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The disposal of nuclear facilities has become a special problem because of the growing number of these facilities and the radioactivity associated with them. The Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC) have the chief responsibilities in this matter with help from the Environmental Protection Agency and the states. Findings/Conclusions: ERDA, which is responsible for disposing of, or decommissioning, its own facilities, has not compiled relevant details for assessing problems, and facilities in need of decommissioning have been accumulating. NRC, responsible for regulating private users of nuclear materials, has done little to plan for decommissioning, and does not require owners of nuclear facilities, except for uranium mills, to develop plans or make financial provisions for future decommissioning. Thus, the State governments can be asked to pay for these problems. Only seven States require bonding or advance accumulation of funds for decommissioning. Before a strategy for meeting these problems is developed, basic questions must be answered pertaining to costs, methods of decommissioning, standards and limits for radiation levels, and the role of the States. A proposed bill directing ERDA to study decommissioning comprehensively is a possible vehicle for providing this information. Recommendations: Congress should designate NRC as the lead Federal agency for overall decommissioning strategy. ERDA should continue research and development efforts to find alternatives, expand its present program, and plan for future decommissioning. NRC should plan for decommissioning at the time of licensing, determine acceptable radiation levels, and encourage States to follow its lead in adopting comprehensive planning. (HTW)

REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Cleaning Up The Remains Of Nuclear Facilities-- A Multibillion Dollar Problem

Energy Research and Development Administration
Nuclear Regulatory Commission

The problem of protecting the public from the hazards of radiation lingering at nuclear facilities which are no longer operating needs Federal attention if a strategy for finding a solution is to be developed.

The solution doubtless will be expensive--but the expense should be known so the responsible parties can plan for the inevitable cost. A strategy to clean up these privately and federally owned nuclear facilities, which continue to accumulate, cannot be developed until basic questions on the magnitude of the problem, such as costs, radioactivity, and timing, have been answered.

EMD-77-46

JUNE 16, 1977

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-164052

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the Nuclear Regulatory Commission's and the Energy Research and Development Administration's programs for disposing of nuclear facilities after these facilities are no longer needed.

We made this review as a part of our evaluation of the effectiveness of the Commission's regulatory activities, as required by the Energy Reorganization Act of 1974 (42 U.S.C. 5876). The Administration was included because of similar program activities.

We are sending copies of this report to the Chairman, Nuclear Regulatory Commission, and to the Administrator, Energy Research and Development Administration, and to interested committees of the Congress.

Sincerely yours,

Comptroller General
of the United States

Enclosure

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

CLEANING UP THE REMAINS OF NUCLEAR FACILITIES--A MULTI-BILLION DOLLAR PROBLEM
Nuclear Regulatory Commission
Energy Research and Development Administration

D I G E S T

Sixty-four commercial nuclear powerplants are now licensed to operate in the United States. By the year 2000, there may be about 235. The licenses for commercial nuclear activities in areas such as medicine and industry, now stands at about 19,000. Numbers of other kinds of nuclear facilities have also been increasing and still are. (See pp. 4 to 8.)

As with every industry, nuclear facilities and equipment may be shut down, replaced, or become obsolete. Cleaning up the remains of nuclear activities, however, presents special problems because of radioactivity and contamination which can endanger public health and safety. Some radioactivity remains hazardous for thousands of years making final and absolute disposal at best a difficult and expensive task. (See p. 3.)

Responsibility for seeing that this is done rests primarily with two Federal agencies with additional help from a third and the 50 states:

The Energy Research and Development Administration is responsible for disposing of, or decommissioning, the radioactive facilities it owns.

The Nuclear Regulatory Commission is responsible for regulating private users of nuclear materials, including powerplants, uranium mills and processors of nuclear fuel.

The 50 States have traditionally been responsible for controlling the hazards of using accelerators and radium.

The Environmental Protection Agency has overall responsibility for issuing standards for the protection of the environment from all sources of radiation. But to do this it must have cooperation from the other two agencies identified.

THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

This agency has not paid enough attention to its facilities that are now obsolete. It has not compiled relevant

details of the facilities it owns--obsolete or operating--which would permit it to assess the magnitude of the decommissioning problems they pose. (See p. 17.)

Funds for decommissioning have been used for several specific projects. One project involved sites used for radiological operations 20 to 30 years ago that were released for unrestricted use by the general public. An attempt is being made now to identify any of these sites that are still contaminated and to do what is necessary to eliminate remaining radiation. (See pp. 9 and 10.)

Meanwhile, this agency's facilities in need of decommissioning have been accumulating. Reliable estimates have not been made but it seems probable that the cost to decommission federally-owned nuclear facilities will run into billions of dollars. One of its contractors estimated it could cost as much as $4 billion to decommission the facilities at the largest of this agency's 26 reservations. (See pp. 17 and 18.)

THE NUCLEAR REGULATORY COMMISSION

The Commission has done relatively little to plan for and to provide guidance for decommissioning of commercial nuclear facilities. Studies sponsored by the Commission on acceptable alternative methods to decommission are several years from completion. It does not require owners of nuclear facilities--except for uranium mills--to develop plans or make financial provisions to cover the cost for future decommissioning. Consequently, the true cost of nuclear power is not being reflected in the cost to the consumer of nuclear power. Without this financial provision, the Federal or State Governments can be asked to pay for problems that rightfully should be paid by private industry. (See pp. 11, 12, and 15.)

Situations where this has happened, or may, have already arisen. For example, the Federal Government will pay about $85 million to clean up residues from inoperative uranium mills that were privately owned. Also, as much as $600 million may be needed to decommission a privately owned nuclear fuel reprocessing plant at West Valley, New York. The State Government is responsible for cleaning-up the plant but has asked the Federal Government for assistance. In a case at Clinton, Tennessee, the Federal and State Governments shared the cost--approximately $110,000--to decontaminate a facility that the owners walked away from in 1971. (See p. 15.)

Although cost estimates to decommission private facilities have not been developed by the Commission, a recently completed study by a private organization estimated the cost to decommission a commercial nuclear reactor to be as much as

$39 million. No cost data, except for wide-ranging estimates, is available for decommissioning other facilities, such as uranium mills or fuel fabrication plants. (See pp. 13 and 14.)

STATE GOVERNMENTS

A conference of State officials has recommended that States protect themselves from financial loss should a company not be able to pay to decommission its facilities. However, only seven States require some form of bonding or advance accumulation of funds for decommissioning. (See p. 23.)

The problem of protecting the public from the hazards of obsolete nuclear facilities needs Federal attention if a strategy for finding a solution is to be developed. The solution, in all likelihood, will be expensive--but the expense should be known so the responsible parties can plan for the inevitable cost.

A strategy cannot be developed until certain basic questions have been answered.

- --How much will decommissioning cost and who should pay?
- --How should nuclear reactors be decommissioned?
- --What is the extent of the decommissioning problem for accelerators?
- --Are standards needed for induced radiation?
- --What should be the limits on acceptable radiation levels?
- --What more should States do to plan for decommissioning?

(See pp. 13 to 24.)

A bill (H.R. 6181) has been proposed directing the Energy Research and Development Administration to study decommissioning comprehensively. This study should provide basic information needed to develop a strategy toward solving decommissioning problems.

RECOMMENDATION TO THE CONGRESS

Because of the magnitude, cost and time already lost, the Congress should designate one lead Federal agency--the Nuclear Regulatory Commission--to approve and monitor an overall decommissioning strategy.

