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STRATEGIES FOR ENVIRONMENTAL RESTORATION IN AN EVOLVING REGULATORY ENVIRONMENT

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ABSTRACT

The U. S. Department of Energy (DOE) is faced with the immense challenge of effectively implementing a program to mitigate and manage the environmental impacts created by past and current operations at its facilities. Such a program must be developed and administered in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). These regulations are extremely complex, burdening the environmental restoration process with a number of planning and public interaction requirements that must be met before remediation of a site may begin.

Existing regulatory and institutional requirements for environmental restoration dictate that extensive planning, characterization and assessment activities be conducted. An important part of the process is the involvement of regulators and the public in the site characterization and assessment activities and in developing reasonable solutions for cleanup. DOE must reach agreements with the appropriate regulatory agencies and public parties before cleanup activities can proceed. The nature of the wastes present at DOE sites complicates the characterization and ultimate cleanup process. Contamination at DOE sites ranges from the standard industrial hazards found at other Hazardous Waste sites (solvents, acids, etc.) to a complex mixture of hazardous and radioactive constituents.

The presence of radioactive components at a hazardous waste site creates special problems for DOE during the characterization and assessment process. There are no specific regulations for handling mixed wastes within the CERCLA process. It will be critical for DOE to develop and implement a standard strategy for handling these sites, and gain approval of the approach from EPA and other regulatory agencies. Of particular concern will be establishing a responsible approach for setting cleanup criteria for these sites.

This paper identifies the regulatory requirements and highlights implementation strategies for key aspects of the environmental restoration process for DOE. Trends in legislation and policy relevant to the DOE environmental restoration process are highlighted, with strategies identified for dealing with the evolution of the regulations while maintaining continuity in the technical activities required for cleaning up the DOE hazardous and mixed waste sites.

BACKGROUND

The remediation of sites contaminated with hazardous or mixed (containing hazardous and radioactive constituents) wastes will be one of the more visible and expensive activities required by existing environmental regulations. Environmental cleanup of DOE facilities will require a multibillion-dollar program extending over a time period of approximately 30 years. Successful accomplishment of program objectives will require consideration of not only technical issues, but perhaps more importantly, evolving regulatory and institutional constraints. The current regulatory requirements for environmental restoration are diverse, including federal law, state law, and special federal facility agreements. An integrated approach that incorporates scientific knowledge, engineering design and regulatory issues will be required to effectively address the needs of DOE's Environmental Restoration program.

The world in which DOE must operate to clean up its waste sites is changing at an increasingly fast pace. Besides the evolving nature of the regulatory issues, a new operating style is demanded. The DOE, thus, is entering a new era of openness in negotiating with regulators and the public to accomplish its cleanup activities. A multidisciplinary approach involving the regulators, the engineers and scientists, DOE management and the public is required. The number of parties involved in the process and the required interaction suggests a need for an innovative approach by DOE.

The evolving regulatory requirements will make it difficult for DOE to plan, manage, and implement its environmental restoration activities. Most of the environmental laws are less than 20 years old and are subject to change as EPA, the States, and the regulated agencies gain experience in implementing these laws. The nature of the environmental laws and regulations in the 1990's is unclear; however, indications are that there will be more environmental laws and the existing laws will become more stringent. Increasing public attention will continue to drive these regulatory changes to the overall environmental problem.

Prior to the enactment of the major environmental laws in the late '60s, DOE and industry generally were meeting the legal requirements for waste generation and disposal. In fact, many of the inactive waste sites were created before the Environmental Protection Agency was established. Thus, the waste sites which were created as a result of using the best available technology at the time and accepted industry practice, are now, in hindsight, being subjected to a strict set of cleanup requirements. The nature of the regulatory environment is such that it will continue to evolve, imposing new and stricter requirements on operating agencies.

DOE is faced with the challenge of effectively implementing programs to remediate its inactive waste sites. Such programs must be developed and administered in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [1], enacted in 1980, the Resource

Conservation and Recovery Act (RCRA) [2], enacted in 1976, the National Environmental Policy Act (NEPA) [3], enacted in 1969, and other federal laws. The regulations implementing these laws are extremely complex, imposing on DOE a number of requirements that must be met during planning and implementing environmental restoration activities.

