Emerging Answers in the Management and Disposal of Radioactive Wastes

L.W. Camper, J.E. Kennedy
U.S. Nuclear Regulatory Commission
Mail Stop T-7-J-8, Washington DC 20555
USA

ABSTRACT

The National Policy of the United States is safe, permanent, surface or subsurface disposal of non-high-level radioactive waste from the nuclear fuel cycle to ensure long-term containment and isolation from the environment. That policy is contained in the fundamental U.S. laws governing nuclear fuel cycle wastes—the Atomic Energy Act, the Low-Level Radioactive Waste Policy Amendments Act of 1985, and the recently passed National Defense Authorization Act for Fiscal Year 2005 (NDAA), among others. The U.S. has been largely successful in implementing this policy to date and most of the low-level radioactive waste (LLRW) generated by NRC licensees has been safely disposed, rather than stored. Only greater-than-class C (GTCC) LLRW has been without a disposal option. At the same time, the U.S. program for radioactive waste disposal can be improved in a number of ways to enhance safety, to better utilize risk information in decision-making, to improve the efficiency and effectiveness of the overall program, and to enhance openness. This paper will address four "emerging answers" that aid in moving the country towards the goal of safe, permanent disposal for all types of non-high level radioactive waste generated in the nuclear fuel cycle.

INTRODUCTION

Over the last twenty-five years, the U.S. has established a large and comprehensive program for the disposal of most types of non-high-level radioactive waste. In the late 1970's, low-level waste (LLRW) generators in the U.S. were threatened with losing access to the existing disposal sites because of State concerns about safety and equity. Since then, a comprehensive regulatory framework for safety has been developed in laws, regulations, at both at the Federal and State levels. In addition, States and commercial firms have ensured that the existing disposal sites remain open and operate safely, and one new site has gone into operation. The three operating LLRW disposal sites have a good safety record. In addition to improvements in safety, the amounts of waste generated by nuclear facility operations have declined significantly, and improved processing techniques have led to efficiencies and even lower volumes of such waste for disposal. At the same time, site cleanup programs have expanded in the U.S., creating large volumes of low-activity waste for disposal. The U.S. Department of Energy (DOE) is also addressing alternative disposal methods for its "waste incidental to reprocessing," or non-high level radioactive waste, in cleanup programs at several of its sites. This material in the past would have been defined as high-level radioactive waste, based on its origin, and be required to be disposed of in a geologic repository, but recently enacted legislation enables DOE to use risk-based disposal options.

Although the U.S. has permanently disposed of much of its non-high-level waste from the nuclear fuel cycle, more needs to be done. GTCC LLRW has no disposal path and it must be stored until a disposal facility is developed. Licensees are able to dispose of Class A, B, and C LLRW, but many are expected to lose access to the Barnwell LLRW disposal facility in mid-2008, and will then be forced to store their Class B and C LLRW. Even for waste streams that have disposal options, generators seek out alternatives that are more economical, especially for low-activity waste. For non-high level waste determinations that DOE may make, NRC and DOE are taking steps to implement provisions in the legislation enacted last year, and to ensure the safe disposal of these wastes. Finally, stakeholders in this area and other interested persons want greater openness in decision-making on nuclear waste issues. This paper discusses emerging answers to questions that bear on these topics. These include:

- How can low-activity waste (i.e., waste at the low end of specific radioactivity for LLRW) be more efficiently and effectively disposed of? What can be done to improve transparency?
- How can NRC and DOE efficiently and effectively implement the new law for DOE's non-high-level waste determinations, while using an open and transparent process?
- What are the next steps for DOE and NRC to take in developing a disposal option for GTCC waste?
- Given that generators will lose access for B/C waste, what improvements might be needed in NRC's storage guidance to facilitate such storage and help to ensure safety?

EMERGING ANSWERS

This section addresses the above four questions. It describes the increased uses of alternative disposal options for low-activity LLRW; implementation of the recently NDAA (for non-high-level waste determinations); recent developments concerning permanent disposal of GTCC waste; and NRC efforts to update and consolidate its LLRW storage guidance, in anticipation of such storage by many U.S. generators for their Class B and C LLRW. In answering the above questions, this paper focuses on the roles, responsibilities, and actions of NRC.