The Nuclear Regulatory Commission is uniquely suited for this role because of its charter to independently regulate commercial nuclear activities to assure public health and safety. This position is consistent with a previous GAO report and testimony. Placing this responsibility with the Commission would, in addition, increase the credibility of Federal regulation over nuclear energy.

The Energy Research and Development Administration should continue its research and development efforts aimed at finding alternatives for decommissioning and decontamination of nuclear facilities.

Recommendations

The Administrator of the Energy Research and Development Administration as part of his research and development responsibility, should

- --determine alternative methods of decommissioning, acceptable levels for induced radiation and surface contamination, and the extent of the decommissioning problem for accelerators;
- --expand and accelerate a program to decommission nuclear facilities currently excess to its needs; and
- --require that program managers plan for future decommissioning and include such cost information in their program budgets.

The Chairman, Nuclear Regulatory Commission, should for those facilities he regulates

- --require specific plans for decommissioning at the time of licensing, including the decommissioning method to be used and a funding mechanism to assure that facility owners pay the costs of decommissioning;
- --determine the acceptable levels for induced radiation and surface contamination consistent with environmental standards being developed by the Environmental Protection Agency; and
- --encourage States to follow the lead of the Commission in adopting comprehensive decommissioning planning for facilities under States' control.

AGENCY COMMENTS

The Energy Research and Development Administration was unable to furnish written comments in time to be finalized in this report. However, GAO met with Energy Research and Development Administration officials and obtained their oral comments which have been incorporated in this report. These officials disagreed with giving the Commission responsibility over Energy Research and Development Administration facilities. However, they will consider this matter further and will provide written comments in the near future.

The Nuclear Regulatory Commission's comments on the report are contained in a letter dated June 10, 1977. (See appendix I.) The letter describes the actions the Commission is taking or plans to take to develop methods and criteria for decommissioning nuclear facilities.

Because of time constraints and the report's relatively limited treatment of the Environmental Protection Agency, its comments were not sought.

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ABBREVIATIONS

AEC	Atomic Energy Commission
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission

CHAPTER 1

INTRODUCTION

Before 1954, nuclear activities were confined largely to the Federal Government and to military applications. In that year, legislation was enacted permitting commercial firms to use nuclear materials and operate nuclear facilities. The uses for nuclear material and facilities then began to expand, reaching farther into such areas as medicine, industry, and electrical production.

As the uses increased, so did the equipment and facilities involved in the uses. Equipment and facilities in the nuclear industry, as in any other, become obsolete, break down, or are replaced or abandoned for a variety of reasons. This report discusses the problems in making sure that the facilities, equipment, and materials involved in nuclear activities are disposed of in a way that precludes any health or safety hazards--now or in the future.

FEDERAL AND STATE RESPONSIBILITIES

The Energy Research and Development Administration (ERDA) is responsible for the radioactivity in facilities it owns, leases, and controls. This includes facilities such as reactors and accelerators located both on nonfederal and on ERDA-owned property--commonly referred to as ERDA reservations.

The Nuclear Regulatory Commission (NRC) is responsible for regulating private uses of nuclear materials. This responsibility covers nuclear powerplants, uranium mills, facilities which make or process nuclear fuel, and the regulation of users of source, byproduct, and special nuclear material 1/. NRC fulfills its responsibility through a system of licensing and inspection.

The Environmental Protection Agency has overall Federal responsibility for issuing standards for the protection of the environment from all sources of radiation. To carry out this responsibility, however, the Environmental Protection Agency must have the cooperation of other Federal agencies. Therefore, ERDA and NRC are primarily responsible for

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1/Source material is naturally occurring radioactive material such as uranium and thorium. Byproduct material is radioactive material created during a nuclear reaction. Special nuclear material is enriched uranium and plutonium.

developing, implementing, and enforcing radiation standards for individual nuclear facilities.

States traditionally have been responsible for protecting the public health and safety and controlling the hazards of radium and naturally occurring radioactive materials which are not subject to NRC control. In addition, 25 States have signed agreements with NRC whereby they control the source, byproduct, and small quantities of special nuclear materials located within their boundaries.

The remaining chapters of this report discuss

--the facilities and activities that present a problem;

--the past and current efforts to solve the problem;

--the major questions that remain unanswered; and

--our conclusions, observations, and recommendations.

CHAPTER 2

FACILITIES AND ACTIVITIES

THAT MUST BE CLEANED UP

While a nuclear activity is ongoing, the materials, equipment, and facilities that come into contact with a nuclear reaction or radioactive material could become contaminated or radioactive. Once the activity is ended, disposing of these items presents special problems. Facilities once used for nuclear activities cannot be abandoned if radioactive materials remain that present a radiation hazard. Structural materials or equipment cannot be recycled if they have been made unsafe by contact with a nuclear activity. A nuclear operations building cannot be reused for other purposes unless radioactive materials and contamination have been removed or reduced to acceptable levels.

Many types of nuclear facilities must be prevented from endangering public health and safety. Each type will have to be handled, or decommissioned, in a different way. A major factor in determining the best way is the nature of the radiation hazard at the facility.

Two types of hazards could be involved in a nuclear facility: induced radioactivity and surface contamination. Induced radioactivity results from a nuclear reaction and is embedded in the equipment or material coming into contact with the nuclear reaction. This induced activity cannot be cleaned-up and can remain dangerous for thousands of years. For this reason, a structure containing induced radioactivity should be dismantled at some point in time. This should be done before the structure begins to deteriorate, thus permitting the radioactivity to enter the environment.

Surface contamination results from facilities or equipment coming into contact with radioactive material. As opposed to induced activity, material having surface contamination can often be cleaned up by scrubbing and washing.

In describing the cleaning-up process, the words decontamination and decommissioning are often used. In this report, decontamination denotes the process of cleaning-up surface contamination. Decommissioning is a term used by NRC and ERDA to indicate the closing or shutting down of a facility with some actions taken to prevent--at least temporarily--health and safety problems. It does not necessarily denote a permanent solution to cleaning-up the facility.

This chapter discusses the major types of nuclear facilities that will have to be cleaned up.

REACTORS

Nuclear power reactors, which have an estimated useful operating life of about 40 years, are a major decommissioning problem because of their enormous size and their large inventory of induced radioactivity. In May 1977, 64 commercial nuclear power reactors were licensed to operate. By the year 2000 an additional 175 may be operating. NRC regulates these commercial reactors.

NRC also regulates more than 73 other so-called nonpower reactors, which are used for tests, research, and university application. ERDA owns about 80 such nonpower reactors. These are much smaller than the commercial power reactors. The military owns an additional 174 reactors, in operation or under construction. Most of these belong to the Navy and are used in nuclear submarines and carriers.

There are generally four recognized methods for decommissioning reactors--dismantlement, entombment, mothballing, and a combination of either entombment or mothballing with subsequent dismantling.

Dismantlement involves the total removal of the facility from the site to radioactive waste burial grounds. The land is then restored to its original condition and released for unrestricted use. The largest problem involved in immediate dismantlement is contending with the radiation hazards from the large amounts of induced activity. To prevent the workers engaged in the dismantling activities from receiving excessive doses of radiation, much of the cutting of the reactor parts must be done by remote-controlled equipment underwater--a costly and time-consuming process.

Entombment consists of sealing the reactor with concrete or steel after all liquid waste, fuel, and surface contamination have been removed and sent to fuel storage facilities or burial grounds. NRC does not require an entombed facility to have security systems to protect against intrusion. However, it does require annual surveillance for possible radiation leaks. Also, periodic maintenance is required to insure the integrity of the entombed structure.

