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Report to the Chairman, Committee on Governmental Affairs, U.S. Senate

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NUCLEAR WASTE

Problems Associated With DOE's Inactive Waste Sites

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Resources, Community, and
Economic Development Division

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The Honorable John Glenn
Chairman, Committee on
Governmental Affairs
United States Senate

Dear Mr. Chairman:

As requested, we reviewed the Department of Energy's efforts to identify the number of inactive waste sites; the degree to which these sites were assessed for environmental, safety, and health problems; and the environmental effects associated with the sites at six major DOE defense installations.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of its issuance. At that time, we will send copies to appropriate congressional committees; the Secretary of Energy; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

This work was performed under the direction of Keith O. Fultz, Senior Associate Director. Other major contributors are listed in appendix I.

Sincerely yours,

J. Dexter Peach

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

An inactive waste site is any place not currently being used to dispose of waste, but where radioactive and/or hazardous waste is present. Such sites—which can be ditches, landfills, wells, ponds, spills, and even buildings containing waste—can cause environmental problems when high levels of dangerous contaminants migrate into the soil, surface water, and/or groundwater. Because of environmental problems reported at various Department of Energy (DOE) installations, the Chairman, Senate Committee on Governmental Affairs, asked GAO to identify the number of DOE inactive waste sites; determine the degree to which these sites were assessed for environmental, safety, and health problems; and assess the environmental effects associated with the sites.

GAO's review focused on six major DOE defense installations—Hanford Reservation, Washington; Idaho National Engineering Laboratory, Idaho; Lawrence Livermore National Laboratory, California; Rocky Flats Plant, Colorado; Savannah River Plant, South Carolina; and Y-12 Plant, Tennessee.

Background

For more than 40 years, DOE and its predecessor agencies have generated large amounts of radioactive and hazardous waste in conducting their primary mission of producing nuclear material for defense purposes. In the past, DOE disposed of the waste at government-owned installations using techniques that allowed the waste to contaminate the environment. According to DOE officials, DOE is now phasing out disposal sites that used these techniques, but many of the sites still contain waste that can migrate and cause environmental problems.

The major legislation governing inactive sites is the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, also known as "Superfund." This law provides for assessment and cleanup of inactive waste sites. DOE uses the term CERCLA (rather than Superfund) to describe its inactive waste site program. DOE requests and obtains funds for this program from the Congress through the normal budgetary process because federal agencies may not use funds from the Superfund account.

Under the Superfund legislation, inactive sites are evaluated for the potential hazard they pose to public health and the environment using the Environmental Protection Agency's (EPA) Hazard Ranking System. Sites scoring at or above 28.5 under the Hazard Ranking System can be nominated for EPA's National Priorities List. Sites on the National Priorities List receive priority attention for remediation. The Superfund

Amendments and Reauthorization Act of 1986 extended the 1980 Superfund legislation, giving new emphasis to the cleanup programs at federal facilities by imposing mandatory schedules for various remedial activities. In addition, the 1984 amendments to the Resource Conservation and Recovery Act of 1976 (RCRA) require corrective actions at inactive waste sites as a condition for receiving a permit for ongoing operations at facilities that generate, treat, store, or dispose of hazardous waste. Further, DOE Order 5480.14, dated April 1985, outlines DOE's five-phase program for identifying, assessing, and cleaning up inactive waste sites. This order is currently being revised to incorporate the additional requirements imposed on federal facilities in the 1986 Superfund amendments.

Results in Brief

Although DOE has been identifying its inactive waste sites since 1981, GAO's review of six major DOE installations revealed that DOE does not yet have a comprehensive listing of all its sites, and large discrepancies exist between DOE headquarters' site inventory and the listings compiled by DOE officials at the six installations. Many identified sites have not been systematically evaluated to determine the possible threat they pose to public health or the environment. Some DOE installations have assessed the hazard posed by their inactive waste sites using evaluation systems which can understate potential dangers—such as not considering the radioactive waste at the site. Further, DOE installations are using different approaches to address inactive waste sites depending on whether Superfund or RCRA authority is applied. Thus, DOE headquarters oversight becomes more difficult because inactive sites across DOE installations are subject to different procedural requirements.

Environmental problems, including contamination of groundwater with radioactive, chemical, and other hazardous substances, were found at all six locations GAO reviewed. In some cases, the contamination was detected at levels hundreds to thousands of times above federal drinking water standards. Because of environmental problems, one installation GAO reviewed is already on the National Priorities List and, based on available information, the other five are likely to be named to the list soon. The most recent DOE information indicates that the total cleanup costs nationwide could be as high as $60 billion.

Principal Findings

Site Inventory Incomplete

Although DOE began identifying inactive waste sites in 1981, the magnitude of the problem is still not fully defined. For the six DOE installations GAO reviewed, DOE headquarters' inventory showed a total of 605 inactive waste sites, while the DOE officials at these installations identified 1,447. The primary reasons for the discrepancies are (1) the discovery of additional inactive waste sites after the headquarters inventory was compiled, (2) a determination by DOE officials at these installations that some inactive waste sites did not have to be reported to DOE headquarters under its program, and (3) errors in the DOE-wide inventory resulting from duplication or misclassification of sites.

Assessment of Site Hazards Incomplete

DOE's assessment of its inactive waste sites' potential hazards has varied across the six DOE installations. Of the 1,447 inactive sites reported to GAO, only 45 percent were scored using EPA's Hazard Ranking System. Twelve percent were scored using variations of EPA's Hazard Ranking System. Some of the variations used can understate potential dangers because they do not fully reflect the hazards posed by radioactive waste. Finally, 43 percent received no evaluation, and DOE has no further plans to score most of these remaining inactive sites because DOE officials believe that they already have a good understanding of their potential impact. As a result of using different evaluation systems or none at all, meaningful comparisons of inactive waste sites at various DOE facilities to establish overall priorities cannot be made because DOE used no common basis to assess its sites.

Different Approaches Followed in Addressing Inactive Waste Sites

DOE installations are using different approaches in defining and addressing their inactive waste sites depending on whether Superfund or RCRA authority is applied to a particular site. Some installations treat purely radioactive sites as sites to be addressed under the Superfund legislation and all others as RCRA sites. Others apply RCRA to sites which became inactive after November 19, 1980—the act's effective date—and the Superfund legislation to sites that existed before that date. One installation is addressing all its inactive sites under the Superfund legislation. This situation makes DOE headquarters' oversight of its installations difficult because inactive waste sites are being addressed differently at various DOE installations. One installation may report most of its sites to DOE headquarters as sites under the Superfund legislation while others

do not report sites to DOE headquarters because they consider them to be sites under RCRA.

Environmental Contamination and Cleanup Cost

High levels of groundwater contamination with radioactive and hazardous substances were present at each of the installations GAO reviewed. High levels of soil contamination were also found at two of the six DOE installations reviewed, along with some surface water contamination. Based on assessments performed to date, one of the six DOE installations GAO reviewed has been named to the National Priorities List and the remaining five installations have severe enough environmental effects at their inactive waste sites for likely placement on the list.

Because of the severity of the environmental problems at inactive sites, a massive cleanup effort will be necessary at DOE. Cleanup costs for inactive sites will be extremely high. Recent DOE information indicates that the cost could be as high as $60 billion. As a result, GAO is calling attention to its previous recommendation that DOE develop a comprehensive plan, including milestones and cost estimates, to bring DOE facilities into full compliance with environmental laws. A significant part of this plan should necessarily address DOE's inactive waste sites, which are a major contributor to DOE's environmental problems.

Recommendations

To strengthen DOE's oversight of its inactive waste sites program nationwide, GAO recommends that the Secretary of Energy:

- Develop and prescribe—in cooperation with EPA and the appropriate states—a comprehensive approach to identifying, assessing, and cleaning up inactive waste sites which integrates provisions of both the Superfund and RCRA legislation. In issuing the revised DOE Order 5480.14, DOE should incorporate provisions that specify this comprehensive approach.
- Update the DOE headquarters' inventory to account for all DOE inactive waste sites. In doing so, the inventory should indicate the relative hazards associated with each inactive waste site.

Agency Comments

GAO discussed the facts presented in this report with DOE officials, who generally agreed with its findings. In accordance with the requester's wishes, GAO did not obtain official agency comments on this report.

Contents

Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CERCLA	Comprehensive Environmental Response,Compensation,and Liability Act of 1980
DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
HRS	Hazard Ranking System
INEL	Idaho National Engineering Laboratory
LLNL	Lawrence Livermore National Laboratory
mHRS	Modified Hazard Ranking System
NCP	National Contingency Plan
NPL	National Priorities List
RCRA	Resource Conservation and Recovery Act of 1976
SARA	Superfund Amendments and Reauthorization Act of 1986

Introduction

An inactive waste site is any location where hazardous and/or radioactive substances have been deposited, disposed of, placed, or otherwise come to be located.[1] Such sites can be ditches, landfills, wells, ponds, spills, and even buildings containing hazardous waste. Because they contain hazardous and/or radioactive substances, these sites can pose a health threat. Some of the more important concerns about these sites are that waste can (1) migrate into rivers and streams, (2) migrate into groundwater supplies, or (3) be inadvertently disturbed by people or animals. The discovery of serious health and environmental problems in communities around the country has shown the consequences that can result from inactive waste sites.

