PNL-7740

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An Overview of Regulatory Issues That Affect the Development of New Waste Treatment Technologies

T. L. Kuusinen
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Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

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PNL-7740

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America

**Available to DOE and DOE contractors from the
Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831;
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**Available to the public from the National Technical Information Service,
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PNL-7740
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AN OVERVIEW OF REGULATORY ISSUES THAT AFFECT THE DEVELOPMENT OF NEW WASTE TREATMENT TECHNOLOGIES

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Richland, Washington 99352

SUMMARY

The development of new and innovative waste treatment technologies can significantly benefit the U.S. Department of Energy's (DOE) environmental restoration and waste management program. New technologies are expected to facilitate faster, better, cheaper, and safer remediation of existing waste problems. To encourage and direct the development of new waste treatment and management technologies, DOE established a research, development, demonstration, testing, and evaluation (RDDT&E) program. The RDDT&E program is managed by DOE's Office of Technology Development.

The development, acceptance, and application of new technologies involves more than simply technical problems. If the best new technologies are to be applied in the fastest and most cost-effective manner possible, DOE must consider regulatory factors early and often in the technology development process. This report presents a number of regulatory issues that are relevant to any program intended to encourage the development of new waste treatment and management technologies. The report was prepared by Pacific Northwest Laboratory.[a]

Statutes and regulations often define the performance criteria that waste management technologies and environmental restoration must meet. The regulatory requirements normally depend not on the technology itself, but rather on the legal classification of the waste being treated or otherwise managed.

Regulatory requirements can impact the development of waste treatment and environmental restoration technology in a number of ways. First, as noted above, regulations could mandate specific performance criteria for specific waste streams being treated by the technology. For example, under the land disposal restrictions program of the Resource Conservation and Recovery Act (RCRA), certain radioactive lead solids must be treated by microencapsulation. Unless a specific technology qualifies for the "best demonstrated available

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technology" (BDAT) under this program, or otherwise qualifies as an equally effective alternative treatment, a technology is not likely to be used in the field.

A second regulatory consideration that may impact technology development is whether the waste streams being generated from a specific treatment technology are themselves hazardous or otherwise contain constituents that make them subject to regulation. This type of regulatory concern may not, by itself, eliminate a specific technology from consideration. The fact that regulations may impede the ultimate application of a new technology, however, is very relevant to RDDT&E decisionmakers.

The acceptability of particular treatment technologies will also be affected by the permitting process, as well as the availability of waivers, exemptions, variances, etc. For example, using a certain technology to treat a waste stream may generate a new waste stream. It is possible that this resulting waste stream would have to be "delisted" under RCRA before the treatment technology can even be used. While delisting may be a viable option on paper, it is, in fact, a lengthy process that will dramatically affect the DOE's ability to expeditiously implement the technology in the field. Accordingly, RDDT&E decision makers must consider the realities of the delisting process and other permitting options when they are selecting technologies for funding. The availability of permitting processes to facilitate developing and testing of new technologies is also pertinent to any evaluation of technology development proposals.

The technologies under consideration in the RDDT&E program generally are intended to address hazardous wastes at DOE facilities. Thus, the most relevant regulatory schemes are those under the principal federal statutes that address the treatment, storage, and disposal of hazardous waste: RCRA and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The National Environmental Policy Act (NEPA), the Clean Air Act (CAA) and the Clean Water Act (CWA) can also have a major impact on the RDDT&E program.

Many of these federal environmental statutes authorize the states to administer the individual regulatory programs, especially in the RCRA area.

The regulatory programs of each state are, thus, extremely important and will have to be considered in particular circumstances. Significant differences can be expected from one state to another, especially regarding the amount of permitting flexibility each state is willing to afford emerging and innovative technologies.

ABBREVIATIONS

AEA	Atomic Energy Act
ARAR	applicable or relevant and appropriate requirement
BDAT	best demonstrated available technology
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
FR	Federal Register
HRS	Hazard Ranking System
HSWA	Hazardous and Solid Waste Amendments
LDR	Land Disposal Restrictions
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPL	National Priorities List
OTD	Office of Technology Development
PRP	potentially responsible party
RCRA	Resource Conservation and Recovery Act
RD&D	Research, Development and Demonstration
RDDT&E	Research, Development, Demonstration, Testing and Evaluation
SARA	Superfund Amendments and Reauthorization Act

SDWA	Safe Drinking Water Act
SIP	state implementation plans
SITE	Superfund Innovative Technology Evaluation
TBC	to be considered (materials)
TCLP	Toxic Characteristic Leachate Procedure
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	treatment, storage and disposal

CONTENTS

FIGURES

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1.0 INTRODUCTION

The treatment, storage, and disposal of hazardous and radioactive waste is heavily regulated at both the federal and state levels. Current statutory and regulatory requirements, as well as evolving regulatory trends, can have major impacts on the development and/or application of new and existing technologies intended to address hazardous and radioactive waste at U.S. Department of Energy (DOE) facilities. Early and careful consideration of regulatory requirements related to the RDDT&E process can help assure that technologies are identified, developed, and applied successfully with few or no regulatory "surprises" to impede or block these projects.

One of the challenges for DOE's Office of Technology (OTD) is to manage a highly technical program aimed at the developing new technologies within the constraints of existing and future environmental regulatory requirements.

1.1 PURPOSE

The objective of this report is to provide a broad introduction to the major regulatory issues and requirements that are relevant to the success of DOE's research, development, demonstration, testing and evaluation (RDDT&E) program. In addition to reviewing the most relevant environmental statutes and regulations, this report cites examples of how these regulatory requirements relate to the RDDT&E decision-making process.

This report is not intended to serve as a review of the regulatory requirements associated with the actual technology development process. Those requirements, such as the need for permits and the availability of waivers and exemptions from permitting requirements, are covered only to the extent that they may affect the overall RDDT&E technology selection process. For instance, certain requirements may impose unacceptable delays in implementing specific new technologies.

1.2 OVERVIEW OF REGULATORY ENVIRONMENTAL ISSUES

The objective of this section is to establish the linkage between the regulatory issues discussed in later chapters and the decisions that OTD must make in managing the RDDT&E program. This linkage is important in terms of establishing a context in which to review the regulatory requirements. Without this context, it is possible to view these requirements as a mixture of rules that seems to have no real impact on DOE decision making. Equally possible is the opposite point of view that regulatory issues constrain decision making in the RDDT&E program and will affect virtually every decision in managing the program.

The appropriate context is between these two opposites. Regulatory requirements are important factors but not the sole drivers of decisions, and they are not equally important for all decisions that OTD must make. In addition, regulatory requirements should not be viewed generally as impediments to applying new technologies. The regulations establish a framework that allows DOE to carry out its business in a manner that is recognized to protect human health and the environment.

1.2.1 Regulatory Issues Impacting Program Objectives

The mission of the RDDT&E program is to rapidly develop, demonstrate, and transfer technologies to the Environmental Restoration, Waste Operations, and Defense Programs components of DOE. Figure 1.1 is a graphical presentation of the RDDT&E process. The basic steps in the process are as follows:

- Basic Research - pursuit of fundamental knowledge through scientific investigation
- Applied Research - pursuit of specific knowledge through scientific investigation to solve an identified problem
- Development - small-scale experimentation and bench-scale testing of equipment and systems designed to embody new knowledge in a usable technology
- Demonstration - the engineered proof-of-principle in a field setting showing the technology works as designed

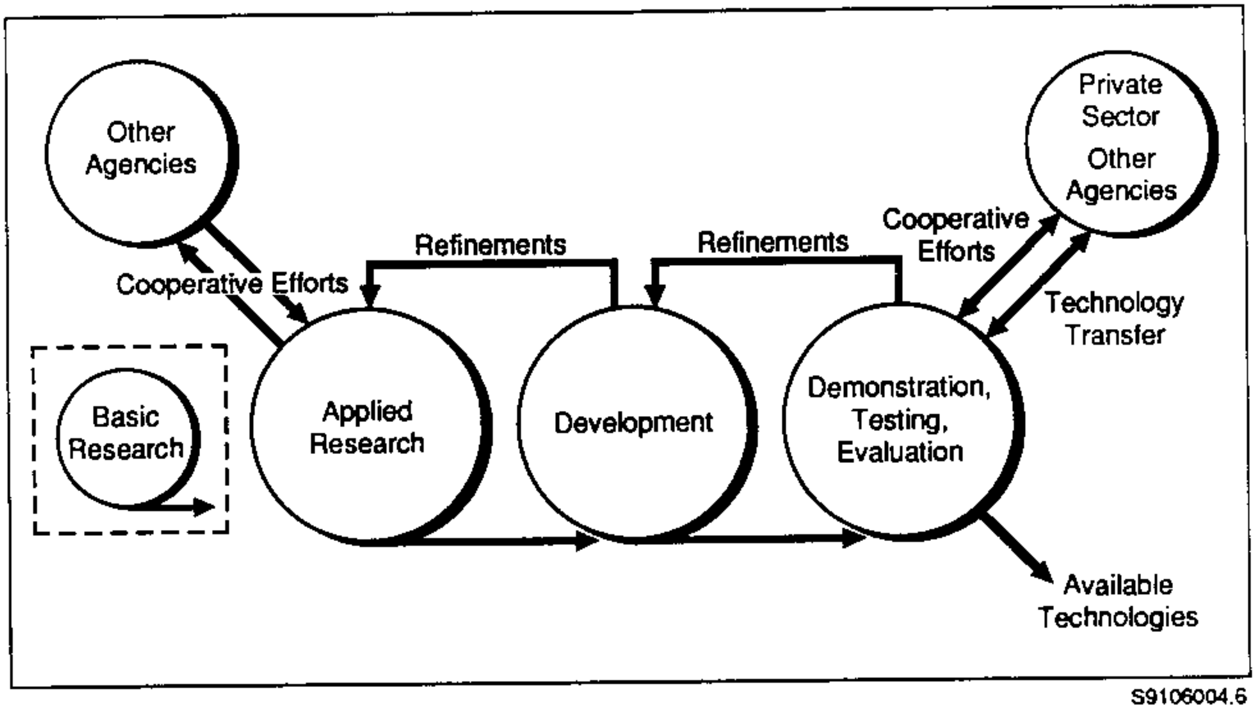


FIGURE 1.1. The Research, Development, Demonstration, Testing, and Evaluation Process

- Testing - recursive performance data collection from technology demonstration systems to determine applicability, durability, consistency, and effectiveness of components
- Evaluation - independent examination and publication of test data to ascertain performance specifications and applicability of technology.

The goal is to use these new technologies to accomplish faster, better, cheaper, and safer remediation of existing waste problems and to safely and permanently dispose of waste in compliance with existing and potential statutes and regulations. Desired features in technologies under development are the ability to perform operations in a more effective and cost-efficient manner than is possible with current technologies, to improve safety and performance, and to reduce the time required for cleanup. Identifying the technologies that can best meet these goals, evaluating progress of the technologies toward these goals, and prioritizing alternative approaches represent a difficult task.

