BY THE U.S. GENERAL ACCOUNTING OFFICE

Report To The Chairman, Subcommittee On Energy Conservation And Power, House Committee On Energy And Commerce

Nuclear And Coal Waste Disposal Hampered By Legal, Regulatory, And Technical Uncertainties

Numerous legal, regulatory, and technical problems and uncertainties are hampering disposal of nuclear and coal fuel cycle wastes. Although Federal agencies are working on these problems, progress has been slow and many uncertainties still need to be resolved.

While available information indicates that coal waste disposal costs are roughly three times higher than nuclear waste disposal costs, this cost comparison must be viewed with caution. Accurate disposal costs are not readily available, particularly for the nuclear fuel cycle, because some nuclear wastes have never been disposed of and actual disposal costs are unknown.

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WASHINGTON, D.C. 20548

ENERGY AND MINERALS
DIVISION

B-204622

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In a letter dated July 1, 1980, the former Chairman, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, requested that we compare the problems and uncertainties of nuclear and coal fuel cycle waste disposal. The former Chairman requested information on eight issues. As agreed with your staff, the first two issues--identifying waste types and quantities and their associated health and environmental effects--were addressed in our September 21, 1981, report to you entitled "Coal and Nuclear Wastes--Both Potential Contributors to Environmental and Health Problems" (EMD-81-132).

This letter addresses the remaining six nuclear and coal waste issues:

--Problems associated with waste collection and disposal.

--Present technical capability of waste collection and disposal.

--Present capability of the transportation system to transport the wastes.

--Comparative costs of waste disposal.

--Legal, regulatory or institutional uncertainties affecting waste disposal.

--Current status, progress, and problems of programs aimed at resolving these issues.

Overall, GAO found that there are numerous legal, regulatory, and technical problems and uncertainties hampering disposal of

nuclear and coal fuel cycle wastes. Although Federal agencies are working on these problems, progress has been slow, and many uncertainties still need to be resolved. In addition, while available information indicates that coal waste disposal costs are higher than nuclear waste disposal costs, this cost comparison must be viewed with caution. Accurate disposal costs are not readily available, particularly for the nuclear fuel cycle, because some nuclear wastes have never been disposed of, and actual disposal costs are unknown.

OBJECTIVES, SCOPE, AND METHODOLOGY

Using the above six issues as a framework, our objective was to determine the problems, progress, and/or status of disposal efforts for each nuclear and coal waste type. Our review was limited to wastes primarily produced from electrical generation and did not include wastes produced from other industries that burn coal, such as steel mills. Our audit was performed in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

Since much information has already been published on nuclear and coal waste issues, we relied heavily on existing literature to develop this report. We used information from prior GAO reports and reviewed over 500 relevant reports and documents issued, for the most part, since 1978 to identify specific health and environmental hazards caused by coal and nuclear fuel cycle wastes and to determine problems related to disposing of these wastes. We then interviewed officials from the Environmental Protection Agency (EPA), the Department of Energy (DOE), the Nuclear Regulatory Commission (NRC), the Office of Surface Mining, the Department of the Interior, and the Department of Transportation to determine the problems and progress of Federal waste disposal programs. In addition, we interviewed officials from 11 electric utilities, 12 State regulatory agencies, a coal mining company, and various interested associations to identify problems they were experiencing in disposing of these wastes, and to determine actions that could be taken at the Federal and State levels to resolve these problems. These utilities represent, for the most part, the largest utilities in the United States, with the majority of them operating both nuclear and coal electrical generating facilities. For a complete list of utilities and other organizations we visited during our review, see appendix IV.

Our study results, however, are not without limitations. First, we could not determine if nuclear wastes are more or less hazardous than coal wastes because each type of waste poses different kinds of hazards, the information available on the hazards of each waste is not readily comparable, and questions and debates as to whether some coal wastes are hazardous are not resolved. Second, although we point out many problems with disposing of

these wastes and discuss Federal and State programs that are attempting to resolve these problems, we did not evaluate Federal and State coal and nuclear waste programs. Finally, the disposal cost comparison data contained in this letter represent the best available estimates of cost we could find. Our data were extracted from various studies prepared by NRC, DOE, EPA, and the Office of Technology Assessment. However, the data must be viewed with some caution because accurate disposal costs are not readily available, particularly for the nuclear fuel cycle, where some wastes have never been disposed of and actual disposal costs are unknown.