Alternative Disposal Options for Low-Activity Waste

Over the last 15 years, the cleanup of government and commercial sites previously contaminated with radioactive materials has received significantly increased attention. NRC established it Site Decommissioning Management Program in the early 1990's, responding to Congressional concerns about commercial sites with radioactive contamination. Not long after that, some nuclear power plants decided to cease operations and begin decommissioning. These remediation and decommissioning activities often generate large amounts of radioactive waste, typically contaminated soil and building debris, whose specific activity is well below much of the waste produced during the operations of nuclear facilities. Certain production processes, such as mining or mineral extraction, may also generate large amounts of these materials. Some of these low-activity wastes can be safely managed or disposed outside of the shallow land disposal facilities licensed under the framework in NRC's 10 CFR Part 61.

Conventional LLW, i.e., the wastes that result from the operation of nuclear plants and the use of radioactive materials in industry, medicine, and research, has typically been disposed of in one type of facility--shallow land disposal facilities licensed under Agreement State regulations compatible with NRC's regulations in 10 CFR Part 61. Part 61 is a performance-based regulation that relies on a system composed of the waste form, engineered barriers, and natural site characteristics to meet overall performance objectives. Although LLW disposal facilities licensed under Part 61 have a good safety record and have successfully isolated LLW, the limited number of these facilities, coupled with the large volumes of LAW and costs of disposal, have caused some LLW generators to consider other alternatives.

Both hazardous waste facilities and municipal or industrial solid waste landfills are now being used more frequently for some LAW disposal, especially from remediation projects. Both types of facilities are regulated under the Resource Conservation and Recovery Act, which is implemented by EPA and States authorized by EPA in the case of hazardous waste, and by States alone in the case of solid waste. Neither type of facility was originally designated for radioactive wastes. Nevertheless, the same containment and isolation technology that is used in their design for hazardous and municipal solid waste can also be relied upon, in certain cases, for radioactive wastes. Overseas, both Spain and France are using similar approaches for low-activity material. France has a facility operating in Morvilliers that is similar a U.S. RCRA hazardous waste facility in design [1]. It is also permitted by the local prefecture under the laws and regulations for hazardous materials, similar to the approach used in the U.S. Spain is currently developing a similar facility for its low-activity waste.

Recently, EPA considered developing a rule that would apply to the use of such facilities for radioactive materials. On November 18, 2003, EPA published an Advance Notice of Proposed Rulemaking (ANPR) for the use of RCRA Subtitle C hazardous waste facilities for the disposal of radioactive wastes [2]. The purpose of the ANPR was to solicit the public's views on this issue. EPA recognizes that RCRA and the Atomic Energy Act employ different regulatory philosophies for the isolation of wastes. RCRA defines specific engineering and construction criteria for landfills to minimize contact between waste and water and therefore ensure that releases to the environment are eliminated or are within acceptable limits. RCRA regulations require, among other things, that a disposal facility have a cap on the disposal cell that minimizes infiltration of liquids, promotes drainage, minimizes erosion, accommodates settling and subsidence and has permeability no greater than that of the disposal cell liner system or natural subsoils. A liner system, constructed of materials of specified thickness, hydraulic conductivity, physical strength, and chemical resistance, is required beneath the disposal cell. In addition, the regulations require a leachate collection and removal system capable of limiting leachate depth above the liner to 30 cm. RCRA also requires that waste be treated before disposal. This treatment can reduce the concentration of hazardous constituents in the waste, and it may change the physical form of the waste, and reduce the likelihood of releasing hazardous constituents from the waste. NRC regulations, on the other hand, have a greater focus on meeting performance standards, without being too prescriptive, and give an operator flexibility in designing and constructing a disposal system to safely isolate waste. EPA considered public comments on the ANPR but has not yet made a decision on whether to proceed with a rulemaking or some other action.

