

# The Pacific Rim Spent Fuel Management Partnership Working Group

**A Common Framework for the Safe, Secure, and Socially Acceptable Siting of Geological Disposal Facilities for High-Level and Long-Lived Intermediate Level Radioactive Waste**

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## Executive Summary

The International Atomic Energy Agency (IAEA) estimates that more than 22,000 m<sup>3</sup> of radioactive High-Level Waste (HLW) and 460,000 m<sup>3</sup> of Intermediate-Level Waste (ILW) had been produced worldwide in 2018, the most recent year for which estimates are available. Both HLW and long-lived ILW require long-term management methods that do not rely on institutional controls because of the timescales over which they remain hazardous. Disposal in geological disposal facilities is internationally accepted as the most appropriate method for long-term management of these types of waste, and it is the method being pursued by most countries with nuclear programs. However, most of the current HLW and ILW inventory remains in interim storage facilities. Although storage is a necessary step of the back end of the nuclear fuel cycle, a more sustainable solution is required.

Social and political difficulties have delayed and, in many cases prevented, implementing geological disposal facilities for HLW. Failure to find an acceptable and sustainable solution to this problem threatens national, regional, and international safety and security; increases proliferation risks; strains the credibility of the nuclear community; undercuts public and political acceptance for all nuclear fuel cycle activities; and adversely impacts serious efforts to address climate change.

In 2013, the Nuclear Threat Initiative (NTI) launched the Developing Spent Fuel Strategies project to strengthen global approaches to nuclear materials management, leading to the establishment of a network of nuclear fuel cycle experts in the Pacific Rim to develop solutions to shared radioactive waste management issues and explore ways to address broader fuel cycle concerns.

Efforts to develop sustainable solutions for the long-term management of HLW have been ongoing for decades, and most programs around the world have

experienced both successes and failures. As science and societal expectations have evolved, it has become increasingly clear that stakeholder involvement and public confidence are key to success.

Building and sustaining public confidence is a significant challenge. It is influenced by a wide range of constantly evolving economic, social, political, and science and technology landscapes that are specific to each country. Although there is no universal template for the right path, there are common themes and approaches that can be used to assemble the building blocks for public confidence and acceptance. International experience suggests the following pillars would increase the chances of success for siting geological disposal facilities:

- A compelling case and narrative for geological disposal;
- A flexible, phased, and adaptable participatory approach grounded on mutual trust and respect, with a clear and transparent decision-making process;
- A comprehensive national legislative and regulatory framework, sustained by political will and commitment.

This document describes a common framework for the safe, secure, and socially acceptable siting of deep geological disposal facilities for HLW and long-lived ILW based on lessons learned from around the world. The framework focuses on key managerial and societal aspects that need to be holistically considered when developing a socially acceptable disposal program. It outlines key pillars and approaches that would increase the likelihood of success. The framework is meant to be a flexible tool that can be augmented and adapted, taking into account each country's specific social, political, and economic conditions.

## Introduction

The IAEA estimates that more than 22,000 m<sup>3</sup> of HLW and 460,000 m<sup>3</sup> of ILW had been produced in 2018, the most recent year for which estimates are available. HLW includes radioactive material with significant heat generation and large amounts of long-lived radionuclides, such as that used nuclear fuel as well as waste from reprocessing used fuel. ILW typically comprises resins, chemical sludges, and metal fuel cladding, as well as contaminated reactor components. ILW may contain long-lived radionuclides that will not decay to acceptable levels over the time they are under institutional controls. Long-lived ILW represents a small percentage of the volume and activity of radioactive waste. This type of waste is typically not suitable for near-surface disposal facilities and requires underground disposal at depth.