NUCLEAR WASTE DISPOSAL--PROBLEMS AND UNCERTAINTIES REMAIN

Nuclear electrical generation produces five basic types of radioactive wastes:

- --Low-level waste is waste, such as filter sludges and bottoms, that is not classified as one of the remaining four waste types and that is contaminated with radioactive elements.

- --Uranium mill tailings are the sand-like wastes that emit low levels of radiation which are produced in uranium refining operations.

- --Spent fuel is "used" reactor fuel that will be classified as a waste if not reprocessed 1/ to recover the usable uranium and plutonium.

- --High-level waste is the by-product coming out of a reprocessing plant which contains highly toxic fission products.

- --Transuranic wastes are 11 man-made radioactive elements that have an atomic number greater than that of uranium and have half-lives of thousands of years.

Improper handling and disposal of nuclear wastes can cause significant environmental and health problems. Consequently, Federal programs exist to control and regulate nuclear wastes, as well as provide for their long-term isolation from the environment. Although some progress is being made, disposal problems and uncertainties still exist for each nuclear waste type that, if left unresolved, could adversely affect the growth of the nuclear power generation industry. Specifically:

1/Reprocessing is the process whereby the unused uranium and plutonium in spent reactor fuel can be removed for use again as nuclear reactor fuel.

--low-level waste disposal is hampered by inadequate disposal capacity, and EPA has not yet issued disposal standards;

--uranium mill tailings disposal is being delayed and will cost more because EPA failed to issue final disposal standards;

--spent fuel and high-level waste disposal plans are making little, if any, progress because of uncertainties about whether spent fuel should be reprocessed or disposed of as a waste, difficulties in finding a disposal site, and problems in transporting these wastes through certain States and localities; and

--transuranic waste disposal is currently not a major problem because not much has been generated, but it could be in the future because large quantities are expected to be produced, and the Federal Government may experience problems similar to those being experienced with high-level waste.

COAL WASTE DISPOSAL--PROBLEMS AND HAZARDS NOT COMPLETELY UNDERSTOOD

Coal electrical generation produces waste in three forms:

--Gases, such as sulfur oxides, nitrogen oxides, carbon dioxide, hydrocarbons, and suspended particles, 1/ that are released into the atmosphere when coal is burned.

--Liquids, such as slurry and sludge, that are produced from coal mining and cleaning operations.

--Solids, such as bottom ash and scrubber sludge, that are produced during coal mining, cleaning, and burning operations.

Although coal has been used to generate electricity for many years, the specific impacts of coal wastes on the public's health and safety were generally not understood. Little effort was made to determine the environmental and health effects of coal fuel cycle wastes, and no Federal programs were established to regulate them until the 1970s. During the 1970s, however, in response to increased public concerns about the quality of the environment,

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1/Suspended particles are actually solid wastes, such as fly ash and soot, but because they are released into the atmosphere when coal is burned, for discussion purposes, we are considering them to be gaseous wastes.

the Congress enacted legislation establishing numerous programs to protect and enhance environmental quality in the United States.

Subsequent studies to determine the causes and sources of pollution have raised concerns and controversies about the environmental and health hazards of many coal wastes. To respond to these concerns, the Federal Government and utilities initiated actions to help control and reduce pollutants emitted from coal-fired power plants. Although these actions have resulted in dramatic progress, the long-term effects of several potentially significant waste problems have yet to be determined accurately, and for the hazards that have been identified, there is still controversy about the extent of damage that is attributable to coal use. Consequently, many problems and uncertainties associated with coal fuel cycle wastes still need to be resolved. Specifically,

--gaseous wastes are contributing to air quality problems which are affecting the planning and locating of new coal-fired power plants; they are also suspected of causing other environmental concerns, namely acid rain 1/ and the "greenhouse effect," 2/ which could make restrictions on new and existing coal-fired power plants more acute in the future and

--solid and liquid wastes currently present few regulatory problems or concerns, but if EPA classifies solid coal wastes as hazardous, disposal problems faced by utilities will undoubtedly increase.

