

THE PERFORMANCE ASSESSMENT PROCESS FOR DOE LOW-LEVEL WASTE DISPOSAL FACILITIES (U)

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THE PERFORMANCE ASSESSMENT PROCESS FOR DOE LOW-LEVEL WASTE
DISPOSAL FACILITIES (U)

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1. INTRODUCTION

The United States Department of Energy (US DOE) manages several large sites in various locations. These sites are involved in nuclear material production and testing, nuclear reactor development and testing, and research and development. Low-level radioactive waste generated at these sites is disposed in near-surface disposal facilities located at six of the sites.

Safety of the low-level waste disposal facilities, as well as all US DOE facilities, is a primary criterion in their design and operation. Safety of low-level waste disposal facilities is evaluated from two perspectives. Operational safety is evaluated based on the perceived level of hazard of the operation. The safety evaluations vary from simple safety assessments to very complex safety analysis reports, depending on the degree of hazard associated with the facility operation.

Operational requirements for the Department's low-level waste disposal facilities, including long-term safety are contained in DOE Order 5820.2A, Radioactive Waste Management (1).

This paper will focus on the process of conducting long-term performance analyses rather than on operational safety analysis.

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2. PERFORMANCE OBJECTIVES FOR WASTE DISPOSAL

Requirements for management of radioactive waste are contained in DOE Order 5820.2A, Radioactive Waste Management (1). This Order became effective on September 26, 1988. Chapter III of the Order details policy and requirements for management of low-level waste.

Performance objectives for low-level waste management are summarized below:

- (1) Protect public health and safety in accordance with DOE Orders.
- (2) Assure that no member of the public receives more than 25 mrem per year, effective dose equivalent, from all pathways combined.
- (3) Assure that the committed effective dose equivalents received by an inadvertent intruder will not exceed 100 mrem/yr. for continuous exposure or 500 mrem for a single acute exposure.
- (4) Protect ground water resources, consistent with Federal, State and local requirements.

3. PERFORMANCE ASSESSMENT REQUIREMENT

The Radioactive Waste Management Order also requires that low-level waste disposal facilities prepare and maintain a radiological performance assessment to demonstrate compliance with the performance objectives. The Order further requires that an Oversight and Peer Review Panel be established to ensure consistency and technical quality within the DOE complex in the development and application of performance assessment models that include site specific climate, geohydrology and waste composition.

4. PERFORMANCE ASSESSMENT REVIEW PANEL

Peer Review Panel members were selected by the Department from nominees presented by each of the Field Offices. One member was appointed by the USDOE Office of Environment, Safety and Health (EH). In addition, the U. S. Nuclear Regulatory Commission (NRC) and the U. S. Environmental Protection Agency (EPA) were invited to appoint technical advisors to the Panel.

The review process, as determined by the Panel, consists of two parts. First, as a performance assessment is being developed, the Panel will conduct an informal review. The informal review consists of tours and discussions at the disposal facility relative to the planned performance assessment methodology followed by recommendations from the Panel to enhance the development of the assessment.

Second, when the performance assessment is finalized, the report is submitted to the Office of Waste Operations (EM-30) for review by the Panel. The final review consists of review and comment by individual Panel members, followed by a meeting of the Peer Review Panel to develop a consensus on the technical adequacy of the PA; the final review process typically requires at least three months. The Panel then advises EM-30 as to the technical adequacy of the assessment.

The Panel has developed and issued two documents:

- Recommended Format and Content for DOE Low-Level Waste Disposal Facility Radiological Performance Assessment Reports, DOE/LLW-81 (2).
- Performance Assessment Review Guide for DOE Low-Level Radioactive Waste Disposal Facilities, DOE/LLW-93 (3).

These documents supplement guidance provided by DOE for the preparation of performance assessments (4) and will provide assistance to the Panel in conducting reviews. The Panel has also provided guidance to the Office of Waste Operations on points of compliance for the performance objectives.

5. PERFORMANCE ASSESSMENT DEVELOPMENT

The development of a performance assessment for a specific low-level waste disposal facility is a multi-step process. Performance assessment is, by nature, a multi-disciplinary process. Thus, the first step is to convene a working group representing the several disciplines involved. Key disciplines include: geology, geochemistry, hydrology, computer modeling, dose assessment, radiochemistry, and low-level waste disposal facility operations.