The Department of Energy (DOE) faces a difficult cleanup effort with its inactive waste sites. For more than 40 years, DOE and its predecessor agencies have generated and disposed of vast amounts of waste. Much of this waste is unique to DOE's primary mission of producing nuclear material for defense purposes. Moreover, DOE has hundreds of inactive waste sites at its various installations across the country. As a result, it now faces a difficult and costly task of cleanup.

Nuclear Defense Operations at DOE Facilities

DOE's primary mission is to produce nuclear material (plutonium and tritium) for weapons and naval fuel. Other major DOE activities include conducting basic and applied energy research and technology development, and producing enriched uranium. The Department performs these activities within a complex of approximately 70 research, technical development, manufacturing, and administrative facilities. These facilities include national multiprogram and specialized energy research laboratories, nuclear production reactors, nuclear weapons manufacturing plants and test sites, and energy technology centers.

While many of these activities generate waste, most of DOE's waste problems result from its defense-related operations. These operations—carried out at numerous facilities located around the nation—consist of a series of complex steps designed to produce nuclear material, fabricate the material into components for nuclear weapons, manufacture the nuclear weapons, and test the developed weapons for effectiveness and safety.

[1] For the purposes of this report, any location which received hazardous or radioactive waste in the past, but is no longer receiving such waste, is considered an inactive waste site.

DOE's operations at these facilities have long used and generated a wide variety of hazardous and/or radioactive substances that have resulted in radioactive waste, hazardous waste, and mixed waste containing both radioactive and hazardous materials. Some of the hazardous wastes include acids, nitrates, oils, reactive metals (e.g., sodium), fluoride, heavy metals (e.g., mercury), and high explosives. Exposure to some of these materials in large doses can pose immediate health threats, long-term illness, or even death. Some of the radioactive material, because of its lethal levels of radiation and high heat generation, must be remotely handled with special shielded equipment to prevent worker exposure. Other material, while much less radioactive, is very toxic and can present a health hazard if inhaled or ingested. Because of their long life, many radioactive materials must be carefully stored so that they are not released into the environment. Finally, DOE's operations generate mixed waste—various combinations of hazardous and radioactive materials such as oil contaminated with plutonium or acids contaminated with radioactive materials. These mixed wastes pose handling and disposal problems because workers and the environment must be protected from both the hazardous and radioactive material.

Historically, DOE has disposed of much of its own waste at government-owned installations. For more than 40 years, DOE used disposal techniques that were the accepted practice at the time, but are no longer considered environmentally acceptable. For example, liquid waste, which contains both hazardous chemicals and radioactive material, has been disposed of directly into the soil at many disposal sites, such as cribs, ponds, trenches, and ditches. At these disposal sites, liquid effluents seep down into the soil. During seepage, the liquid waste loses some of its contaminants, which either combine with the soil, remain at the site, or if radioactive, decay. Some contaminants, however, can reach the groundwater and migrate with it. Solid waste, in some cases, has been buried in unlined trenches. At these sites, rainwater can percolate through the waste, causing it to migrate into the soil and possibly into the groundwater. According to DOE officials, DOE is phasing out the use of disposal sites that allow waste to contaminate the environment. However, many of these sites that resulted from past operations, while now inactive, still contain waste that can migrate and cause environmental problems.

DOE officials do not know how much waste has been disposed of as a result of defense operations. However, available information indicates it is in the billions of cubic meters. For example, at DOE's Hanford installation alone, DOE officials estimate that approximately 1.6 billion cubic

meters of liquid waste—containing various concentrations of radioactive and/or hazardous contaminants—and 140,000 cubic meters of solid waste have been disposed of at inactive waste sites there. According to DOE officials, much of this waste is still present at these sites.

Key Legislation Governing Inactive Waste Sites

Three important environmental laws were passed in the 1980s which address cleanup of inactive waste sites at DOE installations. These laws are

- the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA);
- the 1984 amendments to the Resource Conservation and Recovery Act of 1976 (RCRA); and
- the Superfund Amendments and Reauthorization Act of 1986 (SARA).

These three laws commit DOE to addressing environmental conditions at DOE installations resulting from inactive waste sites.[2]

CERCLA

The CERCLA legislation, commonly known as "Superfund," was enacted on December 11, 1980, in response to problems resulting from the nation's past waste disposal practices. It provides the federal government with the authority to clean up inactive hazardous waste sites and respond to releases of hazardous substances. Under CERCLA, radioactive materials are considered hazardous substances. Federal agencies were required by CERCLA to comply with the statute to the same extent as private entities, although they may not use moneys from the cleanup fund authorized by CERCLA for long-term remedial actions. Further, Section 103(c) of the legislation required owners and operators of facilities that stored, treated, or disposed of hazardous waste—including federal government agencies and contractors—to notify the Environmental Protection Agency (EPA) by June 1981 of the existence at their facilities of suspected or likely releases of hazardous substances.

CERCLA was implemented through a 1982 revision to the National Contingency Plan (NCP),[3] which specifies procedures, standards, and methods

[2]DOE is also responsible for managing the Uranium Mill Tailings Radiation Control Act of 1978. Mill tailings are the earthen residue remaining after uranium has been recovered from crude ore.

[3]The NCP was originally established in 1968 to implement provisions of the Federal Water Pollution Control Act.

for identifying, assessing, and remedying releases of hazardous substances, pollutants, and contaminants. The NCP outlines a series of steps for determining the appropriate response to actual or potential releases. These steps include site discovery, preliminary assessment and site investigation, site evaluation and National Priorities List (NPL) determination, and remedial action planning and implementation.

First, federal agencies were required to identify any known or suspected releases of hazardous substances through the June 1981 notification requirement or through other investigations and information sources. Secondly, the NCP requires that federal agencies conduct preliminary assessments of all known or suspected releases using record searches, personal interviews, facility data, and site visits to identify the source of the problem, evaluate the magnitude of the potential threat, and determine whether removal or remedial actions are necessary. If the preliminary assessment shows an immediate and significant threat to human life, health, or the environment, then immediate emergency removal actions may be taken, as necessary, to prevent or reduce the hazardous waste threat. If the preliminary assessment indicates that remedial actions involving a long-term response are needed to achieve a permanent remedy or cleanup, then the agency conducts a more detailed site evaluation.

The third major step, site evaluation, is designed to further categorize the nature of any releases or potential threats to public health and the environment and to determine whether a site should be included on the NPL. The NPL, which is described in the NCP, consists of those sites which EPA designates as the top priority for possible remedial action. Federal facilities have been eligible for the listing since October 1984.

The primary mechanism for assessing the relative threat posed by inactive waste sites and determining whether a site should be included on the NPL is the score calculated using EPA's Hazard Ranking System (HRS). The HRS evaluates the relative potential of facilities with uncontrolled hazardous substances to cause environmental, safety, or health problems. Under the HRS, a facility is assigned three scores, reflecting the potential for: (1) migration of a hazardous substance away from the facility via groundwater, surface water, or air routes, (2) significant fire or explosions threat, and (3) direct contact by humans or animals with hazardous substances at the facility. EPA ranks facilities for remedial action primarily on the basis of the score that measures hazardous substances' migration, and uses the other two scores to identify facilities requiring emergency attention.

EPA evaluates federal facilities for NPL designation with the HRS, on the basis of information submitted by the facilities. EPA regional officials determine the preliminary scores for the facilities' sites and submit the scoring packages for candidate NPL sites to EPA headquarters for a quality assurance review. Sites with HRS scores at or above 28.5 are eligible for inclusion on the NPL. The proposed list of candidate sites is published in the Federal Register, initiating a 60-day public comment period. EPA headquarters then determines the final HRS scores and publishes a final rule designating the NPL sites.

The final set of activities outlined in the NCP, remedial action planning and implementation, is applied to all inactive waste sites needing long-term cleanup actions—whether or not the site is placed on the NPL. During this phase, a Remedial Investigation/Feasibility Study is conducted to more fully characterize the extent of the threat and to develop and evaluate remedial alternatives. Then, a remedial alternative is selected and cleanup begins. Under CERCLA, the selected remedy must meet applicable or relevant and appropriate federal health and environmental requirements for the specific site.

Amendments to RCRA

RCRA, which was passed in 1976, is designed to regulate the management and disposal of hazardous waste. Originally, its focus was solely on active disposal operations. However, as discussed below, the act was amended on November 8, 1984, to include a provision relating to inactive waste sites.

RCRA requires owners or operators of facilities that treat, store, or dispose of hazardous waste to obtain a permit and comply with performance, recordkeeping, reporting, and facility operation standards. The act also provides that facilities in operation on or before November 19, 1980, may continue operating under "interim status" regulations (e.g., groundwater monitoring may be required in some instances) until a final hazardous waste permit is received.

Another important aspect of RCRA is that it regulates hazardous, but not radioactive, waste. Radioactive waste is specifically excluded in the RCRA legislation. However, on the basis of a June 1987 DOE interpretive rule, RCRA does apply to the hazardous component of mixed waste (waste that contains both hazardous and radioactive material). Under this rule, the radioactive component of mixed waste continues to be regulated under the Atomic Energy Act of 1954. If a conflict develops when

- The Hanford Reservation, Washington State, is primarily devoted to plutonium production for nuclear weapons, fuel fabrication and reprocessing, nuclear waste management, and energy research and development.
- The Idaho National Engineering Laboratory, Idaho, reprocesses spent nuclear material from naval ships and test reactors and conducts energy research and development.
- The Lawrence Livermore National Laboratory, California, conducts research and development on nuclear weapons, energy, and national security programs.
- The Rocky Flats Plant, Colorado, manufactures metal components containing plutonium for nuclear weapons.
- The Savannah River Plant, South Carolina, produces plutonium, tritium, and other special nuclear materials for the national defense.
- The Y-12 Plant, Tennessee, fabricates high- and low-enriched uranium and other materials into finished parts and assemblies for nuclear weapons.