COAL WASTES MAY COST MORE TO DISPOSE OF THAN NUCLEAR WASTES

While available information indicates that coal waste disposal costs are higher than nuclear waste disposal costs, this cost comparison must be viewed with caution. Accurate disposal costs are not readily available, particularly for the nuclear fuel cycle, because some nuclear wastes have never been disposed of, and actual disposal costs are unknown. In addition, disposal methods

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1/Acid rain is the phenomenon where sulfur and nitrogen oxides chemically change in the atmosphere and return to the earth as acid compounds.

2/The "greenhouse effect" is a suspected phenomenon that some researchers predict may occur if carbon dioxide accumulates in the atmosphere and traps heat that would otherwise radiate into space, thereby resulting in a rise of the earth's temperature.

for many nuclear waste types are highly dependent on numerous factors including climate, hydrology, geology, waste preparation methods, chemical and mineral content, and radiation concentrations. However, based on the best available data and information developed by DOE, NRC, EPA, and the Office of Technology Assessment and assuming that coal solid wastes are classified as nonhazardous, disposal costs for coal wastes appear to be roughly three times more than for nuclear wastes. Coal waste disposal is estimated to cost between 3.73 and 4.28 mills/kilowatt hour (kwh), while nuclear waste disposal is estimated to cost between 0.80 to 1.28 mills/kwh, depending on the disposal method used and whether spent fuel is reprocessed or disposed of as a waste.

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Appendices I and II summarize, for nuclear and coal fuel cycle wastes, each of these waste disposal problems and uncertainties. Appendix III provides comparative cost estimates for nuclear and coal waste disposal. Appendix IV contains a complete list of utilities and other organizations we visited during our review. In addition, to supplement the information contained in the appendices, we are providing separately a "statement of facts" to your staff which discusses waste disposal progress and problems in greater depth.

As requested by your staff, we have not obtained agency comments on the matters discussed in this letter. In addition, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of the report. At that time, we will send copies to the Director, Office of Management and Budget; the Secretary of Energy; the Chairman, Nuclear Regulatory Commission; the Administrator, Environmental Protection Agency; and other interested parties. We will also make copies available to others upon request.

Sincerely yours,

J. Dexter Peach
Director

Contents

ABBREVIATIONS

DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
kWh	kilowatt hours
NRC	Nuclear Regulatory Commission

NUCLEAR WASTE DISPOSAL--

PROBLEMS AND UNCERTAINTIES REMAIN

Nuclear electrical generation produces five basic types of radioactive wastes:

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--Transuranic wastes are 11 man-made radioactive elements that have an atomic number greater than that of uranium and have half-lives of thousands of years.

Improper handling and disposal of nuclear wastes can cause significant environmental and health problems. Consequently, Federal programs exist to control and regulate nuclear wastes, as well as provide for their long-term isolation from the environment. Although some progress is being made, disposal problems and uncertainties still exist for each nuclear waste type that, if left unresolved, could adversely affect the growth of the nuclear power generation industry. Specifically,

--low-level waste disposal is hampered by inadequate disposal capacity and the Environmental Protection Agency (EPA) has not yet issued disposal standards;

--uranium mill tailings disposal is being delayed and will cost more because EPA failed to issue final disposal standards;

1/Reprocessing is the process whereby the unused uranium and plutonium in spent reactor fuel can be removed for use again as nuclear reactor fuel.

--spent fuel and high-level waste disposal plans are making little, if any, progress because of uncertainties about whether spent fuel should be reprocessed or disposed of as a waste, difficulties in finding a disposal site, and problems in transporting these wastes through certain States and localities; and

--transuranic waste disposal is currently not a major problem because not much has been generated, but it could be in the future because large quantities are expected to be produced and the Federal Goverment may experience problems similar to those being experienced with high-level waste.

The following sections address the disposal problems and uncertainties for each nuclear waste type in greater detail and provide the status of Federal, State, and/or utility efforts to resolve these problems.