Mothballing is simply removing the fuel and radioactive waste and then placing the facility in protective storage. A mothballed facility requires a security intrusion system, annual radiological surveys, and periodic maintenance.

The fourth method is a combination of either mothballing or entombment with subsequent dismantlement. This method offers the advantage of placing the facility in an entombed or mothballed status for about 65 to 110 years, until the induced activity decays to a level which permits dismantling without undue radiation danger to the workers. The entombment and mothballing methods and, to a lesser extent, the combination methods, would limit the use of the affected land.

ACCELERATORS

An accelerator is a device used to increase the velocity and energy of particles like electrons or protons. They are used in physical, medical, and biological research, as well as for commercial purposes. Acclerators may be a problem at the time of decommissioning depending on (1) the type, (2) the size, and (3) the usage--including length of time operated. High levels of radioactivity may be induced in target materials, structural walls, or in the experimental equipment used during the operation of the accelerator. This induced radiation requires special attention at the time of decommissioning.

Large accelerators may have to be completely dismantled because of the large amounts of induced activity. For example, a large, federally owned accelerator located at Carnegie Mellon University has been dismantled at a cost of about $485,000.

States are responsible for registering and inspecting privately owned accelerators. In fiscal year 1968 there were about 580 accelerators reported as owned by various private concerns and universities under State jurisdiction. This number had increased to about 1,000 at the end of fiscal year 1975. In addition, ERDA officials told us ERDA now owns about 45 large accelerators.

FUEL FABRICATION FACILITIES

Fuel fabrication facilities are used to process and make nuclear fuel. These facilities have only surface contamination to contend with at the time of decommissioning. It seems probable, therefore, that these facilities could be cleaned-up at less cost than reactors. However, to our knowledge, no studies of methods and associated costs to decommission these facilities have been done.

There are 21 commercially operating fuel fabrication plants. We contacted all owners by questionnaire to obtain comments on anticipated problems and costs to decommission. Six of the 14 respondents indicated they did not anticipate

significant problems. One thought there could be a problem because of regulations on decommissioning becoming more stringent in the future. The remaining seven had no comment.

URANIUM MILLS

Uranium mills are used to refine and process the uranium ore that is mined. They too have only surface contamination to contend with at the time of decommissioning. Therefore, the plants themselves can be cleaned-up at much less cost than a reactor. However, uranium mills have a problem with stabilizing uranium mill tailings 1/. This problem is discussed in more detail in chapter 3.

To our knowledge, no studies have been made on decommissioning uranium mills. We sent questionnaires to all uranium mill owners for the 20 licensed mills. Of the 13 who responded, 8 said they did not anticipate any decommissioning problems, 3 said there would be some type of problem because of changing or uncertain NRC regulations, and 2 had no comment.

FUEL REPROCESSING PLANTS

Fuel reprocessing plants are used to separate unused uranium and plutonium from fuel that has been used in nuclear reactors. ERDA is now operating three reprocessing plants. ERDA has one more plant on standby and five plants that were shutdown in the 1950s and 1960s but that have not been decommissioned.

The only commercial reprocessing plant that ever operated in the United States is the Nuclear Fuel Service, Incorporated, plant at West Valley, New York. This plant was shut down in 1972 and has not yet been decommissioned.

VARIOUS USERS OF RADIOACTIVE MATERIALS

Various organizations use source, byproduct, and special nuclear materials for industrial, medical, and educational applications. These organizations vary from firms that use nuclear materials to check the adequacy of welds made on construction projects to physicians and medical organizations that use radioisotopes for therapeutic and diagnostic purposes.

1/Uranium mill tailings are sand-like radioactive waste materials resulting from the extraction of uranium from uranium ore.

Decommissioning facilities and equipment in which radioactive materials were used could be a problem depending on (1) the type of material and form it was in, (2) how it was used, and (3) the half-life 1/ of the material. The radiation hazard is in the form of surface contamination which often can be cleaned at a fairly low cost by scrubbing and washing with acids and water.

The potential for radiation hazard is high if unsealed radioactive materials were used for manufacturing or research and development. On the other hand, the potential radiation hazard is quite small if the user was working only with sealed sources 2/ or with radioactive materials having short half-lives.

As of June 30, 1968, there were 15,913 material licensees --9,257 under NRC control and 6,656 under agreement State control. By December 1975 this number had increased to 19,102--8,468 and 10,634 for NRC and agreement States, respectively.

WASTE HANDLING AND STORAGE

Many operations that produce or use nuclear materials generate radioactive waste. This radioactive waste is usually classified as "high-level" and "low-level". High-level waste is generated during the chemical reprocessing of used or spent fuel. High-level waste has intense radiation, generates heat and is very hazardous.

Low-level waste, in most cases, is less intense but may contain long-lived radiation. For this reason, it is buried underground and monitored indefinitely.

Both types of waste present a problem. High-level waste that has already been produced is stored in large tanks which provide only an interim solution to the disposal problem. At the end of the tanks' useful lives, the waste must be moved to other (new) tanks, or be removed, solidified, and transported

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1/The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years.

2/Sealed source means any radioactive materials that is permanently encased in a container or matrix designed to prevent the leakage or escape of such radioactive material under foreseeable conditions of use and wear.

to burial grounds. The old tanks have to be removed, cut up, and also transported to burial grounds. ERDA, on its Hanford reservation alone, has 156 high-level storage tanks. Some of these tanks have already leaked 1/.

There are presently six commercial and five Federal disposal sites containing more than 51 million cubic feet of other-than-high-level waste. These burial grounds require monitoring for centuries and may present future costly problems.

In a January 1976, report 2/ to the Congress we noted that some radioactive migration has occurred at several of these burial sites. If the situation worsens, it may entail exhuming the waste. If this is required it can be quite expensive running into hundreds of millions of dollars.

1/We are now preparing a report on the subject of high-level waste which we expect to issue during the summer of 1977.

2/Improvements Needed in the Land Disposal of Radioactive Wastes--A Problem of Centuries (RED-76-54, January 12, 1976).

CHAPTER 3

PAST AND CURRENT EFFORTS TO SOLVE THE PROBLEM

The Nuclear Regulatory Commission and the Energy Research and Development Administration are aware of the hazardous and long-term nature of nuclear radioactivity and contamination. In view of the accumulation of nuclear facilities, what have these agencies been doing to assure that the facilities do not endanger public health and safety now or in the future?

ERDA'S EFFORTS

ERDA has sponsored many experimental and demonstration projects located on nonfederal property. These projects included power reactors, university reactors, and accelerators. Some of the more notable power reactors which have been decommissioned are listed below. They were decommissioned between 1969 and 1974.

Decommissioned ERDA power reactors

Facility	Location	Size (megawatts electric)	Method	Cost (millions)
Piqua	Ohio	45	Entombment	1.0
Elk River	Minnesota	58	Dismantlement	6.2
BONUS	Puerto Rico	50	Entombment	1.6

These three reactors were funded by the Atomic Energy Commission (AEC) to demonstrate the feasibility of producing electrical power by different types of reactors. The plants were operated by commercial utility companies, but through contractual provision, AEC was responsible for their decommissioning. These plants are much smaller than the commercial power reactors now operating and being built. Most reactors now being built are in the 1,100 megawatt range.

As noted in the table, only one of the reactors was dismantled. The other two reactors were entombed. ERDA provides for radiological monitoring of these entombed plants and is responsible for any future radiation problem that might occur.