To obtain an understanding of the key phases, roles and responsibilities, and reporting requirements governing DOE's management of its inactive waste sites, we reviewed pertinent legislation including the Comprehensive Environmental Response, Compensation, and Liability Act of 1980; the 1984 amendments to the Resource Conservation and Recovery Act of 1976; and the Superfund Amendments and Reauthorization Act of 1986. We also reviewed federal environmental regulations and DOE and EPA internal orders, directives, and memoranda that implement the established legislative requirements. Further, we interviewed DOE and EPA headquarters officials to determine applicable policies and procedures, obtain their views on the nature of inactive waste problems at DOE, and discuss various issues that have emerged in identifying, assessing, and cleaning up inactive waste sites.

In addressing the review objectives, we relied to a large extent on DOE-generated documents and data. We assessed the completeness of DOE's efforts to identify inactive waste sites by comparing data in a DOE-wide inventory of inactive waste sites compiled by DOE headquarters with listings prepared at our request by the six DOE installations. We also reviewed and analyzed DOE documents at each of the six installations to determine the methodology used in assessing the degree of hazard posed by the waste sites. This included DOE reports describing the results of preliminary assessments conducted at the installations and other technical studies on groundwater and soil monitoring. At each of the six field installations, we interviewed officials from DOE and its contractor organizations and from the pertinent EPA regions to gain perspective on their

roles and responsibilities and obtain their views on DOE's management of its inactive waste site problems. We also interviewed state officials from California, Colorado, Idaho, South Carolina, Tennessee, and Washington.

We discussed the facts presented in this report with officials in DOE headquarters and the six DOE field installations we reviewed and incorporated their clarifications where appropriate. However, as requested by the Chairman, we did not obtain official agency comments on the report. Our work was performed according to generally accepted government auditing standards. Our review was conducted between February 1987 and March 1988.

applying both laws to a specific waste problem, then RCRA yields to the Atomic Energy Act.

In the November 1984 RCRA amendments, the Congress added a provision [Section 3004(u)] requiring corrective actions for all releases of hazardous materials, including those from inactive sites, as a condition for receiving a RCRA permit for ongoing operations. Thus, this provision makes all inactive sites, except purely radioactive sites, subject to both RCRA and CERCLA.

SARA

This act, passed by the Congress on October 17, 1986, reauthorized the CERCLA legislation, amending or expanding many requirements and adding some new provisions.[4] It gave new emphasis to the programs at federal facilities, imposing additional requirements and mandatory schedules for initiating and completing various remedial activities. SARA's key provisions affecting inactive waste sites at federal facilities include: establishing a Federal Agency Hazardous Waste Compliance Docket; setting time frames for federal facility assessments and evaluations; requiring a health assessment for all NPL sites and a revision to the HRS; and adding state environmental standards to the cleanup requirements for each site.

Specifically, SARA requires EPA to establish a special Federal Agency Hazardous Waste Compliance Docket listing federal facilities previously reported to EPA under both RCRA and CERCLA requirements. EPA must update the docket every 6 months and establish a program to provide the public with information about the facilities on the docket. The SARA legislation also sets a specific schedule for assessment and evaluation of federal facilities, including conducting preliminary assessments of all facilities on the federal agency docket by April 1988 and completing evaluation of facilities for the NPL by April 1989. For those facilities which are placed on the NPL, a Remedial Investigation/Feasibility Study must begin within 6 months of the NPL designation.

Other SARA provisions addressed requirements for measuring the health and environmental effects of inactive waste sites. For example, the Agency for Toxic Substances and Disease Registry (ATSDR) in the Department of Health and Human Services must conduct a health assessment

[4]Throughout this report, a CERCLA site means a site that is covered by both CERCLA and its reauthorizing legislation, SARA.

for every NPL site within 1 year from the date the site is proposed.[5] These health assessments are used to determine whether further action should be taken to reduce human exposure to hazardous substances at a site and whether additional information on human exposure and health risks is needed. The ATSDR is also required by SARA to conduct toxicological investigations of compounds most frequently detected at hazardous waste sites.

SARA further mandates that EPA modify the HRS so that it accurately assesses the relative degree of risk to human health and the environment posed by sites and facilities. The amended HRS, which must be issued by October 1988, is to assess the human health risks associated with actual or potential surface waters contamination.

Finally, in addressing cleanup standards for remedial actions, SARA expands the list of "applicable or relevant and appropriate" public health and environmental requirements that must be met to include state as well as federal standards. SARA also states that remedial actions which permanently and significantly reduce the volume, toxicity, or mobility of a hazardous substance are preferable to other measures in considering the level of cleanup.

Objectives, Scope, and Methodology

On December 11, 1986, the Chairman, Senate Committee on Governmental Affairs, requested that we review, among other things, DOE's management of its inactive waste sites. After subsequent discussions with the requester's office, we agreed to focus our work on six major DOE defense installations and determine (1) the number of inactive waste sites at the installations, (2) the degree to which these sites were assessed for environmental, safety, and health problems, and (3) the potential environmental problems that exist at these sites.

The six installations reflect the diversity of DOE's nuclear defense operations, represent a cross-section of DOE's operations offices, and are dispersed over several geographic areas. Also, these six installations contained nearly two-thirds of the inactive waste sites positively identified in DOE's nationwide inventory. The six installations we reviewed are briefly described below.

[5]Sites proposed for the NPL prior to SARA's enactment must receive ATSDR's health assessment by December 10, 1988.

DOE's Efforts to Identify and Evaluate Its Inactive Waste Sites

Since 1981, DOE has been identifying and evaluating its inactive waste sites in response to CERCLA requirements. Based on our review of six major DOE installations, we found that DOE does not yet have a comprehensive listing of all its inactive waste sites and many identified sites have not been systematically evaluated to determine the possible threat they pose. Further, DOE installations are using different legislative requirements in addressing similar inactive waste site problems, making oversight by DOE headquarters difficult to achieve.

DOE needs a more concerted systematic effort to identify all its inactive waste sites and evaluate the threat they may pose. Such an effort is needed to provide a comprehensive picture of the size, scope, and severity of DOE's inactive waste problem. It will also help ensure that all potentially dangerous inactive waste sites have been identified so that appropriate actions can be taken. Also, DOE needs to strengthen its existing programs by providing more detailed guidance to its operating facilities on how it will integrate the requirements of RCRA and CERCLA. Such action can help avoid unnecessary duplication in meeting the requirements of the laws.

Historical Perspective on DOE Efforts to Identify and Assess Inactive Waste Sites

DOE has been disposing of waste at various sites across the country since the 1940s. At many places, waste was disposed of by dumping, injecting, or burying it in the ground. While these practices were consistent with acceptable disposal practices at the time, in many places, it caused contaminants to enter the environment.

The 1980 CERCLA legislation required federal agencies as well as commercial entities to notify EPA of any inactive waste sites where hazardous waste—including radioactivity—has been deposited, stored, disposed of, or located without adequate measures for controlling the release of such wastes into the environment. DOE headquarters issued guidance to its field offices in a May 1981 memo notifying them of CERCLA reporting requirements. In response, 12 inactive sites were identified to EPA. DOE continued to identify inactive waste sites, and in May 1984, reported 155 CERCLA sites to EPA under CERCLA's reporting requirements.

DOE further developed its CERCLA program with the issuance of DOE Order 5480.14, dated April 26, 1985. This program consists of five sequential phases beginning with identifying and evaluating all existing inactive waste sites. Installation reports—called Phase I reports—are required for all DOE installations. The other phases of DOE's program are

confirmation to quantify the presence of waste; engineering assessment to develop a plan for controlling migration of the waste; remedial action; and finally, compliance and verification to ensure that all appropriate remedial action has been completed.

By the time the order was issued, other environmental laws were passed or being considered which affected DOE's ongoing CERCLA program. For example, the 1984 RCRA amendments requiring corrective actions for releases at inactive waste sites raised questions at DOE field offices about whether the CERCLA program outlined in the DOE order still applied to certain inactive waste sites. Moreover, the 1986 SARA legislation—which imposed additional requirements and mandatory schedules for identifying, assessing, and cleaning up inactive sites—led to further uncertainty in the field about the extent to which DOE's CERCLA program should be implemented. Since June 1987, DOE headquarters has been taking steps to revise DOE Order 5480.14 to incorporate the additional requirements in SARA.

DOE's Inventory of Inactive Waste Sites Is Incomplete

DOE has been identifying inactive waste sites since 1981. In our review of six DOE installations, we found large differences between the DOE-wide inventory of inactive waste sites and the number of inactive waste sites reported to us by officials at these installations. Further, it is likely that additional inactive waste sites will be found at many of these installations.