Both HLW and long-lived ILW require management approaches that do not rely on institutional controls because they remain hazardous over an extended time. Disposal in geological disposal facilities is internationally accepted as the most appropriate method available today for the long-term management of these waste streams. It is the method that is being pursued by most countries with nuclear programs. However, all HLW is currently managed on an interim basis in surface storage facilities, mostly at nuclear sites. About 20 percent of ILW is currently managed in disposal facilities, with the rest in interim storage.<sup>1</sup>

Social and political difficulties have delayed and, in many cases prevented, implementing geological disposal facilities for HLW. Failure to find an acceptable and sustainable solution to this problem threatens national, regional, and international safety and security; increases proliferation risks; strains the credibility of the nuclear community; undercuts public and political acceptance for nuclear fuel cycle activities; and adversely impacts serious efforts to address climate change.

In 2013, NTI launched the Developing Spent Fuel Strategies project to strengthen global approaches to nuclear materials management, leading to the establishment of a network of nuclear fuel cycle experts in the Pacific Rim to develop solutions to shared radioactive waste management issues

and explore ways to address broader fuel cycle concerns. The NTI Pacific Rim Spent Fuel Management Partnership Siting Working Group was established as an international forum for sharing experiences on the technical and non-technical challenges related to siting and implementing geological disposal facilities. The working group included participants from Australia, Canada, Japan, South Korea, Taiwan, and the United States (see Appendix A).

This document, developed by the working group, describes a common framework for the safe, secure, and socially acceptable siting of deep geologic facilities based on lessons learned from around the world. The framework focuses on key important managerial and societal aspects that need to be holistically considered when developing a socially acceptable disposal program. It outlines key pillars and approaches that would increase the likelihood of success. The framework is meant to be a flexible tool that can be augmented and adapted, taking into account each country's specific social, political, and economic conditions. For the purpose of this document, stakeholders refer to individuals; groups; organizations; and communities that are either directly or indirectly affected by, interested in, or can influence the siting initiative.

The document does not address many technical and stakeholders' engagement aspects associated with the various phases of implementing disposal programs such as siting, site characterization, safety assessment, construction, and operation.

Numerous publications provide detailed guidance on the many societal and technical aspects related to developing and implementing geological disposal facilities. The Nuclear Energy Agency (NEA) has published many documents on the technical and social aspects related to the long-term management of HLW. The IAEA also has developed the comprehensive *Generic Roadmap Towards Implementing a Deep Geological Repository*<sup>2</sup> as well as a series of training courses on the topic.

1 International Atomic Energy Agency, *Status and Trends in Spent Fuel and Radioactive Waste Management*, IAEA Nuclear Energy Series No. NW-T-1.14, 2018, [https://www-pub.iaea.org/MTCD/Publications/PDF/P1799\\_web.pdf](https://www-pub.iaea.org/MTCD/Publications/PDF/P1799_web.pdf).

2 International Atomic Energy Agency, *Generic Roadmap Towards Implementing a Deep Geological Repository*, forthcoming 2021, <https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/division-of-nuclear-fuel-cycle-and-waste-technology/waste-technology-section>.

## The Need for Public Input and Trust-Building in the Long-Term Management of HLW

Efforts to develop sustainable solutions for the long-term management of HLW have been ongoing for decades. This has led to unprecedented scientific research and international collaboration, mainly driven by the recognition that a long-term solution is needed. Most programs around the world have experienced both successes and failures, and we have learned a great deal as science and societal expectations continue to evolve.<sup>3</sup>

One of the most important lessons is that stakeholder involvement and public confidence are key to success. Because safety has obvious and important implications for society, at some level, the public must have a role to play in judging whether projects that affect them are safe.<sup>4</sup> This means people need to understand what decisions need to be made and their role in the decision-making process. Although any preferred technical option must be based on sound science, it also should reflect people's expectations and perspectives on safety.

Experience shows that public acceptance of and confidence in the safe and secure long-term management of HLW and long-lived ILW requires a dialogue-driven approach that is responsive to people's questions, priorities, and expectations. Building and sustaining public confidence is a complex issue. It is influenced by constantly evolving economic, social, and political landscapes that are specific to each country, as well as advances in science and technology.