The environmental restoration technologies are also relatively new and will continue to evolve over the next several decades. These technologies will be developed and applied in the evolving regulatory climate. These new technologies will be required not only to allow DOE to meet existing and future regulatory constraints, but also to handle the DOE mixed (hazardous and radioactive contaminants) waste.

DOE Waste Sites

DOE waste sites are extremely large and complex. Recent reports indicate that there are more than 3700 release sites currently in DOE inventory for the forty-five major facilities. Contamination at DOE sites ranges from the standard industrial hazards found at other Superfund sites (solvents, acids, etc.) to a complex mixture of hazardous and radioactive constituents. Most of the release sites are old landfills or trenches used for disposal of various materials, or releases from once-operating facilities that have infiltrated surrounding soil and groundwater at a site. Some release sites, however, are from leaking storage tanks, surface spills or contamination, or special test sites. Some DOE sites contain only radioactive constituents with no hazardous constituents present [4].

The diversity of waste sites creates special problems for DOE in developing compliance strategies for environmental restoration. Because there is little to no experience for managing mixed wastes as complex as DOE's within the CERCLA process, DOE needs to develop and implement strategies for managing these sites, and gain approval of the approach up front with EPA and other regulatory agencies. DOE must develop a vigorous and innovative program and creative approaches to remediating their waste sites. The remediation costs will be determined by the effectiveness of the technologies employed. The costs will also be determined by answers to the question of "How clean is clean?" Thus, DOE and the regulators should consider establishing a sensible approach for setting cleanup criteria for its sites.

Relevant Legislation

CERCLA (otherwise known as Superfund) and RCRA are the principal federal statutes prescribing how the nation's hazardous waste problem will be addressed. While each deals with a different aspect of the hazardous waste issue, both have the same overriding goal--protection of the public health and the environment. CERCLA focuses on remediation of old, usually abandoned, hazardous waste sites. The primary goals of RCRA are to ensure the safe disposal of currently generated hazardous waste and the environmentally sound operation of waste treatment, storage, and disposal facilities. Amendments to

RCRA in 1984 also authorized an extensive corrective action program for RCRA-regulated facilities. This corrective action program closely resembles the CERCLA remediation program in intent and function.

Federal agencies generally are subject to the requirements of CERCLA, RCRA, and relevant state laws on hazardous waste cleanup and operation of facilities managing hazardous waste. The CERCLA program is administered by EPA at the regional level. This means that to clean up a hazardous waste site under CERCLA, DOE must get approval on its process and its documentation from the EPA. Under RCRA, the process is somewhat more complicated, because RCRA allows EPA to authorize individual states to administer the RCRA program. Because few states have yet been authorized to administer the full program, DOE must often get approval on cleanup activities under RCRA provisions from both EPA and state agencies.

CERCLA is a liability based statute in that those responsible for the hazardous waste at a site are also responsible for the cost of cleaning up the site. The potentially responsible parties (PRPs) could include the original generators of the waste, the parties who transported the waste to the site, and the site owner. Federal agencies must meet the same requirements as PRPs. CERCLA itself generally does not establish specific cleanup standards, but references other environmental statutes, regulations, and guidance documents for specific remediation levels. CERCLA and must comply with relevant state laws relating to hazardous waste cleanups, as specified in section 120 of CERCLA (42 U.S.C. 9620). This section also states that cleanup criteria chosen for a federal facility must be consistent with those standards established by the U.S. Environmental Protection Agency (EPA).

RCRA, originally authorized in 1976, mandates a "cradle-to-grave" regulatory scheme that tracks hazardous waste from its generation to its ultimate storage or disposal. All treatment, storage, and disposal (TSD) facilities are required to obtain a permit to operate. As with CERCLA, the federal government is required to comply with RCRA requirements and relevant state laws, which means all federal facilities that handle hazardous waste must be permitted in accordance with RCRA. The corrective action program of RCRA is intended to address releases from RCRA facilities that pose a risk to public health or the environment. EPA has drafted detailed regulations, not yet approved, that will set forth the specific requirements of the corrective action program.