In the meantime, LAW generators in the U.S. are using RCRA hazardous waste facilities for disposal of some wastes containing residual radioactive material, as authorized by the permitting agencies in the States in which the facilities are located. There are approximately 20 such facilities in the U.S., far more than the number of commercial LLW disposal sites. While some of the facilities have been accepting technologically enhanced, naturally occurring radioactive material (TENORM) wastes for many years, wastes from the nuclear fuel cycle are being increasingly being disposed of at these facilities. Municipal solid waste landfills are also used for disposal of some radioactive waste that contains very low levels of radioactivity. For example, NRC, in collaboration with the State of Michigan, recently permitted certain very low-activity wastes from the decommissioning of the Big Rock Point nuclear power plant to be sent to a RCRA Subtitle D (solid waste) landfill. Other States, such as Texas, have also determined that these landfills may offer sufficient protection for certain types of radioactive material, such as material with very short half-lives, and have included provisions in their State regulations that define the kinds and amounts of radioactive wastes that may be disposed of in these facilities.

NRC can authorize licensees to dispose of low specific activity waste in these types of facilities under its provisions in 10 CFR 20.2002, "Method for obtaining approval of proposed disposal procedures." This provision states that "A licensee or applicant for a license may apply to the Commission for approval of proposed procedures, not otherwise authorized in the regulations in this chapter, to dispose of licensed material generated in the licensee's activities. Each application shall include:

(a) A description of the waste containing licensed material to be disposed of, including the physical and chemical properties important to risk evaluation, and the proposed manner and conditions of waste disposal; and

(b) An analysis and evaluation of pertinent information on the nature of the environment; and

(c) The nature and location of other potentially affected licensed and unlicensed facilities; and

(d) Analyses and procedures to ensure that doses are maintained ALARA and within the dose limits in this part."

Because of the increased interest in using this provision, NRC staff is developing internal guidance on how to process such requests. It will address such areas as dose analyses to be conducted, coordination with States, allowable dose limits, and so forth. It will also be made available to the public, and will be useful for licensees in understanding better the expectations for approval of such requests. The draft of the internal guidance is expected to be completed in summer 2006.

The staff, at the request of the Commission in Staff Requirements Memorandum COMGBJ-05-0001, is also developing options and recommendations for the Commission on improving transparency for the 20.2002 process. Because these types of approvals have not been frequently used in the past, there is relatively little information on, for example, NRC's web site that explains the purpose of 20.2002, the staff's review process, the criteria for approval, and so

forth. The staff will send a paper to the Commission with options and recommendations in early 2006.

Risk-Informed Decision-Making for Residual DOE Tank Waste

The NDAA was passed by Congress on October 9, 2004, and signed by the President on October 28, 2004. Section 3116 of the NDAA allows the U.S. Department of Energy (DOE) to determine that certain waste at the Savannah River site in South Carolina, and Idaho National Engineering Lab site in Idaho is not high-level waste (HLW). The NDAA requires (1) that DOE consult with the U.S. Nuclear Regulatory Commission (NRC) on it non-HLW determinations and plans and (2) that NRC, in consultation with the State, monitor disposal actions taken by DOE for the purpose of assessing compliance with NRC regulations in 10 CFR Part 61, Subpart C. If the NRC determines that any disposal actions taken by DOE are not in compliance, the NRC shall inform DOE, the affected State, and congressional subcommittees. In addition, the NDAA provides for judicial review of any failure of the NRC to carry out its monitoring responsibilities. In the years prior to passage of this Act, DOE and NRC had been consulting on similar non-HLW determinations, and may continue to do so for wastes at the DOE reservation in Washington, and for the West Valley site in New York. The new law is conceptually similar to the past approaches for managing risks from these types of wastes at these sites, but some of the details are different.

The concept of incidental waste, also known as waste-incidental-to-reprocessing (WIR) or non-HLW, is that wastes can be managed based on their risk to human health and the environment, rather than the origin of the wastes. With respect to wastes from reprocessing of nuclear fuel, such as the tank residuals at some DOE sites, some are highly radioactive and need to be treated and disposed of as HLW in a geologic repository and others do not. WIR does not pose the same risk to human health and the environment, and does not need to be disposed of as HLW in order to manage the risks that it poses. Consequently, incidental waste is not considered to be HLW.

The NDAA requires use of the following criteria for determining that waste is not HLW:

- The waste does not require permanent isolation in a deep geologic repository for spent fuel or HLW;
- The waste has had highly radioactive radionuclides removed to the maximum extent practical; and
- Does not exceed concentration limits for Class C low-level waste and will be disposed of in compliance with the performance objectives in 10 CFR 61, Subpart C; or
- Exceeds concentration limits for Class C LLW but will be disposed of in compliance with the performance objectives of 10 CFR 61, Subpart C, and pursuant to plans developed by DOE in consultation with the NRC.