Although no universal template exists for the right approach, common themes and methods can be used

to assemble the building blocks for public confidence and acceptance. International experience suggests a successful approach can be built on the following interrelated pillars:

1. A compelling case and narrative for geological disposal that answers the following questions:
  - What is the problem and why should it be addressed now?
  - What are today's social priorities and expectations regarding the long-term management of radioactive waste?
  - What waste management approaches are available today?
  - Why is geological disposal the method that responds best to citizens' values, principles, and expectations?
2. A flexible, phased, and adaptable participatory approach grounded on mutual trust and respect, with a clear and transparent decision-making process; and
3. A comprehensive national legislative and regulatory framework, sustained by political will and commitment.

Common themes related to the above pillars are discussed in more detail in the following sections. The proposed approaches and guidance must be tailored and adapted to the specific needs and sociopolitical conditions of each disposal program.

- 3 Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, November 2005, [https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341\\_NWMO\\_Final\\_Study\\_Nov\\_2005\\_E.ashx?la=en](https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341_NWMO_Final_Study_Nov_2005_E.ashx?la=en); Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel, A Summary*, 2005, [https://www.nwmo.ca/~media/Site/Reports/2015/11/11/06/53/342\\_NWMO\\_Final\\_Study\\_Summary\\_E.ashx?la=en](https://www.nwmo.ca/~media/Site/Reports/2015/11/11/06/53/342_NWMO_Final_Study_Summary_E.ashx?la=en); Nuclear Energy Agency Organisation for Economic Co-Operation and Development, *Communication on the Safety Case for a Deep Geological Repository*, NEA No. 7336, 2017, [https://www.oecd-nea.org/jcms/pl\\_15032/communication-on-the-safety-case-for-a-deep-geological-repository?details=true](https://www.oecd-nea.org/jcms/pl_15032/communication-on-the-safety-case-for-a-deep-geological-repository?details=true); Nuclear Energy Agency Organisation for Economic Co-Operation and Development, *Management and Disposal of High-Level Radioactive Waste: Global Progress and Solutions*, NEA No. 7532, 2020, [https://www.oecd-nea.org/jcms/pl\\_32567/management-and-disposal-of-high-level-radioactive-waste-global-progress-and-solutions](https://www.oecd-nea.org/jcms/pl_32567/management-and-disposal-of-high-level-radioactive-waste-global-progress-and-solutions); Nuclear Energy Agency Organisation for Economic Co-Operation and Development, *International Roundtable on the Final Disposal of High-Level Radioactive Waste and Spent Fuel*, NEA No. 7529, 2020, [https://www.oecd-nea.org/jcms/pl\\_39718/international-roundtable-on-the-final-disposal-of-high-level-radioactive-waste-and-spent-fuel-summary-report](https://www.oecd-nea.org/jcms/pl_39718/international-roundtable-on-the-final-disposal-of-high-level-radioactive-waste-and-spent-fuel-summary-report); U.S. Department of Energy, *Blue Ribbon Commission on America's Nuclear Future Report to the Secretary of Energy*, January 26, 2012; U.S. Department of Energy, *Designing a Consent-based Siting Process, Summary of Public Input*, Final Report, December 2016.
- 4 Canadian Environmental Assessment Agency, *Report of the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel, February 1998*, [https://www.ceaa.gc.ca/archives/pre-2003/431C8844-1/default\\_lang=En\\_n=0B83BD43-1.html](https://www.ceaa.gc.ca/archives/pre-2003/431C8844-1/default_lang=En_n=0B83BD43-1.html).

## The Need for a Compelling Narrative to Make the Case for Geological Disposal

Geological disposal is widely accepted within the scientific community as the best method available today for the safe long-term management of HLW and long-lived ILW in a passive manner that does not require long-term institutional controls. Most countries with nuclear programs are pursuing the development of geological disposal facilities supported by robust international cooperation programs to ensure that the best knowledge and practices are used.

