

Why We Need Better Management of Low-Activity Radioactive Waste

The patchwork of legislation and regulations governing low-activity wastes assigns names and disposal requirements to them according to their origins and with little regard to their actual radiological hazard. As a result, some LAWs have limited and expensive disposal options, while others that pose similar radiation hazards are mostly ignored.

By John R. Wiley

Low-activity radioactive wastes (LAWs) suffer from a lot of misunderstanding. While high-level waste, nuclear fuel, and “dirty bombs” get attention, polls have shown that most people don’t even bother to think about the many varieties of wastes that emit very low levels of radiation. But when they do, many people consider LAWs to be as problematic as HLWs. If it’s radioactive waste, it’s dangerous.

Regulators and waste generators don’t necessarily misunderstand LAW, but they are bound by a patchwork of legislation that goes back to the Manhattan Project, when the McMahon Act—the first Atomic Energy Act—was passed in 1946. The Atomic Energy Act of 1954 (AEA) and its amendments, on which subsequent federal statutes and regulations are based, have maintained the definitions in the McMahon Act. These definitions were established before the health hazards of radiation were fully appreciated and when security of potential nuclear weapon materials was paramount. This statute set the precedent for regulating wastes according to their origin rather than their radiation risk that continues today. As a result, some LAWs have limited and expensive disposal options, while others that pose similar radiation hazards are mostly ignored.

The Nuclear Waste Policy Act (NWPA) of 1982, as amended, provides the statutory definition for the class of waste referred to as “low-level waste,” but it defines LLW only in terms of what it is not. That is, LLW is waste that is not already defined by statute as HLW, spent nuclear fuel, transuranic waste, or AEA 11e.(2) by-product material—the leftovers from mining uranium and thorium.

There are two troublesome shortcomings in the NWPA’s definition of LLW. First of all, it’s topless and bottomless—AEA wastes that don’t fit the other NWPA definitions are all “low-level” wastes regardless of whether their radioactivity is too low to measure or high enough to cause acute radiation effects. Second, wastes that arise outside the nuclear fuel cycle (i.e., non-AEA wastes), such as from particle accelerator operations or from recover-

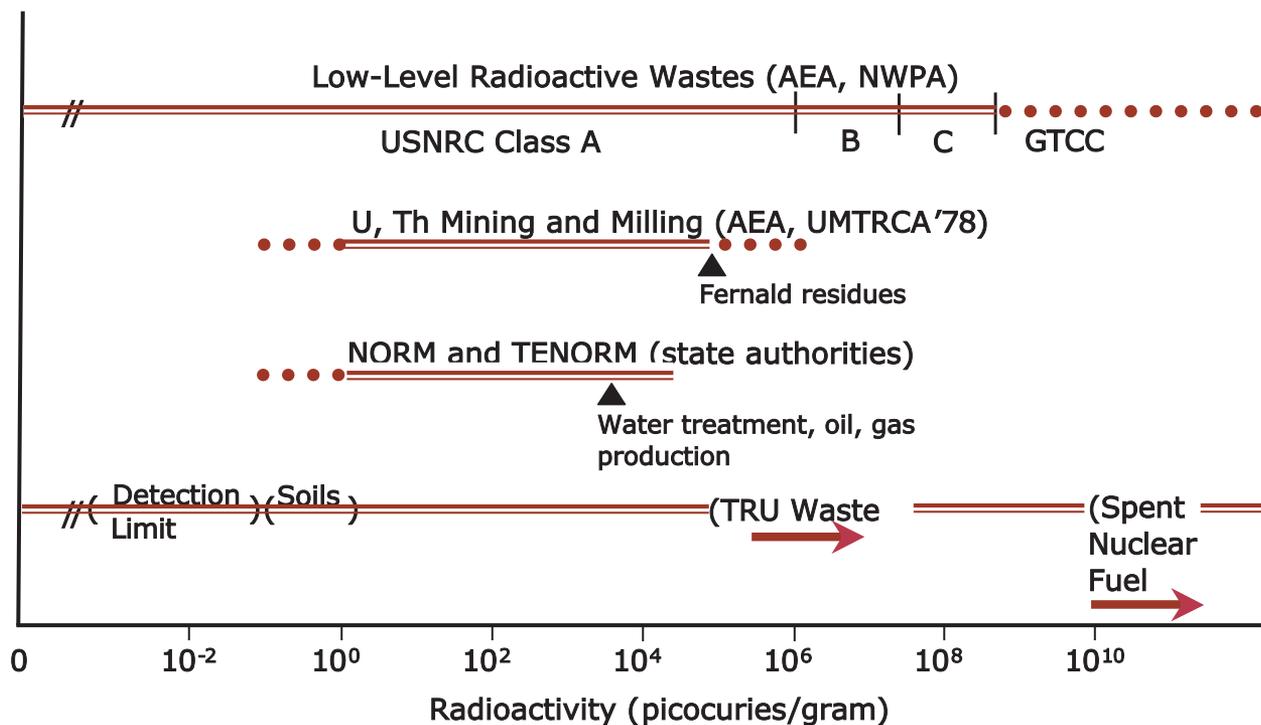


Fig. 1. Low-activity waste types and controls.