ERDA has a limited budget for decommissioning activities, having received a total of $14,300,000 in fiscal years 1976

and 1977. Of this amount, $3,000,000 was used to decommission a nuclear rocket development station facility in Nevada and $5,500,000 was used to decommission a sodium reactor experiment in California, which was located on land that is going to revert to private ownership. Decommissioning work on these projects is continuing.

Much of the remaining funds are being spent on planning, on research, and on past problem areas. One such problem area relates to the old facilities or sites used by the Manhattan Engineering District--which developed the first atomic bomb--and by AEC for various radiological operations. When these operations ceased, AEC released the sites for unrestricted use. In 1976, ERDA's field offices had identified 49 such sites and ERDA was planning to survey them for possible contamination that had not been cleaned up when AEC released them. ERDA's plan called for completing surveys of all 49 sites in 1980.

In an April 9, 1976, letter to the ERDA Administrator, we recommended that ERDA expedite and complete the surveys as soon as possible to protect the public health and safety. ERDA agreed. Since it has accelerated its program, ERDA identified about 35 additional potentially hazardous sites and has completed surveys at most of them. As a result of the surveys, ERDA has identified about 10 sites which will require further effort and remedial actions. ERDA says these 10 sites contain only low-level radioactivity and do not pose an immediate hazard to public health.

ERDA also has two separate programs underway to remedy a radioactivity problem resulting from uranium mill tailings. Unless tailing piles are effectively controlled and stabilized, radium can be spread to the environment by wind and water erosion. One program is in Grand Junction, Colorado, where tailings used in construction were found to be radioactive. Legislation (Public Law 92-314) authorized $5,000,000 in Federal funds to provide financial assistance to the State of Colorado to limit the exposure of individuals to this radiation. Work under this program is continuing.

The second program--an offshoot of the Grand Junction problem--concerns the radioactivity associated with 21 inactive uranium mill tailing sites in the western States. Exact cost estimates have not been prepared, but ERDA estimates that stabilizing these tailing piles will cost the Federal Government $80,000,000.

NRC'S EFFORTS

NRC has certain requirements that licensees must follow at the time of decommissioning. When shutting down a nuclear reactor, uranium mill, or fuel fabrication facility, the licensee must submit a plan and make a final radiological survey. NRC procedures call for visiting the site to confirm the licensee's survey.

Upon termination of a materials license (where the licensee uses source, byproduct, or special nuclear materials), the licensee certifies that the facility has been decontaminated to acceptable levels. The acceptable levels of surface contamination are set forth in NRC's guidelines. NRC may perform a radiological survey of the site if it is believed necessary after considering the type of material at the facility, what was done with it, and the licensee's past performance under the license. No written procedures exist, however, for selecting the sites to be surveyed. An NRC official told us that a very small percentage of sites, perhaps less than 1 percent, are surveyed by NRC.

We performed a limited amount of work to determine if any contamination problems might still exist at commercial facilities which were closed down in the late 1950s and early 1960s, in other words, whether a situation existed which was analogous to ERDA's problem with sites used in the Manhattan Engineering District. The possibility exists for these situations because the care and precautions that are now taken in decontaminating facilities often did not exist in those earlier years.

From the information available in NRC's files, we could not determine whether all defunct commercial facilities had been properly decontaminated. On September 17, 1976, we sent a letter to the Chairman, NRC, bringing this matter to his attention. In October 1976, NRC responded and stated there was little chance that any of these commercial facilities were contaminated but said it would reexamine the files in the ensuing several months to determine if there were any cases where a public health and safety problem might exist.

As of May 1977, NRC had not yet started its reexamination of the files. An NRC official told us that because of staffing limitations the work would probably have to be contracted out and started during fiscal year 1977.

NRC has contracted with Battelle Pacific Northwest Laboratories to study various aspects of decommissioning fuel cycle facilities and commercial power reactors. NRC

plans to use these studies to develop standards and criteria for decommissioning.

Battelle recently completed a draft study on decommissioning a fuel separation facility and has started studies on the decommissioning of uranium mills and fuel fabrication facilities. These studies are scheduled for completion in 1979.

For the reactor decommissioning study, Battelle is using information from a large operating reactor. It is using the blueprints of the plant, evaluating the structure, inventorying the volume of material, and considering the transportation of the material and the waste. The study's objectives include estimating the occupational hazards of decommissioning and the cost of the various decommissioning methods. This study should be completed by the end of fiscal year 1979.

Because of the past problems with uranium mill tailings, NRC is now preparing a generic environmental impact statement on uranium milling to examine mill tailings reclamation and financial surety arrangements. This statement is scheduled to be issued in August 1978. NRC has also recently instituted a new procedure to protect the public from the hazards of these tailings. NRC will no longer issue a mill license, or renew an existing license, unless the mill owner submits a reclamation plan for tailings and a bonding arrangement to finance the plan when mill operations cease. NRC estimates that by 1978 all operating mills will be covered by this requirement.

STATE EFFORTS

A State may assume responsibility for some of NRC's regulatory authority--if agreed to by the State and NRC. There are now 25 agreement States which regulate source, by-product, and small quantities of special nuclear materials. According to NRC officials, all agreement States have good radiological control programs but the nonagreement State radiological programs vary from virtually nonexistent to very comprehensive.

Generally, States do not have separate programs or plans for decommissioning. Instead, it is a part of their overall radiation control program. Most agreement States have a provision in their regulations which requires a licensee to contact the State and decontaminate the facility to accepted levels before vacating a site where radiological operations took place. The State may inspect the facility. The States' systems are similar to NRC's systems for closing out licensees.

CHAPTER 4

MAJOR QUESTIONS REMAIN UNANSWERED

To begin to grapple with the far-reaching problems of decommissioning requires answers to some basic questions. In our review, we found that the questions listed below and discussed in the following section have not been answered.

--How much will decommissioning cost and who should pay?

--How should nuclear reactors be decommissioned?

--What is the extent of the decommissioning problem for accelerators?

--Are standards needed for induced radiation?

--What should be the limits on acceptable radiation levels?

--What more should States do to plan for decommissioning?

DECOMMISSIONING--HOW MUCH WILL IT COST AND WHO SHOULD PAY?

Privately owned facilities

The total cost to decommission privately owned nuclear facilities in the United States is unknown. Very few studies have been made on the subject. In fact, to the best of our knowledge, only one major study on the cost to decommission commercial nuclear reactors has been done to date, and another NRC-sponsored study is in process. A study for fuel fabrication facilities and uranium mills is also in process but will not be available until 1979.

The study on reactors by the Atomic Industrial Forum, Incorporated 1/, was issued in November 1976. The study addressed pressurized and boiling light water reactors, as well as high temperature gas reactors. The cost to decommission each of these three reactor types using the three

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1/An international association of utilities, manufacturers, labor unions, and other organizations in the nuclear area that is involved in peaceful uses of nuclear energy.

primary decommissioning methods and the two combination alternatives were evaluated. These are: mothballing, entombment, prompt dismantling, mothballing--delayed dismantling combination, and entombing--delayed dismantling combination.

The cost estimates are different for each type of reactor and vary depending upon the degree of security required. For example, a mothballed reactor at an isolated location will require security, whereas a mothballed reactor on a site that continues to have other ongoing activities will not. Moreover, an entombed facility will not require additional security.

The following chart developed from the Atomic Industrial Forum study provides some idea as to the decommissioning cost of an average reactor. However, the cost for an individual reactor will vary because of its unique characteristics. It is also important to note that these figures do not include the costs of the burial grounds or waste repositories where the spent fuel and radioactive materials from the reactors will have to be sent.