However, this international consensus among experts is not widely reflected in the public and confidence varies significantly. Public acceptance and confidence require open, transparent, and inclusive two-way dialogues but frequently, technical arguments dominate the narrative, with little focus on societal and ethical aspects, such as intergenerational equity issues that must be addressed by those who today and in the future will benefit from nuclear energy.<sup>5</sup>

A new narrative must clearly and compellingly articulate the societal need that will be served by siting a geological disposal facility. It should give members of a host community the ability to respond clearly and convincingly when a relative or a skeptic questions the societal benefit of hosting a disposal facility in the community. The narrative should also include well-articulated safety case arguments that describe how geological disposal would protect current and future generations as well as the environment from spent fuel. Finally, the narrative must articulate the added value associated with the disposal facility and how it will enhance the quality of life of the host community in a sustainable manner, considering the many lenses of well-being.

A compelling narrative is best developed and validated with early participation of key stakeholders, considering each country's specific social and political conditions. Many countries have expended great effort engaging their citizens, to varying degrees of success, on the societal and technical questions that need to be asked when considering approaches

for the long-term management of HLW. Experience from failures and successes suggests a compelling narrative can be derived and validated using the following steps:

### **Acknowledging the nature of the hazard associated with HLW and long-lived ILW and the limitations of interim prolonged storage.**

This requires engaging the public and other key stakeholders in a discussion around the nature of the radiological and chemical hazards associated with radioactive waste and the need for a sustainable long-term management approach. A key fact that emerged from dialogues with experts around the world is that HLW and long-lived ILW will remain a hazard for people and the environment over significant timescales, and interim storage is not a sustainable approach in the long-term because it relies on institutional controls that cannot be guaranteed over the timescales over which the waste will remain a hazard.

### **Identifying key stakeholders that need to be involved and understanding how they want to be involved.**

This is best achieved through inclusive early dialogues with individuals, groups, and organizations such as civil society groups, including opposition groups, youth, social and technical experts, elected officials, regulators, and others to understand who they are, what interests they have, and how they want to be involved. Early involvement and understanding mutual expectations will strengthen the process and, ultimately, the narrative. The engagement and dialogue approaches should be innovative and adapted to each stakeholder's needs. Sustained engagement is required throughout the phases of implementation of geological disposal facilities.

### **Understanding societal values and cultural norms, priorities, and expectations.**

This requires engaging the public and other key stakeholders to identify the key social and technical questions and principles that need to be considered when evaluating radioactive waste management approaches. Experience to-date shows that although people have expressed

5 Nuclear Energy Agency Organisation for Economic Co-Operation and Development, *Management and Disposal of High-Level Radioactive Waste: Global Progress and Solutions*, NEA No. 7532, 2020, [https://www.oecd-nea.org/jcms/pl\\_32567/management-and-disposal-of-high-level-radioactive-waste-global-progress-and-solutions](https://www.oecd-nea.org/jcms/pl_32567/management-and-disposal-of-high-level-radioactive-waste-global-progress-and-solutions); Nuclear Energy Agency Organisation for Economic Co-Operation and Development, *International Roundtable on the Final Disposal of High-Level Radioactive Waste and Spent Fuel*, NEA No. 7529, 2020, [https://www.oecd-nea.org/jcms/pl\\_39718/international-roundtable-on-the-final-disposal-of-high-level-radioactive-waste-and-spent-fuel-summary-report](https://www.oecd-nea.org/jcms/pl_39718/international-roundtable-on-the-final-disposal-of-high-level-radioactive-waste-and-spent-fuel-summary-report); Nuclear Waste Management Organization *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, November 2005, [https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341\\_NWMO\\_Final\\_Study\\_Nov\\_2005\\_E.ashx?1a=en](https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341_NWMO_Final_Study_Nov_2005_E.ashx?1a=en).

a diversity of views, they tend to agree on the following:<sup>6</sup>

- Today's generation benefits from nuclear energy and owes it to future generations to lay the groundwork for safely and securely disposing radioactive waste.
- Safety and community well-being should be the top priorities.
- Best scientific knowledge and international practices should be considered.
- Ability to retrieve the waste in the future should be considered.
- The management approach should remain flexible and willing to adapt to future changes in technology and societal expectations.

**Evaluating available waste management alternatives.**

Identifying a socially acceptable long-term management approach requires assessing available options and identifying the approach that responds best to citizen values, priorities, and expectations. The assessment framework should include citizen involvement and build on the social and technical questions that citizens identify as important.