A relevant starting point in considering the context of regulatory issues is how they bear on the specific program objectives of the RDDT&E program. The RDDT&E program is aimed at providing the technology necessary to improve DOE capabilities for achieving and maintaining environmental compliance. Environmental compliance is a prerequisite for the success of any technology developed in the RDDT&E program. Regardless of how much faster, better, cheaper, or safer a new technology is, the technology will not be considered successful if it cannot eventually be used in compliance with environmental regulations. To be successful from the OTD perspective, a technology must meet applicable environmental regulations during its development and at the time of its implementation.

The three federal regulatory programs that will likely have the greatest impact on meeting the objective above are the Resource Conservation and Recovery Act (RCRA); the National Environmental Protection Act (NEPA); and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund). Other significant federal environmental programs include the Toxic Substances Control Act (TSCA), the Clean Water Act (CWA), the Clean Air Act (CAA), and the Atomic Energy Act (AEA). States also have significant requirements such as "Mini-Superfund" programs and waste minimization programs. Generally, state requirements are more stringent than federal requirements in nearly all environmental program areas.

1.2.2 How Regulatory Issues Affect OTD Program Management

Achievement of the overall objectives of the RDDT&E program is directly dependent on or directly correlated to numerous decisions by OTD and technology developers and to the implementation skills of the end users. A simplified description of the major responsibilities of the major entities involved in technology development and implementation is shown in Figure 1.2; the figure is not intended to show the overall scope of decisions and

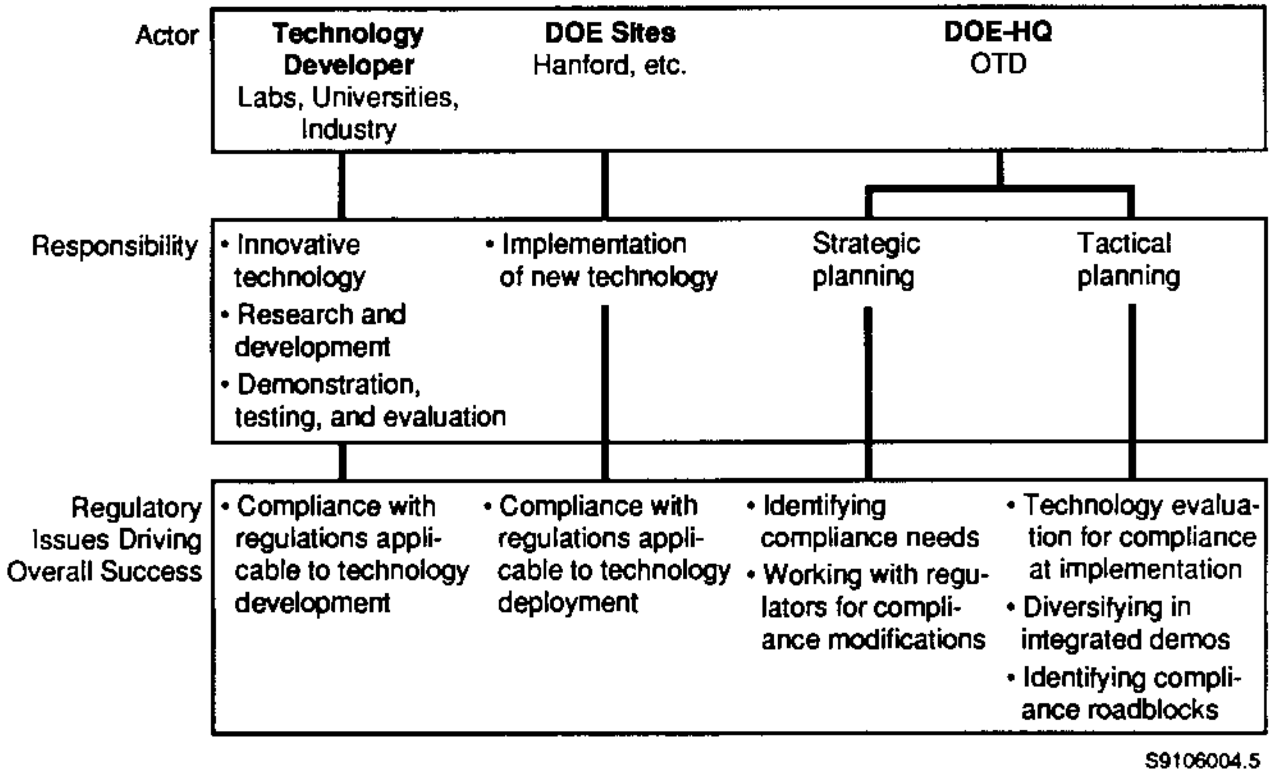


FIGURE I.2. Roles and Responsibilities of Technology Developers and Users

regulatory requirements, but simply to point out the differences between how regulatory issues affect implementation activities and decision making activities.

Technology developers such as national laboratories, universities, and industry work together to develop new technologies to meet DOE's environmental restoration and waste management needs. The primary regulatory requirements that affect the overall success of these activities are compliance with regulations specific to technology development activities. While compliance to environmental regulations in the technology development process is very important to the success of the RDDT&E program, this will have little impact on OTD since the primary responsibility for compliance lies with the technology developers.

The implementation sites are the second group of major actors in the RDDT&E program. These sites may also be involved in technology development, but during implementation, they will focus on complying with regulations for technologies that have been accepted and are being applied. The compliance issues once again will be the primary responsibility of the sites and will not have a significant impact on OTD program management activities. (However, lack of regulatory compliance at the site level could result in delays in technology application, which could in turn reflect on the perceived success of the RDDT&E program.)

The primary focus of OTD in the technology development process is on setting the direction of the program. As shown in Figure 1.2, this responsibility can be divided into strategic planning and tactical planning. Strategic planning is focused on developing the overall goal of the OTD program and is oriented toward the "big picture." Examples of strategic planning include deciding which problems are most important and which issues within the problems have highest priority. Tactical planning involves the more specific decisions of how to get to the goals and objectives defined by the strategic vision. Examples of these types of decisions include deciding which specific technologies to develop and how the technology development process will be carried out.

The regulatory issues that are major factors linked to strategic planning are related to understanding the DOE site needs and working toward modifying (where appropriate) the regulatory process for OTD-developed technologies. The compliance issues at various DOE sites must obviously be considered in setting the overall priorities and direction for OTD development activities. Also important is advance work with regulators aimed at streamlining the cleanup process and developing specific requirements for conducting RDDT&E activities and implementing the technologies that are developed.

Regulatory issues that are linked to the tactical planning side are related to ensuring that the technologies which are developed can be easily and quickly implemented when the RDDT&E process is completed. The regulations and DOE's ability to comply are key factors used in selecting technologies for development activities. In addition, technologies under development should be diversified where needed to minimize the risks that none of the technologies will comply with regulations. For example, components of different technologies can be integrated into demonstrations to provide an alternative path to regulatory compliance if problems develop with one component. Finally, the tactical planning with OTD should be aimed at identifying roadblocks to compliance for any of the technologies under development. This objective can be accomplished by an ongoing review program for each active technology to track the technical progress of the technology against the goals established in order to achieve regulatory compliance.

1.2.3 How Regulatory Issues Affect the Technology Development Process

Meeting regulatory constraints (e.g., administrative requirements, design criteria, performance criteria) will be an important part of the success of specific technologies that are developed under DOE sponsorship. Technology performance criteria will vary significantly depending upon the regulatory classification of the waste that is to be managed and upon the regulatory program in which the waste management and environmental restoration activity is to be conducted. Therefore, DOE must identify those regulatory requirements in the environmental restoration and waste management arena that can most significantly impact the ultimate implementation of the new technologies.

Regulatory compliance issues obviously will have a major effect on the RDDT&E program. Regulatory considerations will impact the program in at least three different but related ways. In general, these impacts can be characterized as 1) regulatory requirements that must be complied with as part of the technology development process; and 2) regulatory considerations related to the implementation of the technologies and 3) regulatory considerations that affect DOE's decision making in selecting which technologies are developed and in guiding the development process.

The regulatory analysis associated with technology development is relatively straightforward, although it may be time-consuming. It involves such questions as the need for and timing of various permits associated with the development and testing process and the availability of waivers and exceptions from the normal permitting processes. Because the regulatory issues in this area are usually very site- and technology-specific, a regulatory analysis should be performed for each technology development project that is funded. Regulatory analysis should be an ongoing effort to identify any requirements associated with the development of the specific technology. These requirements include issues such as obtaining R&D permits, complying with various reporting requirements, conducting appropriate reviews and submitting appropriate documentation under NEPA, and adhering to appropriate worker health and safety requirements and guidelines. In addition, other regulatory "overhead," such as the time and effort to maintain ongoing "informal" interaction with regulatory agencies, needs to be identified and understood.

The regulatory issues related to implementing the technology closely parallel those related to developing it. The principal concern here is to identify and comply with regulations pertaining to the implementation of the new technologies. These regulations will usually be very specific and, very likely, site-specific and will frequently depend upon individual state requirements and their interpretation by state agencies.

The analysis of regulatory issues associated with DOE's decision making in selecting technologies to pursue involves the highest degree of uncertainty. It involves the consideration of a number of factors, such as how regulatory requirements would impose a variety of barriers to the implementation of a proposed new technology. For example, a technology that generates a secondary hazardous waste stream may be less promising, from a regulatory point of view, than a technology that generates material that can be recycled. In addition, broader regulatory issues need to be addressed. These include issues such as whether it is advisable to make substantial investments in incineration technologies considering the current regulatory climate or whether bioremediation is wise to pursue considering possible constraints imposed by the land disposal requirements (LDR) of RCRA (bioremediation, in some circumstances, may not be the technology specified by the applicable LDRs).

Another issue is whether delays associated with regulatory requirements related to implementing an otherwise promising proposed technology would nonetheless make that technology unacceptable. For example, when evaluating two otherwise comparable but competing technology proposals, it will be very relevant to the RDDT&E decision makers that one of the technologies may face fewer regulatory hurdles before being implemented in the field. Factoring this sort of regulatory consideration into the RDDT&E decision-making process is vital to getting new technologies implemented into the field faster and cheaper.

In addition, other factors, such as requirements contained in legal agreements or an immediate need to address public or political concerns, may necessitate certain tradeoffs in the RDDT&E program. For example, the need to meet a milestone established in a federal facility agreement (FFA) may lead DOE to fund the development of acceptable, but less effective, technologies because they can be implemented in the field faster.

While all the types of regulatory considerations (referred to above) are obviously important to the success of DOE's RDDT&E program, the focus of this report is to identify regulations that may influence the selection and development of technology options. The report's focus is keyed to DOE-HQ's role in selecting technologies for development and application, as well as in evaluating the results of the RDDT&E projects. Incorporating regulatory considerations into the decision-making process is essential to ensure that the new technologies will be accepted by regulators and the public. In addition, developing technologies with regulatory constraints in mind will minimize unnecessary and avoidable delays to technology implementation. Of course, one other result of the timely consideration of regulatory issues is that less desirable technology development projects may be terminated at any time during the development cycle. Such cancellations should be an expected element of any technology development project.

A fundamental question is why does the RDDT&E program need to be concerned with the broad spectrum of regulatory issues beyond those requirements imposed as part of the technology development process. First and foremost, DOE has committed to carry out all of its activities in compliance with applicable environmental statutes and regulations. Accordingly, any technologies developed as part of the RDDT&E program will need to be implemented in accordance with the regulatory requirements. Incorporating these regulatory considerations into the decision-making process will allow DOE to anticipate and, therefore, address regulatory roadblocks at an early point and to prioritize technology development needs. The benefits of early and continuous identification and analysis of regulatory issues should be that regulatory "surprises" are prevented and that there are no untimely delays in implementing a given technology.