ADDITIONAL DISPOSAL CAPACITY AND STANDARDS NEEDED FOR LOW-LEVEL WASTE DISPOSAL

Low-level waste is produced in all stages of the nuclear fuel cycle and includes materials such as filter sludges and bottoms, resins, used gloves and protective clothing, and discarded tools and equipment. Low-level waste is currently being disposed of in licensed shallow land burial grounds. The Nuclear Regulatory Commission (NRC) is primarily responsible for regulating low-level waste disposal practices and sites, but commercial generators are ultimately responsible for disposing of all the waste that they produce. In 1979, approximately 73,000 cubic meters of commercial low-level waste was disposed of. Although radiation has been accidently released to the environment from low-level waste sites in the past, the Department of Energy (DOE) believes the technology exists to safely dispose of this waste. However, the nuclear industry is faced with a lack of low-level waste disposal capacity and standards to govern its disposal.

Since 1979, commmercial low-level waste has been disposed of at only three sites in the United States: Hanford, Washington; Beatty, Nevada; and Barnwell, South Carolina. As of January 1981, approximately 31 percent of the total low-level waste disposal capacity for these sites had been exhausted. According to NRC and DOE, five to seven new low-level waste disposal sites will be needed by 1990.

Recently, a series of events occurred that raise additional concerns about the future availability of existing low-level waste disposal capacity. In 1979, two of the three operating commercial disposal sites closed because of accidents involving radiation releases caused by packaging and shipping inadequacies. The sites have since reopened after assurances by Federal regulatory agencies that appropriate actions would be taken to resolve

the problems that caused the accidents. About the time of these accidents, however, the Governors of the three States operating low-level waste disposal sites announced possible restrictions on the future use of these sites. Their rationale was that their States should not be assuming the entire burden of disposing of the Nation's low-level waste.

In response to the Governors' actions and in recognition of possible future low-level waste disposal needs, the Congress passed the Low-Level Radioactive Waste Policy Act of 1980. This act established the intergovernmental framework for developing a national system of low-level waste disposal facilities. The act made each State responsible for providing capacity by 1986 for disposing of low-level waste generated within its borders. The act, however, (1) allowed interstate compacts to be established among groups of States for managing and disposing of this waste on a regional basis and (2) permitted these compacts to restrict the use of regional disposal facilities to low-level waste generated within the boundaries of the participating States.

Utilities that are unable to use the three existing disposal sites are using a variety of measures to store their waste until a permanent disposal site is found. DOE, NRC, and the States are acting to help provide some of these measures, including volume reduction and on-site storage. DOE and NRC are also evaluating the possibility of storing commercial low-level waste at DOE facilities that normally handle only defense-generated waste. Although these interim measures can alleviate the need for immediate disposal, they will not alleviate the long-term need for additional disposal sites and capacity.

In addition, standards need to be established for disposing of low-level waste. When established in 1970, EPA was given the responsibility for developing low-level waste standards, which would, among other things, identify the types of low-level waste suitable for shallow land burial and specify environmental requirements for disposing of the waste. Although the legislation did not mandate EPA to issue the standards by a certain date, over 11 years have passed and EPA still has not fulfilled this responsibility. EPA officials say they have not issued the standards because other tasks had higher priority. EPA's latest estimate for publishing these standards is 1984.

The immediate consequences of the lack of EPA standards are uncertain, but it could cause problems in the future, depending on how stringent the EPA standards are. NRC has been using interim standards that it developed to regulate low-level waste disposal until the EPA standards are developed. If the EPA standards differ from NRC's interim standards, NRC would have to revise its standards to comply with EPA's standards. Consequently, it is possible that shallow-land burial is being used both for material that could be disposed of more simply and less expensively, and for material that warrants more restrictive disposal.

LACK OF FINAL EPA STANDARDS
DELAYING MILL TAILINGS DISPOSAL

Until the early 1970s, uranium mill tailings were not recognized as hazardous, and the Federal Government did relatively little to control or regulate milling operations. Recent studies, however, have shown that mill tailings, if not properly disposed of, may pose hazards to the public's health and the environment.

