Free Executive Summary

Improving the Regulation and Management of Low-Activity Radioactive Wastes

Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Wastes, National Research Council

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Overview

By far the largest volumes of radioactive wastes in the United States—millions of cubic meters—contain only low concentrations of radioactive material. These low-activity radioactive wastes (LAW) should be regulated and managed according to their intrinsic hazardous properties and, thus, the degree of risk they pose for treatment, storage, and disposal. The current regulatory structure is based primarily on the wastes' origins[1] rather than their actual radiological risks. There is no scientific basis for applying *different* degrees of control to wastes that pose similar risks or applying *similar* controls to wastes that pose very different risks. Such inconsistencies are inherent in the current system.

In this report, the authoring committee[2] develops its vision of a risk-informed system for regulating and managing all types of low-activity waste in the United States. The framework for risk-informed decision making combines scientific risk assessment with public values and perceptions. The framework is implemented in a gradual or stepwise fashion—but always with regard to the hazardous properties[3] of the waste in

[1]The current system regulates LAW according to the enterprise that produced it (e.g., national defense, nuclear industry, non-nuclear industry, medicine).

[2]The National Academies Committee on Improving the Regulation and Management of Low-Activity Radioactive Wastes. This study benefited from the support of eight domestic and two international sponsors.

[3]While this report discusses explicitly only radiological hazards associated with low-activity waste, the committee is well aware that these wastes often manifest chemical,

question and their comparison to those of other waste materials, and not to the enterprise that produced the waste.

The committee recognizes that public perceptions of risk may differ from scientific assessments. Determining a level of acceptable risk is a matter of public policy informed by science. The committee also recognizes the substantial body of laws and regulations and the large financial investment in management infrastructure, including disposal facilities, that are now in place. While regulatory authorities are adequate to ensure safety, the current system is complex, is inconsistent, and does not address risks of the various LAW systematically. The system is inefficient and will grow increasingly so in the future as more and different wastes are generated (e.g., from nuclear facility decommissioning, site cleanups, and new nuclear applications).

The committee found no easy way to change the existing system. Efforts over the past 25 years to improve the system generally have not been successful. Radioactive waste issues are highly controversial among citizens, especially those whose communities might be involved in waste facility siting or transportation routes. For public policy makers, the political liabilities for engaging in these issues are high and benefits are small. Nevertheless, among decision makers at all levels who are responsible for continuing to ensure the safety of LAW management, there is strong interest in improving current practices.

In addressing its charge, the committee sought to be practical. The report discusses and recommends a four-tiered system of change based on established principles for risk-informed decision making, current risk-informed initiatives by waste regulators in the United States and abroad, solutions available under current regulatory authorities, and opportunities for focused legislation as needed if simpler approaches are inadequate.

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biological, and possibly other hazards. The risk-informed methodology developed in this report could, generally speaking, be extended to incorporate all such hazards, although the details of doing so are beyond the scope of this study. See Recommendation 1.

Summary

By far the greatest volumes of radioactive wastes that arise annually in the United States contain only small concentrations of radioactive material. These low-activity wastes (LAW) present much less of a radiation hazard than either spent nuclear fuel or high-level radioactive waste. Improperly controlled, however, they have the potential to produce significant chronic (and in some cases acute) health risks. LAW arise in many sectors, including national defense, private industries, medicine, and research. Not all of these wastes are produced by enterprises that use nuclear materials or ionizing radiation—million cubic meter per year volumes arise incidentally in non-nuclear enterprises, primarily mineral mining and oil and gas recovery. These latter wastes contain naturally occurring radioactive materials (NORM), such as uranium, thorium, and their radioactive decay products, including radium and radon.

In the United States, low-activity wastes are subject to a regulatory patchwork that has evolved over almost 60 years. Statutes and regulations that control LAW are based primarily on the type of enterprise that produced it—the origin of the waste—rather than the waste's actual radiological hazard or potential health risk. The Atomic Energy Act of 1954 (AEA), as amended, provides federal control of nuclear energy-related enterprises, including their wastes. Federal control is exercised primarily by the Department of Energy (DOE), Nuclear Regulatory Commission (USNRC), and Environmental Protection Agency (EPA).