A scenario that DOE could avoid through appropriate planning is funding the development of a specific technology only to find that particular regulatory requirements either will block or significantly delay that technology's implementation. For example, DOE may fund a technology that can be used to treat radioactive hydraulic oils containing mercury. Under the LDRs of RCRA, incineration is the "best demonstrated available technology (BDAT)" to be used. The technology being funded by DOE does not involve incineration. After the expenditure of significant funds, it is discovered that the LDRs apply to this waste stream and that the technology under development is not the BDAT specified. If the new technology's performance does not equal that of incineration, the new technology is not likely to be implemented. Even if the new technology performed as well as incineration, DOE would still need to petition the EPA or the state for approval of that technology as an alternative treatment method. If the technology is approved, such a procedure is likely to take a considerable amount of time and to significantly delay the use of the new technology in the field.

Regulatory issues likely will impact emerging technologies differently depending upon their stage of development. In some cases the specific regulatory constraints will differ depending upon where a technology is in the development process (e.g., different permitting requirements related to demonstration and field testing of new technologies). Thus, the principal effort is to obtain an appropriate level of detail in information to enable decision makers to proceed with confidence through the RDDT&E stages.

For example, an issue relevant to the RDDT&E program may be whether there will be any air emissions from a proposed technology. Air emissions could raise serious regulatory questions that would impact the timeliness of the technology's implementation. Information needed to address this concern would include identifying any air emissions as well as the constituents of these emissions and their levels or amounts. This information would then be compared with existing or anticipated regulatory standards. As a technology moves through the RDDT&E process, more detailed information should be available. One would not expect to have detailed information on constituent levels at the R&D stage and would be willing to proceed with the project in its absence. However, these data should be available after field testing.

1.3 SCOPE

This report reviews statutory and regulatory issues related to the selection, development, and application of new technologies under DOE's RDDT&E program. The major regulatory areas reviewed in this report include the requirements under RCRA, CERCLA, NEPA, and other related federal and state regulatory schemes. State laws are especially relevant in the regulation of hazardous wastes because RCRA is essentially a federally authorized, state-administered statute. In addition, many states have their own "mini-Superfund" statutes that are applicable to the federal government.

1.4 CONTENTS

This report is organized according to regulatory issues related to each major statutory area. Chapter 2 gives an overview of RCRA's hazardous and mixed (radioactive and hazardous) waste regulations as they relate to waste management technology development. Chapter 3 outlines how CERCLA regulates technology development activities. Chapter 4 describes other relevant federal environmental regulatory programs. Chapter 5 briefly discusses applicable state requirements.

2.0 RESOURCE CONSERVATION AND RECOVERY ACT

Federal regulation of solid and hazardous waste, which previously had been viewed as an entirely state and local issue, had its beginnings with the passage of the original Solid Waste Disposal Act, which Congress enacted as a stand-alone Title II attached to the Clean Air Act of 1965. This initial effort at federal leadership in solid waste issues dealt primarily with providing minimum federal criteria for municipal solid waste management.

The first major amendments to the Solid Waste Disposal Act were passed as RCRA. RCRA created statutory definitions of solid waste and hazardous waste and established a "cradle-to-grave" system to control the treatment, storage, and disposal (TSD) of hazardous waste. Control of nonhazardous solid waste remained primarily the states' purview. In the case of hazardous waste oversight, however, RCRA authorizes the lead role only to states that demonstrate that their regulatory structure is at least as stringent as the federal program and then only under the supervision of EPA. Over 40 states currently have been delegated RCRA hazardous waste authority. The federal government is generally subject to RCRA requirements, whether administered by EPA or the states.

Because it established the first substantial federal solid waste regulatory authorities, RCRA now is commonly used as an acronym for the body of law technically known as the Solid Waste Disposal Act, as amended. Major revisions to RCRA were enacted as the Hazardous and Solid Waste Amendments of 1984 (HSWA), and additional RCRA amendments are likely to pass Congress in the 1991-1992 session. The distinctions between solid waste, hazardous waste, and non-waste material are extremely important in determining the cost-effectiveness of specific RDDT&E technology proposals.[a]

(a) For example, assume Technology "A" is capable of treating 100 barrels of regulated hazardous waste and converting 90 barrels of the original waste into commercially sellable product, while leaving 10 barrels of residual waste to be further treated and landfilled. Not including operating costs, use of Technology "A" could reduce remaining waste management costs by 90% and provide revenue from a product sold (assuming the new residual waste is not more expensive to manage than the original waste).

RCRA can affect waste management and environmental restoration technology development priorities in at least two ways. First, as will be discussed in Section 2.2, RCRA requires that specific categories of hazardous waste be pretreated before the waste can be landfilled. Thus, while it may be technically feasible to treat a large variety of wastes with a particular experimental technology, RCRA requirements must first be examined to determine whether the experimental technology in question would satisfy the applicable standards for each potentially treatable waste category. Second, permits and/or exemptions will be required before large-scale testing with wastes to demonstrate and evaluate technologies can begin and before the technology can be implemented.

To better understand the implications of RCRA on the RDDT&E program, the most important relevant provisions of the 1976 RCRA statute will be outlined, followed by highlights of the major changes brought about by HSWA and, finally, by issues likely to be addressed in RCRA reauthorization. Because HSWA introduced an important new jurisdictional distinction between EPA and RCRA-authorized states, it is helpful to present RCRA and HSWA provisions separately and then describe how they interrelate.

2.1 RELEVANT PROVISIONS OF THE RESOURCE CONSERVATION AND RECOVERY ACT OF 1976

To be regulated as a hazardous waste, a material must first fall under the definition of a solid waste [42 USC 6903(27) and 40 CFR 261.2]. Contrary to common usage of the term, the legal definition of "solid waste" under RCRA includes certain wastewaters, sludges, slurries and containerized gases.[a] Because the costs of managing hazardous waste are substantial, there has been considerable controversy about the circumstances under which a material becomes a waste, versus a commodity, a by-product, or other non-waste material.[b] The result of court rulings is that EPA has been granted broad jurisdiction to regulate secondary materials and by-products of hazardous wastes. Generally speaking, any material that is abandoned, discarded or

(a) Congress created this apparent non sequitur because of its intent to use the RCRA statute to fill remaining gaps in environmental law after the passage of the Clean Water Act and the Clean Air Act.
(b) See 40 CFR 261.1,.2,.4 and American Mining Congress v. EPA, 824 F.2d 1177, (D.C. Cir. 1987).

recycled is legally defined as solid waste, unless the material is directly reinserted into the same manufacturing process in which it was generated. Certain types of materials are specifically excluded from the definition of solid waste, including waste water that is sewered or discharged pursuant to a Clean Water Act permit and source, special nuclear, or byproduct material, as defined by the Atomic Energy Act.

A solid waste may also be considered a hazardous waste if it either exhibits a hazardous waste characteristic or is listed by the EPA (RCRA 3001 and 40 CFR 261.3). Regulation of hazardous waste, which is extensive, is governed by Subtitle C of RCRA. Federal requirements (Subtitle D of RCRA) currently in place for the regulation of nonhazardous solid waste are minimal. The procedural and administrative costs of managing regulated hazardous waste, either before or after the application of RDDT&E technology, are generally at least ten times the cost of managing a nonhazardous solid waste.

Current characteristics used to define hazardous waste are corrosivity, ignitability, reactivity and toxicity (40 CFR 261 Subpart C). Some examples are the following:

- Most liquid wastes with a flash point greater than 60°C (140°F) are ignitable hazardous wastes and have an EPA Hazardous Waste Number of D001.
- An aqueous waste with a pH under 2 or over 12.5 would be D002 corrosive hazardous waste.
- A waste material that reacts violently with water would be D003 reactive hazardous waste.

Effective September 25, 1990, the toxicity characteristic is defined by the Toxicity Characteristic Leachate Procedure (TCLP), a laboratory method for evaluating the mobility of 8 heavy metals and 31 organic compounds in waste (40 CFR 261 Appendix II, final regulations published on March 29, 1990, 55 FR 11798-11877).

40 CFR 261 Subpart D establishes three types of listed hazardous wastes: specific sources (e.g., K083 - distillation bottoms from aniline production), nonspecific sources (e.g., F007 - spent cyanide bath solutions from electroplating operations), or discarded or off-specification commercial chemical

products (e.g., P015 - Beryllium and U051 - Creosote). Listed "P" series wastes are considered acutely hazardous waste and have an accumulation limit (small quantity generator, discussed below) of 1 kilogram (kg) per month, as opposed to 100 kg per month for any other hazardous waste.

Any material that is mixed with or derived from a listed hazardous waste is also deemed to be a hazardous waste unless it is "delisted."[a] As a practical matter, this "mixture and derived-from rule" severely limits options for reusing treatment residues generated from listed hazardous waste. Generally speaking, however, once a material is incorporated into a product sold in commerce (and that product can be used without further reclamation as an effective substitute for a virgin material), as long as it is not burned or applied to the ground, it is no longer a solid waste and, therefore, no longer hazardous waste [40 CFR 261.3(c)(2)(i)].

Most RCRA TSD permit requirements are designed to prevent releases of waste constituents onto the land. As discussed in Chapter 5, the Clean Water Act and the Clean Air Act are the primary means of controlling releases to the water and air, respectively. There are two significant exceptions, however, where RCRA permitting requirements apply directly to releases to the air. 40 CFR 264 Subpart O establishes requirements for air emissions from hazardous waste incinerators.[b] 40 CFR Subpart AA and Subpart BB establish limits on the release of volatile organic compounds from certain types of waste treatment technologies.[c]

(a) Procedures for facility-specific exclusions of waste streams from a hazardous waste listing are found in 40 CFR 260.22. Requirements for such delisting petitions are extensive, and a final ruling from EPA can take years.

(b) Incinerators must be constructed and maintained to destroy or physically remove 99.99% (or 99.9999% for dioxin wastes) of each "principal organic hazardous constituent" in the input stream. Additional limits apply to particulate emissions and hydrochloric acid.

(c) If a feed stream to distillation, factionalization, thin-film evaporation, solvent extraction, or air or stream stripping operations exceeds 10 ppm organics, process vent emissions standards from 40 CFR 264 Subpart AA may apply. Subpart BB standards for equipment leaks apply if organics exceed 10% by weight.

Any person or organization that generates more than 100 kg per month of hazardous waste (or more than 1 kg per month of acutely hazardous waste) at a facility must obtain an EPA identification number (ID) for that facility (40 CFR 262.12). Any such generator who produces less than 1000 kg of hazardous waste per month is considered a conditionally exempt small-quantity generator and is subject to streamlined requirements (40 CFR 261.5). Most DOE sites will not qualify for small generator status because waste generation must be aggregated across an entire facility when applying the 1000-kg-per-month limit.