The first phase of DOE's CERCLA program is installation assessment to locate and identify those inactive waste sites that may pose an undue risk to health, safety, and the environment as a result of waste migration.[1] Under this phase, a report is prepared for each DOE installation showing the number of inactive waste sites and their locations. These reports, commonly referred to as Phase I reports, are used by DOE headquarters to ensure that all inactive waste sites and problem areas at an installation have been identified. EPA regional offices have used these reports in evaluating DOE installations for the NPL. DOE has also used

[1]To accomplish this, each DOE installation is to conduct a review of available records of the site operations (e.g., accident reports, site maps, and past management practices) to identify potential inactive waste sites. Also part of this phase is a physical inspection to validate information obtained in the record search.

these Phase I reports as a basis for compiling an inventory of DOE inactive waste sites.[2] This inventory was designed to contain all inactive sites, regardless of whether RCRA or CERCLA authority was applied to assessment and remediation activities at the sites.

As of December 1987, DOE's nationwide inventory of inactive waste sites contained 982 sites at all DOE installations. Most of these sites (over 80 percent) are associated with DOE's nuclear defense programs. They include a variety of radioactive, hazardous, and mixed (radioactive and hazardous) waste sites. Most of these sites are places where DOE disposed of waste (e.g., landfills, cribs, and trenches, etc.) or where accidental releases occurred (e.g., spills). DOE headquarters officials told us that while this inventory represents the best available data at headquarters, they expect more sites to be identified. These officials believe that there may be approximately 800 more inactive sites at DOE installations around the nation.[3]

To assess the completeness of the data, we requested DOE officials at the six installations we reviewed to compile a list of all their inactive waste sites—any place where hazardous and/or radioactive waste has come to be located and is not being used as an active waste disposal, treatment, or storage facility. Table 2.1 shows a comparison, by installation, between the number of inactive waste sites reported to us by installation officials and the number specified in the DOE-wide inventory.

Table 2.1: Inactive Waste Sites at Selected DOE Installations (As of December 1987)

Installation	Number of inactive sites	
	Specified in the DOE-wide inventory	Reported to GAO
Hanford Reservation	335	998
Idaho National Engineering Laboratory (INEL)	96	232
Lawrence Livermore National Laboratory (LLNL)	9	12
Rocky Flats Plant	78	102
Savannah River Plant	66	69
Y-12 Plant	21	34
Total	**605**	**1,447**

[2]DOE's inventory of inactive waste sites is used as a tool by DOE headquarters to monitor implementation of DOE's CERCLA order nationwide. It has also been used by GAO and congressional committees to obtain an understanding of the size of DOE's inactive waste site problems.

[3]These inactive waste sites do not include sites being addressed under other DOE remedial programs including the Formerly Utilized Sites Remedial Action Program and the Surplus Facilities Management Program. DOE is examining the extent to which CERCLA is applicable to these sites.

As table 2.1 shows, the DOE-wide inventory of inactive waste sites for the installations we reviewed contains less than half of the sites reported to us by DOE officials at the selected installations. The primary reasons that additional sites were reported to us but were not on the DOE-wide inventory are (1) the identification of more inactive waste sites after draft Phase I installation reports had been sent to DOE headquarters, (2) the determination by the DOE officials at these installations that some inactive waste sites did not need to be reported to headquarters officials under DOE's CERCLA program, and (3) errors in the DOE-wide list resulting from duplication or misclassified sites.

At the Hanford Reservation, 663 more inactive waste sites were reported to us than appear in the DOE-wide inventory. These additional sites consist of: (1) 330 unplanned releases and/or spills that were assessed after Hanford's draft Phase I report was submitted to DOE headquarters in July 1986, (2) 161 sites associated with old single-shell tanks for high-level waste,[4] and (3) 152 sites that became inactive after November 19, 1980, which Hanford officials consider subject to RCRA, not CERCLA. The inactive waste sites reported to us also reflect 18 sites discovered after Hanford's draft Phase I report was sent to headquarters and an adjustment (+2) for sites that were misclassified on the DOE-wide inventory.

At the Idaho National Engineering Laboratory (INEL), 136 more sites were reported to us than appear in the DOE-wide inventory. These additional sites include: (1) 53 sites not reported to DOE headquarters because INEL officials did not believe them to be significant, (2) 40 sites which once received hazardous and/or radioactive waste but now only receive nonhazardous, nonradioactive waste,[5] and (3) 49 sites that were identified after INEL submitted its draft Phase I report to headquarters. These additional sites also include an adjustment (-6) for sites that, according to INEL officials, were misclassified.

For the remaining four installations, the additional sites reported to us were either the result of sites being identified after the installation's draft Phase I report was sent to headquarters or because the inactive waste sites were not considered to be CERCLA sites. Specifically, at Lawrence Livermore National Laboratory (LLNL) and the Rocky Flats Plant,

[4]At the time of our audit, DOE was considering the applicability of DOE's CERCLA program to these sites.

[5]Such sites should be considered inactive because hazardous or radioactive waste is located there, and they are no longer used to dispose of such waste.

the additional sites reported to us primarily were, according to DOE officials, the result of identifying additional sites after the installation's Phase I report was submitted to headquarters. At the Y-12 Plant and the Savannah River Plant, the additional sites are considered to be RCRA sites and consequently were not reported under DOE's CERCLA program.

While the number of inactive sites reported to us is the most comprehensive as of December 1987, DOE officials told us the number of inactive sites is likely to change. Additional sites will likely be found as these installations continue their investigations and routine monitoring activities. For example, according to a contractor official at Hanford, 22 additional sites have been identified but not yet confirmed as inactive waste sites. At INEL, officials told us that they have identified an additional 78 inactive sites which they classify as potential because, while the best information or guess at this time is that no hazardous waste was disposed there, some waste may be present. Similarly, DOE officials at the Y-12 Plant, the Rocky Flats Plant, LLNL, and the Savannah River Plant told us that additional sites may also be found at their locations. Other sites may drop from the inventory as DOE continues its identification efforts. For example, Hanford officials told us that single-shell tanks, previously identified as inactive, may eventually be considered active for RCRA purposes. DOE officials at the sites we reviewed, while acknowledging that some additional sites may be found, believe all major problem areas have been identified.

DOE's Efforts to Assess Inactive Waste Sites Are Incomplete

Our review of the six DOE installations shows that, as of December 1987, 45 percent of the 1,447 inactive waste sites reported to us were scored using EPA's HRS. An additional 12 percent of these inactive waste sites were scored using variations of EPA's HRS, and about 43 percent received no evaluation. At most of the installations we reviewed, DOE has no further plans to score any more of their inactive waste sites.

Preliminary assessments using scoring systems are carried out to determine if the inactive waste site has the potential to cause health, safety, ecological, or environmental problems. EPA's HRS identifies those inactive waste sites that appear to pose the more serious threat.[6] Those sites that score high—at or above 28.5—with the HRS are considered for the NPL. The NPL, which is established by EPA, consists of those sites which are to be given priority attention for remedial action.

[6]Under SARA, EPA is required to modify the HRS and apply it to all inactive waste sites after October 1988.

DOE Order 5480.14, issued in 1985, specified that nonradioactive sites should be evaluated with EPA's HRS and that sites containing radioactive material should be evaluated with DOE's own ranking system. DOE's system, a revision of EPA's system, is referred to as the modified Hazard Ranking System (mHRS). DOE developed this system because it felt that the HRS system discriminated against sites containing radioactive material by failing to consider the natural decay of radioactive contaminants. DOE's official position of using two slightly different systems has changed since the 1985 order was issued. The Assistant Secretary for Environment, Safety, and Health, in a memorandum dated October 23, 1986, recommended that DOE installations score all their inactive waste sites using the HRS because EPA has not recognized the mHRS.

Although DOE's current policy is that all its inactive waste sites should be scored using the HRS, we noted, as shown in table 2.2 that, as of December 1987, only 45 percent of DOE's inactive waste sites were scored using EPA's HRS.

Table 2.2: HRS Assessments of DOE's Inactive Waste Sites (As of December 1987)

Installation	Number of inactive sites reported to GAO	Number assessed using the HRS	Percentage assessed
Hanford Reservation	998	497	50
Idaho National Engineering Laboratory (INEL)[a]	232	49	21
Lawrence Livermore National Laboratory (LLNL)[b]	12	9	7
Rocky Flats Plant[c]	102	14	1[illegible]
Savannah River Plant	69	59	86
Y-12 Plant	34	19	56
Total	**1,447**	**647**	**45**

[a]In addition to using the HRS for some sites, INEL used a variation of the HRS at EPA's direction for RCRA purposes. All 232 inactive waste sites were assessed using the variation of the HRS.

[b]LLNL sites were general areas of the installation rather than discrete sites.

[c]Rocky Flats Plant officials also calculated two aggregate HRS scores for the installation as a whole which are not reflected in the table.

In addition to HRS scoring, other scoring systems were used at some DOE installations. At INEL, a variation of the HRS system was developed for RCRA purposes and used to score all 232 inactive waste sites at INEL including those already scored under the HRS. Under this variation of the HRS, some HRS factors, such as the possibility of direct contact with the waste, were not considered. Further, according to DOE officials at INEL,

radioactive waste was not considered because it is not regulated under RCRA. The important result of using this type of system was that radioactive inactive waste sites were given a score of zero. Moreover, if an inactive site had mixed waste, the radioactive content of the waste was not considered in scoring.[7] At Rocky Flats, DOE officials prepared aggregate scores for the installation as a whole using the HRS system rather than scoring individual sites. Finally, DOE's own mHRS system was used to various degrees to assess inactive waste sites at the Hanford Reservation, INEL, Rocky Flats, and the Y-12 Plant.[8] At the Hanford Reservation, those sites scored with the mHRS were rescored using the HRS.

