MANAGING SUSPECT RADIOACTIVE MATERIAL IN THE DOE SYSTEM -- A PROGRAM TO ESTABLISH LOWER ACTIVITY DISPOSAL CRITERIA

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ABSTRACT

Operations at Department of Energy (DOE) nuclear installations routinely generate radioactively contaminated waste. A large portion of this waste has extremely low levels of radioactive contamination or is suspect waste. Despite these very low levels of contamination, this waste is disposed of as low-level radioactive waste (LLW) or mixed waste. Doing so depletes limited available disposal capacity while providing little or no incremental benefit to the public health and safety.

Efforts have been made by federal agencies, states, and industry to establish less rigorous control criteria for waste with low levels of radioactive contamination. The DOE addressed the establishment of lower activity disposal criteria in its threshold limit guidance in the early 1980s, but, to date, no formal limits have emerged from the Department. A number of DOE installations have calculated suitable site-specific release limits. Efforts by other federal agencies range from proposed dose criteria for Below Regulatory Concern (BRC) waste developed by the U.S. Environmental Protection Agency (EPA) to policy statements by the U.S. Nuclear Regulatory Commission (NRC) on BRC waste which were subsequently withdrawn. The NRC and several agreement states have implemented release limits for specific radionuclides and waste streams.

Applying the insight gained from efforts to establish lower activity disposal criteria could help in the development of limits for DOE waste streams. Such limits may be developed incrementally, focusing first on waste streams that are easily characterized and that will provide the greatest immediate benefit to the DOE system. Limits may then be developed for waste streams containing more complex mixtures of radionuclides. Separate limits may be developed for each DOE site, taking into account the site-specific disposal conditions, or a single set of limits may be developed for the entire DOE system. Once lower activity disposal limits are established, DOE installations will need to develop waste characterization methods adequate to ensure compliance with the new lower activity disposal criteria.

INTRODUCTION

The U.S. Department of Energy nuclear installations handle and process radioactive materials for defense and research and development programs. Routine operations at the installations result in a variety of radioactively contaminated waste materials. Additional waste is generated as a result of decontamination and decommissioning of numerous facilities at almost all of DOE's installations. Finally, several installations are conducting remedial feasibility investigations in response to contaminant releases from various disposal facilities. Site remediation and facility decommissioning and decontamination activities will generate additional large quantities of radioactive waste.

A large portion of the waste generated at the DOE installations as a result of routine operations and clean-up activities is low-level radioactive waste or low-level mixed waste. Much of this waste is contaminated with extremely low levels of radioactivity or is simply suspected of being contaminated. Despite these very low levels of contamination, this waste is routinely disposed of as either LLW or mixed waste.

Orderly continuation of DOE installation activities depends, in part, upon an adequate supply of disposal capacity for waste generated during routine, remediation, decommissioning and decontamination activities. In fact, LLW and mixed waste disposal capacity is in short supply at several of the DOE installations. Disposal facilities currently in use are approaching their capacity and plans for siting new facilities or expanding existing ones are underway at a number of installations. Public opposition to the establishment of such additional disposal capacity can be expected to complicate the effort. For example, Los Alamos National Laboratory has already suffered a setback in expanding its LLW disposal site because of public opposition.

The rapid depletion of existing DOE LLW disposal capacity can be slowed by establishing lower activity disposal criteria for radioactive waste. Waste streams with radionuclides concentrations less than these criteria could be managed with respect to the material's non-radiological characteristics. Waste with concentrations in excess of the lower activity disposal criteria would continue to be managed as radioactive waste.

The establishment of lower activity disposal criteria will also limit the demand for mixed waste disposal capacity. Mixed waste streams with very low levels of radioactive contamination could be managed only in terms of their hazardous characteristics. This might require additional treatment or alternative disposal technologies but would help minimize disposal facility requirements for mixed waste.

Disposal of lower activity waste using a less rigorous approach will reduce the management responsibilities associated with the material. For example, mixed waste with radionuclide concentrations less than the release limits would be managed only in terms of its hazardous characteristics. Management responsibilities for radioactive waste deemed suitable for disposal in a sanitary landfill would be substantially reduced. A significant benefit of such an approach is that management resources can be focused on the wastes that deserve this attention.