In response, the Congress passed the Uranium Mill Tailings Radiation Control Act of 1978, which established the current Federal mechanism for regulating mill tailings operations. Among other things, the act required EPA to develop standards for controlling and stabilizing mill tailings at inactive and active mill sites. The act required EPA to develop standards for inactive sites by November 8, 1979, and for active sites by May 8, 1980. However, EPA has yet to issue either standard.

The lack of standards is preventing remedial action at 25 inactive mills that contain over 25 million tons of mill tailings, produced primarily in support of the defense program. The act required DOE to complete remedial action at these sites within 7 years from issuance of EPA's final standards. Although DOE has identified the sites, established a preliminary schedule for performing the work, and begun negotiating cooperative agreements with the affected States, 1/ actual remedial action has been delayed until EPA issues the standards. Currently, EPA estimates that the final standards for inactive sites will be available sometime in 1983, over 3 years after the date specified in the legislation.

EPA's failure to issue mill tailings standards for active sites is also causing problems in regulating mill tailings disposal at active sites. In the absense of EPA standards, NRC established new uranium mill licensing standards in October 1980. However, the legality of these standards is being questioned by many groups, including the American Mining Congress, on the basis that NRC has no authority to promulgate such standards in the absence of EPA standards. NRC, on the other hand, believes it has not only the authority to develop such standards, but also the duty to ensure that the management of mill tailings at active sites is carried out in a manner that protects public health and safety.

If EPA finally issues its standards for active sites which it anticipates will not be before 1983, it could cause problems for NRC. NRC recognizes its standards must be compatible with

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1/Three States--Colorado, Pennsylvania, and Utah--have already signed a cooperative agreement with DOE.

EPA's. If EPA's standards differ significantly from NRC's interim standards, wasted time and resources could result and delays in disposing of some commercial waste or excessive costs could occur if additional work is needed because the EPA standards are more stringent.

WHERE, WHEN, AND HOW SPENT FUEL AND HIGH-LEVEL WASTE WILL BE DISPOSED OF IS STILL IN DOUBT

One of the most significant controversies and uncertainties relating to the nuclear fuel cycle centers on the questions of where, when, and how to dispose of spent fuel and/or high-level waste, and what impact possible restrictions on transporting these wastes will have on disposal efforts. DOE and much of the scientific community believe that the technology is available to safely dispose of spent fuel and high-level wastes. However, because the technology has not been fully demonstrated, questions still exist particularly on the long-term integrity of spent fuel disposal. Currently, no man-made barrier can be constructed which will guarantee isolation of spent fuel for the life of its toxicity. Since several elements in spent fuel remain toxic for hundreds of thousands of years, existing disposal technology requires almost complete reliance on the geological features of the site to contain the waste.

In spite of these technological concerns, DOE believes that the major obstacle to disposing of highly radioactive waste is gaining public and political acceptance of the waste disposal concept and disposal site locations. Since the 1950s, the Federal Government has attempted to identify and develop disposal sites, but in every case, attempts have failed or problems have surfaced primarily because of political and public opposition. Presently, high-level waste in liquid form--primarily generated by defense weapons activities--is being placed in underground tanks located near reprocessing facilities. Plans are to eventually solidify the waste and place it in permanent repositories. In the meantime, DOE is working closely with States to locate adequate disposal sites. Overcoming this problem is, perhaps, the most significant challenge DOE faces in its waste management program. Failure to find suitable disposal sites could prevent future construction of nuclear power plants and may force existing reactors to stop operating.

Spent fuel and high-level waste disposal could also be hampered by transportation problems. Federal officials are concerned that adequate numbers of shipping casks to transport spent fuel may not be available because utilities are reluctant to order and manufacturers are reluctant to produce casks until they know whether spent fuel will be moved. Also, the railroad industry has expressed reluctance to carry high-level waste or spent-fuel without having "special" or "dedicated" train service

because they believe these shipments involve disproportionately higher accident and liability risks. Finally, some States and local municipalities have enacted restrictions or bans on trucking high-level nuclear waste and spent fuel shipments through their jurisdiction because of public opposition to such shipments. Unless these uncertainties are resolved, future movements and disposal of these wastes will be hindered.