A hazardous waste generator may store waste onsite for up to 90 days, provided certain conditions are met (40 CFR 262.34). Any other treatment, storage, or disposal of hazardous waste requires a permit, as depicted in Figure 2.1. Offsite shipments of waste must be accompanied by a signed "manifest" tracking form. Extensive regulations apply to owners and operators with an interim status TSD permit (40 CFR 265) (a so-called "Part A" permit) and to those with a final "Part B" permit (40 CFR 264 Subpart H).

The process of acquiring a "Part B" TSD permit can cost several hundred thousand dollars; typically, it takes 2 to 5 years to prepare and obtain approval for a fully operational facility. Also, permit writers naturally tend to apply more scrutiny to permit applications that involve use of emerging technology because it has not yet been proven safe and effective. This tendency can create a significant barrier to the development and diffusion of innovative technologies. However, several permitting innovations, discussed below and summarized in Table 2.1, allow exemptions and variations for special circumstances. The applicability of these permitting options to specific RDDT&E technologies can have significant impacts on technology implementation timetables.

2.1.1 Sample Exclusion

Hazardous waste samples may be sent for composition analysis to a laboratory without a TSD permit, provided the laboratory meets certain conditions [40 CFR 261.4(d)].

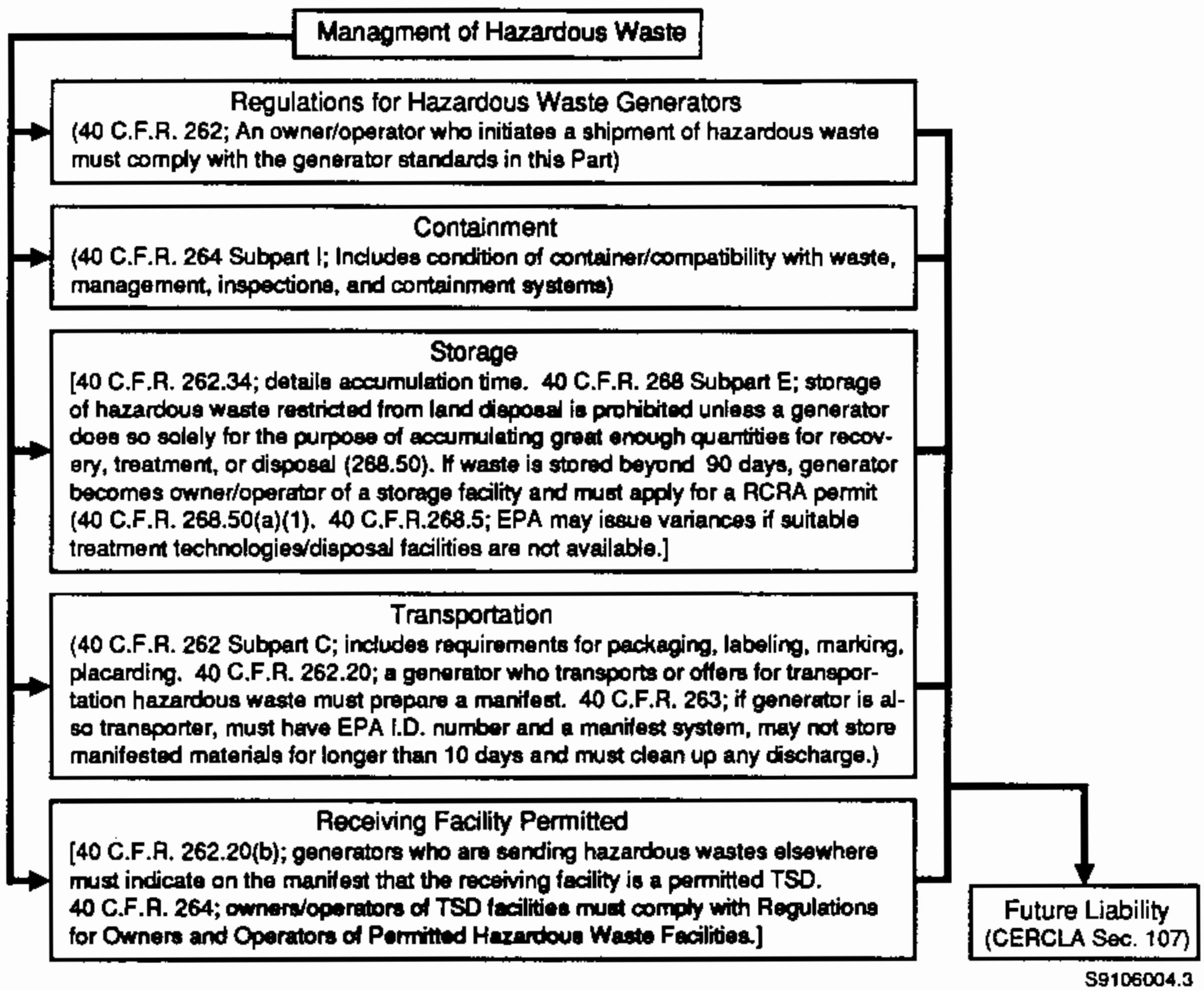


FIGURE 2.1. Management of Hazardous Waste

2.1.2 Treatability Exemption

Certain types of low-volume waste treatability studies may also be exempted from federal permitting requirements [40 CFR 261.4(e)]. This change in the federal permitting program is a relatively recent change, promulgated on June 19, 1988. Because the program is considered "less stringent" than the pre-existing TSD permitting program, states are not required to adopt it in order to retain RCRA authorization, and few have done so (Washington State is one notable exception).

TABLE 2.1. Summary of RCRA Permitting Innovations

Innovation	Purpose	Status	Regulatory Classification and Applicability
Sample exclusion	Waste characterization	Final	Component of base TSD permitting
Treatability studies	Technology testing	Final	Non-HSWA; in effect in non-authorized states; optional in RCRA-authorized states
RD&D permits	Technology demonstration	Final	HSWA provision, less stringent than base; optional in HSWA-authorized states
Permit modification	Streamlined permit revisions	Final	Non-HSWA; in effect in non-authorized states; optional in RCRA-authorized states
Subpart X	Permit miscellaneous technologies	Final	Non-HSWA, broader than base, states must adopt
Mobile treatment units	Transferrable permit	Proposed	Non-HSWA; in effect in non-authorized states; optional in RCRA-authorized states
Subpart Y	Permit multiple experiments	Conceptual	Non-HSWA; in effect in non-authorized states; optional in RCRA-authorized states

In states that have adopted the treatability exemption (and states without RCRA authorization, where the EPA regional office is responsible for permitting), waste samples undergoing treatability studies are exempt from regulation if the testing facility, including a mobile treatment unit, meets all of the following requirements:

- notifies EPA or the state at least 45 days before conducting tests
- has an EPA ID number
- receives no more than 250 kg per day of waste
- does not store more than 1 kg of acutely hazardous waste, 500 kg of contaminated soil or water, or 1000 kg total hazardous waste (not including testing residue) at any given time

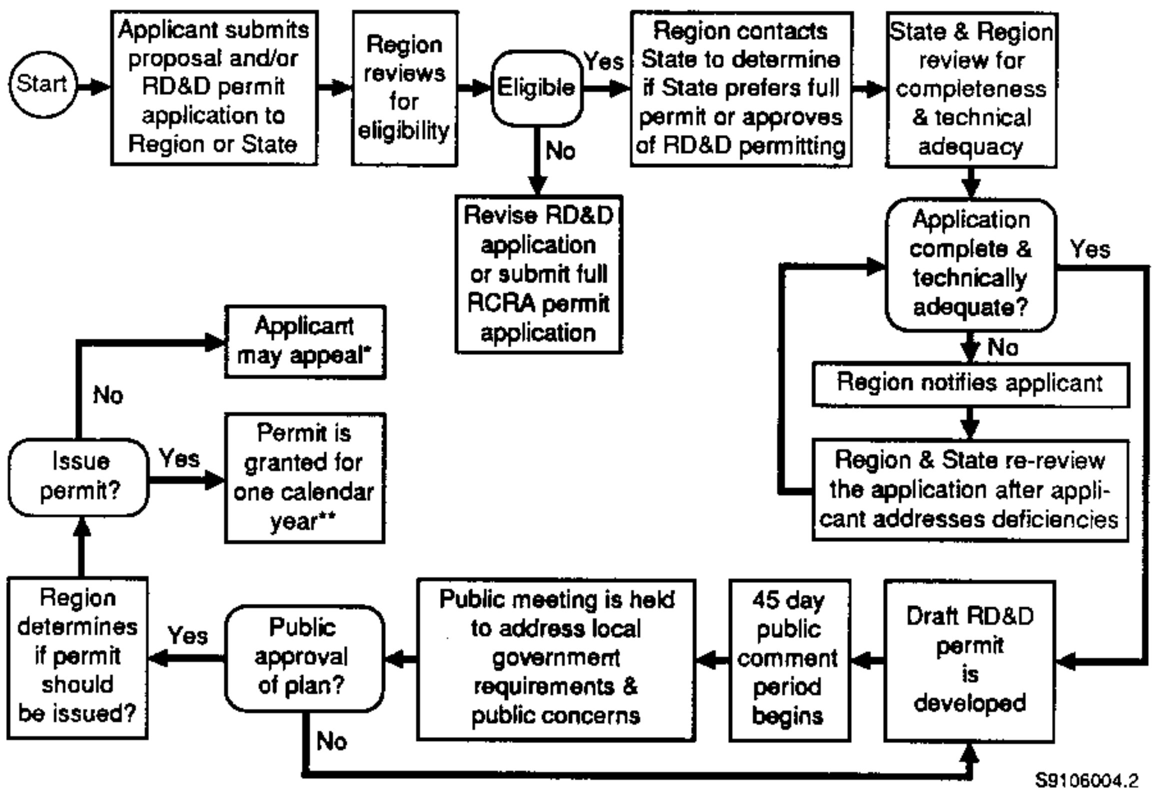
- returns waste and residue from studies to generator within specified time limits
- does not engage in open burning or land placement of waste
- maintains certain records for 3 years, reports certain information annually, and informs EPA or the state when it plans to stop testing at the site.

2.1.3 Research, Development and Demonstration Permits

Facilities that would exceed any of the above criteria and that anticipate numerous treatability studies can apply for a research, development and demonstration (RD&D) permit (42 USC 6925(g) and 40 CFR 270.65). EPA developed RD&D permits specifically to streamline the permitting process for innovative and experimental technologies for which permit standards (e.g., performance specifications) do not yet exist. See Figure 2.2 for a flow diagram of the RD&D permitting process (EPA 1986). Again, this is a discretionary permitting innovation in RCRA-authorized states and has not been widely adopted.[a] During the first 3 years in which RD&D permits were available, EPA had issued 13 permits out of 39 applications it had received.

Technologies at any point in the RDDT&E process would be eligible to apply for an RD&D permit. Such a permit would be valid for one year, with up to three 1-year renewals, and would limit waste receipts to the quantity needed to demonstrate technology performance. EPA or the authorized state can establish any requirements deemed necessary to protect human health and the environment, but the permitting process requires public participation and a showing of financial responsibility. To expedite processing, applicants are

(a) Although EPA was developing the RD&D permitting process before the passage of HSWA, the process has its first explicit statutory basis in HSWA. As will be elaborated later, like other HSWA-based provisions, RD&D permitting technically took effect nationwide upon promulgation of the regulations. However, because the RD&D permitting process is less stringent than the base TSD permitting program, state adoption is optional. EPA can issue RD&D permits in any state until EPA approves of equivalent provisions adopted by the state. Practically speaking, however, many states have more stringent requirements, which preclude the operation of a facility under a federal RD&D permit.