ing minerals that incidentally contain naturally occurring radionuclides, are not included in the NWPA. Non-AEA wastes are controlled by the individual states rather than by federal authority, even though their radioactivity often comes from the same isotopes in about the same concentrations as in LLWs.

Such observations of the patchwork way statutes and regulations that control LAWs have developed over almost 60 years led the National Academies' Board on Radioactive Waste Management (now incorporated into the new Nuclear and Radiation Studies Board) to undertake a study on how this picture might be improved. The board intended the term "low-activity waste" to include the spectrum of materials from national defense, nuclear power, industrial, institutional, or natural sources that emit low-levels of ionizing radiation and that are considered as wastes—without being constrained by current regulatory and origin-based definitions. A study committee, the National Academies' Committee on Improving Practices for Regulating and Managing Low-Activity Radioactive Waste, developed an overview of the problem, which we summarize here. In developing the overview, the committee sought to identify gaps and inconsistencies that would suggest areas for significant improvements.

FEDERAL AND STATE CONTROL OF LOW-ACTIVITY WASTES

The federal framework established by the AEA controls radioactive materials associated with nuclear energy production—from ore mining to waste disposal. The U.S. Environmental Protection Agency (EPA) has authority to set generally applicable standards for radioactivity in the environment. For nuclear applications in the commercial sector, the U.S. Nuclear Regulatory Commission is an independent agency responsible for implementing EPA's standards through regulations and ensuring compliance

with its regulations through its licensing authority. For defense nuclear applications, the U.S. Department of Energy is self-regulated through internal directives and regulations that are consistent with EPA standards and similar to NRC regulations to the extent appropriate and practical.

Much LAW falls into the NWPA's definition of LLW. Contaminated equipment, protective clothing, laboratory residues, animal carcasses, filter media, soils, and sludges that arise from the operation of nuclear plants and the use of radioactive materials in industry, medicine, and research—these are representative of the spectrum of these wastes. In the commercial sector, LLWs are disposed of in near-surface facilities licensed under agreement state regulations compatible with the NRC's regulations in the *Code of Federal Regulations*, Title 10, Part 61. (The AEA allows the NRC to relinquish portions of its licensing authority to individual states, referred to as "agreement states." All three commercially operated LLW disposal facilities are located in agreement states.) To help compensate for the bottomless/topless definition of LLW, Part 61 defines three LLW classes (A—the least hazardous; B; and C—the most hazardous), based largely on the concentrations and half-lives of radionuclides that are deemed suitable for near-surface disposal (see Fig. 1). This classification system ensures that disposal facilities licensed to receive these wastes will meet the NRC's dose-based performance objectives. (For example, there is an annual dose limit to any given member of the public from radioactive material that might be released to the environment.)

The 1980 Low-Level Radioactive Waste Policy Act (LLRWPA), amended in 1985, required every state to provide for disposal of its own LLW, either alone or by forming congressionally approved compacts with other states. The states have formed 10 compacts, and most states are members of a compact, but no new disposal sites have been developed by the compacts in spite of their spending a total of about a billion dollars in failed siting attempts. The nation's only disposal sites for commercial LLW—

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near Barnwell, S.C.; Clive, Utah; and Richland, Wash.—were established by private-sector companies. A site near Andrews, Texas, which may be licensed in 2007, is a private initiative being developed according to the state compact provisions of the LLRWPA.

The spectrum of LAWs includes the large volumes of uranium and thorium mining and milling wastes that date back to the Manhattan Project. Uranium and thorium processing wastes are defined as by-product material in Sec. 11e.(2) of the AEA, so they cannot be NHPA “low-level wastes.” As shown in Fig. 1, their radioactivity levels are comparable to NRC Class A wastes, although their isotopes have much longer half-lives than allowed for Class A wastes (the LLW bar in the figure is an example for rubble contaminated with Sr-90). In 1978 the Uranium Mill Tailings Radiation Control Act (UMTRCA) vested the EPA with overall responsibility for establishing health and environmental cleanup standards for uranium

milling sites and associated properties, the NRC with responsibility for licensing and regulating uranium production and related activities including decommissioning, and the DOE with responsibility for remediation of inactive mill tailings sites and long-term monitoring of all the decommissioned sites.