The Low-Level Radioactive Waste Policy Act of 1980 (LLRWPA), as amended, gave each state (or compacts of states) responsibility for dis-

posing of a subset of AEA wastes, defined by statute as "low-level wastes," from private enterprises within the state. Generally speaking, the states control non-AEA wastes, such as NORM and TENORM[1] wastes. Both the USNRC and EPA have programs for withdrawing their federal authorities in order to allow the states to exercise their own authorities over public health and safety.

Private-sector enterprises and citizens are also important stakeholders in the management and regulation of LAW. Previous National Academies' studies found that disposing of slightly radioactive metal and concrete from decommissioning the current fleet of nuclear power reactors could cost $4.5 billion to $11.7 billion (NRC, 2002, p. 6) and that the cost of managing LAW is a major factor in biomedical research (NRC, 2001a). Citizens' perceptions of radiation risks can vary widely from those of technical experts, yet public perceptions of LAW are often important factors in decisions about disposal facility siting and waste transportation routes.

With this report, the committee[2] completes a two-part study to assess and recommend technical and policy options for improving practices for regulating and managing low-activity waste (the statement of task appears in Sidebar 1.1). The committee finished the first part of its study with an interim report published in late 2003. The interim report, reprinted in Appendix A of this report, gives an overview of the current LAW system in the United States: waste characteristics, inventories, management and disposal practices, and federal and state regulations that control these wastes. In the interim report the committee found that there is adequate authority for managing LAW. However, the system is complex, and significant inconsistencies have arisen from regulating LAW mainly according to its origins rather than systematically considering its risks (see Sidebars 1.2 and 1.3).

In seeking ways to improve the system, the committee confronted the fact that current practices result from years of evolution of the origin-based system, involving many interactions among federal and state regulators, waste generators, and concerned citizens. Substantial change will not be easily. The objectives envisioned by Congress in the LLRWPA generally have not been met. Waste generators have only a limited number of disposal options, which often result in large volumes of waste being shipped long distances for disposal. The planned closure of the Barnwell,

[1]NORM that become more concentrated during mineral recovery or other operations are referred to as "technologically enhanced naturally occurring radioactive materials" (TENORM). TENORM includes material that has been made more accessible to human contact and therefore more likely to cause exposures.

[2]The Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Waste is referred to as "the committee" throughout this report.

South Carolina, site in 2008 could leave generators in more than 30 states without access to disposal for USNRC Class B and C low-level wastes. Significantly, however, federal regulatory agencies and other organizations have developed initiatives that could help improve the system. The DOE has developed an efficient strategy for disposing of very large volumes of very low activity wastes from its facility decommissioning and site cleanups. Chapter 2 summarizes these current initiatives and the near-term disposal situation.

To prepare this final report, the committee considered a number of options for improving the current system of LAW management. The committee came to the conclusion that a "risk-informed" approach would provide the best option for improving LAW regulation and management practices in the United States. A risk-informed approach is based on information provided by science-based risk assessment but includes stakeholders as a central component in decision making. Basing regulatory decisions and actions on the actual radiological hazards presented by the wastes themselves, and hence the risks they pose for their management and disposal, could provide the basis of a risk-informed framework for managing and disposing of the various types of LAW, and decisions within that framework would involve all stakeholders. The committee discusses these ideas in Chapter 3.

Another challenge for the committee was to agree how to move from the present origin-based system to a risk-informed system. Throughout its information-gathering activities, the committee heard a nearly unanimous opinion from congressional staff, regulators, generators, and public stakeholders that a sweeping conversion of the present origin-based patchwork of regulations and practices to a coherent system that uses risk as a basis for managing these wastes (i.e., a risk-informed system) would be most desirable (see Sidebar 4.3 of Appendix A). The same presenters, however, cautioned that such a conversion would be virtually impossible given the long history and investment in the regulatory and operational infrastructure of the current system, the disruption that an abrupt change could cause, and the lack of political will to effect such a change. Views varied widely about the urgency of changes and how to make them.

The committee found that while individual agencies and organizations are proposing important initiatives for moving toward an improved, risk-informed system, these single-agency initiatives lack priority. Better integration of these initiatives through cooperation among agencies could improve their chance of success. Integrated, practical, and stepwise improvements are most likely to succeed.

Chapter 4 describes a practical, tiered approach for making risk-informed changes under existing regulatory authorities, relying on congressional remedies when necessary. The committee distinguishes between

the current "patchwork" approach of regulating, when the need arises, new or altered waste streams according to the enterprise that produced them, versus the committee's suggested "tiered" approach in which regulatory changes are directed toward controlling wastes according to their intrinsic radiological properties—with the appropriate level of control being determined through a risk-informed process in each instance.