The working group must define the facility being assessed, including disposal unit design, waste generation processes, waste form and packaging (including waste treatment), waste emplacement and stabilization, technology for final closure, expected inventory of radionuclides, and inventory of chemicals potentially affecting migration of radionuclides. The disposal facility environs must also be characterized including climate, meteorology, geology, hydrology, ecology, and human population distribution (both current and projected). Use of natural resources (both current and projected) in the environs should be described as well as potentially disruptive natural phenomena such as seismicity and volcanism. Degradation of engineered design features such as concrete vaults (5) and erosion or breaching of clay caps must also be considered, as appropriate.

The analysis of performance should begin by formulating conceptual models representing potential mechanisms for release of radionuclides from the waste, transport through the environment and exposure to humans.(6,7,8) Screening calculations should be employed to define the major radionuclides, pathways and exposure scenarios for more refined analysis.

For each of the scenarios and/or pathways selected for detailed analysis, the following steps should be followed:

- Present a clear and concise description of the system being analyzed,
- Define the conceptual model developed to represent the system,
- Select a computational model to analyze the conceptual model, and justify the selection.
- Perform the necessary calculations, being careful to justify all assumptions.

Throughout this process, site-specific data should be used to the extent possible. When an assumption is made because of the lack of data, the assumption and justification for it must be documented.

Following the initial detailed analysis, an analysis of the sensitivity of calculations to assumptions and selection of parameters should be performed. The propagation of uncertainty in parameters and scenarios should be assessed and the overall uncertainty in the results of analyses should be estimated.

6. INTEGRATION AND INTERPRETATION

The final step is to interpret the results of the analyses and integrate the interpretation into the overall assessment of long-term performance.

The integration and interpretation of results is commonly not given enough emphasis. Frequently, the PA preparer views the PA process as simply completing a number of calculations and reporting the results. Admittedly, these calculations can be very complex. However, just as important as completing the calculations is the process of "making sense" of the results in light of the assumptions that had to be made, the uncertainty in input data, etc. This is called integration and interpretation. Only through the process of integration and interpretation can the PA give an indication of whether the disposal facility is likely to meet the required performance objectives.

7. LESSONS LEARNED FROM REVIEWS

To date, the Panel has conducted six preliminary reviews at the Hanford site (Grout facility), at the Nevada Test Site (Area 5 burial ground), at the Idaho National Engineering Laboratory (Radioactive Waste Management Complex burial ground), at the Los Alamos National Laboratory (Area G burial ground), at the Oak Ridge National Laboratory (Solid Waste Storage Area 6 burial ground), and at the Savannah River Site (Saltstone facility). The Panel has also concluded the final review of the Hanford Grout facility assessment. The recommendations generated by the Panel from these reviews have been compiled and condensed into the following guidance.

- In the description of the facility and environs, sufficient detail must be presented to demonstrate adequate understanding of the facility and environmental processes potentially affecting contaminant migration. Most DOE Sites have a considerable history of environmental investigations/studies that should be factored into the performance assessment.
- Justification of each aspect of the assessment is critical. The review process is primarily that of validating the judgement of the assessor as pathways and scenarios are defined, computer codes are selected, etc. Thus, clearly stated and justified assumptions, selections of parameter values, choice of radionuclides for analysis, etc. are necessary.

- Disposal of low-level waste is evolving toward the reliance on engineered barriers to achieve performance objectives. Thus, the estimation of the lifetime of the barriers under disposal conditions is necessary for a credible performance assessment. Undue conservatism will result from taking no credit for engineered barriers.
- It may be helpful to present two overall analyses of performance, one health-conservative and the other a best engineering estimate. Such a presentation may point out critical uncertainties in the analysis and qualitatively indicate the degree of conservatism in the health-conservative analysis.
- Formulation of intruder scenarios should consider site-specific conditions (climate, environment, historical patterns of human activity, etc.) as well as "standard" scenarios (5). Passive controls (markers, land use records, etc.) may be considered in the analysis of intrusion, however, the duration and effectiveness of the controls must be justified.
- The integration and interpretation of the results of the analyses required for a performance assessment is critical to the success of the assessment. This step involves interpreting the results of several analyses in light of the associated uncertainty and sensitivity, the extent of assumptions necessary to conduct the analyses, etc. Frequently, this step is neglected or not given sufficient emphasis, resulting in diminished credibility of the assessment.
- Sufficient detail must be documented to enable the review panel to undertake confirmatory calculations in order to judge the acceptability of the assessment.

8. REFERENCES

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