Because of the similar goals of each of the statutes, there exists substantial overlap between the requirements of the RCRA corrective action program and the CERCLA program. Frequently, specific sites or facilities could be remediated under either program. With respect to federal facilities, the decision concerning which regulatory program to use to address a site normally involves several factors. Sites associated with currently operating facilities normally will be subject to RCRA corrective requirements. Sites not associated with a currently operating facility usually will be addressed under CERCLA. Often, such decisions are largely political and are the result

of negotiations between the federal and state regulatory agencies and the responsible federal parties. In addition, DOE is developing legal agreements that establish very specific activities and milestones for the environmental restoration program for a facility. These agreements generally will be enforceable by courts.

The CERCLA process, as designed by Congress and implemented by the EPA, includes an intensive planning process to ensure that the cleanup action eventually implemented at a site will provide a permanent remedy for environmental protection. An important part of the process is the involvement of regulators and the public in determining the problems at a site and developing a reasonable, effective cleanup approach. This involvement is mandated through a series of planning and documentation steps that are presented in EPA's regulations and guidance. This planning process normally must be accomplished before actual site cleanup can begin. The remedial investigation focuses on site characterization activities. Field investigations are conducted to define the nature and extent of contamination (characterize waste types, concentrations, and distributions). Based on these investigations, the initial cleanup goals are determined.

Cleanup goals are developed based on an analysis of relevant environmental regulations. The issue of developing applicable, relevant, and appropriate requirements (ARARs) is complicated, but very important, because it is by these regulations and standards that EPA will judge the acceptability of final cleanup options and actions. The purpose of the feasibility study process is to develop and screen alternative technologies and approaches for cleaning up the site. These activities include identifying potential remedial alternatives, performing treatability studies to ensure remedial technologies will operate as expected in the field, and selecting recommended alternatives. These potential technologies are then screened against the remedial action objectives and the ARARs to determine their suitability. If all the requirements are met, the potential technologies are then written into the alternatives.

Remedial alternatives are selected based on the following criteria: effectiveness, implementability, and cost (between equally effective alternatives). The alternative selected must, among other things, protect human health and the environment; attain the applicable ARARs; reduce toxicity, mobility, or volume; and be technically reliable. The selection of technologies must also consider monitoring, maintenance, and possible replacement activities for post-cleanup. The costs of these operations must also be considered.

In addition to meeting the requirements of CERCLA and RCRA, DOE must also consider the requirements set forth in NEPA and the Atomic Energy Act (AEA) [5]. NEPA requires DOE to "utilize a systematic, interdisciplinary approach that will insure the integrated use of the natural and social sciences and the environmental design arts in planning and decisionmaking which may have an impact on man's environment." DOE must collect and utilize

ecological information in the planning and development of their projects. DOE must identify and develop methods and procedures that will insure that environmental values are given appropriate consideration along with economic and technical concerns. NEPA also ensures that interested parties are part of the NEPA process. Under the AEA, DOE must consider protection of workers and public health from exposure to radiation resulting from DOE activities. As amended, the AEA make, DOE responsible for its waste management activities.

Because all of these statutes are applicable to waste management activities and must be integrated, DOE is in a position of having to resolve issues and inconsistencies among these requirements. This is currently being done on a case-by-case basis. A systematic approach based on DOE policies and case-by-case experiences should be developed for future use. DOE has initiated some NEPA/CERCLA integration activities. RCRA and CERCLA are being integrated using the FFAs.

ARARs are intended to focus the integration issues. Environmental restoration decisions must be made by taking into consideration the standards against which constraints on technical solutions will be evaluated. CERCLA requires DOE to look at the entire suite of standards and apply them to their activities. DOE has recently established a standards working group and initiated a study to develop a baseline understanding of the standards available in EPA, NRC, and DOE regulations. Information is being gathered on whether these standards are risk-based or technology-based. Simultaneously, DOE is comparing the hazardous and radioactive constituents found at their facilities to these standards to establish the ARARs framework applicable to DOE. Risk-based standards are presently being considered by DOE for use as the primary means of determining acceptable concentrations of contaminants in environmental media that are undergoing restoration. DOE is presently reviewing information on risk-based and technology-based standards that have been promulgated as regulations, and that could be used as the basis for determining acceptable concentrations of contaminants in environmental media. Based on information about the contaminants that occur on DOE sites and the existing risk-based or technology-based standards that pertain to those contaminants, DOE will identify the technical and policy issues related to applying these standards to DOE's environmental restoration activities. Alternative strategies will be developed for addressing these issues.