Even though various assessment systems were used, approximately 43 percent of the inactive waste sites reported to us received no score. Even though some sites were never scored, in general, DOE officials believe their assessment process is sufficient to characterize the major problem areas at their installations and have no further plans to score their inactive waste sites. At the Hanford Reservation, DOE officials told us they have no further plans to score their additional sites unless requested by EPA or the state of Washington. At the Rocky Flats Plant, DOE officials told us that although many of their sites were never scored, they believe they have a very good understanding of the potential impact of their inactive waste sites. They have no plans to score any more sites. DOE officials at the Savannah River Plant and the Y-12 Plant told us they have no plans to score any more of their inactive waste sites. Only officials at LLNL told us they plan to have two additional sites scored using the HRS.[9]

DOE headquarters officials told us that the HRS has served its intended purpose of providing a method for identifying NPL sites with priority for remedial action, and that further HRS scoring of inactive waste areas by DOE is unnecessary. They also noted that DOE headquarters has developed a system—the Multimedia Environmental Pollutant System—for ranking DOE's environmental problems at its installations nationwide, on

[7]This type of scoring system can have a dramatic effect on the scores for the sites containing radioactive waste. For example, one mixed waste site at INEL received a score of 41.9 using the mHRS and a score of only 4.9 using the variation of the HRS that does not consider radioactive waste.

[8]Because of the various scoring systems used at a single installation, many sites received two scores, and some sites received three.

[9]Since the third additional site is located in an area of LLNL that has already been named to the NPL, DOE officials are not requiring that this site be scored.

the basis of relative health and environmental risks posed by the problems. This system focuses on problem areas, such as groundwater contamination, and does not assess individual inactive waste sites.

Different Approaches Being Used by DOE Installations as They Continue to Address Inactive Waste Sites

DOE installations are subject to the requirements of both CERCLA and RCRA. At the installations we reviewed, somewhat different approaches are being used to address their inactive waste sites under these laws. One installation is addressing its inactive waste sites under CERCLA, while others are addressing them primarily under RCRA. Others are using a combination of RCRA/CERCLA coverage to address their inactive waste sites.

While CERCLA and RCRA both address cleanup of inactive waste sites, there are procedural and scope differences. CERCLA sets forth a phased approach for cleaning up inactive waste sites. This includes scoring with HRS, possible placement on the NPL, and now under SARA, a timetable for cleaning up NPL sites. The enforcing entity under CERCLA for NPL sites is EPA. RCRA, on the other hand, links cleanup of waste sites to obtaining a RCRA permit for treating, storing, or disposing of hazardous waste. The enforcing entities under RCRA are state governments when authorized by EPA. State governments can establish the time frame and procedural framework in cleaning up the waste. Thus, a particular inactive waste site can be subject to two different procedural processes under RCRA and CERCLA. Another difference in the two laws is their scope. CERCLA covers both hazardous and radioactive material, while RCRA exempts radioactive material from regulation. This is important for DOE because it has both types of inactive waste sites, along with mixed waste sites containing both hazardous and radioactive material. Finally, different cleanup standards could be applied to a given site, depending on whether RCRA or CERCLA authority is used. EPA recognizes this potential problem and is trying to achieve as much consistency as possible between its RCRA and CERCLA program.[10]

At the DOE installations we reviewed, different approaches in implementing these laws center around what constitutes a CERCLA site versus a RCRA site. At the Hanford reservation and the Savannah River Plant, officials told us that any site which became inactive after November 19, 1980—the effective day of RCRA—is a RCRA site for purposes of remedial action. These sites are not routinely reported to DOE for inclusion in its

[10]Hazardous Waste Corrective Action Cleanups Will Take Years to Complete (GAO/RCED-88-48, Dec. 9, 1987).

DOE-wide inventory. For example, 152 inactive waste sites at Hanford were not reported in the DOE-wide inventory. Hanford officials consider them to be RCRA sites because they became inactive after November 19, 1980. These classifications could change, based on subsequent review by EPA or the appropriate state government.

Other DOE installations we reviewed—the Rocky Flats Plant, the Y-12 Plant, and INEL—have taken a different approach. In general, these installations are addressing their inactive waste sites as RCRA sites regardless of when the site became inactive. INEL officials told us all their inactive waste sites are being addressed under an agreement with EPA's Region X, which implements RCRA. Because radioactive material is exempt under RCRA, radioactive sites and the radioactive constituents of mixed waste sites will be further addressed under CERCLA in determining the appropriate remedial action. At Rocky Flats, DOE officials told us that all their sites, except for solely radioactive sites, are being addressed under RCRA. As a result, these officials consider only 6 of their 102 inactive waste sites to be CERCLA sites. At the Y-12 Plant, only 1 of its 34 inactive sites is now considered a CERCLA site.

An official at LLNL told us that all of its sites are considered to be CERCLA sites because the installation was placed on the CERCLA NPL. Hence, LLNL has begun efforts to take remedial action on its inactive waste sites in accordance with CERCLA.

Although some DOE installations are following different approaches in implementing CERCLA and RCRA, DOE believes the end result will be the same. Disposal units will be characterized; potential impacts assessed; and remedial action evaluated, implemented, and verified as appropriate. However, many DOE officials at various installations have expressed concern about increased paperwork and analysis of sites resulting from being subject to both laws (e.g., providing analysis and data on inactive waste to state governments under RCRA and similar information under CERCLA to EPA). For example, INEL scored some of its inactive waste sites under the HRS system for DOE's CERCLA program and rescored them under a variation of the HRS for RCRA purposes. In the future, some DOE officials see possibly bigger problems because different sets of cleanup standards could be applied to inactive sites depending on whether CERCLA or RCRA authority was followed. Coordinating cleanup to ensure that both laws are met could cause delays.

According to a DOE headquarters official, DOE installations used different approaches to address their inactive waste sites because they received

varying instructions from their EPA and state regulators. Until recently, DOE installations lacked specific guidance from DOE's headquarters and field offices and from EPA on policies and procedures for concurrently implementing RCRA and CERCLA requirements at their inactive waste sites. In January 1988, however, EPA's Assistant Administrator for Solid Waste and Emergency Response issued a memorandum to EPA's regional offices outlining options for developing a comprehensive strategy addressing both RCRA and CERCLA issues at federal facilities. In this memorandum, EPA encouraged the use of one enforceable agreement between EPA, the state, and the federal facility to address both RCRA and CERCLA activities. This agreement would serve as a comprehensive plan for investigatory and remedial activities at the facility. EPA considers the memorandum a first step in developing an integrated RCRA/CERCLA federal facility compliance and cleanup strategy.

DOE headquarters officials recognize the need for a comprehensive approach to implementing RCRA and CERCLA requirements at inactive sites. For example, in December 1987, DOE's Assistant Secretary for Environment, Safety, and Health notified EPA and DOE's Operations Offices that DOE had identified nine facilities representing DOE's top priorities for developing comprehensive agreements with EPA and the states covering RCRA/CERCLA compliance activities. Further, in May 1988, DOE headquarters provided its field offices with model provisions for such agreements, developed jointly by DOE and EPA headquarters.

Conclusions

Although DOE began identifying inactive waste sites in 1981, the size of the problem still remains undefined. According to DOE headquarters' information as of December 1987, DOE had positively identified 982 inactive waste sites containing hazardous and/or radioactive waste. Our review of six DOE installations shows large discrepancies between the headquarters' inventory and the list of inactive sites prepared by DOE field offices. The six DOE installations reported 1,447 inactive waste sites to us, while DOE headquarters' inventory for these six installations showed only 605. The differences between the DOE headquarters' inventory and the number of inactive sites reported to us are primarily the result of (1) sites being identified and assessed after the installation's Phase I report was sent to headquarters and (2) the determination by DOE installations that some inactive waste sites did not need to be reported under DOE's CERCLA program. We also noted that additional sites are likely to be found at almost all the facilities we reviewed.

The extent to which DOE installations assessed their inactive waste sites varied greatly between the six installations. About 45 percent of DOE's inactive waste sites at the installations we reviewed have been assessed using the HRS. In addition, other evaluation systems have been used at some DOE installations. Some of these evaluation systems can minimize potential problems. For example, all of INEL's inactive waste sites were assessed using a system that zeros out the radioactive constituents of the waste. Hence, the hazards associated with the radioactive waste are not reflected when using that system. Other sites have generalized their waste problems by grouping a number of inactive waste sites together. Because DOE has not assessed all its sites in a systematic fashion, we do not believe DOE has an overall picture of the type or severity of the problems that exist. Further, meaningful comparisons of the problems at various DOE installations cannot be made to establish funding priorities because many sites have not been assessed or have been assessed using different evaluation systems.

We believe that an underlying cause of this situation is the different way that DOE installations are implementing provisions of RCRA and CERCLA. Some DOE installations are addressing inactive waste sites primarily under RCRA. For example, Y-12 Plant officials told us that all but one site will be reported and addressed under RCRA. Rocky Flats Plant officials told us that all inactive waste sites except radioactive sites are RCRA sites. Lawrence Livermore National Laboratory, on the other hand, is addressing all of its inactive sites under CERCLA.