The NRC determined that it has no legal authority over mill tailing sites that it had not licensed before UMTRCA was enacted. As a consequence of this determination, essentially identical wastes are or are not subject to NRC control depending only on when they were generated. Pre-UMTRCA wastes not controlled by the NRC are subject to state authorities. A large amount of pre-UMTRCA wastes was produced under the former U.S. Atomic Energy Commission and is now managed by the Formerly Utilized Sites Remedial Action Program.

Finally, an important group of LAWs that few people recognize comes from activities unrelated to the nuclear fuel cycle. Mining and oil and gas production can concentrate naturally occurring radioactive isotopes—uranium, thorium, and their radioactive decay products like radium and radon—to levels that are comparable to LLW and AEA 11e.(2) wastes. These isotopes are sometimes concentrated to relatively high levels in sludges and ion exchange resins from municipal water treatment plants—especially in areas where the natural groundwater contains uranium and radium above EPA drinking-water limits and treatments to remove them are necessary. These wastes are usually referred to by their acronyms NORM (naturally occurring radioactive material) or TENORM (technologically enhanced NORM) wastes. Because these wastes are not covered by the AEA, their regulation is the responsibility of the individual states.

**A HAZARD-BASED LOOK
AT LOW-ACTIVITY WASTES**

The patchwork of legislation and regulations just described assigns names and disposal requirements to LAWs according to their origins and with little regard to their actual radiological hazard (see Fig. 2). In seeking gaps and inconsistencies in the present system that would point the way toward improving it, the committee found it useful to take a step back from current origin-based regulations and look more closely at the wastes’ radiological properties. The committee agreed that considering



Fig. 2. Regulatory boxes.

A Hazard-Based View of Regulatory Inconsistencies

Wastes that fall within the legal definition of *low-level waste* can have very different radiological properties:

- Much LLW fits comfortably within the regulatory Classes A, B, and C.
- However, large volumes of wastes from decommissioning and site cleanup emit very little or no measurable radiation, but they cannot exit the regulatory system because Class A has no lower threshold.
- Although defined as LLW, out-of-service radioactive sources can emit intense radiation that exceeds Class C.

Other wastes that fall under different legal definitions have very similar radiological properties:

- Uranium and thorium mining and milling wastes are under federal control according to the Atomic Energy Act.
- Wastes from the recovery of other natural resources or in processes like municipal water treatment can also contain uranium, thorium, and their daughter isotopes, but they are controlled by the individual states.

LAWs in five categories provides an instructive and inclusive overview.

The first three categories include wastes defined and regulated as “low-level wastes” according to the NWP. Although their legal box is the same, the wastes are very different in their radiological and physical characteristics. First of all, there are the wastes that fit comfortably into the NRC classification system, e.g., Class A, B, and C, such as those disposed of at Barnwell and in typical DOE “burial grounds.” Second, there are the very large volumes of debris, rubble, and contaminated soils from nuclear facility decommissioning and site cleanup that produce very low or practically undetectable levels of radiation. They fall at the very low end of Class A but can’t escape the regulatory requirements for LLW since Class A has no bottom threshold. Third, there are out-of-service radiation sources and associated materials from industrial, medical, and research applications. They can emit high enough levels of radiation to cause acute health effects or serious contamination incidents. They arise in small volumes, but absent a geological repository (e.g., Yucca Mountain if licensed and constructed), sources that exceed NRC Class C have no present means of disposal. Nevertheless, they are “low-level wastes” because of the NWP’s topless definition. (The committee included them in its LAW overview only to illuminate problems with current definitions.)

The committee’s other two comparative categories comprise wastes whose radioactivity arises from uranium, thorium, and their daughter radioisotopes, notably radium and radon. These categories recognize wastes that are similar in their radiological and physical properties but very different in their regulation. In the first category are wastes that arise from mining and processing of ores to recover uranium or thorium for the nuclear fuel cycle and are federally controlled under the AEA. In the second category are NORM and TENORM wastes that arise incidentally in nonnuclear enterprises. They are not subject to the AEA, but are controlled in various ways by state authorities.

The states also control wastes that arise from operation of particle accelerators. Although NORM and accelerator-produced materials are quite different in their radiological properties—NORM isotopes typically have 1000-plus-

year half-lives, whereas accelerator-produced isotopes typically decay in seconds to decades—the same state authorities are often responsible for both. They are often grouped together under the acronym NARM (naturally occurring and accelerator-produced radioactive materials).