* Appeal procedures are outlined in 40 CFR part 124

** Permit may be renewed for up to three calendar years

FIGURE 2.2. Processing of Research, Development and Demonstration Permits

encouraged to submit a notice of intent summarizing anticipated research before preparing the RD&D permit applications. Experience with the RD&D permitting program is limited, but EPA regional officials estimate that their processing typically takes 12 to 18 months, compared with 2 to 5 years for a traditional TSD permit (EPA 1990).

2.1.4 Permit Modification Rule

Simplifications to the permit modification process were promulgated by EPA on September 28, 1988 (40 CFR 270.41 and 270.42). This rule simplifies the process of incorporating innovative treatment processes at facilities with existing TSD permits, but again is considered less stringent than the base program and is only available in a few states.

2.1.5 Subpart X

On December 11, 1987, EPA added a new Subpart X to 40 CFR 264 to establish standards for miscellaneous units not covered by other TSD-permitting standards. By setting generic standards for nonconventional units, EPA hoped to create a better-defined framework for processing TSD permits for innovative technology. However, these technologies must still receive a full Part B permit and, thus, encounter the time and expense involved in that permitting process. Additionally, EPA has had little experience preparing Subpart X permits, and most authorized states have yet to promulgate regulations for Subpart X. Significant time delays can be expected if RDDT&E technologies are to acquire Subpart X permits.

2.1.6 Mobile Treatment Units

EPA published a proposed rule on June 3, 1987, that would have simplified permitting procedures for transportable treatment technologies. Under existing procedures, mobile treatment units must undergo a full Part B permitting process at every operating location. As will be discussed in Chapter 4, this effectively limits the attractiveness of mobile technologies to CERCLA onsite cleanups where RCRA permits are not required. Publication of a final rule apparently has fallen low on EPA's list of priorities.

2.1.7 Subpart Y

When EPA issued its treatability study regulations on July 18, 1988, it stated an intent to develop a new Subpart Y to 40 CFR 264 to establish permitting standards for experimental facilities that test multiple types of waste treatment technologies. EPA has not yet proposed a rule in this area.

2.2 RELEVANT PROVISIONS OF THE HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

The three most significant changes to the federal hazardous waste program established by the HSWA are

- certification that all hazardous waste generators have a waste minimization program in place
- creation of a land disposal restrictions program to require pretreatment of hazardous waste prior to land disposal

- establishment of requirements for corrective action to clean up contamination from past practices at TSD-permitted facilities.

The first of these, waste minimization, has yet to advance much beyond the policy statement phase. However, as will be discussed later, stronger provisions implementing waste minimization are likely in the next round of RCRA reauthorization.

In authorizing the substantial expansion of hazardous waste regulatory authority created by HSWA, Congress realized that states would require substantial time to pass conforming legislation and regulations that would enable them to accept authority for the new HSWA part of the federal program. To avoid jeopardizing the operation of existing hazardous waste programs in RCRA-authorized states, HSWA established a dual implementation scheme: HSWA mandates would be effective immediately and would be enforceable by EPA, while RCRA-authorized states would retain their authorizations for pre-HSWA programs and would be placed on a schedule to receive authorization for the new HSWA provisions. This new dual implementation arrangement created dual permitting requirements in authorized states at facilities subject to new HSWA programs, such as corrective action.

2.2.1 Waste Minimization

HSWA establishes a national policy of waste minimization (42 USC 6902). HSWA requires the following:

- generators show certifications on every hazardous waste manifest form that a waste minimization program is in place [42 USC 6922(b)]
- TSD permit holders make a similar waste minimization certification annually [42 USC 6925(h)]
- EPA submits a report to Congress on waste minimization.

The term "waste minimization" was not defined by Congress, which predictably resulted in considerable semantic debate during the years following HSWA's passage. "Pollution prevention," a term closely related to waste minimization, has also recently come into vogue.

For the purposes of this report, waste minimization will be considered a subset of pollution prevention. Both terms refer to source reduction and recycling of pollutants; waste minimization being limited in scope to RCRA hazardous waste. Pollution prevention is inclusive of all types of environmental pollution. As shown in Figure 2.3, waste minimization techniques include product changes, raw material substitution, process enhancements, operating practices improvements, onsite or offsite recycling, and burning for energy recovery. Some would prefer to exclude offsite recycling and/or any recycling involving combustion (OTA 1986).

Support for waste minimization activities, including development of innovative technology, is available from several sources at EPA, as well as several state waste reduction technical assistance programs (EPA 1987, 54 FR 3845-3847).

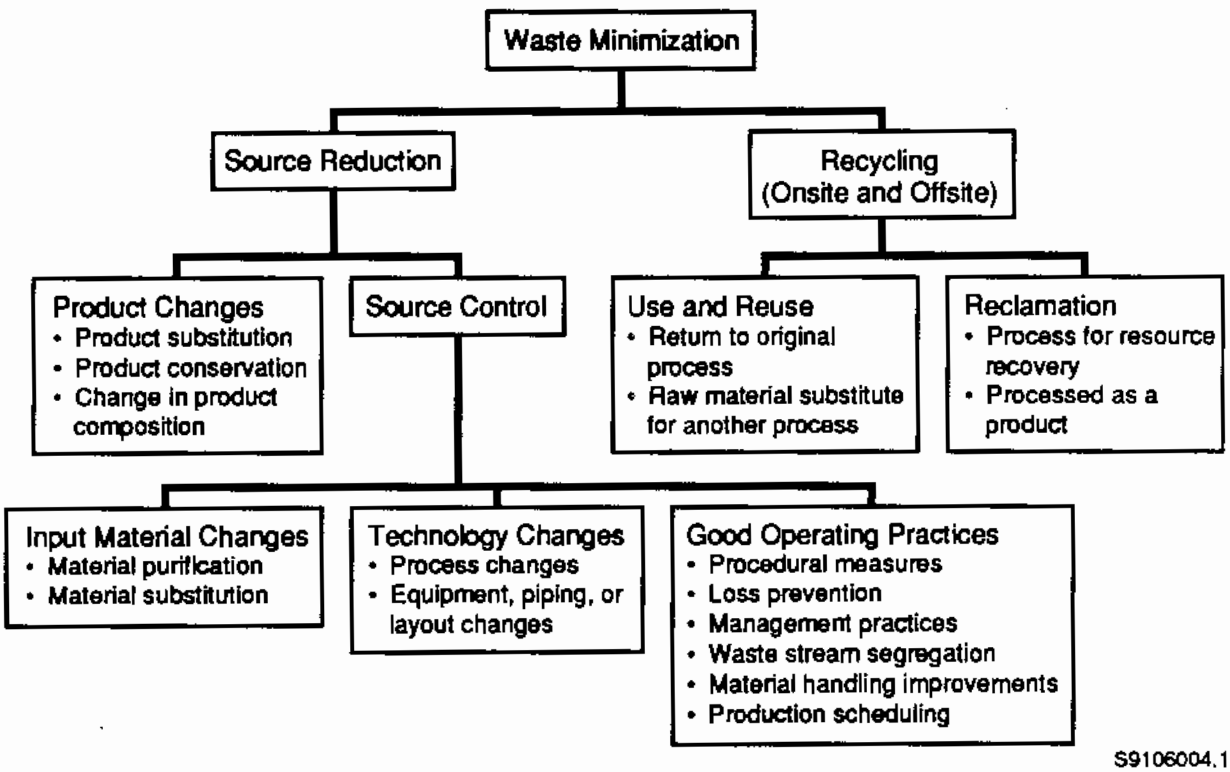


FIGURE 2.3. Waste Minimization Techniques

2.2.2 Land Disposal Restrictions

Because of concern about continuing problems at currently operating hazardous waste land disposal facilities, as part of HSWA, Congress instructed the EPA to establish the LDR program. EPA promulgated LDR regulations in five parts: the first two established by HSWA, and the last three (the so-called First-Third Wastes, Second-Third Wastes, and Third-Third Wastes) based on EPA's assessment of toxicity and volume of hazardous waste generated.[a] LDR treatment standards apply to hazardous wastes that are land disposed, including those injected into deep wells, or placed in surface impoundments, waste piles, land treatment facilities, salt dome formations, underground mines or caves, or any enclosure intended for disposal purposes. The hazardous wastes restricted from land disposal (essentially all regulated hazardous wastes) are listed in 40 CFR 268.

LDR standards are extremely important to the RDDT&E program because they define the regulatorily acceptable parameters for treatment of hazardous waste. Each of the LDR regulations establishes BDAT standards for treatment of specific categories of hazardous waste (40 CFR 268 Subpart D). EPA developed BDAT treatment standards, either as specific technologies or as performance standards. Specific technologies are used when data are inadequate to set concentration levels or when it is determined that one method

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(a)
1. Solvents and dioxins (November 8, 1986)
2. "California List" Wastes (July 8, 1987)--liquid and non-liquid hazardous wastes containing halogenated organic compounds above 1,000 ppm and liquid hazardous wastes containing polychlorinated biphenyls above 50 ppm, certain toxic metals above specified statutory concentrations, and corrosive liquid wastes that have a pH level below two.
3. First Third Wastes (August 8, 1988)--183 of the "worst" hazardous wastes, including some of the F-,K-, P-, and U-coded wastes
4. Second Third Wastes (June 8, 1989)--67 additional wastes and the remainder of the F-coded wastes
5. Third Wastes (May 8, 1990)--344 wastes, 5 newly listed wastes and all characteristic wastes.

is the appropriate way to manage the waste. When the treatment standard is set in this way, the specific technology must be used. When standards are based on performance levels, any permissible technology may be used to meet the treatment standard.[a]

Treatability variances may be granted by the EPA if the standard cannot be achieved because unique properties of the waste interfere with treatability. Petitioners must demonstrate that the waste is significantly different from that used by EPA in establishing standards and cannot be treated to the desired level or by the method specified by the treatment standard or that the specified standard or treatment is inappropriate to the waste (51 FR 40605). EPA has stated that the minimum amount of time to approve treatability variances is 6 months.[b] Given the technical complexity of these variances it is unlikely that EPA will be able to process them in less than 18 months.

Hazardous wastes that are restricted from land disposal may be treated in a surface impoundment provided it meets certain technological requirements [40 CFR 268.4(a)(3)]. The treatment residuals that do not meet treatment standards (or statutory prohibition levels if treatment standards do not exist) must be removed within 1 year of entry and cannot be placed into another surface impoundment.

If a petitioner can demonstrate that hazardous waste will not migrate from a disposal unit or an underground injection for as long as the waste is

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(a) In the cases where EPA established BDAT as a specific technology, it effectively created substantial barriers to technology innovation by making different, innovative treatment technologies subject to special variance procedures before a new waste treatment approach can be applied. For example, the BDAT for mixed waste containing elemental mercury is amalgamation with zinc, copper, nickel, gold or sulfur to reduce leachability. If an RDDT&E technology were developed that performed better technically than amalgamation (hypothetically a new glassification or polymerization process), a variance would still be required before the new process could be used in lieu of the amalgamation BDAT.