It is apparent that there are several potential benefits associated with managing radioactive waste with very low levels of contamination separately from more hazardous waste streams. Estimates of the amount of waste potentially affected by this management approach are provided. Historical efforts to establish criteria for managing waste with low levels of contamination are reviewed and the perspective gained from these efforts used in formulating the conceptual

approach for the DOE system. This paper then provides a strategy for implementing this waste management option in the DOE system.

The concepts of "de minimis" and "below regulatory concern" (BRC) wastes have evolved from attempts to establish management practices for radioactive waste with extremely low levels of contamination. For simplicity, suspect waste or waste with levels of radioactivity below the established criteria is referred to here as "lower activity waste."

CANDIDATE LOWER ACTIVITY WASTE STREAMS

The magnitude of the potential benefits of implementing lower activity disposal criteria will depend upon the proportion of the waste requiring disposal that falls below the criteria. This proportion, in turn, will be influenced by the lower activity disposal criteria themselves and the variability in the types and quantities of waste generated at the DOE installations. Consequently, definitive estimates of the quantities of candidate wastes cannot be formulated. However, estimates of candidate waste volumes can be developed for selected waste streams and/or installations.

A number of candidate waste streams have been identified by DOE-Oak Ridge personnel and are, in fact, the basis for work currently underway to establish revised criteria (1). The candidate waste consists of liquid and solid waste streams, generated during normal operations and through various decontamination and decommissioning, and remediation activities. The liquid waste streams, consisting primarily of oils and solvents, are generated at an estimated rate of 250,000/year. An additional 2,400,000 were in storage as of 1990. The solid candidate waste streams include PCB-contaminated waste (e.g., transformers, capacitors, soil and concrete, drums and debris), labpacks, contaminated scrap and soil from remediation projects, and miscellaneous waste. These solid waste streams are generated at an estimated annual rate of 830 m^3.

DOE-Rocky Flats generates waste that is not involved in the processing of radioactive materials but may contain background levels of radioactivity (2). The candidate waste consists of liquid and solid waste streams. The radioactivity in these waste streams may have been present when the material was initially brought on-site, or may result from contact of the material with other materials or equipment contaminated at background levels. The generation rate of the liquid waste streams (including oils, solvents, paint, and coolants) is estimated at 57,000/yr. Approximately 31 m^3 of solid waste, primarily paper and glass, is expected to be generated annually.

DOE-Los Alamos National Laboratory generates LLW and mixed waste from research and development projects. In the last three months of 1993, Los Alamos disposed of 220 m^3 of LLW and 230 m^3 of suspect waste at its LLW disposal facility (3). Approximately 50% of the solid LLW disposed at *Los Alamos* is suspect waste. Los Alamos generates over 1000 m^3/year of suspect waste that could potentially be categorized as lower activity waste.

The DOE Uranium Task Force examined the problems associated with the treatment and disposal of uranium-bearing wastes, and identified options for the safe treatment and disposal of these materials (4). In performing these functions, the task force examined the potential benefit of implementing the draft EPA BRC limit of 4 mrem/yr. Current and future annual generation rates of uranium-bearing waste were estimated at 94,000 and 350 m^3, respectively. Based on a release limit calculated from drinking water exposures, it was concluded that "about 80 percent of the generated volume of uranium-bearing wastes, with little or no treatment, could be handled by sanitary landfill-type disposal."

In short, there is waste being disposed as LLW at DOE installations nationwide that could be disposed in a less restrictive manner. The lifetimes of all DOE's existing LLW disposal facilities could be extended by establishing lower activity disposal criteria and better LLW management practices.

EFFORTS TO ESTABLISH REGULATORY CUT-OFF AND SEGREGATION LIMITS

Numerous organizations have recognized the need for criteria governing the disposal of lower activity waste by means less restrictive than those used at conventional LLW and mixed waste disposal facilities. A brief summary of the efforts made by federal agencies, states, and industry to establish disposal limits for this waste is provided in the following paragraphs.

Federal Agencies

The NRC has implemented a biomedical waste disposal rule for H-3 and C-14 which places limits on concentrations in liquid scintillation vial waste and biomedical waste (8). These wastes can be disposed of without regard to radioactive content if the H-3 and C-14 concentrations fall below 0.5 μCi/g. This rule specifies a concentration limit for two specific radionuclides and defines the waste streams to which the concentration limits can be applied.