A vast amount of work has been conducted internationally over the last decades to explore possible methods for safely managing HLW. For example, in Canada, a three-year dialogue with the Canadians public and other key stakeholders explored 14 possible waste management alternatives ranging from geological disposal, centralized interim storage, disposal in the ocean floor, disposal in subduction zones, etc.<sup>7</sup> At the end of the dialogue, organizers found that geological disposal met most of the stakeholder's values, principles, and objectives. It is a technically sound method that will safely contain and isolate HLW for generations to come and is the method that responds best to societal values, priorities, and expectations.

6 Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, November 2005, [https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341\\_NWMO\\_Final\\_Study\\_Nov\\_2005\\_E.ashx?la=en](https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341_NWMO_Final_Study_Nov_2005_E.ashx?la=en)

7 Nuclear Waste Management Organization, *Choosing a Way Forward: The Future Management of Canada's Used Nuclear Fuel*, November 2005, [https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341\\_NWMO\\_Final\\_Study\\_Nov\\_2005\\_E.ashx?la=en](https://www.nwmo.ca/~media/Site/Files/PDFs/2015/11/04/17/30/341_NWMO_Final_Study_Nov_2005_E.ashx?la=en)

## The Management Approach: Adaptable, Transparent, Fair, and Inclusive

International experience shows that public confidence and acceptance require a dialogue-driven approach where stakeholders are involved from the very beginning. This requires a management approach that is adaptable and grounded in fairness, trust, and respect. The approach should aim to create safe spaces for dialogue with interested communities and other stakeholders.

The decision-making process for the implementation approach should clearly identify decision points, decision criteria, and who is involved in making those decisions. Communities and stakeholders should be provided with the resources they need to fully participate in the various stages of planning and implementation. The management approach should ideally consider the following components:

- A socially acceptable, fair, and inclusive siting

process designed to seek an informed and willing host.

- Comprehensive community engagement programs to build awareness and, ultimately, acceptance.
- A commitment to engage in a two-way dialogue with citizens on the safety of geological disposal to understand their perspectives and address their questions and concerns.
- A commitment to explore how to implement the project in partnership with the local communities in a manner that will enhance their quality of life, considering the many lenses of well-being.

The following sections expand on the above considerations.

## Socially Acceptable Siting Process

An inclusive, fair, and transparent siting process developed with the involvement of citizens is central to gain trust and confidence. Key considerations include:

- A series of guiding principles and commitments, including a strong commitment to seek an informed and willing host (voluntary process).
- An understanding that communities control their participation in the process and have a safe space to learn about the project so they can make an informed decision.
- A stepwise site evaluation process with key milestones and clear technical and social site evaluation factors.
- A transparent decision-making process outlining the decisions to be made, when they need to be made, and who will make them. The role of the communities, proponents, and regulatory authorities in the decision-making process should also be clearly outlined.
- The community should demonstrate a clear willingness to host. There is no universal definition of willingness and how it should be measured and demonstrated by potential host communities. It is influenced by social, cultural, and political conditions that are specific to each country and region.
- The site evaluation process and decision-making schedule should allow for sufficient time for communities to learn about the project and make an informed decision.
- A commitment to provide communities with the financial and human resources they need to build their capacity and participate in the site selection process.



## Comprehensive and Sustained Local and Regional Engagement Programs to Build Awareness and Ultimately Support

Implementing organizations need to have comprehensive and sustained engagement programs with clear goals and deliverables. The programs should be developed in collaboration with the target audiences to ensure their specific needs are met. Engagement programs should aim to build awareness and acceptance within a wide range of stakeholders such as the public, local potential host communities and their neighbors, youth, local and regional media outlets, elected officials, civil society organizations, and key local and regional opinion leaders.

The engagement programs should be adequately resourced and led by trained staff and contractors who are able to convey the narrative and communicate complex technical topics in an easily understandable manner. All staff and contractors need to have a good awareness and understanding of local and regional cultural practices and sensitivities. The engagement programs should be inclusive and delivered in local languages and dialects as appropriate.

