CONSIDERATIONS IN REGULATION OF LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT AND DISPOSAL*

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INTRODUCTION

The U.S. Nuclear Regulatory Commission is planning to develop a comprehensive regulation, 10 CFR Part 61, for the management and disposal of low-level radioactive waste (LLW). The regulation will address both the radioactive waste classification and the LLW disposal technologies. In accordance with NEPA and 10 CFR Part 61, an Environmental Impact Statement (EIS) is required to support major rulemaking actions.

Recent events have shown that, the development of the LLW regulation and the necessary supporting documents continues to be the single most important issue facing the LLW program. Guidance is needed not only to address specific day-to-day disposal problems at the existing operating sites, but also to address the stabilization and final closure of the sites that are no longer operational, and to provide better guidance to applicants seeking to establish new LLW disposal sites.

Shallow land burial has been the predominant method of LLW disposal since the beginning of the Federal Atomic Energy programs in the 1940's, and difficulties have been experienced at several of the sites. Although some limited controls have been applied to waste form, packaging, and disposal facilities, the natural characteristics of the disposal environment were principally relied upon to provide confinement of the waste over the long term. Apparently, the difficulty in quantifying the natural characteristics of a particular site with certainty, and

* This paper is presented in memory of Alexander E. Aikens, jr.

relating these characteristics to the site's ability to confine the LLW were not fully considered. Moreover, the broad range of types of LLW with diverse and ill-defined chemical, physical, and radiological characteristics, presently mixed together during disposal, as well as the form and packaging of the waste currently delivered to disposal sites, were also major contributing factors to the difficulties experienced at some of the existing sites. Furthermore, the lack of uniform site practices guided by the application of viable and consistent environmental principles, and the lack of clear delineation of institutional issues such as financial and ownership responsibilities, have also contributed to the existing conditions.

Clearly, the facts that one cannot quantify a site's ability to confine the LLW with certainty, that LLW will continue to have diverse and ill-defined physical, chemical, and radiological characteristics, and that site operations can vary within given guidelines, have not been fully acknowledged and, if necessary, compensated for by indirect means.

It is within this framework that Dames & Moore has accepted the responsibility, under contract to the U.S. NRC, to assist in preparation of an EIS to guide and support the development of the 10 CFR Part 61 regulation on LLW management and disposal. In accordance with the CEQ Regulations, the EIS should serve as a decision making tool.

This paper discusses some of Dames & Moore's considerations that are being included in the development of the EIS and the analyses of the environmental impacts.

GENERAL CONSIDERATIONS

The goals of LLW management and disposal have been stated in the past. For example, these goals have been expressed as "Objectives and Procedures" (IRG), as the answers to questions "what is the problem?" and "what should be done?" (NUREG-300), and as the basic objectives of an acceptable radioactive waste classification system (UCID-17497). These goals are:

- o Assurance of Public Health and Safety,
- o Protection of the Environment, and
- o Minimization of the Need for Long-Term Social Commitment.

These goals can be achieved by assuring that: the potential population and occupational doses are within applicable limits and criteria, existing air and water quality standards are observed, direct and indirect impacts on public institutions and the human environment are minimized, and the time periods for social commitment are controlled.

In addition to the above goals, the following considerations (among others) should also be applied in the development of the regulation:

- o Timeliness,
- o Practicality, and
- o Equitableness.

Timeliness means that the regulation must be implementable in a timely manner, and although it must allow for future technological innovations, its dependence on research and development must be eliminated, i.e., it must utilize the existing infrastructure for LLW management and disposal to the greatest extent possible. Practicality means that the regulations should be understandable, sensible, and workable to all the industries generating and disposing of LLW, and have clearly delineated licensing procedures. Finally, the regulation should be equitable in its demands for conformance, should incorporate good economic practices, and should not impose undue burdens. It is also necessary that the public and state participation in the regulatory process be assured, and their contributions clearly delineated.

The EIS, and the regulation, must also be developed on a sound technical basis, and should be capable of resolving, within the framework of the system, the technical, environmental, and societal issues that may arise. The EIS, and the regulation, should also address a range of potentially viable land-based LLW disposal methods, be compatible with the standards, criteria, and regulations being promulgated by other agencies, should address the entire field of LLW management and disposal from the waste sources to the institutional controls, and should permit greater control and flexibility in decisions regarding the disposal requirement for particular wastes and waste forms.

One more important consideration must be addressed, and that is the "macro-alternatives" associated with the entire regulatory process, i.e. viable answers to questions such as "why regulate?", "who should regulate?", and "how the regulations should be structured and implemented?" must be incorporated into the regulatory framework.

The above scope can best be accomplished through impacts analyses that address viable alternative forms of all the "regulatable items", and by developing the requirements in the form of performance objectives which establish what should be achieved in the disposal of LLW rather than quantifying detailed technical specifications for individual waste streams and disposal methods.

Alternative impacts analyses consist of the calculation of various impact measures such as cost, radiological dose, and resource use (land, energy, manpower, etc.), and permit the most meaningful comparison of cases resulting from variation of diverse and numerous independent parameters. The performance objective form approach, rather than the prescriptive form approach, achieves greater flexibility in addressing a range of potential LLW disposal technologies, better timeliness in allowing for future technological developments, and better practicality in view of the diverse nature of the industry under consideration.

TECHNICAL CONSIDERATIONS

Given the number of parameters, their variations and uncertainties associated with assessment of impacts of LLW management and disposal, the items that can be quantified/analyzed must first be compiled. These items on which appropriate regulatory constraints/barriers can be imposed are:

- o Waste Form and Package
- o Waste Contents
- o Site Location
- o Site Design
- o Site Operations
- o Site Closure, and
- o Institutional Controls.