Finally, the question of whether spent fuel should be disposed of as a high-level waste or be reprocessed is still unresolved. As previously mentioned, reprocessing is the process whereby the uranium and plutonium in spent fuel can be separated from the waste products. The process not only provides fuel (i.e., the separated uranium and plutonium), but also reduces the quantity of waste that needs to be disposed of. In fact, spent fuel disposal may require as much as three times more disposal capacity than the wastes created from reprocessing spent fuel. For the past 5 years, the reprocessing issue has been widely debated and executive branch support, as well as Federal policy, has shifted back and forth. Utilities are currently storing spent fuel at reactor sites, but storage capacity is limited. Final resolution of this uncertainty is needed to provide the nuclear industry, as well as Federal agencies, a basis for planning storage and/or disposal requirements.

DISPOSAL SITE NEEDED FOR TRANSURANIC WASTE

Transuranic wastes, such as chemical process residues, discarded equipment and tools, paper, clothing, and glass, retain radiation for thousands of years. The majority of transuranic waste is being produced by Federal nuclear weapons and research programs. Commercial nuclear operations are also producing small quantities of transuranic waste. Most of this waste is generated by industrial and Government-sponsored fuel fabrication and research activities which do not directly contribute to the generation of electricity. Transuranic waste can also be generated from reprocessing operations and decommissioning activities. When, and if, reprocessing is resumed and when commercial nuclear facilities are closed and decommissioned, large amounts of commercial transuranic waste will be produced.

In the past, the Federal Government did not fully recognize the health hazards of transuranic waste and therefore allowed its disposal in low-level waste burial grounds. In 1970, however it was recognized that transuranic waste could create a health hazard because it could leach out of the burial site and contaminate surrounding waterways with its long-lived radioactive elements. At that time, a Federal policy was established requiring transuranic waste to be disposed of in a manner similar to high-level waste.

The Federal Government, however, is having a problem finding a suitable transuranic waste disposal site. The crux of this problem involves the controversy over whether the transuranic waste site should contain the waste from both commercial and defense operations or if each waste should be disposed of in separate sites. Until this controversy is resolved, commercial transuranic waste is temporarily being stored at the sites where it was produced.

NRC and industry have appealed to DOE to accept commercial transuranic waste for storage until a disposal facility is available. DOE, however, has refused, citing questions of legal authority and difficulties with establishing charges, as well as DOE concerns about possible NRC regulation. As a result, a number of licensees are storing their waste for an indeterminate period until a commercial disposal site can be established. This situation is causing problems for some of these licensees, particularly those who are trying to terminate their license with NRC and get out of the nuclear business, but are unable to do so as long as they are responsible for storing this waste.

Additionally, if large amounts of commercial transuranic wastes are produced in the future, transportation and other problems, similar to those expected for spent fuel and high-level waste, may occur.

COAL WASTE DISPOSAL--
PROBLEMS AND HAZARDS NOT
COMPLETELY UNDERSTOOD

Coal electrical generation produces waste in three forms:

--Gases, such as sulfur oxides, nitrogen oxides, carbon dioxide, hydrocarbons, and suspended particles, 1/ that are released into the atmosphere when coal is burned.

--Liquids, such as slurry and sludge, that are produced from coal mining and cleaning operations.

--Solids, such as bottom ash and scrubber sludge, that are produced during coal mining, cleaning, and burning operations.

Although coal has been used to generate electricity for many years, the specific impacts of coal wastes on the public's health and safety were generally not understood. Little effort was made to determine the environmental and health effects of coal fuel cycle wastes, and no Federal programs were established to regulate them until the 1970s. During the 1970s, however, in response to increased public concerns about the quality of the environment, the Congress enacted legislation establishing numerous programs to protect and enhance environmental quality in the United States.