Based on past experience with these types of determinations, NRC and DOE have a good foundation for implementing these new provisions in the NDAA. Over the years, DOE periodically requested the NRC to provide a technical review of specific WIR determinations at

its sites. DOE believed that the NRC review would result in a technically improved WIR determination and provide additional assurance that the DOE analysis and proposed actions were protective of the public health and safety. The NRC provided technical assistance and advice to DOE regarding its WIR determinations but did not provide regulatory approval for DOE's actions.

Past practice was for NRC staff to review DOE's WIR determinations to assess whether DOE's technical assumptions, analyses, and conclusions met the applicable incidental waste criteria. In general, the staff would examine technical areas such as estimated radionuclide inventory, technology alternatives, performance assessment (PA) methodology, engineered system performance, infiltration, release and transport parameters, receptor scenarios and assumptions, and uncertainty and sensitivity analysis. The staff typically evaluated information submitted by DOE, generated requests for additional information (RAIs), met with DOE representatives to discuss technical questions and issues, and documented the final review results in a Technical Evaluation Report (TER).

The staff will use a similar technical approach for conducting the reviews of DOE's non-HLW determinations under the NDAA. The first step in the process will be DOE's submittal of its non-HLW determination and supporting documentation, including a performance assessment (PA) if necessary. The NRC staff will review the information and transmit any requests for information (RAIs) to DOE. The staff will review whether DOE's assumptions, modeling, and conclusions are technically adequate and in compliance with the requirements of the NDAA. In addition to responding to the specific RAIs, DOE may decide to revise the non-HLW determination based on NRC's questions and comments. The NRC will then review the revised non-HLW determination and RAI responses and document its findings in a TER. Contrary to previous practice, DOE's initial non-HLW determination submittal, the staff's RAIs, DOE's RAI responses and any revised non-HLW determinations, and NRC's final TER will all be made publicly available.

The NDAA requires additional work in two areas: (1) DOE must now consult with NRC on DOE's plans to dispose of non-HLW waste that exceeds Class C concentrations, and (2) NRC must, in coordination with the State, monitor DOE's disposal actions to assess compliance with 10 CFR Part 61, Subpart C and issue reports if noncompliance is found. The staff believes this technical review process for additional consultation will follow the same general process described above for non-HLW determination reviews.

The NRC must also monitor DOE's plans for non-HLW determinations and issue reports if noncompliance is found. This monitoring will be conducted in a risk-informed and performance-based manner, and will verify that DOE's actions to implement its waste determinations are consistent with the performance objectives in 10 CFR Part 61. The NRC staff will also perform any necessary environmental monitoring to ensure that the performance objectives of 10 CFR Part 61, Subpart C, are being met.

For the sake of efficiency, the staff is developing a Standard Review Plan (SRP) for waste determination reviews and monitoring as internal guidance for the NRC staff. In November 2005, NRC held a meeting on the Standard Review Plan to solicit comments from the public and

other stakeholders on the content of the SRP. The comments received at the meeting are being used to develop the SRP, which is scheduled to be issued in draft form in the spring of 2006.

Like the efforts under way to address alternative disposal practices for low-activity waste, the NDAA promotes the management of risk of waste based on the intrinsic hazard of the waste, rather than its origin. NRC and DOE are actively working together to implement the provisions of the NDAA so that certain wastes can be safely managed based on the hazard it poses. NRC is also taking steps to standardize the process so that future reviews can be conducted more efficiently, while also ensuring that stakeholders are informed about these important activities conducted to carry out the NDAA.

Greater-Than-Class C Waste (GTCC)

GTCC is the only category of LLW that has no disposal option at his time. It is the most highly radioactive LLW, containing concentrations of radionuclides that exceed the limits for wastes that can routinely be disposed of in near-surface disposal facilities. It generally falls into three categories—sealed sources used in medicine, industry, and science; metal components near fuel assemblies in operating nuclear power reactors that have become highly activated by the neutron flux in the reactor vessel; and other wastes such as power plant resins and fuel fabrication facility materials. Unless a safe alternative disposal option is identified, GTCC is presumed to be disposed of in a geologic repository, like spent fuel and high-level radioactive waste.