Any one of these regulatable items may not individually assure the safe disposal of LLW, but each item can be examined and appropriate requirements applied to provide a reasonable degree of confidence in the ability of the total system to safely confine the LLW. Using this approach, an overall assessment of the effectivess of any disposal method can be made within the limitations and uncertainties in the various system parameters.

Several general requirements can be imposed on these regulatable items: stability, predictability of long-term performance, minimization of radionuclide mobility, effective utilization of resources, minimization of occupational dose, etc. In addition, specific requirements can be imposed on each item. For example, waste form and packaging requirements can include ease of handling, package availability, and cost. Waste content requirements can include consideration of unintentional (intruder) reclamation, non-radiological impacts, and hazard duration. Site location requirements can include monitorability, transportation, demography, ease of construction, and the disposal technology (e.g., shallow land burial, mined cavity disposal, etc). Site design requirements can include monitorability, and reclamation. Site operations requirements can include records, surveys, audits, ownership, training, security, and emergency programs. Finally, site closure and institutional control requirements can include financing, security, maintenance, monitoring, mode of control, and control periods. This approach allows a greater emphasis to be placed on those individual factors which can be quantified/identified as being most important to assuring safety, and allows analysis of potential consequences due to the failure of one or more barriers.

The level of safety with which the above stated goals can be and should be achieved must also be considered. The level of safety can be designed for prevention (e.g., stopping rainwater infiltration into the waste cell) or for mitigation (e.g., minimizing the amount of leachate leaving the waste cell) or for both. An important consideration in evaluating the effectiveness of a safety design feature is the predictability of its long-term performance. Experience at shallow land burial sites have shown that many of the safety features were not designed with long-term performance predictability as a primary consideration, and as a consequence they have neither prevented nor mitigated some of the difficulties.

The time axis pertaining to the disposal technologies can be broken into five distinct periods called the pre-operational,

operational, closure, institutional control, and public access periods by the following four boundaries: start of disposal operations, end of disposal operations, license termination/ beginning of institutional control, and the end of institutional control. The regulations must be very clear and specific on the administrative and procedural requirements of the first three periods given the need for additional disposal capacity under the existing waste management conditions. Also, given the experiences at some of the shallow land burial sites, the general requirements of stability and long-term performance predictability in conjunction with minimization of the need for long term social commitment indicate that the regulatory framework be structured such that only passive institutional controls would be necessary after the termination of license, and that all necessary measures be implemented prior to license termination to assure this passive mode.

Within the above framework, the EIS should consider the viable alternatives to all the regulatable items, calculate the consequences/impacts including radiological doses, costs, resource use, and through comparison of the impact measures, assess the environmental acceptability of the options.

In order to perform meaningful comparisons between the alternatives, the entire spectrum of LLW to be generated between now and the year 2000 for various growth projections are being considered. The LLW from nuclear fuel cycle, institutions, and industries are included in the spectrum which will be composed of approximately 40 waste streams in four major groups: LWR-process waste, trash, high surface radiation special waste, and other wastes. Volumetric breakdowns of each stream by regions have been accomplished. Basic data including volumetric growth rates, physical, chemical and radiological characteristics, as well as applicable existing treatment methods and their effects on the characteristics,are being considered.

Alternatives to the existing LLW spectrum will differ by total volume, and by characteristics. The alternatives selected (tentatively five or six) will bound the potentially viable future composition of the LLW. For example, one of the spectra being considered, tentatively labeled as the "maximum volume reduction" case, envisions calcination of all calcinable waste, incineration of all incinerable waste, and volume reduction by extreme measures of non-combustable trash, etc. This scenario would require the installation of appropriate facilities at the disposal site, if necessary, and the impacts resulting from the on-site processing facility would be considered. Another spectrum allows for the "deminimus" concept to be incorporated in the criteria for certain institutional waste streams.

Comparison of the impacts resulting from the alternative waste spectra for a given set of other regulatable items on site parameters, will permit, on an equitable basis, decisions to be made on the performance objectives pertaining to waste form, container, and contents. For example, it is likely that volume reduction of trash, by incineration or by compaction, will prove to be environmentally more acceptable due to the advantages to be gained from volume utilization and long-term waste form stability. In this case, waste handling and processing facilities might be needed at the disposal site to serve the waste generators that cannot install in-house volume reduction capability cost-effectively.

The alternative waste spectra will be analyzed in conjunction with alternative disposal technologies which incorporate the last five of the regulatable items. Alternative disposal technologies will allow for the variation of the land-based conceptual approach, e.g., shallow-land burial, engineered structures; for design variations within a given technology, e.g., grouting vs. not grouting or trench vs. pit, or rigid vs. natural walls, etc.; for variations of site location, e.g., the regional disposal sites, environmental transfer media parameters; for variations in site operations, e.g., segregation of wastes, on site treatment and/or repackaging; for variation of post-closure/pre-licence termination activities, e.g., duration, intruder and/or bio barrier implementation, surface stabilization; and for variation of the duration of the institutional control period.

Comparison of the impacts resulting from the alternative disposal technologies for a given waste spectrum will permit, on an equitable basis, decisions to be made on the performance objectives pertaining to site location, design, operation, and closure. For example, it is likely that segregation of the wastes into streams such as solidified process waste, trash, industrial high activity wastes, etc., and separate handling and disposal procedures for these streams will prove to be environmentally more acceptable due to the advantages to be gained from volume utilization, waste cell stability, and measures necessary to assure passive institutional control, and that special disposal areas within the same facility with more elaborate safety features may be needed to handle just the high surface radiation packages.

These are some of the considerations that are being included in the preparation of the Environmental Impact Statement on low-level radioactive waste management and disposal.