Because DOE installations are using different approaches to address their inactive waste site problems, it is difficult for DOE headquarters to maintain oversight of how effectively DOE installations are addressing these problems. One facility may report most of its sites to DOE headquarters as CERCLA sites pursuant to DOE Order 5480.14, while others do not report sites to DOE headquarters because they consider them to be RCRA sites. Also, assessing the relative dangers at these sites becomes difficult. Some DOE installations follow DOE's CERCLA order and use an HRS evaluation. Other installations which consider the inactive waste sites to be RCRA sites either do no scoring assessment or have developed their own system. Finally, we are concerned that radioactive waste sites may be given a secondary priority if DOE installations implement RCRA—which excludes radioactive material from regulation—first and then CERCLA.

We believe DOE needs to develop a comprehensive approach for implementing the provisions of RCRA and CERCLA together. In developing this

approach, DOE should follow EPA's January 1988 memorandum covering a RCRA/CERCLA strategy. Such action, in our view, can help DOE avoid duplicative administrative and reporting requirements and confusion in managing remedial action efforts and can aid DOE in establishing funding priorities at its inactive waste sites nationwide. Such a strategy should be incorporated into DOE orders as soon as possible. In this regard, we note that DOE is still revising Order 5480.14. We believe DOE should add provisions to the order describing its strategy and how it will be implemented at DOE installations.

Recommendations

To improve DOE's oversight of its inactive waste sites nationwide, we are recommending that the Secretary of Energy:

- Develop and prescribe—in cooperation with EPA and the appropriate states—a comprehensive approach to address inactive waste sites which integrates provisions of both CERCLA and RCRA. For those inactive waste sites where CERCLA and RCRA authorities overlap, assessments and remedial action plans should be developed that address the sites as both a CERCLA and RCRA site. In issuing the revised DOE Order 5480.14, DOE should incorporate provisions that specify this comprehensive approach to be followed by DOE installations nationwide.
- Update the DOE headquarters' inventory to account for all DOE inactive waste sites. In doing so, the inventory should indicate the relative hazards associated with each inactive waste site.

Environmental Contamination and Cleanup Costs of Inactive Waste Sites at Selected DOE Installations

The waste disposal practices used by DOE and its predecessor agencies over the past 40 years have released hazardous radioactive and chemical substances into the environment. According to DOE records, high levels of groundwater contamination were present at each of the six installations we reviewed, in some instances, at levels hundreds to thousands of times that of federal drinking water standards. To a lesser extent, high levels of soil contamination have also resulted from some of DOE's inactive waste sites, along with some surface water contamination. As a result of these environmental hazards, one DOE installation we reviewed was placed on EPA's National Priorities List, one installation was proposed, and the four others are likely to be placed on the list. NPL designation sets in motion an extensive remedial investigation and cleanup process at inactive sites. Recent DOE headquarters information indicates that the total cost of cleaning up these sites nationwide could eventually be as high as $60 billion.

The following is a discussion, for each of six DOE installations we reviewed, describing some of the more serious environmental effects associated with its inactive waste sites, the status of the NPL consideration at the installation, and some perspective on the estimated costs of cleaning up all of these installations' known inactive waste sites.

Hanford Reservation, Washington State

The Hanford Reservation, established in 1943, contains numerous facilities involved in plutonium production for nuclear weapons, fuel fabrication and reprocessing, nuclear waste management, and energy research and development activities. The Hanford reservation is located close to a population center and water sources. Groundwater aquifers underlie the site, and the Columbia River flows through the northern and eastern part of the site.

Over the years, Hanford's waste disposal practices have contaminated the groundwater. In particular, liquid waste containing hazardous, radioactive, or mixed waste was frequently discharged directly into the ground, causing the waste to seep into the soil, surface water, and groundwater over an extended period of time. Hanford officials have identified a tritium plume covering a significant area of the reservation, along with many sites contaminated with nitrates, Iodine-129, and other hazardous chemicals. Other major environmental concerns at inactive waste sites on the reservation include leaks in high-level radioactive waste tanks, surface radioactive contamination, and Strontium-90

releases from the N-Reactor cribs. This contamination is particularly significant at Hanford because of its proximity to the Columbia River. Typical environmental concerns at the reservation are illustrated by the following two examples of its inactive waste sites—the No. 316-2 North Pond and the No. 316-3 Trench.

The North Pond, in use from 1949 to 1974, is located in the area of the reservation containing fuel fabrication and research facilities. The pond received large quantities of low-level radioactive liquid waste, cooling process water, and other liquid waste containing uranium. An estimated 10 billion liters of low concentrations of chemical and radioactive waste was disposed of here, including uranium, sodium, sodium aluminate, nitric acid, and other chemicals. Although the pond has dried since it was taken out of use in 1974, DOE-Hanford officials told us that, over the years, the waste has leaked into the groundwater. The site is located on the Columbia River bank and 4 miles upstream from a drinking water source for the city of Richland, Washington.

The trench, also located in the fuel fabrication area of the reservation, received radioactive and chemical wastes from operating facilities and a nearby pond during the 1953 to 1963 period. Approximately 1 billion liters of diluted waste was disposed of including copper and uranium. Like the North Pond described above, this trench has leaked contaminants into the groundwater and is cause for concern since it is located upstream from a Richland, Washington, drinking water source.

At the time of our audit, DOE-Hanford officials were completing their preliminary assessment of Hanford's inactive waste sites and beginning to confirm the presence or absence of hazardous substances and quantify the extent of contamination. To date, no sites had reached the remedial action phase or been cleaned up. Officials from DOE's Richland Operations Office, EPA's Region X, and the state of Washington's Department of Ecology were also developing an agreement for bringing both active and inactive units into compliance with environmental laws. The agreement will include implementation and groundwater-monitoring plans, along with target dates for remedial action. Further, a DOE-Hanford contractor is preparing an action plan for characterizing and remediating all of Hanford's inactive waste sites.

The Hanford Reservation was first considered by EPA's Region X for the NPL in the summer of 1987. On September 1, 1987, the EPA region submitted a package of information to its headquarters recommending that Hanford be considered a candidate for the NPL. EPA's Region X scored

Hanford as four areas, each receiving a score well above 28.5—the cutoff for the NPL. An EPA headquarters official told us that Hanford will likely be proposed for the NPL in 1988.

Among all the DOE installations we reviewed, Hanford has the largest number of inactive waste sites (998), many of which will require cleanup. DOE officials at the Richland Operations Office cannot predict their total cleanup costs until characterization and remedial investigation work is complete. Cleanup for radioactive sites (both active and inactive) has been explored in some detail. A DOE-Hanford official told us that an estimated $1.5 billion is needed to clean up inactive radioactive sites. Cleanup for all inactive waste sites at Hanford could be much higher because of the added costs of cleaning up the nonradioactive hazardous waste at inactive sites. Recent DOE headquarters information indicates that the upper boundary of cleanup options could potentially cost as much as $45 billion. However, until cleanup standards are negotiated and finalized by regulatory agencies, DOE officials told us that any total cleanup cost should be considered tentative.

Idaho National Engineering Laboratory, Idaho

INEL—initially established in 1949 to develop and test nuclear reactors—now carries out a wide range of activities including reprocessing spent nuclear fuel from naval ships and test reactors, nuclear safety research, reactor development, and waste management. Additionally, INEL carries out various energy research and development activities. INEL facilities generate hazardous, radioactive, and mixed waste. Some past practices that created actual or potential sources of contamination include discharging low-level radioactive liquid waste and chemicals into ponds or wells, or directly into the Snake River Plain aquifer, which flows under the site. Further, solid radioactive and chemical wastes have been disposed of in burial grounds, sometimes buried directly in the soil. This contamination resulting from INEL's past waste disposal practices can become a significant environmental concern because of the presence of the aquifer, which underlies the installation and provides much of the industrial, irrigation, and drinking water for southern Idaho. Officials in DOE's Idaho Operations Office and the state of Idaho consider the aquifer a valuable natural resource.

Some of the environmental problems associated with INEL's inactive waste sites are illustrated by two examples—the TRA Warm Waste Leach Pond and the TAN/TSF Injection Well. The TRA Warm Waste Leach Pond is an unlined pond that received low-level radioactive and chemical liquid

waste. The hazardous chemicals discharged into the pond include chromium, sodium hydroxide, and sulfuric acid. The pond has released chromium to the groundwater[1] near the pond in concentrations eight times above the federal drinking water standards. Further, DOE-INEL officials assume that tritium and other radionuclides, which have been detected in the nearby wells, have migrated from the pond. In response to RCRA Section 3004(u) requirements, these officials have developed a corrective action plan for measuring and characterizing the extent of contamination, including chromium, and for evaluating potential corrective actions.

The TAN/TSF Injection Well, in use from 1953 to 1984, received low-level radioactive waste, process wastewaters, and treated sanitary sewage from the laboratory's Test Area North/Test Support Facility. DOE-INEL officials suspect that the hazardous wastes disposed of in this well include mercury, potassium chromate, lead, chromium, and various solvents. The radionuclides disposed of in the well include tritium, Strontium-90, Cesium-134, and Cesium-137. Most of the hazardous and radioactive substances disposed of in this well have been discharged into the Snake River Plain Acquifer, which provides the entire water supply, including drinking water supplies, for INEL. High levels of contamination have been detected in the well, including trichloroethylene in concentrations as high as 7,000 times above the federal drinking water standard and trans-1,2-dichloroethylene in concentrations over 300 times the proposed drinking water standard. Low-level contaminants have also been detected in nearby drinking water wells. In response to RCRA Section 3004(u) requirements, DOE-INEL officials prepared a corrective action plan for confirming the sources of drinking water contamination in the TAN/TSF area, measuring the extent of contamination, monitoring the laboratory's drinking water supplies, and pursuing remedial action alternatives.