Decommissioning method	Cost estimate in 1975 constant dollars (millions)
Mothballing	$ 2.8 to $3.1
Annual surveillance with security	.21
Annual surveillance without security	.11
Entombment	7.1 to 9.5
Annual surveillance	.07
Prompt dismantlement	33.6 to 39.0
Mothballing--delayed dismantling	
With security	35.8 to 39.4
Without security	28.5 to 29.3
Entombment--delayed dismantling	30.0 to 31.0

Although there has been no generic study, fuel fabrication facility owners provided us with their cost estimates for decommissioning. They ranged from $100,000 to $6,000,000 1/.

1/Because of time constraints, we did not analyze these large ranges to determine their relationship to such factors as plant size.

Likewise, uranium mill owners provided us with their cost estimates for decommissioning. They ranged from $71,000 to $2,000,000 1/.

The only commercial reprocessing plant ever operated, Nuclear Fuel Services, Incorporated, at West Valley, New York, which was shut down in 1972, has not yet been decommissioned. 2/ However, it is estimated that it will cost from $90,000,000 to $600,000,000 to dispose of all the radioactive material, including dismantlement and removal of the structures.

There is no requirement for and generally no effort being made today, with the exception of uranium mills, to provide for the cost of future decommissioning of privately owned nuclear facilities. The failure to make such provision can result in the Federal and/or State Governments assuming responsibility that rightly belongs to private industry. Situations where this has happened or may happen have already arisen. For example, the Federal Government will be paying about $85,000,000 to clean up radioactive tailing piles at all inoperative uranium mills that were privately owned.

Another example is the West Valley, New York nuclear fuel reprocessing plant. When the plant owner decided in 1976 to transfer control of the site to the New York State Energy Research and Development Authority, it imposed a large financial burden on the State. Although the cost will undoubtedly run anywhere from the tens to the hundreds of millions of dollars, New York has set aside only $3,000,000 to take care of the problem. Because of this, the New York Authority has asked ERDA to completely take over the West Valley site. ERDA has not accepted this request, but has agreed to discuss the problem with the Authority.

We should quickly point out the cost to decommission private nuclear facilities may not be as high as these two unusual cases. There are no other privately owned fuel reprocessing plants, and the problem of uranium mill tailing piles was not discovered until after the mills were shut down.

1/Because of time constraints, we did not analyze these large ranges to determine their relationship to such factors as plant size.

2/We have issued a report entitled "Issues Related to the Closing of the Nuclear Fuel Services, Incorporated, Reprocessing Plant at West Valley, New York" (EMD-77-27, March 8, 1977).

Lesser amounts will be required to decommission smaller activities. Even so, these smaller activities--often owned by smaller companies--may be prone to financial difficulties that can result in the Government paying for the necessary decommissioning. For example, a company in Clinton, Tennessee --a manufacturer of sealed radioactive sources--went out of business in mid-1971. The owners walked away from the plant leaving a significantly contaminated area. The Federal and State Governments shared the cost--approximately $110,000 --to decontaminate the facility.

Regulations for funding decommissioning

With the exception of uranium mills, NRC has no requirement that licensees make specific financial provisions to cover the cost of future decommissioning. Instead, it determines, before issuing a license to operate, whether the licensee is generally financially responsible. This determination is based on an evaluation of the company's profit history and the proposed operating expenses for a facility to be licensed. NRC considers this information to be indicative of financial soundness and the ability of the company to pay for future decommissioning. Therefore, in the case of nuclear reactors, NRC makes a judgment, even before a powerplant begins to operate, that a utility can pay for decommissioning costs which will not be incurred for at least 40 years and possibly for as much as 150 years. That judgment is not based on a specific estimate of the anticipated cost of decommissioning.

Extent of efforts to fund decommissioning

Various approaches could be taken by private industry to provide today for future costs rather than saddling future generations with this responsibility. These approaches include:

--A direct charge to users or customers in the price of a product and depositing such funds into an escrow or trust fund.

--A system for recovering the cost of decommissioning nuclear reactors through depreciation accounts. This depreciation cost could then be passed on to users. The funds could be set up in special accounts to insure their integrity until needed.

--A bonding arrangement to protect the governmental bodies from a financial burden should a licensed nuclear facility not be able to decommission its activities.

We sent questionnaires to all companies with operating uranium mills and fuel fabrication plants and all utilities with operating or planned nuclear reactors. Of 9 companies with 11 operating mills, 3 companies are providing some form of bonding and 1 firm has established a $70,900 fund for future decommissioning. This company established the fund because of its inability to obtain bonding. Only 3 of the 14 fuel fabrication companies which responded to our inquires have established a fund to cover the cost of decommissioning.

Thirty-two utilities with 48 operating reactors responded to our questionnaire. Seventeen stated that they use depreciation accounts to reflect decommissioning costs which ultimately wind up in utility rates. However, even though funds collected through this method are an advance recovery of costs, these funds are not set aside in special accounts. Instead, the funds are used in current operations in lieu of borrowing. These utilities expect to be able to pay the eventual decommissioning costs from whatever future budget is affected. The 15 other respondents are presently doing nothing to accumulate funds for decommissioning.

Although the cost to decommission a nuclear reactor may be in the millions of dollars, the utilities do not consider these costs significant in relation to the construction costs for a reactor which are now about $1 billion. Consequently, they do not see a need for advance accumulation of funds.

ERDA-owned facilities

ERDA conducts most of its nuclear activities at 26 major sites or reservations. As structures, tanks, etc., become obsolete or are no longer needed, these facilities are placed in "excess" by ERDA. An October 1976, ERDA document stated there were 300 excess facilities and an additional 100 were expected to become excess by 1981.

ERDA is developing a computer data system to supply the information needed to plan for decommissioning its facilities located at Hanford reservation. The Hanford reservation--1 of the 26 sites--contains most of ERDA's excess facilities. This computer system, scheduled for completion in June 1977, will list 537 facilities, both operating and in excess, at Hanford. The system will include cost estimates for various decommissioning methods, priority schedules, and other information. None of the other reservations were included in the system because they have relatively small numbers of excess facilities. These other reservations do, however, include a significant number of operating facilities, that eventually have to be decommissioned.

ERDA officials told us they do not compile relevant details of the facilities it owns--obsolete or operating--which would permit it to assess the magnitude of the decommissioning problems they pose. Such details include the nature and extent of the radiation problems at these facilities, the decommissioning methods that would be feasible, the cost of the methods, schedules, and priorities. Efforts to develop these details have been plagued by a failure of ERDA to develop standard definitions and rules for the ERDA reservations to use in describing the facilities located there.

In a memorandum to the Office of Management and Budget, ERDA estimated it would cost $25,000,000 to $30,000,000 a year for the next 100 years--or a total of $2,500,000,000 to $3,000,000,000--to decommission its existing excess facilities. We do not believe this is a credible estimate because

--ERDA does not have sufficient data to support this estimate;

--ERDA does not have the information necessary to assess the magnitude of the problem posed by its excess facilities;

--ERDA lacks similar information for its operational facilities;

--an ERDA contractor estimated in 1972 that it would cost as much as $4,000,000,000 to decommission the Hanford facilities alone (exclusive of waste); and

--ERDA has not developed cost estimates for disposal of 71,000,000 gallons of high-level waste. The disposal of 600,000 gallons of high-level waste at West Valley, New York may cost as much as $565,000,000.

COMMERCIAL NUCLEAR REACTORS--HOW SHOULD THEY BE DECOMMISSIONED?