The ultimate question facing DOE is "How do they remediate their waste sites in a cost-effective, timely manner that is protective of human health and the environment?" DOE Secretary Watkins is committed to a new culture. What does this mean? How will DOE develop and implement innovative strategies? The development of the Environmental Restoration and Waste Management Five-Year Plan [6] and the Applied Research, Development, Demonstration, Testing and Evaluation Plan [7] is just the beginning of the new culture. The philosophies set forth in these plans form the umbrella for DOE's environmental restoration activities. Specific, detailed environmental restoration strategies must be developed under this framework.

There are a number of specific strategies DOE should consider to enhance its effectiveness in cleaning up its waste sites in an evolving regulatory and technological climate. These include 1) streamlining the CERCLA planning and remediation process; 2) integrating the CERCLA requirements with the NEPA process; and 3) managing the risks associated with environmental restoration. Managing risks for these activities will also include establishing contingency plans for all environmental management activities, and developing creative approaches for involving the public and regulatory agencies. The remainder of this paper provides a discussion of these areas and some recommendations for incorporating them into DOE's environmental restoration activities.

Streamlining the CERCLA Process

The CERCLA process has been the subject of a number of critical evaluations. The Office of Technology Assessment (OTA) [8], the Government Accounting Office (GAO) [9], and a number of industry and public groups have all described a variety of problems with site remediation programs. There is a common theme among all of them: the study portion of the CERCLA process is taking too long and costing too much. At complex sites such as DOE's, millions of dollars may be spent over a ten year timeframe just to reach a Record of Decision (ROD). DOE and EPA must develop mechanisms for streamlining the CERCLA process and more rapidly and cost-effectively completing the planning and study portion of CERCLA.

EPA's current approach to hazardous waste site remediation is based on the assumption that all important information about a site can be known before remediation begins. This approach, based on the conventional engineering paradigm of study, design and construct, leads to the selection of a single remedial alternative with no contingencies for variations encountered during construction. This conventional approach works well for traditional engineering activities (i.e., building bridges), where uncertainty can largely be eliminated by study and investigation and by the existence of a large body of empirical evidence. However, hazardous waste site remediation is dominated by uncertainty. Variations in soil conditions, geohydrology, transport mechanisms, waste source, and chemical and physical characteristics make it impossible to completely characterize and understand actual site conditions. Thus, the remedial process has to a large extent become "bottlenecked" by the uncertainties associated with fully understanding the nature of hazardous waste problems. DOE needs to understand and manage these uncertainties within the current and evolving regulatory framework.

To manage uncertainties associated with the environmental restoration process, DOE should take into account regulatory, science, and engineering considerations throughout the process. Classically, scientists tend to be responsible for the remedial investigation (RI) portion of the process, with the engineers generally not involved until the feasibility study (FS) phase. The engineering input early in the CERCLA process will help keep the process focused and ensure that the information obtained through characterization is

useful for engineering purposes. Scientific input in the later stages (i.e., during the FS portion of the CERCLA process) will ensure that the alternatives/technologies chosen are protective of the environment. Regulatory, scientific, and engineering input should be incorporated into all phases of the cleanup process, from initial planning to post-closure monitoring.

Integrating CERCLA and NEPA Requirements

The NEPA process is required for any major federal action. DOE will be required to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs) for actions associated with the environmental restoration program. However, the CERCLA process also requires an integrated analysis of alternatives that is somewhat duplicative of NEPA requirements. DOE policy is to try to integrate the requirements of NEPA for environmental restoration activities with those of the CERCLA process. The implementation of this policy in the field, however, is not straightforward. The CERCLA process requires that documents be written at the operable unit level. NEPA requires that cumulative impacts be considered, along with other alternatives, in making a decision on appropriate actions. There are also somewhat different data requirements for preparation of NEPA documents from those required for CERCLA documentation. In addition, it is important to understand the NEPA issues when looking at streamlining the CERCLA process, for instance, to ensure that NEPA requirements for not prejudging the process are adequately considered. To work through this process efficiently, DOE will need to outline the requirements for the different processes, and ensure that data collection and other activities proceed in a way that will satisfy the requirements of both laws.

