the idea of knowledge sharing and even further encourages multiple stakeholders to collaborate such as the Organisation for Economic Co-operation and Development (OECD), National Environment Agency (NEA), European Commission (EC), World Nuclear Association (WNA), and other international organisations. Some examples of the past coordinated research project under the IAEA relating to spent fuel and radioactive waste management is as follows.

The Demonstrating Performance of Spent Fuel and Related Storage System research and testing ran for a hefty 4 long years from 2012 to 2016. The project fostered 16 partnerships from 11 different member states. The goal of the demonstration was to improve the nuclear power technical basis for spent fuel management licences while testing a prototype of extended-life dry storage. The result of the demonstration was found to be an important set of data contributing to closing the gap that existed enabling further research to advance towards the long-term performance of spent fuel within the technical aspects.

The Spent Fuel Performance Assessment and Research that was conducted from 2016 to 2020 successfully fostered 11 partnerships from 10 different member states. It aims to obtain as much operational experience as possible from different types of reactors and different types of conditions. The scope of the research is to find behaviour analysis of spent fuel management and assembly. The result is simply just to gain knowledge with new technology measurement to assist them in their analysis.

Ageing Management Programmes for Dry Storage Systems that was conducted

in 2016 has fostered 6 partnerships from 4 member states. The goal of the collaboration is to collect data on the current R&D framework, system, part, evaluation, monitoring, and other programmes. The data is then set to be shared to support other future research such as to enhance spent fuel dry storage. The data was also used by policy makers or decision-maker bodies to oversee renewal licensing policy and developing safety management protocols for the dry storage systems.

QARMA 3

a. Background of the Problem

There are commonly accepted disposal options for radioactive waste management (RWM). One approach to RWM is near-surface disposal at the ground level, or in caverns below ground level which is implemented for low-level radioactive waste (LLW) and short-lived intermediate-level radioactive waste (ILW). Another approach to RWM is geological disposal, which involves sealing the waste deep underground in a stable environment at depths between 250m or up to 5000m. The deep geological disposal is implemented for long-lived ILW and high-level radioactive waste (HLW), including used fuel. However, as this method poses many challenges, it is important that the theoretical approach will be integrated into a real-world waste management system.[7]

b. Recent Developments

The disposal of low and intermediate level wastes is well established in several countries. Long term safety determines the measures needed to protect people and the environment. A number of countries have made good progress towards implementing geological disposal of spent fuel, in particular Finland, France and Sweden.

c. Relevant Actors/Institutions

National policy frameworks should promote participatory, adaptable, and accountable decision-making.[8] Interactions between a diverse group of stakeholders and specialists will help increase societal awareness of geological radioactive waste management issues and options. Broad participation today may also partially compensate for future generations' unavoidable absence from current reflections or negotiations. Local and regional actors' empowerment has been steadily increasing over the last decade. There have been the following trends observed:

1. Move away from framing a "decision" as a complete solution and toward viewing it as one step in a prudent societal process of examining and choosing.

[7] Nuclear Energy Agency. (2020). *Management and Disposal of High-Level Radioactive Waste: Global Progress and Solutions*
[8] Nuclear Energy Agency. (2002). *An International Peer Review of the Yucca Mountain Project TSPA-SR*. Paris, France.

2. Move away from information and consultation and toward collaboration.
3. Local communities must transition from a passive to an active role.
4. Recognize regional interests, concerns, and prerogatives in addition to local ones, and include regions in dialogues.
5. Creation of a diverse range of administrative formats for collaboration and partnership between regional/local and national stakeholders.
6. Acceptance of the necessity and legitimacy of empowerment measures, competency-building support mechanisms, and socioeconomic benefits.
7. Transition away from technocratic approaches and toward new ideals and bases for collaboration, such as mutual learning, adding value to the host community or region, and integrating the repository into a sustainable development plan.

d. Past International Approaches

The NEA's primary focus in the field of radioactive waste management is on strategies for disposing of long-lived radioactive waste, primarily spent fuel and high-level waste from fuel reprocessing, as well as on assessing long-term safety and evaluating geological sites suitable for the construction of underground disposal facilities. The Radioactive Waste Management Committee (RWMC) oversees the NEA's work in this area. The RWMC is a forum for senior operators, regulators, policymakers, and senior representatives of research and development institutions involved in radioactive waste management. The RWMC's cross-party representation of industry, safety authorities, and government policy bodies, as well as the breadth of expertise it draws from NEA Member countries, makes it an unmatched international forum for discussing radioactive waste management issues.

Sources for Further Research

European Nuclear Safety Regulations Group

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