Recommendation 1

The committee recommends that low-activity waste regulators implement risk-informed regulation of LAW through integrated strategies[3] developed by the regulatory agencies. Improving the system will require continued integration and coordination among regulatory agencies including the USNRC, EPA, DOE, DOD, and other federal and state agencies.

While current statutes and regulations for LAW provide adequate authority for protection of workers and the public, current practices are complex, inconsistent, and not based on a systematic consideration of risks. More efficient and uniformly protective management of the risks posed by these wastes will require moving away from the present origin-based regulatory system—a system that is firmly established through decades of practice and involves a number of federal and state agencies that have different authorities.

The development and use of integrated strategies would strengthen waste regulators' ongoing efforts to improve LAW regulation and management practices by

1. Focusing the attention of decision makers at all levels on the needs for and benefits of implementing risk-informed practices,
2. Providing a unified approach to developing risk-informed practices that is recognized by all stakeholders as cooperative and mutually supportive, and
3. Promoting harmonization (consistency on the basis of risk) in changes at each of the four tiers discussed in this report.

An important purpose of interagency strategies would be to help regulatory agencies balance their use of the four-tiered approach (see Rec-

[3]By "integrated strategies" the committee means the results of agencies working together to develop a single or joint strategies for using the approach in Recommendation 2 to implement risk-informed practices. Because the regulatory agencies have different legal authorities they may develop separate, but coordinated, strategies.

ommendation 2), including instances where targeted legislation[4] might be needed if the first three tiers are not sufficient for developing solutions.

Cooperative interagency efforts have made significant progress in improving regulations in areas that are relevant to LAW management and disposal. Examples include development of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)[5] and guidance from the Interagency Steering Committee on Radiation Standards (ISCORS), the latter of which includes eight federal agencies and has the goal of improving consistency in federal radiation protection programs. Development of the integrated strategies should build on the successes of MARSSIM, ISCORS, and similar interagency efforts and make even greater use of such efforts. Developing and instituting implementation strategies may require several years, as did the work on MARSSIM.

Two areas identified in this study exemplify where risk-informed regulations would improve the current system and could provide a focus for development of the strategies:

- Wastes containing uranium or thorium and their radioactive progeny generated by AEA- and non-AEA-controlled industries pose similar hazards (according to the type and concentration of their radioactivity) but are controlled under very different regulatory regimes.
- There is no generalized provision for wastes that contain very low concentrations of radioactivity to exit the regulatory system, although there are examples of case-by-case exemption or clearance of some such wastes.

Recommendation 2

The committee recommends that regulatory agencies adopt a risk-informed LAW system in incremental steps, relying mainly on their existing authorities under current statutes, and using a four-tiered approach: (1) changes to specific facility licenses or permits and individual licensee decisions; (2) regulatory guidance to advise on specific practices; (3) regulation changes; or if necessary, (4) legislative changes.

The committee advocates a stepwise "simplest-is-best" approach to implementing risk-informed LAW regulation and management. Acting under their existing authorities, regulatory agencies and site operators

[4]The 2005 Energy Policy Act's expanded definition of byproduct materials is an example of such legislation. See Chapter 2.

[5]See Chapter 4.

can effect significant changes from the bottom up, beginning with changes to specific facility licenses, permits, or decisions. By changing licenses and permits, the burden of moving toward risk-informed practices is shared by generators, facility operators, and regulators. Good business practices can lead generators toward better waste prevention, minimization, and segregation if there is more flexibility in selecting options for dispositioning their wastes. Chapter 4 provides details of these measures for implementing risk-informed LAW practices.

Recommendation 3

The committee recommends that government agencies continue to explore ways to improve their efforts to gather knowledge and opinions from stakeholders, particularly the affected and interested publics, when making LAW risk management decisions. Public stakeholders play a central role in a risk-informed decision process.

When those affected by a decision are involved in the decision-making process, the outcome is generally more accepted and more easily implemented than it would be otherwise. Management and disposal of LAW and other potential environmental hazards have evolved beyond ex post facto announcements by facility operators and regulatory agencies into a deliberative process involving partnerships with the affected and interested publics.