Potential host communities should also have their own independent engagement programs. A good practice is establishing local community committees with a mandate to facilitate objective and impartial learning within the community. These committees are typically led by the community and include a cross-section of community members willing to advocate for providing community members with opportunities to hear from multiple voices, including opposing views.

Siting geological disposal facilities is a long-term process. Experience shows that as the site selection process advances, increasingly more community members become interested and join the ongoing dialogue without the knowledge that other community members acquired over the years. Therefore, it is important to maintain corporate knowledge and ensure that engagement programs remain consistent with the narrative and founding values and principles.

## Involving Communities in Dialogues about Safety

Safety has a social dimension and citizens have a role to play in discussions about safety. Communities may have perspectives and concerns about safety that are not necessarily addressed or considered through traditional approaches to conducting safety assessments. Therefore, it is critical to involve communities early to understand their questions, concerns, and perspectives.

Although implementing organizations need to develop a safety case that would withstand the scrutiny of the regulator, potential host communities also need to build their own narrative on safety, related to why they are considering hosting a repository. It is critical for communities to build their knowledge and resiliency.

Some of lessons learned over time include:

- Communities need to have the time and the resources to learn and process the large amount of information associated with developing geological disposal facilities.
- As much as possible, communities need to be involved in joint planning, execution, and interpretation of field investigation studies to assess the technical suitability of the sites.
- Communities should be provided with opportunities to hear from multiple sources of information, including opposing voices, regulators, and range of independent experts.
- Elders and knowledge holders in local indigenous communities should be included to explore opportunities for interweaving indigenous knowledge in assessments.
- When multiple potential sites are available, potential host communities should be involved in selecting socially acceptable repository sites based on their own socioeconomic and cultural criteria.

## Implementing Geological Disposal Facilities in Partnership with Local Communities

Geological disposal facilities are large infrastructure projects that are developed and operated over many decades. They offer a unique opportunity for decades of sustainable development. Organizations responsible for implementing such facilities need to engage potential communities in exploring how the project can be implemented through partnership in a manner that will enhance well-being. The added value of the project is an important component of the community narrative for hosting a geological disposal facility. Developing supportive and resilient partnerships could involve the following:<sup>8</sup>

- Communities having independently developed a vision of their future and assessing whether the project aligns with that vision.
- A stepwise process to engage community leaders and members in partnership discussions, including discussions on values and principles, potential community benefits and impacts, project implementations options, required local and regional partnerships, and required investments to implement the project.
- Exploring potential partnership models and opportunities for the communities to participate in implementing and managing certain components of the project as appropriate.
- A clear demonstration that the project aligns with the well-being vision the host communities have for themselves, consistent with their narrative.
- An agreement that articulates the benefits that potential host communities will receive from hosting the project (the added value) and the commitments on both sides.
- A commitment to establishing a visitor center that could become a national and international scientific hub. Such facilities can help potential host communities further support their narrative for why they are considering hosting the project.

8 Nuclear Waste Management Organization, NWMO (2021), “Working Together in Partnership,” <https://www.nwmo.ca/en/A-Safe-Approach/About-the-Project/Working-in-Partnership>.

## Comprehensive National Legislative and Regulatory Framework

Successful and socially acceptable implementation of geological disposal facilities requires a clear national legislative, regulatory, and implementation framework for the long-term management of radioactive waste. Stakeholders' confidence is increased when the national regulatory framework is consistent with the approaches, guidelines, and standards adopted by international organizations such as the IAEA, NEA, the International Commission on Radiological Protection, and the European Commission.

Governments have the primary role in developing the national framework, which should consider, at a minimum, the following components:

- (a) Clear national policies, strategies, and regulations for managing radioactive waste.
- (b) Financial surety to ensure funding is available to cover all implementation phases.
- (c) Adequate resources to support implementing the national framework.