Of the installations we reviewed, INEL had the second largest number of inactive waste sites—232. The entire installation is currently under evaluation by EPA's Region X for placement on the NPL. Although EPA has not yet scored the installation, we believe that INEL could be placed on the NPL. Many waste sites at INEL were not constructed to prevent the waste from entering the environment. DOE's scoring of INEL sites resulted in five sites' scoring over 28.5—the EPA cutoff score for NPL designation—with one site scoring above 50.

[1] According to INEL officials, the groundwater was created by the pond and will eventually dry up.

DOE-INEL officials did not have estimates for cleaning up the installation's inactive waste sites but did estimate that about $50 million will be needed to complete characterization work for inactive waste sites. We also found that total cost estimates have been calculated for INEL's buried transuranic radioactive waste sites. For this type of waste, DOE has estimated the costs for three alternative treatments: (1) providing continued control for at least 100 years ($200 million), (2) improving confinement of the waste and providing continued monitoring and surveillance ($300 million), and (3) retrieving and processing the waste ($700 million). Recent DOE headquarters information indicates that the cost of corrective actions at all of INEL's inactive waste sites could potentially be as high as $2 billion.

Lawrence Livermore National Laboratory, California

LLNL is a multiprogram laboratory established in 1952 to conduct research and development on nuclear weapons, energy, and national security programs. The laboratory consists of two sites—(1) the main Livermore site, containing numerous facilities used for research on weapons systems, laser fusion, isotope separation, biomedical and environmental sciences, and other programs and (2) Site 300, located about 15 miles from Livermore and used for high explosives and materials testing and experimentation. During the 1940s and 1950s, the Livermore site was a Naval Air Station where aircraft were assembled and repaired.

Over the years, LLNL and its predecessors have used, stored, and disposed of hazardous materials on the property, using disposal practices that are no longer acceptable, such as dumping chemicals and solvents directly onto the ground. Suspected sources of chemical releases at the Livermore site include spills and leaks from outdoor storage facilities, burial grounds, and underground storage tanks and pipelines, along with past discharges to the site's storm drain system. Chemicals, solvents, and radioactive materials used at both the Livermore and Site 300 locations have seriously contaminated the groundwater at levels hundreds, and in some cases, thousands of times above federal drinking water standards. Two of the more severe problem areas are the Southwest Section/Off-site Plume and the Building 403 Gasoline Leak located at the main Livermore site.

The southwest section of the Livermore site was designated as a hazardous waste site because volatile organic chemicals have contaminated the groundwater in this area and have spread off-site. The contamination plume contains solvents including tetrachloroethylene at levels nearly

110 times above the federal drinking water standard and trichloroethylene in concentrations 120 times above the standard. The major sources of contamination include waste discharges from storm drains, degreasing and disposal practices, and spills and leaks.[2] The contamination has migrated off-site, causing concern because of the site's proximity to wells used for municipal and private drinking water supplies as well as agricultural uses. This concern led EPA, in October 1984, to propose the Livermore site for the NPL. EPA finalized the site's designation on the NPL in July 1987.

The Building 403 Gasoline Leak site resulted from the loss of approximately 17,000 gallons of gasoline that leaked from several underground storage tanks sometime prior to the period October 1978 through March 1979, when an inventory discrepancy was discovered and measured. As a result of the leaks, the soil and groundwater are contaminated with very high levels of fuel hydrocarbons. For example, the on-site groundwater near the leak is contaminated with benzene in concentrations as high as 9,000 times above the federal drinking water standard.

LLNL officials believe they have discovered and assessed the major sources of contamination at the Livermore site and Site 300, but they acknowledge that they have not identified all potential contamination areas, nor fully characterized the extent of contamination at the identified sites. At the Livermore site, LLNL is negotiating an interagency agreement with EPA's Region IX, DOE's San Francisco Operations Office, and the state regulatory agencies to cover the legal and technical aspects of CERCLA's implementation including reporting requirements, cleanup standards, time schedules, dispute resolution, and other issues. At Site 300, the laboratory has developed plans for remedial action alternatives at one inactive waste area and plans to continue groundwater investigations at the other sites. According to an EPA regional official, Site 300 will be evaluated separately for NPL designation.

DOE estimates that it will spend a total of approximately $180 million by the year 2025 to clean up inactive waste sites at the Livermore and Site 300 locations. This estimate includes the costs of assessing the site, developing and evaluating remedial alternatives and performing cleanup activities. An LLNL official told us that this cost could increase depending on the extent of contamination found, the remedial alternatives selected,

[2]LLNL officials believe that U.S. Navy activities during the 1942-46 period caused all of the off-site contamination and much of the on-site contamination in the southwest section of the Livermore site, while recognizing that LLNL's own disposal practices during the 1950-70 period also contributed to a relatively small proportion of the on-site contamination.

and the level to which the groundwater is cleaned. Recent DOE headquarters information indicates that the total cleanup cost could be as high as $370 million.

Rocky Flats Plant, Colorado

The Rocky Flats Plant, established in 1952, makes metal components containing plutonium for nuclear weapons and recovers these materials from components returned to the plant. Waste generated at the plant includes a wide variety of hazardous and radioactive materials. Most of the waste generated at the plant is shipped off-site. In the past, however, some waste was disposed of on-site.

Past practices have caused contamination of groundwater, surface water, soil, and air. Environmental releases of plutonium and tritium have occurred in the air and surface waters. Groundwater contamination with radioactive and hazardous substances has been detected on-site, and some off-site soil has become contaminated with low levels of plutonium. DOE-Rocky Flats officials believe they have assessed and assigned priority status to what they consider to be the more serious inactive waste problems at the plant. Two examples of such priority sites include the 903 Drum Storage Area and a group of solar evaporation ponds.

The 903 Drum Storage Area was utilized as a storage facility for radioactive lathe coolant—a mixture of hydraulic oil and carbon tetrachloride. Most of the oil stored was contaminated with plutonium or uranium. In 1964, approximately 400 of the drums were discovered leaking. Corrective action was taken to remove the drums and contaminated soil, but some contaminants remained. The groundwater in this area is contaminated with solvents (some hundreds of times above the federal drinking water standards), radioactive material (more than 10 times the drinking water standard), and other hazardous substances such as lead (slightly greater than the drinking water standard).

The solar evaporation ponds, used from the 1950s to the present at the Rocky Flats Plant, are surface excavations for storing and evaporating the effluents that remain after processing liquid waste. Originally, the ponds were simply clay-lined but later were lined with asphalt. During the 1960s, new ponds were constructed with cement and asphalt. Many of the ponds over the years leaked waste into the ground. Groundwater monitoring shows the groundwater contaminated with radioactive materials (above the drinking water standard) and nitrates (greater than 500 times above the drinking water standard).

Because of the environmental impact resulting from its inactive waste sites, the Rocky Flats Plant was proposed for EPA's NPL in 1984. The plant is addressing its inactive waste sites under a Federal Compliance Agreement with the state of Colorado and the EPA regional office. In accordance with this agreement, Rocky Flats officials have assigned priority to their most severe problem sites, are investigating the extent of contamination, and are developing feasibility studies for remedial actions.

DOE officials believe that it will cost about $20 million per year over the next 10 years to clean up their inactive waste sites, for a total cost of $200 million. This includes removing the most hazardous waste, taking actions to better ensure that the remaining waste is stabilized, and providing continual monitoring. These officials recognize, however, that if very strict standards are applied to the site, the total cost may be much higher. Recent DOE headquarters information indicates that the total cleanup cost could be as high as $400 million.

Savannah River Plant, South Carolina

The Savannah River Plant was established in 1950 primarily to produce plutonium, tritium, and other special nuclear materials for national defense purposes, but also to conduct some civilian energy functions. Its defense activities include nuclear fuel and target fabrication, materials production in nuclear reactors, and chemical separations. In over 30 years of operation, the plant has generated large quantities of hazardous, radioactive, and mixed wastes. These wastes include (1) hazardous materials such as acids and caustic wastes, lead, waste oil and degreasers, and chemicals and spent solvents, (2) high- and low-level liquid radioactive waste and transuranic solid waste, and (3) mixed waste such as tritium-contaminated waste oil and lead-contaminated radioactive solid waste. Over the years, these wastes have been disposed of in various ways including shallow land burial, discharge to seepage basins, and burning or evaporation processes. According to plant assessments, seepage basins, such as the Ford Building seepage basin and the TNX seepage basin, are among the more significant environmental problems at the plant.

The Ford Building Seepage Basin, which was used from 1964 to 1984, received waste water from equipment repair operations conducted in a nearby building. The waste water contained only low levels of radioactive contamination and trace amounts of oil and grease; however, soil sampling indicates that other hazardous substances including lead, chromium, mercury, and other metals, may have been disposed of in this

basin. This site has contaminated the surrounding soil with radionuclides, including Strontium-90 in concentrations as high as 580 times above background levels, Cesium-137 in concentrations 125 times above background levels, and Cobalt-60 in concentrations over 100 times above background levels. Additionally, the soil is contaminated with lead, chromium, mercury, and various metals above background levels. SRP plans to complete the site's assessment in 1988, implement closure in 1989, and continue groundwater monitoring indefinitely.