Several countries have been generally more successful than the United States in gaining public stakeholder support for siting low-activity waste disposal facilities. As discussed in Chapters 3 and 4, reasons that these stakeholders have been more supportive include greater transparency of decision making, public enfranchisement and participation in decision making, better involvement of elected local officials, and ultimately the ability of local communities to veto an initial site selection. Besides outreach, another way a few government organizations in Europe and the United States have helped public stakeholders become more central in risk decision-making processes is by helping them hire their own technical experts.

While agencies with responsibility for LAW in the United States have improved their efforts to involve the public in waste disposal decisions, many citizens continue to perceive those efforts as falling short of their intended goals. A continuing, concerted effort is needed to understand and address those shortcomings and, in particular, ensure that public stakeholders are a central part of a risk-informed decision process.

Recommendation 4

The committee recommends that federal and state agencies continue to harmonize their regulations for managing and disposing of AEA and non-AEA wastes so that those wastes will be controlled consistently according to their radiological hazards rather than their origins.

In the interim report's overview of low-activity wastes, the committee developed five categories that it considered inclusive of the spectrum of LAW and that helped to point out gaps and inconsistencies in present regulation and management practices. The two major deficiencies listed in Recommendation 1 stood out. The committee is not alone in recognizing these deficiencies. As discussed in Chapter 2, current initiatives by Congress, regulatory authorities, and other organizations are important initial steps in rectifying them. These initiatives should continue under current regulatory authorities as described in Chapters 2 and 4 and Recommendation 2.

Recommendation 5

The committee recommends continued collaboration among U.S. and international institutions that are responsible for controlling LAW. Greater consideration of international consensus standards as bases for U.S. regulations and practices is encouraged.

International organizations, especially the European Commission (EC) and the International Atomic Energy Agency (IAEA), are making significant progress in developing consistent, risk-based standards for managing LAW. Their approaches include a number of important elements of a risk-informed system. The IAEA waste classification system focuses on radiological properties of the waste rather than its origins. For example, at the very low activity end, EC regulations and IAEA standards provide guidelines for wastes to be cleared or exempted from control as radioactive material. At the high end, nuclear fuel reprocessing wastes and wastes with similar properties are classified as "high-level wastes." In the U.S. system, only wastes from reprocessing meet the legal definition of high-level waste, leaving other wastes that might pose similar risks to be defined as "greater-than-Class C low-level wastes," as discussed in Chapter 2.

Public stakeholders are likely to be more receptive to waste management practices that are known to be accepted and implemented in other developed countries. If waste management technical experts and regulators develop broad agreement, publics might be more trusting of their ability

to ensure safe management and disposal practices. Moving toward risk-informed practices in the United States could have the net effect of increasing stakeholder support in all countries.

CONCLUSION

The committee concluded that, while challenging, it is possible to move in incremental steps to a more risk-informed system for controlling management and disposition of radioactive materials. In contrast with the patchwork evolution of the past 60 years, stepwise implementation would move in a consistent direction: away from regulating LAW according to how or when it was generated and toward regulation based on the actual hazard and potential risk of the material. Risk-informed practices are good business practices. By working with regulators, public authorities, and local citizens to implement risk-informed practices, industry can increase the cost-effectiveness of its LAW disposals and increase its options for such disposals; and by moving away from the ad hoc nature of the current origin-based system, industry can increase the predictability of its disposal options. Through open and objective dialogue, risk as perceived by generators, regulators, concerned citizens, and elected officials can provide a common basis—a common currency—leading to better cooperation, agreement, and progress.

Improving the Regulation and Management of Low-Activity Radioactive Wastes

Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Waste

Nuclear and Radiation Studies Board

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NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

The 10 organizations that provided financial support for this report are recognized in the Preface.

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DAVID H. LEROY, *Chair*, Leroy Law Offices, Boise, Idaho
MICHAEL T. RYAN, *Vice Chair*, Charleston Southern University, South Carolina
EDWARD L. ALBENESIUS, Westinghouse Savannah River Company (retired), Aiken, South Carolina
WM. HOWARD ARNOLD, Westinghouse Electric (retired), Coronado, California
FRANCOIS BESNUS, Institute de Radioprotection et de Sûreté Nucléaire, Cedex, France
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JAMES YATES, JR., Office Assistant