NRC regulatory guides permit three alternatives for decommissioning a nuclear reactor. It does not require that a plan for decommissioning be available at the time an operating license is approved or that a method be selected. Officials of utility companies told us there is a lot of uncertainty as to what will actually be required at the time of decommissioning some years in the future.

The Atomic Industrial Forum study recommended a combination method of temporary protective storage for 65 to 110 years with later dismantlement. The study showed that immediate dismantlement

presents a serious occupational radiation hazard to personnel doing the dismantling, as well as greater environmental impact. The occupational hazard is due primarily to the cobalt-60 in the reactor vessel which decays in approximately 100 years.

While other radionuclides in a reactor require many thousands of years to decay, these radionuclides present a lower biological hazard. Therefore, if the cobalt-60 is allowed to decay to safe levels, the radiation hazard would be sufficiently reduced to permit manual removal of the reactor vessel. The study also showed that temporary protective storage with delayed dismantling can be from $3,000,000 to $10,000,000 less expensive than immediate dismantlement.

Although the long-lived radionuclides present a lower biological hazard, it is important that they remain inaccessable to the public until they decay to a safe level. For this reason, permanent mothballing or entombment are not considered final or absolute decommissioning alternatives because of the need for perpetual surveillance and major structural repairs. Yet, NRC now permits utilities to select these alternatives.

A paper presented to the International Atomic Energy Agency by an ERDA official also concluded that the combination method is the logical approach to reactor decommissioning. Preliminary conclusions by a contractor currently studying decommissioning methods for NRC also support this approach. This study is expected to be completed in 1979.

We employed a consultant, a professor of nuclear physics and an authority on the environmental impact of nuclear power including waste disposal, to independently review the Atomic Industrial Forum study. He agreed with the study's conclusions. He also reviewed data on five previously decommissioned reactors now in protective storage. He concluded that cobalt-60 was the principal contaminant of any consequence and that between 70 and 110 years would be required before radioactivity would decay to safe levels.

A question arises as to whether the reactor structure would survive the 70 to 110 years until the primary radioactivity decayed to safe levels. We employed another consultant, a professor of civil engineering who is an expert on the structural integrity of concrete, to physically examine a decommissioned reactor to determine whether the structure could be expected to survive over the life of the cobalt-60. This consultant concluded that such a facility could easily last for that period of time.

ACCELERATORS--WHAT IS THE EXTENT OF THE DECOMMISSIONING PROBLEM?

The significance and extent of the problem of decommissioning particle accelerators in this country is not known. A complete inventory by size, type, and usage is not available, although their use partly determines the radiation hazard. These uncertainties do not permit adequate control over the decommissioning of accelerators.

Accelerators are measured in terms of electron volts and range in size from desk top models with less than one megavolt to the recently completed 200,000 megavolt, 4 miles in circumference, accelerator located in Batavia, Illinois.

Induced radiation causes decommissioning problems in accelerators and the amount of such radiation is determined by size, type, and usage. It is generally agreed that most accelerators 4 megavolts or less will not emit enough energy to produce any amount of induced radiation. Those units over 4 megavolts could present a problem, however.

State health agencies are supposed to submit an annual inventory of accelerators to the Food and Drug Administration, Department of Health, Education, and Welfare; but not all States provide this data. The ones that do, submit only the number of accelerators, not the size, type, or use. For fiscal year 1975 the number reported was 1,010.

We tried to obtain more definitive information, particularly the number of accelerators above or below 4 megavolts, by sending a questionnaire to each State health agency. Our efforts were unsuccessful. Some States did not respond. Some responded but did not provide data, and the data we did receive could not be reconciled to the Food and Drug Administration data. For example, one State reported to the Food and Drug Administration that 127 accelerators were located in the State in fiscal year 1975. The State officials informed us, however, that there are 36 accelerators in the State and only 5 have ever been decommissioned. We also visited several State health agencies and were advised by State officials that they did not know size, type, and usage of accelerators in their State.

ARE INDUCED RADIATION STANDARDS NEEDED?

NRC and ERDA both have guidelines for the unrestricted release of facilities and equipment containing surface contamination. These guidelines contain specific radiological levels to which facilities and equipment must be decontaminated before they can be used for any other purpose. However,

neither NRC nor ERDA has standards for unrestricted release of materials and equipment containing induced activity. This presents a problem at the time of decommissioning because if the equipment or materials contain even very low levels of induced activity, it is not known whether it is safe for unrestricted release. Generally, the current practice is to send any equipment or facility to a waste burial ground if induced activity is above natural radioactivity.

The dismantlement of an ERDA-owned reactor illustrated the problems that can occur due to the lack of induced standards. All concrete with any trace of radioactivity was removed from the site and transported to a burial site in another State. If there had been standards for material and equipment containing induced activity, perhaps much of this concrete could have been sent to a refuse area within the State at much less cost. This problem is generic to any future decommissioning project where induced activity is present.

In July 1974, we sent a letter to AEC spelling out problems presented by the lack of standards for induced radiation. The specific problems dealt with decommissioning a large accelerator. Tons of valuable copper, steel, and stainless steel containing radiation levels slightly above naturally occurring background radiation could not be released for unrestricted use by the general public because there were no standards for induced radiation.

AEC officials told us they would have such standards developed by about September 1975. As of June 1977, however, these standards had still not been developed. It is apparent that such standards would permit cost savings and more effective planning for decommissioning.

WILL CURRENT RADIATION STANDARDS CHANGE?

Because man can tolerate only certain amounts of radiation without ill effects, standards have to be set to limit his exposure from all sources. Since the first radiation standards were established--as long ago as 1902--they have grown progressively more restrictive. The first standard was established to protect against external radiation burns. As more was learned about the actual hazards of radiation, such as biological and genetic effects, the standards were changed. For example, as illustrated in the table below, the standard for maximum allowable whole body exposure of persons to radiation in restricted areas where radioactive materials are

present has been periodically reduced from 10 rem 1/ per day in 1902 to 1.25 rem per calendar quarter in 1976.

Occupational Standards

Year	Standard
1902	10.00 rem/day
1925	.20 rem/day
1936	.10 rem/day
1950	.30 rem/week
1964	5.00 rem/year
1976	1.25 rem/calendar quarter

Moreover, in January 1977, the Environmental Protection Agency, which is responsible for setting standards for protection of the environment from all sources of radiation, issued regulations to reduce, from 0.5 rem to 0.025 rem annually, the allowable radiation exposure to the general population from all nuclear fuel cycle activities. These standards are to be effective December 1, 1979.

There are currently no standards for induced radioactivity, but NRC has adopted standards for acceptable surface contamination levels. Logically, these standards, by their very nature, must correlate to whole body exposure rates and therefore have gradually become more stringent and refined with increased technical knowledge.

If the historical trend for radiation standards continues, then the rules that we now use to govern decommissioning and decontamination will likely be considered unsafe years from now.

WHAT ABOUT NAVAL REACTORS?

As of June 1976 the Naval Nuclear Propulsion Program had 127 reactors in operation and 43 under construction. Ships have been taken out of active status and the reactor fuel removed and sent to an ERDA facility. The ships themselves, which still contain the nuclear reactors, are in the reserve fleet in a mothballed status where they are continuously monitored.

It may be that the cost to decommission these reactors will not approach the cost for the average 1,100 megawatt power reactor. However, it is reasonable to assume that the

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1/A rem is a measure of radiation dose to body tissue.

170 reactors will ultimately require decommissioning, and just as with power reactors, there will be a cost and a potential environmental hazard for this operation.