(b) Telephone conversion August 13, 1990, with Jim Berlow, U.S. EPA, Office of Solid Waste, Washington, D.C.

hazardous, the EPA may grant an exemption and allow the land disposal of a restricted hazardous waste that does not meet the treatment standard [40 CFR 268.6(h)]. For injected wastes, the demonstration must consist of either flow and transport models or geochemical modeling (40 CFR 148.20).

To provide industry with the time needed to comply with new regulations, EPA can grant, at a minimum, a 3-month national capacity variance for all affected wastes. During the period of variance, wastes that are placed in a landfill or into surface impoundments that do not meet the treatment standards must be disposed of in a way that meets the requirements of Section 3004(o) of RCRA (minimum technological requirements), as well as the record-keeping requirements of 40 CFR 268.7. If they do meet the treatment standards, these wastes can be disposed of in a Subtitle C landfill or a surface impoundment regardless of whether either one meets minimum technological requirements (55 FR 22526).

DOE encounters unique problems when attempting to comply with the LDR program because of the significant quantities of "mixed waste" (i.e., hazardous waste that is also radioactive) that it must manage. Mixed waste is not only subject to RCRA but also to the AEA. This dual regulatory scheme applies regardless of the type of radioactive constituents in the mixed waste and creates challenging compliance issues. In situations where mandated BDAT is inappropriate because of the radioactive hazard of a mixed waste (i.e., requires a different technology design), DOE would have to file for a site-specific variance from the promulgated standard. If EPA then granted the variance, the specified alternative treatment standards would have to be met before land disposal of the mixed waste.

Although EPA concluded that national capacity was lacking, it established technology-based BDAT standards[a] for all mixed waste in the May 8, 1990, Third-Third Rule (40 CFR 268.42, Table 3). Mixed waste was divided into three categories: low level, transuranic, and high level. Mixed waste that does not fall within a specific treatability group established by EPA remains subject to the applicable treatment requirements for the hazardous component of the waste.

As part of its May 8, 1990, LDR rule making, EPA granted a national 2-year capacity variance for radioactive waste mixed with First-, Second- or Third-Third Waste. No variance was granted for radioactive waste mixed with solvents and dioxins or California-List Waste. Most mixed waste is now in storage. There currently are no land disposal facilities in the United States

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(a) The following mixed wastes must be treated using the technologies specified in the BDAT standards:

Low-level, metal-containing waste and the low-level fraction separated from high-level waste: chemical precipitation of metals in waste water and grout stabilization of metals (in waste water sludges or non-waste waters) to reduce leachability

Organic low-level waste: incineration, except carbon absorption where incineration of waste water is impractical

High-level waste and TRU waste with considerable radioactive components: high-level vitrification in compliance with relevant NRC radioactive protection requirements

Radioactive mixed-waste solids containing elemental lead: microencapsulation with polymeric organics or a jacket of inorganic material (pretreatment, such as surface decontamination, is not precluded)

Mixed waste containing elemental mercury: amalgamation with zinc, copper, nickel, gold or sulfur to reduce leachability

Radioactive hydraulic oils containing mercury: incineration.

licensed under both RCRA and the AEA. Because RCRA prohibits storage of a waste subject to LDR,[(a)] EPA must still address the continued storage of mixed waste for which a capacity variance has not been granted.

Obviously, development of mixed waste land disposal, waste minimization, and treatment capacity is of utmost importance to DOE. Unless EPA approves extended storage, DOE may have no options which achieve compliance with RCRA because of the lack of permitted disposal facilities.

2.2.3 Corrective Action

As mentioned earlier, the third major change HSWA created in the federal hazardous waste program is the requirement for corrective action to clean up contamination caused by past releases at TSD-permitted facilities [42 USC 6924 (u), (v), and 6928(h)]. On July 27, 1990, EPA published proposed regulations implementing corrective action requirements (55 FR 30798).

Until EPA finalizes its regulations, the criteria for conducting corrective action activities at individual TSD facilities will continue to be negotiated on a case-by-case basis. EPA has, however, published guidance on the steps generally required to meet corrective action obligations at contaminated sites (EPA 1988b and EPA 1988c). Figure 2.4 compares the steps of the current RCRA corrective action process with analogous phases of the CERCLA remediation program (discussed in more detail in Chapter 3).

Several significant controversies were raised in EPA's proposed corrective action rule, making it likely that a final regulation will not be promulgated before 1992. Among the most significant controversies of relevance to the RDDT&E process are the following:

- How much hazardous waste must be present in a contaminated material before it is considered to be hazardous waste?

(a) Storage of prohibited wastes in tanks and containers is prohibited except where storage is solely for the purpose of accumulating sufficient quantities of wastes to facilitate proper treatment, recovery or disposal. In that case, the facility, under burden of proof, may store the waste for up to 1 year. A conflict exists for wastes granted 2-year capacity variances, but which cannot be stored beyond 1 year.

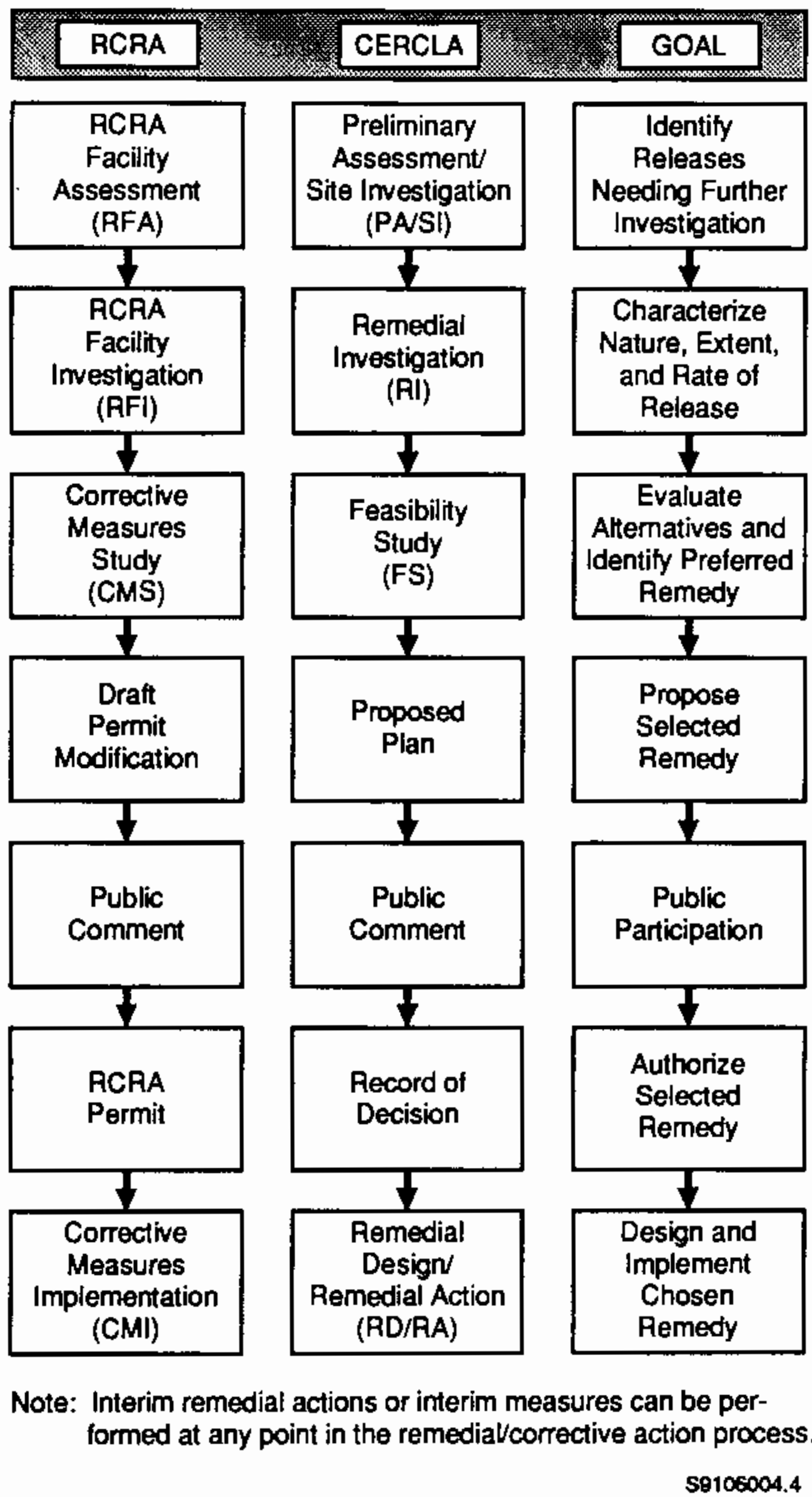

FIGURE 2.4. Comparison of RCRA Corrective Action and CERCLA RI/FS Processes

- Under what circumstances can hazardous waste be managed in place without triggering LDR requirements?
- What point of measurement and which criteria must be met in order to comply with the corrective action compliance?

2.3 ISSUES LIKELY TO ARISE IN RCRA REAUTHORIZATION

As the general public's level of concern about environmental quality has increased over the last several years, so has the interest in Congress in passing dramatic new environmental legislation. RCRA reauthorization bills currently being considered in Congress would increase waste minimization activities and reporting, expand the definition of hazardous waste, restrict dilution of hazardous waste, authorize citizens to petition federal agencies to reduce waste generated, and establish corrective action deadlines and expand its coverage. These issues are outlined in the following subsections.

2.3.1 Waste Minimization

Annual waste minimization audits and reporting of progress in reducing the quantity and toxicity of wastes generated could be required. This requirement would substantially increase pressure on DOE to deploy new RDDT&E technologies which help achieve annual waste minimization goals. Producers of commodities such as lubricating oil are likely to be given financial incentives to ensure that downstream users of their products achieve specified recycling efficiencies. Such a procedure departs from traditional environmental legislation in two ways. First, it would employ market incentives, rather than technology specifications, to achieve desired environmental results. Second, it places responsibility on product manufacturers for the actions of downstream product users.

2.3.2 Hazardous Waste Definition

The number of constituents that would render a waste hazardous could increase tenfold and a waste could be hazardous because of total concentrations of constituents, as well as because of the leachable fraction. This would greatly increase the amount of waste that must be managed as hazardous, but it would pave the way for simplified concentration-based delistings and the potential elimination of the hazardous waste listing program.

2.3.3 Dilution Restriction

There is significant pressure on Congress to restrict dilution and to tighten BDAT levels for characteristic hazardous wastes.

2.3.4 Citizen Petitions

Citizens could petition federal agencies to take actions to reduce waste generated and to procure materials with recycled content. Responses to such petitions would have to be published in the Federal Register.

2.3.5 Corrective Action

Corrective action could be expanded to all hazardous waste generators, not just those at permitted TSD facilities, and EPA could be subject to rapid implementation deadlines and "hammer" provisions if it misses any deadlines. Congress also is likely to establish more specific corrective action cleanup standards, effectively reducing the number of technical options available for cleanup of contaminated sites. These potential requirements increase the urgency of demonstrating the promise of new clean-up technologies to convince Congress to allow enough flexibility in corrective action to accommodate technical innovation.