Managing Risks Associated with DOE's Environmental Restoration Activities

DOE must manage a variety of risks associated with its environmental restoration activities [10]. The ambitious goals of the environmental restoration program require that decisions made on technology development and application include consideration of critical success factors, such as performance, cost, regulatory compliance and public acceptance. Extensive evaluation of the performance of a technology and its cost-effectiveness is required by the CERCLA regulations. Technologies must be able to efficiently and effectively solve the cleanup problem and meet long-term engineering and regulatory performance criteria. In addition, the acceptance of the technology by the local community is critical to a successful application. A consistent approach to integrating public input to the development process is required to maintain DOE credibility with the public.

DOE should develop standardized tools for evaluating its environmental restoration problems and the technical solutions in terms of various risk measures (such as performance, cost, health/safety, regulatory compliance and public acceptance, all of which are required to be evaluated

under CERCLA and which are increasingly required for permitting waste operation technologies) and establish mechanisms for the standardization and coordination of data. Standardized analysis tools will be required for evaluating and gaining the acceptance of technologies with the regulatory agencies and the public. Site-specific models will also be required to deal with the unique concerns and data of particular sites.

DOE should develop a process and a set of standardized tools for maximizing program success by ensuring that engineering designs incorporate cost, regulatory, and public input in the development process. There are five primary elements of risk management to be considered: 1) needs assessment, 2) risk and performance assessment, 3) technology evaluation, 4) cost/benefit and decision analysis, and 5) public/regulatory integration. Historically, most of the environmental restoration decisions have been based on risk and performance assessment. While this remains a critical area for managing DOE's risks, and will probably be the greatest driver, the need for attention in the other areas has been recognized to ensure the success of the environmental restoration program and will receive increasing attention.

Planning for Contingencies

DOE's environmental restoration program must be fully integrated with its applied research, development, demonstration, testing and evaluation (RDDT&E) program and its waste management operations activities. DOE does not currently have all the technologies needed to characterize and remediate most of its hazardous and mixed waste sites. Thus, a successful RDDT&E program that is focused on environmental restoration needs is a necessity. In addition, the technologies that will be used to remediate the DOE sites need to be permitted. Close interactions among these three programs (environmental restoration, waste management operations, and RDDT&E) will ensure a needs-driven, successful program.

The interdependency of the three program areas requires contingency planning in an environment of evolving regulations and technology development activities. For example, if a given waste management facility will not be operational within timeframes necessary to meet environmental restoration schedules, what are the alternatives? If the technology development program is unable to test and evaluate a given environmental restoration technology within required operating schedules, what are the alternatives? DOE should focus its contingency planning across all of its environmental management activities.

Public and Regulators: Involvement and Negotiation

The public has a critical role in the decision-making and review processes associated with environmental restoration. The legal and political issues surrounding hazardous waste, which are driven by public opinion, have had more impact in setting the direction of cleanup programs than have the technical issues associated with site cleanup. In the future, the public is

likely to demand even greater input into the decision-making process as special interest groups become more savvy in their dealings with DOE and EPA, and concerns about waste issues continue to grow. Because of the importance of public involvement, DOE should build on existing community relations plan and develop a complex-wide comprehensive strategy for involving the public in its environmental restoration decision-making and implementation activities. This strategy should address DOE's particular social, political, and organizational realities.

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, DOE is in a position to be an international and national leader in the environmental restoration and technology development arenas. By developing and implementing creative, innovative solutions to its environmental restoration problems, DOE will develop new technologies and strategies that can be applied to waste problems throughout the world. New approaches to risk management, public involvement, and negotiated regulatory requirements for environmental restoration and waste management will be integral part of DOE's success.

DOE's environmental restoration activities will be implemented in evolving regulatory and technological arenas. The decisionmaking process for DOE's environmental restoration process is still in its early stages. Thus, the evolving regulatory regime surrounding mixed waste and inactive waste site cleanup should be tracked and made an integral part of environmental restoration planning. A "feedback loop" should be established through which changes in regulatory requirements, definitions, and interpretations can be assessed early enough in the planning process to ensure that decisions are made based on the most current regulatory requirements and on a knowledge of the areas in which significant changes are likely. This will aid decision-makers in building the flexibility into the decisionmaking process necessary to accommodate regulatory changes without significantly impacting their environmental restoration activities.

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