Subsequent studies to determine the causes and sources of pollution have raised concerns and controversies about the environmental and health hazards of many coal wastes. To respond to these concerns, the Federal Government and utilities initiated actions to help control and reduce pollutants emitted from coal-fired power plants. Although these actions have resulted in dramatic progress, the long-term effects of several potentially significant waste problems have yet to be determined accurately, and for the hazards that have been identified, there is still controversy about the extent of damage that is attributable to coal use. Consequently, many problems and uncertainties associated with coal fuel cycle wastes still need to be resolved. Specifically:

1/Suspended particles are actually solid wastes, such as fly ash and soot, but because they are released into the atmosphere when coal is burned, for discussion purposes, we are considering them to be gaseous wastes.

--gaseous wastes are contributing to air quality problems, which are affecting the planning and locating of new coal-fired power plants; they are also suspected of causing other environmental concerns, namely acid rain 1/ and the "greenhouse effect," 2/ which could make restrictions on new and existing coal-fired power plants more acute in the future and

--solid and liquid wastes currently present few regulatory problems or concerns, but if the Environmental Protection Agency classifies solid coal wastes as hazardous, disposal problems faced by utilities will undoubtedly increase.

For the most part, detailed information is not available on the problems associated with coal liquid waste disposal. Most of the studies we examined failed to discuss this waste type in depth. The disposal problems with liquid waste usually occur when solid and liquid wastes are combined. Therefore, we have included relevant issues for liquid wastes in our discussion of solid waste disposal.

The following sections address the disposal problems and uncertainties for gaseous and solid coal wastes in greater detail and the status of Federal and State efforts to resolve them. Since transportation is not a problem in coal waste disposal, we did not discuss it.

GASEOUS EMISSIONS PROBLEMS MAY RESTRICT FUTURE COAL USE

Coal-fired power plants emit tremendous amounts of gaseous wastes into the atmosphere--about 17.5 million tons of sulfur oxides, 5.6 million tons of nitrogen oxides, and 72,000 tons of hydrocarbons each year. This represents about 69 percent of all sulfur oxide, 23 percent of all nitrogen oxide, and 1 percent of all hydrocarbon emissions in the United States. The remainder of these emissions comes from other sources such as automobile exhausts and burning of other types of fuel by industry, commercial businesses, and the public.

1/Acid rain is the phenomenon where sulfur and nitrogen oxides chemically change in the atmosphere and return to the earth as acid compounds.

2/The "greenhouse effect" is a suspected phenomenon that some researchers predict may occur if carbon dioxide accumulates in the atmosphere and traps heat that would otherwise radiate into space, thereby resulting in a rise of the earth's temperature.

These emissions can create air pollution problems which have been linked to respiratory ailments, such as asthma and bronchitis, and damage to crops and forests. Furthermore, sulfur and nitrogen oxide emissions can chemically change in the atmosphere and return to the earth as acid compounds, a phenomenon known as "acid rain."

In addition to these emissions, coal-fired power plants also emit hundreds of millions of tons of carbon dioxide annually. Although accumulation of carbon dioxide in the atmosphere has never been considered a health hazard, some researchers are beginning to believe that the continued accumulations of carbon dioxide may, by the beginning of the 21st century, cause a rise in the earth's temperature and result in a phenomenon called the "greenhouse effect." Although this is currently a highly debatable and controversial issue, some researchers say this could, among other things, affect cloud formation, precipitation, and wind patterns, which, in turn, could (1) change agricultural production areas; (2) shift the locations of grasslands, forests, deserts, and the animal life associated with those areas; and (3) cause changes in ocean currents.

Air pollution problems are already causing utilities difficulties in locating new coal-fired plants in many regions of the country. Various pollution control devices have been used to substantially reduce sulfur oxide, nitrogen oxide, and hydrocarbon emissions in recently constructed coal-fired power plants. However, for economic and technical reasons, these devices are not as widely used in the older plants which produce about 95 percent of the coal-generated electricity in the United States. Although progress has been made at reducing emissions from these older plants, primarily by burning coal of lower sulfur content, these plants continue to emit substantially larger quantities of pollutants than newer plants. Consequently, air pollutants currently being emitted by coal-fired power plants, as well as by other industrial sources, continue to add to existing air quality problems for many parts of the country.