Naval program officials told us that they have developed plans and strategies for decommissioning and decontaminating naval reactors. They stated, however, that the technical details of these plans and strategies are classified. We are currently reviewing the naval plans and strategies for decommissioning and decontaminating reactors.

WHAT SHOULD BE THE STATES' ROLE IN DECOMMISSIONING?

The States are responsible for accelerators and naturally occurring radioactive material. Although many accelerators will not present a serious decommissioning problem, some of the large accelerators will. Some States do not have adequate controls over accelerators. There is also an increasing concern over the control of natural radioactivity such as the radium problem from uranium mill tailings.

States generally do not have a separate program for decommissioning. With few exceptions, there are no provisions or requirements which would protect the States from financial loss in the event of default.

In joint sponsorship with NRC and the Environmental Protection Agency, the National Conference of Radiation Control Program Directors investigated options available to States to assure licensee financial responsibility in the event of default. They issued a report in April 1976, which concluded that bonding for decommissioning and a trust fund for perpetual care would satisfy many of the situations that an individual State may encounter. Even though this body of State representatives made such recommendations over a year ago, only seven States told us through our questionnaires that they require an advance accumulation of funds or some form of bonding for decommissioning. The Conference is also studying control of natural radiation, and NRC is considering whether the responsibility for radium--produced by natural uranium--should be brought under Federal control.

WHAT DOES THE FUTURE HOLD FOR NUCLEAR POWER AND DECOMMISSIONING?

Until recently, the role of nuclear power as an electrical generating source for the future has been a clear and unchallenged Government policy. Light water reactors, and then breeder reactors with their ability to replenish their

own fuel, have been viewed as long-term, almost perpetual, energy sources.

The President is now trying to implement an energy program that would change the future of nuclear power. It is his policy to (1) defer the U.S. commitment to advanced nuclear technologies that are based on the use of plutonium, and (2) use more of the current light water reactors to meet our needs.

Light water reactors require a supply of natural uranium. How much natural uranium exists is a major question that, when answered, dictates the viability of light water reactors as an energy source. Estimates of U.S. uranium resources range between 1.8 and 3.7 million tons. This amount of natural uranium could fuel 240 large light water reactors--about the number expected to be operating in the year 2000--for 40 to 85 years.

Obviously, light water reactors cannct be expected to continue indefinitely. If another generation of nuclear reactors cannot be developed or is not needed because another energy source, such as solar energy, has been introduced, the end of light water reactors could also be the end of the commercial nuclear power industry.

The possibility of this industry ending raises questions as to whether there will be nuclear-related organizations, nuclear equipment, and individuals expert in the nuclear field that would be capable of dealing with the decommissioning and decontamination problems that could remain for about 100 years after the last reactor is shut down.

CHAPTER 5

CONCLUSIONS, OBSERVATIONS AND RECOMMENDATIONS

The problems that nuclear-related operations leave behind are increasing because of the expansion of nuclear technologies. All of those involved--the Energy Research and Development Administration, the Nuclear Regulatory Commission, State Governments, and industry--are partly to blame for what has happened.

ERDA has accumulated a large number of excess facilities which will involve a monumental clean-up effort. At this point in time, it lacks the necessary information to even plan this task. It does not know the radiation and contamination problems at its facilities, the decommissioning methods that should be used, the corresponding costs, or priorities. ERDA has begun to gather this information at one of its reservations, but this is only the beginning.

While elimination of these excess facilities is important, it is also important that ERDA begin to consider and plan for decommissioning in all future projects. This requires that decommissioning costs be recognized at the outset of a project.

Similarly, NRC, which has responsibility on the commercial side, has not developed cost estimates, acceptable methods, or standards needed by industry to plan decommissioning or disposal of their facilities. NRC has not paid much attention to one of the biggest problems that may confront the public in the future--that is, who will pay the cost of decommissioning nuclear power reactors. It has not made any plans or established any requirements for advanced accumulation of funds for decommissioning reactors or any facilities it licenses with the exception of uranium mills.

We believe the cost of decommissioning should be paid by the current beneficiaries, not by future generations. Just as ERDA should consider decommissioning costs in its projects, private companies have an obligation to accumulate funds for decommissioning during the life of their projects. NRC should make advance planning for decommissioning mandatory at the time of licensing, including provision for funding.

If the States are to maintain their responsibility over selected nuclear activities, they must be made aware of the problems with decommissioning and be encouraged to adopt legislation that will assure that proper decommissioning and decontamination is carried out.

Answers to basic questions are missing which preclude developing a strategy for solving a problem that we are losing ground on. The solution may very well be expensive--but the expense should be known so that it can be planned for and paid for by the responsible parties.

Although the task of cleaning up the present problem and preventing future problems will involve a concentrated effort by all those involved, the Federal sector must lead the way and set the example. In the past, the Federal Government has been shortsighted in its approach to solving decommissioning problems. The Federal agencies must now view decommissioning with an eye toward the future, particularly in the areas of financial responsibility, radiation standards, and capability to perform the needed decommissioning tasks.

A bill (H.R. 6181) has been proposed directing ERDA to comprehensively study decommissioning. The study needs to be done. Hopefully it can provide basic information needed to develop a strategy to solve decommissioning problems.

RECOMMENDATION TO THE CONGRESS

Because of the magnitude, cost and time already lost, the Congress should designate one lead Federal agency--the Nuclear Regulatory Commission--to approve and monitor an overall decommissioning strategy. ERDA should continue its research and development efforts aimed at finding alternatives for decommissioning and decontamination of nuclear facilities. However, we believe that NRC is uniquely suited for the lead role because of its charter to independently regulate commercial nuclear activities to assure public health and safety. This position is consistent with a previous GAO report and testimony wherein we advocated independent assessments by the Commission of certain ERDA operations. In addition, placing this responsibility with the Commission would, in our view, add to the credibility of Federal regulation over nuclear energy.

RECOMMENDATIONS FOR THE ADMINISTRATOR, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION AND THE CHAIRMAN, NUCLEAR REGULATORY COMMISSION

We recommend that the Administrator, ERDA, as part of his research and development responsibility

--determine the (1) acceptable alternative methods of decommissioning, (2) acceptable levels for induced radiation and surface contamination, and (3) extent of the decommissioning problem for accelerators;

--expand and accelerate a program to decommission the nuclear facilities currently excess to its needs; and

--require that program managers plan for future decommissioning and include decommissioning cost information in their program budgets.

In addition, we recommend that the Chairman, Nuclear Regulatory Commission, for those facilities he regulates

--require specific plans for decommissioning at the time of licensing, including the decommissioning method to be used and a funding mechanism to assure that facility owners pay the costs of decommissioning;

--determine the acceptable levels for induced radiation and surface contamination consistent with environmental standards being developed by the Environmental Protection Agency; and

--encourage States to follow the lead of the Commission in adopting comprehensive decommissioning planning for facilities under States' control.

AGENCY COMMENTS

ERDA was unable to furnish written comments in time to be finalized in this report. However, we met with ERDA officials and obtained their oral comments which have been incorporated in this report. ERDA officials disagreed with giving NRC responsibility over ERDA facilities. However, they will consider this matter further and will provide written comments in the near future.

NRC's comments on the report are contained in a letter dated June 10, 1977. (See app. I.) The letter describes the actions NRC is taking or plans to take to develop methods and criteria for decommissioning nuclear facilities.

Because of time constraints and the report's relatively limited treatment of the Environmental Protection Agency, its comments were not sought.