The U.S. Congress mandated the NRC to establish procedures for acting expeditiously on petitions to exempt specific waste types from NRC regulations in the Low-Level Radioactive Waste Policy Amendments Act of 1985 (5). This mandate required specification of criteria that could be used to determine if a waste is BRC. In response, the NRC published a policy statement and implementation plan in 1986 for handling petitions to exempt specific radioactive waste streams from disposal in licensed LLW disposal facilities (6). This policy statement was reviewed favorably by EPA. However, in 1989 the Commission also published a policy statement on general exemptions from regulatory control. This statement received considerable criticism in Congress and elsewhere (7). This policy statement was subsequently withdrawn, along with the 1986 policy statement, because of the criticism of the whole BRC issue.

Under the authority of the Atomic Energy Act(9), the EPA prepared draft environmental protection standards for managing LLW and designating waste containing low levels of radioactive materials as BRC waste (10). Under these standards, the EPA allowed the possibility that some waste may contain radioactivity in such small quantities, and at such low concentrations, that it might be declared BRC. The EPA noted that disposal of individual BRC waste streams must be considered in conjunction with other candidate BRC waste streams, as appropriate. The EPA also recognized that the NRC or the DOE might impose additional considerations in determining what constitutes a BRC waste.

The EPA developed its BRC criteria by an inverse cost effectiveness analysis, determining that the cost of further control of some wastes was unwarranted. This was the approach that EPA believed was necessary for any type of BRC determination. This low-level waste standard was withdrawn from Office of Management and Budget review when the EPA and NRC could not agree on several aspects, including the

approach to BRC waste management. EPA has announced that it is again considering standards for LLW. Whether this will contain some regulatory cut-off consideration remains to be seen.

As part of its proposed Drinking Water Standards, EPA also proposed guidelines that would allow sludges from water treatment facilities containing low concentrations of naturally occurring radioactive material to be disposed of at sanitary or industrial landfills (11). These criteria were based on the levels of radioactivity in these wastes, as well as on the amount of waste dilution that would be expected from other domestic waste sources.

The EPA is now actively involved in defining concentrations below which wastes do not need to be managed as hazardous waste under Resource Conservation and Recovery Act regulations. A Federal Advisory Committee has been formed to develop these criteria. The schedule calls for the Committee to issue a proposed rule by October 1994 containing clean-up criteria for contaminated media. The schedule calls for the final rule to be in place by October 1995. The Committee also plans to establish such criteria for as-generated waste, but the clean-up criteria have been given priority.

The DOE funded work aimed at the development of threshold limit guidance for DOE LLW disposal facilities in 1984 (12,13). The guidance identified a dose criterion corresponding to a threshold risk for waste disposal, that is, a risk at which society is likely to be unconcerned. Radiological dose assessments were performed for two DOE sites to determine maximum radionuclide concentrations in waste that correspond to the threshold guidance dose. No efforts were made to implement the threshold guidance or to extend it to other DOE sites.

Except for soil and contaminated equipment release criteria in DOE Order 5400.5, the DOE has not addressed the establishment of lower activity disposal criteria through DOE orders or formal guidance. However, various DOE installations have investigated the problem of establishing such limits. Oak Ridge National Laboratory is currently performing work designed to establish release limits for several liquid and soil waste streams generated at the Oak Ridge, Paducah, and Portsmouth installations. If approved, these limits would provide a basis for sending waste with very low levels of radioactivity to incinerators and non-radioactive waste disposal facilities for treatment and disposal.

An analysis similar to that conducted for DOE-Oak Ridge was conducted for waste generated at the Rocky Flats Plant (3). The waste streams considered in that analysis included a number of liquid waste streams, trash, construction debris, and miscellaneous hazardous wastes. The limits were based on release of the waste for heat recovery or destructive incineration and subsequent disposal of the residue.

States and Industry

A number of states have recognized the fact that some short-lived radioactive wastes do not require disposal in a licensed low-level radioactive waste disposal facility. Agreement states have adopted the NRC's biomedical waste disposal rule for H-3 and C-14. A number of agreement states, including Texas and Louisiana, have expanded the rule to include I-125 with the same concentration and waste stream limits.

Rulemaking was completed in Texas in 1987 that allows the disposal of LLW containing only short-lived radionuclides below specific concentration and annual curie limits in sanitary landfills. The calculated release limits are based on a multi-pathway risk assessment in which exposures to an individual in the critical population group were modeled. Generators of waste are allowed to implement the limits following approval by the Texas Radiation Control Agency. Approval is granted only after the waste generator has demonstrated that it has the administrative and technical capability to segregate the waste, account for radionuclide concentrations, and properly package the short-lived waste for transport. This rule has reduced the volume of Texas' non-utility solid LLW stream by 70 percent.