The Low Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) assigned the Federal Government (DOE) responsibility for disposal of GTCC waste. The LLRWPAA also specifies that all GTCC waste resulting from the activities licensed by NRC (and NRC Agreement States), "shall be disposed of in a facility licensed by the Nuclear Regulatory Commission that the Commission determines is adequate to protect the public health and safety."

Recently, DOE has taken steps to examine options for disposal of this waste, and expects to issue an environmental impact statement (EIS) in the next few years that will propose various options. On May 11, 2005, DOE issued an Advance Notice of Intent to prepare an EIS, to inform and request early comments from the public and interested agencies about their proposed action, the preliminary range of alternatives, and the potential issues related to DOE's decisions for this category of waste [3]. DOE has stated that it intends to consider not only deep geologic disposal for GTCC, but also new or existing DOE or commercial facilities, including greater confinement disposal configurations, and enhanced near-surface disposal facilities. DOE plans to issue the Notice of Intent in early 2006 and complete the final EIS within one and one half to two years from issuance of the Notice.

NRC promulgated regulations in 10 CFR Part 61 in 1989 to address licensing of a GTCC disposal facility. NRC regulations state that such waste must be disposed of in a geologic repository unless proposals for disposal of such waste in a disposal site licensed pursuant to Part 61 are approved by the Commission. Because DOE is considering disposal options other than deep geologic disposal, NRC may need to develop other licensing criteria in the future if DOE pursues one of these alternatives. For that reason, NRC will be following closely the actions of DOE. In the near-term, NRC will be commenting on the draft EIS for GTCC disposal. As DOE

moves towards selecting one or more options for disposal, NRC will develop licensing criteria, and began preparations for review of a license application.

LLRW Storage Guidance

With the planned closure of the Barnwell LLRW disposal facility to out-of-compact generators in mid-2008, generators in 36 States will have to store their Class B/C LLRW. This anticipated closure has caused NRC to consider updating its LLRW storage guidance. In a Staff Requirements Memorandum for SECY-03-0223, the Commission directed the staff to conduct an annual review of the potential need for rulemaking and/or regulatory guidance for long term storage of low-level radioactive waste. Some of the factors in the decision-making process include the fact that certain guidance is more than 25 years old, and contains outdated staff positions and regulatory references. Furthermore, all of the guidance was developed before the emphasis on risk-informed, performance-based regulation, and improvements to the guidance in this area are possible. NRC has also developed guidance and orders regarding the security of nuclear materials since 9/11, including some for waste in storage that is not currently contained or referenced in the existing guidance. Finally, the guidance is currently contained in a number of documents, and may benefit users if it were consolidated. The staff will be providing its annual review and recommendation to the Commission in early 2006.

CONCLUSION

This paper has highlighted some of the emerging answers to questions related to how the U.S. can achieve its national policy of permanent disposal of radioactive wastes from the nuclear fuel cycle. Last year, Congress enacted the NDAA that provides for a new framework to manage and dispose of DOE's non-HLW. NRC and DOE are actively working to implement the provisions of the new law for the States of South Carolina and Idaho. At the same time, responsible organizations continue to make progress and effect improvements in the national program, operating under existing laws.

REFERENCES

1. M. Dutzer, F. Chastagner, N. Ricquart, F. Duret, 2005, Agence nationale pour la gestion des dechets radioactifs, *Disposal of Very Low-Level Waste and Safety Assessment*, Proceedings of an International Symposium Disposal of Low-Activity Radioactive Waste, International Atomic Energy Agency.
2. U.S. Environmental Protection Agency, 2003, *Advance Notice of Proposed Rulemaking, Approaches to an Integrated Framework for Management and Disposal of Low-Activity Radioactive Waste: Request for Comment*, Federal Register, Vol. 68, No. 222, pp 65119-65151, November 18, 2003,
3. U.S. Department of Energy, 2005, *Advance Notice of Intent to Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste,* Federal Register, Volume 70, No 90, page 24775-24778, May 11, 2005.