INITIATIVES FOR IMPROVING THE CURRENT SYSTEM

The board was not alone in its observation that the patchwork system might warrant improvement. Regula-

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tory agencies and professional societies have put forward a number of initiatives intended to address shortcomings in the current system.

LAW Disposal in Landfills

On November 18, 2003, the EPA published an Advance Notice of Proposed Rulemaking for the use of hazardous waste disposal facilities—defined under Subtitle C of the Resource Conservation and Recovery Act (RCRA)—for the disposal of certain low-activity radwastes, such as large-volume wastes that fall at the low end of NRC Class A. (See www.epa.gov/fedrgstr/EPA-WASTE/2003/November/Day-18/f28651.htm.) Subtitle C regulations require, among other things, that a disposal facility have a cap to minimize infiltration of liquids and a liner and drainage system beneath the waste. Both the EPA and the NRC believe that appropriate RCRA-permitted LAW disposals can be as safe as disposals in NRC-licensed facilities. The EPA is considering public comments on the advanced notice and has not yet made a decision whether to proceed with a rulemaking or some other action.

In the meantime, some LAW generators are using RCRA hazardous waste facilities for disposals, as authorized on an individual basis by the permitting agencies in the states in which the facilities are located. There are approximately 20 such facilities in the United States, far more than the three commercial LLW disposal sites. While some of the facilities have been accepting TENORM wastes, AEA wastes from the nuclear industry increasingly are being disposed of at these facilities. Facilities in Texas and Idaho currently accept low-activity AEA wastes.

To a limited degree, RCRA Subtitle D municipal waste landfills are also used for disposal of radioactive waste that contains very low levels of radioactivity. For example, the NRC worked with the state of Michigan to permit some very low activity wastes from the decommissioning of the Big Rock Point nuclear power plant to be sent to a municipal landfill. Other states, such as Texas, have also determined that municipal landfills offer sufficient protection for certain types of radioactive material, for example, material with very short half-lives, and have defined in their state regulations the kinds and amounts of radioactive wastes that may be so disposed of.

Disposal in UMTRCA Mill Tailings Impoundments

Uranium mill tailings impoundments might provide an option to dispose of other LAWs. (See www.nma.org/pdf/legal/white_paper_non112esubmission_052804.pdf.) These facilities are currently regulated by the NRC's regulations under 10 CFR 40, which are based in part on the EPA's RCRA hazardous waste standards. The mill tailings regulations include specific provisions for, among other items, radiation protection, radon mitigation, and long-term care and ownership by the DOE or the state in which the facility is located, with NRC oversight.

The present system of regulatory boxes poses obstacles to disposal of radioactive wastes other than mill tailings in these impoundments. For example, under UMTRCA, the DOE is authorized to accept long-term responsibility for uranium mill tailings sites. If other

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wastes were disposed of in UMTRCA sites, the DOE would need to be consulted to ensure that it would be willing and has the authority under law to accept those wastes for long-term care. Disposal of LLW in an impoundment would also require approval from the host state's compact. TENORM or mixed hazardous and radioactive waste disposal would add state and/or EPA oversight of the impoundment.

Limited or Free Release for Reuse

Disposal in a landfill is only one alternative for the disposition of slightly radioactive materials. Others being considered by the NRC include conditional reuse (e.g., for roadbeds or bridges) or unconditional release with no limitation on reuse, if a radiation survey verifies that levels are acceptable. (See <http://ruleforum.llnl.gov/cgi-bin/library?source=html&library=SM RFC info&file=background&st=ipcr>.) The NRC has guidance that allows for the release of very low-level radioactive material from licensees on a case-by-case basis. Currently, the NRC is conducting an enhanced participatory rulemaking process on disposition of solid materials to determine whether a dose-based regulation is appropriate. This approach is consistent with a previous National Academies' report, which concluded that while the NRC's case-by-case approach is sufficiently protective of public health, the NRC should move ahead to evaluate alternatives.

Congressional Actions

In 2008, the Barnwell site—the only commercial facility that can accept all classes of LLW from generators

nationwide—will close to states outside the Atlantic Compact, leaving generators in some 36 states without access to disposal of their Class B and C wastes (Northwest and Rocky Mountain Compact states have access to the Richland, Wash., site). Some view this as an impending train wreck—a consequence of the failure of the states and state compacts to develop even one new disposal facility. Others, including the Government Accountability Office (GAO) (formerly the General Accounting Office), note that there is abundant capacity for Class A waste, and the relatively small volumes of Class B and C wastes could be stored by their generators, if necessary. The GAO recommended that Congress consider directing the NRC to monitor disposal and storage conditions and report if conditions change enough to warrant congressional intervention.