The Electric Power Research Institute (EPRI) efforts to justify and validate BRC limits for nuclear power plant waste streams are presented in a 1989 EPRI report (14). This report estimated that nuclear power plant dry active waste less than 1 nCi/g gives potential doses of less than 1 mrem/yr if disposed in a sanitary landfill. EPRI never submitted a formal request for BRC rulemaking to the NRC because at that time the Commission's BRC efforts were facing strong political opposition.

DEVELOPMENT OF LOWER ACTIVITY DISPOSAL CRITERIA FOR THE DOE SYSTEM

Past attempts to establish BRC and other regulatory cut-off criteria provide valuable insight for other organizations interested in establishing lower activity disposal criteria for their waste. This perspective is used in the following discussion of a conceptual approach for the development of criteria for DOE waste streams.

Two efforts to establish and implement disposal criteria have been successful to date. These are the biomedical waste disposal rule, established by the NRC and implemented by a number of agreement states, and the Texas rule allowing the sanitary landfill disposal of waste with only short-lived radionuclides. These programs have resulted in considerable savings in terms of treatment and disposal costs and LLW disposal capacity, and will continue to do so in the future. At the same time, the U.S. nuclear utility industry has shown that significant reductions in LLW volume can be obtained through improved waste management and segregation practices.

The biomedical waste disposal rule and the Texas rule are similar in that both rules focus on a small number of waste streams and address a limited number of carefully selected radionuclides. The waste streams are readily characterized in terms of radionuclide content and are generated in considerable quantities. These characteristics ease the burden of demonstrating compliance with the rules, while maximizing benefits to the generators.

Establishing lower activity disposal criteria for DOE installations will require an acceptable risk level and methodology. The clean-up criteria effort currently underway by EPA will set a risk level and a methodology that, if suitable, could be used as a standard for development of DOE lower activity disposal criteria. Using an accepted EPA approach might assist DOE in establishing such criteria.

The development of lower activity disposal criteria for DOE waste should be approached in an incremental manner. Similar to the rules discussed above, limits should be developed for waste streams that are readily characterized, that may be contaminated by a single radionuclide or by a mixture of a small number of easily quantified radionuclides, and that are generated in relatively large quantities. These characteristics will allow straightforward characterization of the waste streams and

rapid implementation of the limits by waste generators, thereby maximizing savings in LLW disposal capacity and disposal costs. Examples of these candidate waste streams include liquid scintillation waste, suspect waste, uranium waste, and waste containing only short-lived radionuclides.

Following the establishment of disposal criteria for readily characterized, high volume waste streams, attention can be turned to waste streams with more complex mixtures of radionuclides. The increased number of radionuclides may require that additional resources be devoted to waste characterization.

The disposal criteria for DOE low radioactivity waste streams must account for the variety of disposal conditions found at the DOE installations. Criteria may be developed and implemented independently for each installation. This approach would allow installations with superior measurement, management and disposal programs to more aggressively manage their low activity wastes. Conversely, the most restrictive criteria could be selected from across the DOE system and implemented at all installations. This approach minimizes the complexity of implementation, but limits the potential benefits of implementing a low activity waste management approach.

The implementation of lower activity disposal criteria will require waste generators to characterize candidate waste streams to determine if the waste qualifies for disposal by new, less restrictive means. Waste may be characterized using direct measurement techniques or process knowledge. The frequency with which characterization procedures must be performed will depend, in part, upon the variability in the waste stream under consideration.

In many instances, simple changes in management practices will be sufficient for classifying candidate waste as lower activity waste. For example, suspect waste often results because waste from areas adjacent to controlled areas is indiscriminately mixed with trash from the controlled area. Managing waste from these two areas as separate waste streams would provide immediate benefits to the installation using this process knowledge.

In summary, DOE efforts in establishing and implementing lower activity disposal criteria should concentrate on: defining waste streams; establishing limits for treatment and disposal facilities; and developing methodologies and instrumentation for rigorous, cost-effective implementation of lower activity disposal criteria. Waste streams generated at DOE nuclear installations should be managed commensurate with the risk posed by the waste to the general public. More aggressive management of lower activity waste, including suspect waste, will conserve disposal capacity for LLW and mixed waste, save money, and reduce management responsibilities. The technology exists to implement this management strategy, it is up to the DOE to provide the management direction and incentive for its implementation.

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