3.0 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

CERCLA is the second major environmental law addressing hazardous waste that could have major impacts on technology development and application under the RDDT&E program. CERCLA generally does not directly establish clean-up or technology performance standards, but instead provides the framework for the application of standards established in other federal and state statutes and regulations.

3.1 OVERVIEW

Congress passed CERCLA in 1980 in response to the public outcry regarding a number of abandoned hazardous waste sites, such as Love Canal, that appeared to present serious and imminent threats to human health and the environment. CERCLA is intended to address the cleanup of abandoned or inactive sites containing hazardous substances. Unlike RCRA, CERCLA is generally administered by EPA, rather than by the states. Public and congressional dissatisfaction with the implementation of CERCLA and the pace of site cleanups led to the passage of the Superfund Amendments and Reauthorization Act (SARA) in 1986. Among other things, SARA expanded EPA's enforcement authorities, made CERCLA clearly applicable to federal facilities, and added new health-related responsibilities.

CERCLA is a liability-based statute, in that those responsible for the hazardous substances at a site are also responsible for the cost of cleaning up the site. A potentially responsible party (PRP) could include the original generator(s) of the waste, the parties who transported it to the site, and the site owner(s).

CERCLA established a fund of money to pay for the cleanup of sites for which no PRPs can be identified. However, these monies are not available for the remediation of federal facilities. Generally, federal agencies must use their own appropriated funds to pay for the remediation of sites for which they are responsible.

CERCLA generally does not establish specific cleanup levels or technology requirements, but references other environmental statutes, regulations, and guidance documents to determine specific remediation levels. These levels are referred to as applicable or relevant and appropriate requirements (ARARs) and will be discussed in greater detail below. The clean-up levels required under different chemical-specific ARARs and performance standards required under different action- and location-specific ARARs, especially when aggregated on a national level, need to be considered during the development of technologies intended to address CERCLA sites. In addition, the statutory preferences expressed in CERCLA, such as for permanent treatments and onsite remediation, may also influence the RDDT&E program.

Generally, CERCLA expresses a clear preference for site remedies that permanently treat wastes onsite by reducing their mobility, volume, or toxicity. Onsite remediation is preferred because it discourages a "shell game" of simply shifting wastes from one location to another, as well as from one regulatory scheme to another.

Federal agencies are subject to the requirements of CERCLA and must comply with relevant state laws relating to hazardous waste cleanups. In addition, cleanup criteria selected for a federal facility must be consistent with EPA's standards for private sites.

3.2 NATIONAL CONTINGENCY PLAN

The National Contingency Plan (NCP) (40 CFR 300) contains EPA's procedures for implementing CERCLA. It outlines the framework for investigating a contaminated site, evaluating cleanup alternatives, and selecting a remedy.

Under this framework, once potentially hazardous sites are identified, EPA conducts a preliminary assessment and site investigation (PA/SI) at the site. EPA uses the information gathered during the PA/SI to score a site under the Hazard Ranking System (HRS). If a site scores high enough, it is placed on the National Priorities List (NPL), which was established to prioritize remediation at those sites posing the greatest threats to human health and the environment. Once on the NPL, a site is further characterized and remediation alternatives identified during the remedial investigation and feasibility study (RI/FS). The final remediation decision is set forth in the record of decision (ROD). Actual clean-up efforts are designed and implemented during the remedial design and remedial action (RD/RA) phase. Few of the DOE sites have moved beyond the RI/FS stage.

Normally, EPA is the lead regulatory agency for DOE sites undergoing CERCLA remediation, which means that all final regulatory approvals rest with EPA. DOE is usually responsible for conducting the RI/FS and implementing remedies for its sites.

The NCP specifies that when EPA or a PRP prepares a feasibility study for a site, the remedial alternatives recommended must include treatment that reduces the toxicity, mobility, or volume of the contaminants [40 CFR 300.430(e)(3)(i)]. In addition, the feasibility study must include an innovative treatment technology if it offers the "potential" for better performance, fewer adverse impacts, or lower cost than a demonstrated technology [40 CFR 300.430(e)(5)]. A CERCLA feasibility study thus must not only consider the best demonstrated technology, but unproven technology as well.

The NCP, at least on paper, strongly encourages the consideration and selection of new and innovative technologies to address hazardous waste problems at CERCLA sites. Specifically, CERCLA and its implementing regulations clearly prefer new technologies that could potentially reduce the toxicity, volume, and mobility of hazardous contaminants.

Technologies that offer this potential should be strongly considered by DOE. The use of new and innovative technologies is also facilitated by CERCLA insofar as the law exempts onsite treatment from the procedural requirements of other federal and state environmental regulations. As illustrated in Table 3.1, any remedy that is intended to be used exclusively onsite must meet the substantive requirements of identified ARARs; however, there is no need to adhere to the procedural requirements of these laws, such as the requirement to obtain permits under certain conditions.

3.3 ARAR SELECTION

CERCLA requires that the ARARs of RCRA, CWA, SDWA, CAA, and other federal and state environmental laws must be met in the remedy selection process.

TABLE 3.1. Applicability of Permits by Regulatory Program

Regulatory Program	Federal	State	Local
CERCLA, Onsite[a]	No	No	No
CERCLA, Offsite	Yes	Yes	Yes
RCRA, Onsite or Offsite	Yes	Yes	Yes
State Cleanup (Non-CERCLA)	Yes[b]	Yes[c]	Yes[c]

(a) CERCLA sites must meet substantive ARARs, but do not need permits.
(b) RCRA-authorized states generally can waive certain federal or state RCRA permit requirements if they have state statutory authority and if that authority is exercised in a manner no less stringent than allowed under federal permit waiver authority.
(c) May vary from jurisdiction to jurisdiction.

To be considered materials (TBCs) may also be used if ARARs are not sufficiently protective or are nonexistent for the particular site conditions.

There are three general classifications of ARARs:

- ambient or chemical-specific requirements
- performance, design or other action-specific requirements
- location-specific requirements.

A requirement is applicable if the specific terms of the law or regulation directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirement (EPA 1988a).

Potential ARARs may fall under many individual federal and state laws and regulations. Common chemical-specific ARARs include the RCRA LDRs, the SDWA maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs), the CWA water quality standards, and the CAA national ambient air quality standards.

ARARs must be identified at several points during the remedy selection process. During the site characterization phase of the RI/FS process, potential chemical- and location-specific ARARs should be identified. Later, during the development of remedial alternatives, action-specific requirements for each alternative must be identified. Finally, the technical specifications of the detailed design must ensure that ARARs are attained. This attainment applies to hazardous substances left onsite after completion of remediation, during the implementation of remedial actions, and at all points of potential exposure.

Because ARAR selection is generally a very site-specific activity, their impact on the RDDT&E process is not as direct as that of many of the RCRA standards. However, it is likely that ARARs selected for the various DOE sites will be fairly consistent because many of these sites have very similar problems and contaminated media. Accordingly, many of these recurring standards at DOE sites, especially those that relate directly to chemical- and action-specific requirements, may have a large impact on technology development. For example, MCLs established under the SDWA for radionuclides may be commonly selected ARARs for contaminated groundwater or surface water at DOE sites. Technologies targeted to address radionuclides in groundwater should be developed with these MCLs in mind.

Another example likely to be frequently encountered is the RCRA LDR restrictions on the treatment of RCRA hazardous wastes found at DOE CERCLA sites. Should the LDRs be identified as a frequently used ARAR for DOE CERCLA sites, the technology selected for the site remediation would need to be the BDAT for the particular waste to be treated. For example, if organic low-level mixed wastes were found at CERCLA sites and it is determined that the LDRs are ARARs, these wastes would have to be treated either through incineration or technologies such as carbon absorption where incineration is not practical. This type of regulatory consideration is highly relevant to decisions to develop technologies to treat these types of hazardous waste.

3.4 SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION (SITE) PROGRAM

CERCLA authorizes EPA to carry out a program to research, develop, and demonstrate alternative or innovative technologies. EPA's Superfund Innovative Technology Evaluation (SITE) program has two major purposes: 1) to accelerate the development, demonstration, and use of new or innovative treatment technologies and 2) to demonstrate and evaluate new innovative measurement and monitoring technologies (EPA 1988d). Many of the activities of the SITE program parallel those of DOE's RDDT&E program.

The SITE program has five components:

1. The Demonstration Program develops performance engineering and cost information on innovative alternative technologies so that they can be adequately considered in decisions about remediation for hazardous waste sites.

2. The Emerging Technologies Program performs laboratory pilot- and bench-scale evaluations for technologies that are not yet ready for field demonstration.

3. The Technology Transfer Program includes numerous components that incorporate a variety of outreach activities. This program disseminates demonstration and waste remediation data from all components of the SITE program to regional and state managers of Superfund cleanup activities, federal agencies, the engineering community, related industries, and the public.

4. The Measurement and Monitoring Technologies Development Program seeks to improve Superfund site characterization efforts by continually developing new and innovation measurement and monitoring technologies.

5. The Innovative Technologies Program was an outgrowth of early research and development efforts. It promotes transfer of EPA-developed technologies to the private sector for commercialization and use at Superfund sites.

The EPA Inspector General recently found that EPA needed to increase its efforts to demonstrate innovative treatment technologies and to disseminate the results to those who make decisions about regional cleanup (EPA 1990). In addition, EPA's newly formed Superfund Technology Innovation Office plans to establish an clearinghouse for information on innovative technologies, a federal roundtable on remediation technologies, and "technology incubators" to support development of hazardous waste treatment technologies.

4.0 OTHER FEDERAL ENVIRONMENTAL REQUIREMENTS

Besides RCRA and CERCLA, other federal environmental regulatory programs of significance to the RDDT&E process are the TSCA, the CAA, the CWA, and the NEPA. DOE Orders and other public statements may also contain commitments that have impact on technology development timetables or performance criteria, but are beyond the scope of this report. The other federal environmental regulatory programs referred to above are described in the following subsections.

4.1 NATIONAL ENVIRONMENTAL PROTECTION ACT

Development and implementation of technology that could significantly impact environmental quality require the preparation of an environmental impact statement (EIS). Specific technology demonstrations may be subject to NEPA assessment requirements. 40 CFR 1502.4 specifically states that an EIS, when needed, shall be prepared before the technology development program "has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives."

DOE has recently proposed the establishment of a categorical exclusion for all bench-scale research (55 FR 46444). This exclusion would permit R&D activities to proceed without any further NEPA documentation. It is uncertain when this proposed amendment to DOE's NEPA guidelines will become final.

As technologies progress through the RDDT&E process, NEPA requirements will likely increase. Depending upon the potential complexities of demonstration and testing, along with potential environmental impacts, environmental assessments (EAs) or EISs may need to be prepared during the DT&E phase. These decisions will need to be made on a case-by-case basis.

4.2 TOXIC SUBSTANCES CONTROL ACT

If a waste management technology resulted in the creation of a new chemical substance or a significant new use of a chemical, EPA would need to be notified within 90 days [TSCA Section 5(a)]. Records of significant adverse reactions to human health or the environment caused by a chemical substance must be kept for 30 years [TSCA 8(c)]. The EPA must be notified if a chemical substance is found to present a substantial risk of injury to health or the environment [TSCA 8(e)]. Any health and safety studies conducted regarding a chemical substance must also be submitted to EPA.