CHAPTER 6

SCOPE OF REVIEW

We obtained the information contained in this report by reviewing documents, studies, reports, correspondence, and other records, and by interviewing officials at

--NRC headquarters, Bethesda, Maryland;

--NRC regional offices at Atlanta, Georgia; Glen Ellyn, Illinois; King of Prussia, Pennsylvania; and Arlington, Texas;

--ERDA headquarters, Germantown, Maryland; and

--ERDA operations offices at Chicago, Illinois; and Oak Ridge, Tennessee.

We also visited various States, utilities, uranium mills, accelerators, and universities. We sent questionnaires to all utilities with nuclear reactors currently in operation or under licensing review, uranium mill owners, fuel fabrication facilities, State rate-setting commissions, and State radiation control units.

ENDIX I

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

June 10, 1977

Mr. Monte Canfield, Jr.
Director, Energy and
Minerals Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Canfield:

We have reviewed the GAO draft report entitled "Cleaning Up the Remains of Nuclear Facilities - A Multi-Billion Dollar Problem." We provided your representatives with oral comments on this draft report on June 7, 1977. The one day which we were given for our review was insufficient for a thorough review. As you know, due to your schedule for publishing this report, we did not have the opportunity to review a draft that incorporated any changes that were made in response to these oral comments. Therefore, the following comments are based on our understanding of how your final report reflects our oral comments.

The report as written, and particularly the Digest section, gives the impression that the NRC has done little or nothing to establish acceptable methods or criteria for decommissioning of nuclear facilities over which it has responsibility. In fact, the Commission has established acceptable methods for decommissioning nuclear facilities, i.e., dismantlement, entombment, mothballing, and combinations of these. Furthermore, it is continuing to study the problem to further refine the requirements for decommissioning. Rather conclusive evidence that acceptable methods for decommissioning nuclear facilities have been established is the fact that more than 50 reactor facilities have been successfully decommissioned and numerous licenses for other nuclear facilities and activities have been terminated. Furthermore, 10 CFR Part 50 §50.82 provides rules for dismantling a reactor facility and terminating the facility license, and the NRC has published a guide (Regulatory Guide 1.86) which describes conditions and procedures acceptable to the NRC for decommissioning reactor facilities.

The Commission is currently sponsoring a study by Battelle Memorial Institute - Pacific Northwest Laboratories (PNL) of the environmental effects, radiological effects, costs and appropriate radioactivity limits for each of the currently accepted methods of decommissioning nuclear reactor and fuel cycle facilities.

The NRC staff is now reviewing a report on the results of an Atomic Industrial Forum (AIF) study of the environmental effects, radiological effects and costs of different methods of decommissioning nuclear power facilities. The staff will perform an analysis of the AIF decommissioning data as a part of this review. The NRC has also initiated a review of the AIF report by Battelle-PNL as part of the Battelle-PNL study.

The GAO report questions who will pay for decommissioning nuclear power plants. It is NRC's view that the licensee is to pay for this activity. The cost to decommission has been shown by the AIF study and our independent evaluation referred to above to be a small factor in the overall cost of operating a nuclear power plant. The licensee should be able to fund these costs out of current revenue. Therefore, we do not perceive the cost of decommissioning nuclear power reactors -- which will likely be incurred for many reactors several decades from now -- as a crisis situation or a problem that requires crash efforts to resolve. We do believe that an orderly effort to establish procedures and requirements to provide greater assurance that these funds will be available should be initiated.

In addition, the GAO report does not recognize EPA's role in the process by which NRC and ERDA develop criteria for acceptable levels of contamination. EPA is responsible for developing generally applicable environmental standards. Any criteria which we develop must be consistent with EPA standards. 1/

The GAO report discusses nuclear facilities of all types, with the implication that all will have large future decommissioning problems and costs. Recognition was not given to the large variations in complexity among the various nuclear operations which range from nuclear power plants to possession of small amounts of short-lived radioactive materials for use in industry, medicine and education. The great majority of nuclear facilities are of the latter category and result in little or no technical or financial decommissioning problems for license termination.

With respect to nuclear power reactors it is true that, with the exception of dismantlement, the other methods of decommissioning (mothballing and entombment) that have been identified as being acceptable to the Commission are not final, in that they do not provide acceptable disposition of the facility for all time. However, the use of mothballing and entombment do not relieve the licensee of requirements for continued maintenance, access control, radiation monitoring, environmental monitoring, and inspections until residual activity is removed or decays to

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1/ GAO note. The report was changed to reflect EPA's role.

APPENDIX I

levels acceptable for unrestricted access. For the large modern plants, it is clear that postponing the removal of certain components until the radioactivity has decayed to permit more direct access for dismantlement may prove to be the most desirable alternative with respect to the environment, radiological effects and cost for most facilities. Also, the degree of decommissioning effort required to protect the public health and safety and the environment will depend significantly on the site specific characteristics -- an observation not made in the report.

The Commission does examine various decommissioning plans and their costs and environmental impacts prior to issuance of an operating license for a commercial power reactor or test reactor. We assure ourselves in each case that feasible decommissioning alternatives, including alternatives for complete dismantling, exist and that the applicant either possesses or has reasonable assurance of obtaining the necessary funds, as required by our Regulations (10 CFR 50.33F). We do not require bonds or setting aside of any contingency funds at the operating license stage and do not impose any particular decommissioning plan as a condition of the operating license.

Federal and State regulatory commissions have historically treated plant decommissioning and maintenance costs as allowable operating expenses recoverable through rates chargeable to customers. It is therefor reasonable to assume that the decommissioning and subsequent maintenance costs would be charged to operating expenses either in the year they are incurred or amortized over a period of years according to the policy of the rate making regulatory authorities.

In the area of nuclear fuel cycle facilities, the NRC is currently preparing a Generic Environmental Impact Statement (GEIS) on uranium milling. This GEIS is to examine mill tailings reclamation and financial surety arrangements and will be the basis for NRC regulations and regulatory guides. The draft GEIS is scheduled to be issued in August 1978.

In this area, until the GEIS is issued and new regulations implemented, NRC is taking a conservative approach with respect to renewing licenses and granting new applications. For new applications, we are requiring applicants to develop and commit to a tailings management plan as a license condition. This reduces the impact of the tailings to essentially the same impact as occurs at that site with the material in its natural state. In addition, NRC is requiring that the applicant provide a financial surety arrangement to assure that the tailings management plan will be carried out. With regard to existing licenses, NRC is requiring that a tailings management plan and financial surety arrangement be committed to before license renewal as a license condition.

APPENDIX I

Also, for new major fuel cycle licenses and at the time of renewal for existing licenses, the licensee is being requested to provide decommissioning plans and financial arrangements for defraying these expenses. These will be made license conditions. Additionally, the staff is exploring what statutory or regulatory changes are needed. NRC does not plan to firm up details of financial arrangements until after a study on financial surety arrangements now being carried out as part of the GEIS on uranium milling is completed, since most of the considerations dealt with in that study will also be applicable to fuel cycle licenses. In addition, NRC feels that a few practical cases should be completed prior to rule making.

Thanks for the opportunity to comment on the report.

Sincerely,

Lee V. Gossick
Executive Director
for Operations

PRINCIPAL OFFICIALS RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
Nuclear Regulatory Commission		
CHAIRMAN:		
Marcus A. Rowden	Apr. 1976	Present
William A. Anders	Jan. 1975	Apr. 1976
Energy Research and Development Administration		
ADMINISTRATOR:		
Robert W. Fri (acting)	Jan. 1977	Present
Robert C. Seamans, Jr.	Jan. 1975	Jan. 1977