List of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

David Adelman, University of Arizona, Tucson
Jan Beyea, Consulting in the Public Interest, Lambertville, NJ
Robert J. Budnitz, Lawrence Livermore National Laboratory, Livermore, CA
Michael Corradini, University of Wisconsin-Madison, Madison, WI
Sharon Dunwoody, University of Wisconsin, Madison, WI
Gordon Linsley, International Atomic Energy Agency (retired), Oxon, England
Michael McWilliams, Stanford University, Stanford, CA
Richard Meserve, Carnegie Institution, Washington, DC
Dianne Nielson, Department of Environmental Quality, Salt Lake City, UT
Allan Richardson, Environmental Protection Agency (retired), Bethesda, MD
Atsuyuki Suzuki, Nuclear Safety Commission, Japan

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by John F. Ahearne, Sigma Xi and Duke University, Research Triangle Park, NC. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with NRC procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the NRC.

Preface

Studies by the National Academies provide scientific and technical advice to assist public decision makers. Studies are typically conducted at the request of a government agency, which funds the study. This study, however, was self-initiated by the National Academies' Nuclear and Radiation Studies Board (NRSB). Looking back over 60 years since the widespread use of nuclear energy began, Board members recognized that statutes, regulations, and commercial practices that deal with low-activity radioactive wastes—which comprise overwhelmingly the largest volume of radioactive wastes in the United States—have evolved as an inconsistent patchwork. Low-activity wastes range from medical and laboratory wastes, to industrial-scale equipment and process residues, to rubble and contaminated soils from nuclear facility decommissioning and cleanup, and to mining and mineral extraction wastes. Clearly this wide variety of wastes touches on many sectors of the economy.

Low activity wastes are regulated primarily by their origins—the nature of the industry that produced them—rather than the actual radiological hazards they present. Wastes from some origins are tightly controlled, resulting in limited and relatively expensive management and disposal options; while other wastes that present equal or greater risks are less closely controlled.

Once initiated by the NRSB, this study received a great deal of interest from agencies responsible for the regulation and disposition of low-activity wastes as well as from public stakeholders. The committee gratefully acknowledges the financial support of the following 10 federal, state, and foreign organizations, which made this study possible:

- Army Corps of Engineers
- California Environmental Protection Agency
- Department of Defense Executive Agent for Low-Level Radioactive Waste
- Department of Energy
- Environmental Protection Agency
- The Institute of Applied Energy—Japan
- Institute de Radioprotection et de Surété Nucléaire—France
- Midwest Interstate Low-Level Radioactive Waste Compact
- Nuclear Regulatory Commission
- Southeast Compact Commission

The committee benefited greatly from the diversity of perspectives, concerns, and new ideas brought to our attention by our sponsors. Congressional staff, industry representatives, and members of the public also provided valuable insights. Presentations to the committee (see Appendix C) generally cited needs and opportunities to improve the current system of regulations and management practices, but differed in what specific changes were needed or their urgency. Presenters also cautioned the committee that its advice should be practical and implementable in the context of existing legislation, regulation, and commercial infrastructure.

The first half of this study culminated in an interim report that provided an overview of the current system and identified areas for improvement.[1] In the second half of the study, which led to this final report, the committee developed the concept of a "risk-informed" framework that would provide rationale and structure for significant improvements in the system. By focusing on the risk presented by given wastes, rather than their origin, and requiring consistent measures to control these risks, the framework would further enhance safety, improve efficiency, and promote cooperation among all stakeholders.

While noting current initiatives in the United States and internationally that are sound examples of risk-informed practices, the committee did not suggest specific changes in current legislation, regulations, or commercial practices. Rather it is the committee's position that specific changes are matters of public policy to be developed through the risk-informed decision making structure set forth in this report.

The committee especially recognizes the efforts by the members and staff of the NRSB to initiate and secure funding for this study. NRSB staff

[1]The committee's interim report is reproduced in Appendix A.

director Kevin Crowley was primarily responsible for starting the study. John Wiley, who served as study director, ably assisted the committee through all stages of information gathering, report development, and review. Staff members Toni Greenleaf, Darla Thompson, Marili Ulloa, Laura Llanos and James Yates all helped bring this study to its successful conclusion.

David H. Leroy, Chair Michael T. Ryan, Vice Chair[2]

[2]During the preparation of this final report Michael Ryan served as Chairman of the Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste, which developed a white paper "History and Framework of Commercial Low-Level Radioactive Waste Management in the U.S." submitted to the Commission on December 30, 2005.

Contents