### Clear National Radioactive Waste Management Policies, Strategies, and Regulations

The radioactive waste management legislative and regulatory framework should provide clarity to all stakeholders involved, including the public. It should aim to achieve the following:

- An integrated radioactive waste management policy and implementation strategies that consider the entire nuclear fuel cycle.
- A strong, independent regulator with clear safety policies and regulations, and a transparent decision-making process that provides opportunity for the public to be heard.
- A clear implementation framework that clearly defines roles and accountabilities of various levels of governments, regulators, waste owners, and implementing organizations. Having multiple parties involved in siting geological disposal facilities and interacting with communities may lead to inconsistencies in the approach and narrative, which may erode public trust and acceptance. Dedicating an organization to be responsible for the long-term management of radioactive waste tends to increase stakeholders' confidence.
- Support at multiple levels of governments, including among opposition parties, is critical. Political divisiveness trivializes the importance of the challenges associated with the long-term management of radioactive waste and erodes public confidence in all parties involved.
- Support for research and development and commitment to international cooperation.

## Financial Surety

Citizens expect that the funds necessary to pay for the long-term management of radioactive waste are available and managed responsibly. The funding sources, funding process, and financial controls should be transparent and embedded in the legislative and regulatory framework. The financial surety system should, at a minimum, include the following:

- Regularly updated cost estimates that cover covering the full life cycle of implementing the geological disposal facility.
- An independent review and audit process that ensures cost estimates are accurate and sufficient to cover implementation.
- Establishment of appropriate trust funds or financial guarantees to cover the long-term costs, including a clear process and mechanism establishing the amounts and frequency of waste owners' contributions to the funds.
- An independent oversight process to ensure funds are secure and adequately managed, including compliance with the rules and conditions governing access to the funds by implementers.

## Adequate Implementation Resources

Successfully siting and implementing geological disposal facilities is a lengthy process requiring a great deal of financial and human resources. This should be accounted for early in the process because it takes time for organizations to build their internal capacity to site and implement geological disposal facilities. Experience shows that the demand for resources increases with time as communities learn more about the project, become more involved in the engagement effort, conduct their own independent activities to learn about the safety of geological disposal and how the project will impact their environment and quality of life.

## Conclusion

Geological disposal is being pursued by most countries with nuclear programs supported by robust international cooperation programs. It is widely accepted within the scientific community as the best method available today for the safe long-term management of HLW and long-lived ILW in a passive manner that does not require long-term institutional controls. However, international consensus among experts is not widely reflected in the public and confidence varies significantly. One of the most important lessons learned is that stakeholder involvement and public confidence are key to success. Although any technical option must be based on sound science, it should also reflect citizens' perspective on safety.

Building and sustaining public confidence is a challenge. It is influenced by constantly evolving economic, social, and political landscapes that are specific to each country, as well as advances in science and technology. Although no universal template for the right approach exists, common themes and approaches can be used to assemble the building blocks for public confidence and acceptance. These include:

- A compelling case and narrative for geological disposal.
- A flexible, phased, and adaptable participatory approach grounded in mutual trust and respect, with a clear and transparent decision-making process.
- A comprehensive national legislative and regulatory framework, including political will and commitment.

The compelling narrative for disposal is best developed and validated with early participation of key stakeholders to ensure that it reflects their common values, principles, and expectations. Developing the narrative requires involving stakeholders in understanding and acknowledging the nature of the hazard associated with HLW and long-lived ILW and the limitations of interim storage; identifying those who need to be involved and understanding how they want to be involved; and agreeing on the technical and social criteria that should be used to assess waste management alternatives.

Public confidence and acceptance require a dialogue-driven implementation approach where key stakeholders and citizens are involved from the very beginning. This requires a flexible and adaptable management approach that includes a clear decision-making process. Key components of this approach include a socially acceptable fair and inclusive siting process; a comprehensive community engagement program to build awareness and, ultimately, acceptance; a commitment to engage in a two-way dialogue with citizens; and a willingness to partner with potential host communities.

Successful and socially acceptable implementation of geological disposal facilities requires a comprehensive national legislative and regulatory framework. International experience suggests the framework should include clear national policies, strategies, and regulations for managing radioactive waste; financial surety to ensure funding is available to cover all phases of implementation; and adequate resources to support implementation.

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