The TNX seepage basin, in operation from 1958 to 1980, received process waste water from pilot-scale tests conducted at waste management and chemical separations facilities in the area. In 1981, the basin was drained to the adjacent wetlands, backfilled with a sand and clay mixture, and covered with asphalt. During its operation, this basin received hazardous substances including radionuclides, heavy metals, and chemicals. The waste discharged to this site has contaminated the surrounding groundwater and soil. The groundwater, for example, contains the solvent trichloroethylene in concentrations as high as 165 times above the federal drinking water standard, and manganese in concentrations nearly 50 times above the standard. The surface water adjacent to the basin is also contaminated with mercury at levels as high as 50 times above the drinking water standard, radium in concentrations over 30 times above the standard, and chromium 10 times above the standard. Further, the soil contains numerous radionuclides and heavy metals above background levels including plutonium, radium, uranium, chromium, mercury, and silver. The plant plans to develop a closure plan for this basin in 1988 and continue groundwater monitoring efforts to further characterize the environmental impact.

Because of existing environmental problems, the Savannah River Plant is under consideration by EPA's Region IV for NPL designation. EPA regional officials have developed a preliminary aggregate score for the entire plant of 49.1—well above the 28.5 cutoff for the NPL. EPA regional staff believe that this score is sufficient to place the plant on the NPL. Based on the current evidence about high levels of groundwater and soil contamination at the plant, this DOE installation will likely be named to the NPL.

Savannah River Plant officials had detailed cost estimates to address inactive waste sites. Their estimates include actions to remediate each inactive waste site identified, along with the costs to manage the site for 5 years after remedial action. DOE officials estimate that the cost of

cleaning up its 69 inactive waste sites will be $285 million. This cost represents DOE's preferred approach to reduce or eliminate any health threat, but does not include the costs of removing all of the waste present at its sites. Recent DOE headquarters information indicates that the total cleanup cost at the plant's inactive sites could be as high as $6.5 billion.

Y-12 Plant, Tennessee

The Oak Ridge Y-12 Plant, built in 1943, was established to produce nuclear weapons components, to process source and special nuclear materials, develop and fabricate test hardware for weapons design laboratories, and provide engineering and other support for federal agencies. The plant is one of three major facilities that comprise DOE's Oak Ridge Reservation. To accomplish its missions, the plant conducts various activities that include producing lithium compounds, recovering enriched uranium from scrap metal, and fabricating uranium into finished weapons parts. The Y-12 Plant is located adjacent to the City of Oak Ridge and the Clinch River.

Y-12 Plant activities generate both hazardous and radioactive waste including mercury, uranium, organic solvents, waste oils, nitrates, asbestos, and other materials. Over the years, the plant's waste disposal practices have included hazardous liquid and solid wastes being placed into unlined trenches and ponds; waste solvents being burned in open tanks and pits; mercury being vented into the atmosphere; and low-level radioactive solid waste being disposed of by shallow land burial. Spills and leakage from inactive disposal and storage facilities have resulted in many contaminated areas in and around the plant.

Inactive waste sites at the plant have contributed to severe groundwater contamination, with solvent and nitrate concentrations reported at levels 1,000 times above the federal drinking water standards, mercury at levels 500 times above the standard, and chromium at levels 30 times above the standard. Further, off-site soil contamination with mercury from the Y-12 Plant operations has been recorded at over 3,600 times above background levels. According to Y-12 assessments, two of the more significant inactive waste sites are the Bear Creek Burial Grounds and the mercury-contaminated areas.

The burial grounds consist of a series of trenches used for disposal of liquid and solid wastes including uranium, thorium, oils, solvents, PCBs, and contaminated waste from floor-cleaning operations known as mop waters. Until 1981, wastes generated from the main production

processes at the Y-12 plant were disposed of in this area. The burial grounds are located about 2 miles from the Y-12 Plant and near several creeks, including one that drains into the Clinch River. Past disposal practices at this inactive site, including the use of unlined trenches, have contaminated the groundwater with volatile organic chemicals, lead, and chromium exceeding federal drinking water standards and have caused soil contamination. Further, deposits of uranium chips have created a fire threat. Although the adverse environmental effects associated with the burial grounds are significant, a 1985 DOE-contracted study on the Bear Creek disposal area concluded that the contamination in this area poses no direct threat to drinking water supplies and no imminent threat to public health. Y-12 Plant officials have prepared a plan for closing the burial grounds in stages beginning in late 1988.

Mercury contamination resulting from past operations at the Y-12 Plant has been widespread. Mercury was extensively used at the plant during the 1955 to 1963 period as part of a lithium isotope separation process. During this period, mercury was released into the environment through spills to the storm-sewer system which drains into the nearby East Fork Poplar Creek and through releases to the soil and atmosphere. Mercury is also present in the building structures and drain systems and was trapped in process equipment. As a result, the mercury releases have contaminated an on-site creek and the surrounding soil, and mercury contamination above background levels has been detected in the Tennessee River soil as far as 118 miles downstream from the Oak Ridge Reservation. The Y-12 Plant plans to eliminate the mercury contamination sources that are readily removable, remove contaminated equipment and piping, and refurbish storage tanks.

The Y-12 Plant is being considered for the NPL by EPA's Region IV. Regional EPA officials have prepared a preliminary HRS score for the entire Oak Ridge Reservation, including the Y-12 Plant, Oak Ridge National Laboratory, and Oak Ridge Gaseous Diffusion Plant. The preliminary score was 43.6, which was well above EPA's cutoff score of 28.5. Specific environmental degradation from the Y-12 Plant, including off-site mercury contamination in nearby creek beds, was included in the overall scoring. DOE's own scores of the contamination in the two nearby creek beds were 31.2 and 25.7.

Funding requirements for remedial actions at the Y-12 Plant have not yet been determined. DOE is still exploring remedial action alternatives for many of its inactive waste sites. However, DOE officials at the plant

estimate that at least $500 million will be needed to clean up the inactive sites. They also recognize that this cost could eventually be much higher if the most stringent environmental cleanup standards are applied. Recent DOE headquarters information shows that the total costs to remediate inactive sites could be as high as $660 million.

Conclusions

Over the past 40 years, DOE and its predecessor agencies employed waste disposal practices that have adversely affected the environment at their facilities. Our review of six DOE installations showed that inactive waste sites have led to high levels of contamination of groundwater with radioactive, chemical, and other hazardous substances. Soil and surface water have also been contaminated. Each of the six installations reviewed had identified groundwater contamination linked to its inactive sites. Sometimes the contamination was thousands of times above the federal drinking water standards. Similarly, the soil surrounding DOE's inactive sites has become contaminated. Two of the six installations reported soil contamination at levels hundreds to thousands of times that of background amounts. To a lesser extent, surface water contamination has also been identified at three of the installations reviewed. While significant contamination has been reported at the six installations we reviewed, the full environmental effect of DOE's inactive waste sites is unknown since DOE is still investigating and characterizing the extent and severity of contamination at its facilities.

Although DOE has not yet identified or systematically assessed all of its inactive waste sites at the six installations, the information available to date on groundwater and other contamination indicates that the environmental problems are severe enough for all of them to make EPA's NPL. Lawrence Livermore National Laboratory has already been named to the NPL, and the Rocky Flats Plant has been formally proposed for the list. Further, the other four installations included in our review are under consideration. Three have received preliminary scores from their EPA region that exceed the NPL cutoff score.

Because of the severity of the environmental problems, a massive cleanup effort will be necessary. Currently, cost estimates vary considerably at the six installations because each location is still assessing the full scope of the problem and developing the necessary remedial action alternatives. A further complicating factor is the degree of cleanup that will be necessary at an individual site. DOE could be required in some instances to remove all of the waste and in other cases simply be

required to treat the waste so that it is less hazardous and mobile. Treatment versus removal could have a significant effect on the eventual cost. Cleanup costs for inactive sites will be extremely high, and DOE officials have estimated the cost to be over $1 billion at some installations. Further, recent DOE data indicate that the eventual cost for all DOE installations could be as high as $60 billion.[3]

Because of our concerns about the magnitude of environmental problems resulting from DOE's inactive waste sites, and the extremely high potential costs of cleaning up these sites, we are calling attention to an earlier recommendation we made to DOE, viz., that DOE prepare a comprehensive plan, including milestones and cost estimates, to bring DOE facilities into full compliance with environmental laws.[4] A significant part of this plan should necessarily address DOE's inactive waste sites, which are a major contributor to DOE's environmental problems. DOE is currently working on such a long-range plan that will cover the extent of all environmental problems at DOE facilities, DOE's plans to address these problems, the time frames for completion, and the estimated total costs. DOE expects to complete this plan, which will include inactive waste sites, in July 1988.

[3]We previously reported that DOE cannot readily identify its budgeted or expended RCRA and CERCLA dollars because the funds are commingled with moneys for Defense operations (GAO/RCED-88-62, Dec. 16, 1987).

[4]See Environmental Issues at DOE's Nuclear Defense Facilities (GAO/RCED-86-192, Sept. 8, 1986).

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