The GAO report and the possible need for congressional action were discussed at a hearing of the Senate Energy and Natural Resources Committee in fall 2004 (See <http://frwebgate.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=809110117357+0+0+0&WAISaction=retrieve>.) Actions could include establishing a federal site for disposing of Class B and C wastes, changing the LLRWPA with respect to the state compact system, and resolving issues related to the disposal of radioactive sources that exceed Class C. Senate staff expects further hearings and possible action this year.

Recently, the Health Physics Society and the Organization of Agreement States recommended congressional action to put concentrated (“discrete”) TENORM sources—especially radium sources—and radioactive materials from particle accelerator operations under the AEA. (See www.hps.org/documents/MaterialControl.pdf.) These groups recognize that a consistent, uniform regulation of all radioactive materials is needed, especially for sources that present significant radiation hazards and could potentially be used as dirty bomb material. The proposal would put the relatively uncontrolled NARM sources under the same strict federal controls as AEA nuclear materials.

It is worth observing that recent public and congressional attention to materials that have been mostly ignored by the regulatory system, such as NARM, or regulated as “low-level” waste is being driven by concern that they might be acquired and used by terrorists. Today, 60 years after the McMahon Act, national security has again become paramount in controlling radioactive materials.

A COHESIVE MOVEMENT TOWARD A MORE RISK-INFORMED SYSTEM

As stated at the beginning of this article, the current system is a hodgepodge of laws and regulations based on the wastes’ origins rather than their potential radiological risks. Taken individually, the initiatives reviewed herein would seem to perpetuate the piecemeal approach. Viewed collectively, however, they reflect a cohesive movement toward a more risk-informed system. Overall, the initiatives would allow broader and probably less expensive—but fully protective—options for disposing of the truly low activity wastes. The higher activity fractions of “low-level waste” and discrete NARM sources



Fig. 3. Morvilliers site in France (photo courtesy of P. Bourguignon, ANDRA).

would be brought into stricter, more consistent federal control.

Toward more consistent, risk-informed management of LAWs, there is also a growing exchange of ideas with the international community, with a mutual strengthening of knowledge and credibility. France recently opened a disposal facility for large volumes of very low activity wastes at Morvilliers (see foreground in Fig. 3). It is physically separate from the Centre de l'Aube (Fig. 3 background), which is designed for the relatively smaller volumes of wastes that are more typical of the U.S. Class A, B, and C wastes. The disposal trenches at Morvilliers are quite similar to EPA hazardous waste landfills, including a trench cap, liner, and drainage system. Japan has special regulations for very low level waste from its nuclear industry but has yet to develop regulations for other types of LAW. Last year, the International Atomic Energy Agency issued guidance in its Safety Standard Series on "Application of the Concepts of Exclusion, Exemption and Clearance." In developing its proposed rule for alternative disposition of very slightly contaminated materials, the NRC is considering implementing portions of this guidance.

While LAW continues to be misunderstood—either ignored or viewed as highly dangerous—scientists, waste generators, regulators, and concerned citizens are taking more realistic views of the problems and their solutions. A presentation at the recent American Association for the Advancement of Science symposium on LAWs emphasized that the effects of low radiation doses are well understood scientifically. Representatives of both generators and citizens' groups at the symposium noted that there are still concerns about risk uncertainties but agreed that over-regulating wastes that produce small risks is coun-

terproductive—excessive handling and transporting large-volume, low-activity wastes increases worker risks and diverts resources. Partnerships between the public and private sectors as well as cooperation among regulatory agencies, rather than more complicated and rigid laws, are best suited to ensure safe, cost-effective management of LAWs in the future. ■

FURTHER READING

"Low-Level Radioactive Waste: Disposal Availability Adequate in the Short Term, but Oversight Needed to Identify Any Future Shortfalls," GAO-04-604, General Accounting Office (2004).

"IAEA Safety Standards: Application of the Concepts of Exclusion, Exemption and Clearance," Safety Guide No. RS-G.1.7, International Atomic Energy Agency (2004).

"Improving the Regulation and Management of Low-Activity Radioactive Wastes: Interim Report on Current Regulations, Inventories, and Practices," National Research Council, National Academies Press (2003).

"The Disposition Dilemma: Controlling the Release of Solid Materials from Nuclear Regulatory Commission-Licensed Facilities," National Research Council, National Academies Press (2002).

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