If EPA determines that a chemical (including a waste) presents an unreasonable risk to human health or the environment, TSCA 6(a) empowers EPA to mitigate such a risk by exercising a variety of authorities, including warnings or outright bans. In its 1986 report to Congress on waste minimization, EPA declared its intent to use TSCA 6(a) authority to mandate waste minimization if it determined that specific hazardous waste streams posed unreasonable risks. EPA has promulgated extensive regulations for management of PCBs (40 CFR 761) pursuant to TSCA 6(e).

4.3 CLEAN AIR ACT

As discussed in Chapter 2, air emissions from incinerators and certain treatment technologies are regulated under RCRA. Other types of air emissions require permits under the Clean Air Act.

The 1990 Clean Air Act Amendments dramatically broadened the scope of the original law by including provisions on acid rain and ozone protection and by listing the hazardous air pollutants to be controlled. Authority is still largely vested in the states through the state implementation plans (SIP), although states that fail to develop a SIP will be subject to a federal implementation plan.

The stringency of permitting requirements (Title V) may have a negative impact upon developing technologies, especially those that require modifications during their evolution. The requirement that permits be formally amending for even the most minor of modifications is expected to be strictly enforced.

The regulations for hazardous air pollutants (Title III) likely will also pose an obstacle to technologies undergoing development. Title III specifically names 189 pollutants; these pollutants will be regulated by categories of sources. Any technology emitting a hazardous pollutant will have to follow the requirements for the source category.

Finally, the Clean Air Act Amendments of 1990 offer opportunities to those new technologies that can alleviate or delete the emissions of problematic pollutants.

4.4 CLEAN WATER ACT

Waste water discharges from waste treatment technologies, if connected to a publicly owned sewage treatment plant, may require compliance with federal pretreatment standards (40 CFR 403). Such discharges also would have to comply with conditions specified in the waste water permit issued by the local sewer authority. Direct discharges of waste water into navigable waters would require issuance of a National Pollutant Discharge Elimination System permit (40 CFR 122) by state authorities. If the additional waste water would not violate any permanent conditions, an existing facility permit may cover the discharge. Underground injection wells are subject to both the Clean Water Act Underground Injection Control program (40 CFR 144 and 145) and RCRA LDRs (40 CFR 268).

4.5 ATOMIC ENERGY ACT

The Atomic Energy Act authorizes DOE to establish radiation protection standards for managing its own radioactive and mixed waste. Such standards are implemented through DOE Orders (see DOE 1988a, 1988b, 1989, 1990). These DOE Orders would primarily affect RDDT&E technology development by establishing radiation exposure limits and specific environmental protection standards for the general public and occupational workers. While these DOE orders do not establish technology performance criteria per se, they establish limits for facility-wide radiation releases and worker exposures against which any radioactivity resulting from RDDT&E technologies would have to be judged.

4.6 OCCUPATIONAL SAFETY AND HEALTH ACT

The Occupational Safety and Health Act establishes worker chemical exposure limits analogous to the worker radiation exposure limits in DOE Orders. It also establishes the Federal Hazard Communication Standard (29 CFR 1910.1200). Although RCRA hazardous wastes are exempted, this standard would apply to any other hazardous chemicals used in conjunction with hazardous waste management. Though the Occupational Safety and Health Act deals with worker safety training generally, requirements for safety and emergency preparedness training for workers at permitted TSD facilities are established by RCRA and appear at 40 CFR 264.16 and 40 CFR 265.16.

5.0 STATE ENVIRONMENTAL REQUIREMENTS

The state environmental regulatory programs of greatest significance to the DOE RDDT&E process are state RCRA programs, so-called "Mini-Superfund" programs, and state waste minimization programs, as explained in the following subsections.

5.1 STATE RCRA PROGRAMS

As mentioned earlier, RCRA-authorized states are not required to adopt federal RCRA program changes that are considered less stringent than the base program. The result can be significant variations in the amount of flexibility in areas such as the treatability studies and RD&D permitting that states will allow for demonstrating emerging and innovative technologies. Also under RCRA, states are expressly allowed to adopt requirements more stringent than federal requirements, even if they do not have an approved RCRA program. Thus, even in states where EPA administers the RCRA program, there may be practical limitations to the availability of federal permitting innovations, as well as other significant program differences from state to state. For instance, states may include additional substances in their definition of hazardous wastes.

5.2 MINI-SUPERFUND PROGRAMS

While CERCLA is administered exclusively by the federal government, a number of individual states have passed "mini-CERCLA" laws. These mini-CERCLA laws apply to hazardous waste sites that are not cleanup priorities under the federal CERCLA program. Unless otherwise preempted by federal law, these state laws are applicable to federal facilities.

State cleanup laws generally follow the CERCLA trends toward permanent, onsite treatment. In addition, state laws may influence technology development by setting cleanup standards that are specifically geared to the use of "best demonstrated available technology." State laws that set either technology- or risk-based standards may also become ARARs under CERCLA to be applied to sites that fall under the jurisdiction of that regulatory scheme.

As with any other frequently used ARARs, these standards could potentially impact technology development on a national level.

5.3 STATE WASTE MINIMIZATION PROGRAMS

Several states have developed active waste minimization programs which go beyond federal requirements:

- Washington requires source reduction, recycling and treatment plans, with a goal of 50% reduction in hazardous waste disposal by 1995.
- Oregon's Toxics Use Reduction and Hazardous Waste Reduction Act of 1989 allows state regulators to critique and hold hearings on a generator's waste reduction plans.
- California can demand an explanation if a generator disposes of a waste which the state has identified as potentially recyclable.
- The Massachusetts Toxic Use Reduction Act of 1989 includes hammer provisions for mandatory waste reduction if a voluntary industry program does not achieve specified reductions by a certain date.

5.4 OTHER STATE ENVIRONMENTAL PROGRAMS

Except for CERCLA, TSCA and pesticide registration, all other major federal environmental programs are delegated to the states. As mentioned in Chapter 4, specific RDDT&E technologies may be subject to air emissions or waste waster discharge permitting requirements. States also may generally enact environmental requirements which are more stringent than federal requirements. State air toxics programs may establish emissions standards that significantly affect the implementation of waste treatment and environmental restoration (see, for example, EPA 1989).

6.0 REFERENCES

40 CFR 122. 1980. "Environmental Protection Agency National Pollutant Discharge Elimination System Permit Regulations." U.S. Code of Federal Regulations.

40 CFR 144. 1983. "Environmental Protection Agency Permit Regulations for the Underground Injection Control Program." U.S. Code of Federal Regulations.

40 CFR 145. 1983. "Environmental Protection Agency Regulations on State Underground Injection Control Program Requirements." U.S. Code of Federal Regulations.

40 CFR 148. 1988. "Environmental Protection Agency Regulations on Hazardous Waste Disposal Restrictions for Class I Wells." U.S. Code of Federal Regulations.

40 CFR 260. 1980. "Environmental Protection Agency General Regulations for Hazardous Waste Management." U.S. Code of Federal Regulations.

40 CFR 261. 1980. "Environmental Protection Agency Regulations for Identifying Hazardous Waste." U.S. Code of Federal Regulations.

40 CFR 262. 1980. "Environmental Protection Agency Regulations for Hazardous Waste Generators." U.S. Code of Federal Regulations.

40 CFR 264. 1980. "Environmental Protection Agency Regulations for Owners and Operators of Permitted Hazardous Waste Facilities." U.S. Code of Federal Regulations.

40 CFR 265. 1980. "Environmental Protection Agency Interim Status Standards for Owners and Operators of Hazardous Waste Facilities." U.S. Code of Federal Regulations.

40 CFR 268. 1986. "EPA Regulations on Land Disposal Restrictions." U.S. Code of Federal Regulations.

40 CFR 270. 1983. "Environmental Protection Agency Regulations for Federally Administered Hazardous Waste Permit Programs." U.S. Code of Federal Regulations.

40 CFR 300. 1982. "Environmental Protection Agency National Oil and Hazardous Substances Pollution Contingency Plan Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980." U.S. Code of Federal Regulations.

40 CFR 403. 1978. "Environmental Protection Agency Pretreatment Standards." U.S. Code of Federal Regulations.

40 CFR 761. 1990. "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." U.S. Code of Federal Regulations.

40 CFR 1502. 1978. "Major Federal Actions Requiring the Preparation of Environmental Impact Statements." U.S. Code of Federal Regulations.

51 FR 40605. November 7, 1986. "Hazardous Waste Management System; Land Disposal Restrictions (First Third Wastes)." *Federal Register.*

54 FR 3745-3847. January 26, 1989. "Pollution Prevention Policy Statement."

55 FR 11798-11877. March 29, 1990. "Hazardous Waste Management System; Identification and Listing of Hazardous Waste; Toxicity Characteristics Revisions."

55 FR 22520. June 1, 1990. "Land Disposal Restrictions for Third Third Scheduled Wastes." *Federal Register.*

55 FR 30798. July 27, 1990. "Corrective Action for Solid Waste Management Units (SWMUs) at Hazardous Waste Management Facilities." *Federal Register.*

55 FR 46444. November 2, 1990. "National Environmental Policy Act Implementation Procedures." *Federal Register.*

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Public Law 96-510, as amended.

National Environmental Policy Act (NEPA). 1975. U.S.C. 4341, as amended.

Office of Technology Assessment (OTA). 1986. Serious Reduction of Hazardous Waste: Pollution Prevention and Industrial Efficiency, OTA-ITE-318, U.S. Congress, Washington, DC.

Resource Conservation and Recovery Act (RCRA) of 1976. Public Law 94-580, as amended.

Toxic Substances Control Act (TSCA). 1976. Public Law 94-469, as amended.

U.S. Department of Energy (DOE). 1988a. "Radioactive Waste Management." DOE Order 5820.2A.

U.S. Department of Energy (DOE). 1988b. "Radiation Protection for Occupational Workers." DOE Order 5480.11.

U.S. Department of Energy (DOE). 1989. "Hazardous and Radioactive Mixed Waste Program." DOE Order 5400.3.

U.S. Department of Energy (DOE). 1990. "Radiation Protection of the Public and the Environment." DOE Order 5400.5.

U.S. Environmental Protection Agency (EPA). 1986. Guidance Manual for Research, Development, and Demonstration Permits Under 40 CFR Section 270.65. EPA/530-SW-86-008, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1987. Waste Minimization: Environmental Quality with Economic Benefits. EPA/530-SW-87-026, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1988a. CERCLA Compliance with Other Laws Manual: Interim Final. EPA/540/G-89-006, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1988b. RCRA Corrective Action Plan - Interim Final. EPA/530-SW-88-028, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1988c. RCRA Corrective Action Interim Measures Guidance - Interim Final. EPA/530-SW-88-029, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1988d. The Superfund Innovative Technology Evaluation Program: Progress and Accomplishments - A Report to Congress. EPA/540/5-88/001, Office of Research and Development and the Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1989. CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements. EPA/540-G-89/009, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1990. RCRA, The Nation's Hazardous Waste Management Program at a Crossroad. EPA/530-SW-90-069, U.S. Environmental Protection Agency, Washington, D.C.

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