Current Federal environmental regulations are directed at improving air quality in areas that exceed specified pollutant limits and maintaining the quality in areas that do not exceed these limits. Thus, the regulations are making it difficult for utilities to plan and locate new coal-fired generating facilities in those areas of the country that exceed or nearly exceed the pollution limits. Unfortunately, many of these areas, such as the Midwest, rely on coal to meet their electrical generation needs. EPA has considered changing the regulations to ease these problems, but decided that additional studies must first be done to determine the extent that coal burning contributes to air quality problems, and the impact that changes to the regulations would have on Federal environmental goals.

The acid rain problem may further complicate environmental compliance problems being experienced by the coal electrical generation industry. However, there is substantial disagreement about the causes and the impacts of acid rain. Studies are in progress and legislation is being considered which seeks to control acid rain. If regulations are imposed, it may require more stringent controls to reduce gaseous emissions, thereby resulting in additional costs to utilities that burn coal.

In a September 11, 1981, report entitled "The Debate Over Acid Precipitation--Opposing Views--Status of Research" (EMD-81-131), we clarified the often confusing range of viewpoints on the main technical and regulatory issues and the status of scientific research on key issues, determining what is presently known and what is uncertain. We also have a study in progress to respond to the question of whether it is appropriate that the Federal Government act now to try to reduce the extent of acid rain or wait until further study is done.

Much more serious difficulties for the coal electrical generation industry may occur if the "greenhouse effect" is found to be a significant environmental problem. Although this is also currently a highly debatable and controversial issue, it could have far reaching impacts on the coal electrical generation industry, if additional research shows this phenomenon will lead to environmental problems. Currently, technology does not exist to reduce carbon dioxide emissions, and such reductions could only be achieved by reducing our use of fossil fuels. The Department of Commerce, in cooperation with 10 other Federal agencies, is currently sponsoring research to (1) determine whether carbon dioxide is building up in the atmosphere, and, if so, whether the build-up causes problems; (2) examine the positive effects, if any, on crop production; and (3) compile sufficient quantitative data to aid in formulating policy for this matter. Departmental officials stated that they expect to issue an initial report in 1984 which shows the status of this research effort.

POSSIBLE RECLASSIFICATION OF SOLID WASTE COULD CAUSE DISPOSAL PROBLEMS

In the past, coal solid wastes were not considered to be hazardous and presented relatively few regulatory problems or concerns. Recently, however, coal solid wastes were found to contain harmful concentrations of toxic elements that may prove to be hazardous to the public's health and the environment. Based on these concerns, the Congress passed the Resource Conservation and Recovery Act of 1976. The act, among other things, directed EPA to develop criteria by which it could classify solid materials as being either hazardous or nonhazardous.

In response to this requirement, in 1978, EPA issued draft regulations that classified coal solid combustible wastes as hazardous. During the regulatory comment period, utility industry officials disputed EPA's proposed classification on the basis that EPA lacked sufficient evidence to demonstrate the health and environmental hazards of coal solid wastes. Because of this controversy, EPA is currently conducting a study to determine whether coal solid wastes warrant a hazardous classification. If such a classification were made, future regulatory and compliance problems could occur.

Utility officials told us that they may have difficulties complying with proposed hazardous waste disposal regulations for two reasons. First, because hazardous waste disposal regulations would be more stringent, they estimate that current disposal costs could increase 2 to 13 times. Secondly, hazardous waste disposal sites needed to handle the additional 200 million tons of solid coal wastes generated each year may be difficult to find.

Furthermore, some States are concerned about their capability, under such circumstances, to effectively regulate solid coal waste disposal practices. EPA currently provides technical and financial support to States to help them plan and develop programs to manage nonhazardous wastes. However, Federal financial assistance is scheduled to terminate by the end of 1982, and States have not established alternative funding sources to allow their programs to continue. Thus, funding problems could reduce the current effectiveness of State programs to regulate nonhazardous waste disposal practices. In addition, States may experience similar difficulties if solid coal wastes are classified as hazardous. Existing Federal financial assistance to States for managing hazardous waste disposal practices is already limited--$40 million is authorized for fiscal year 1982. Because of the large volume of solid coal wastes that would have to be disposed of each year, it is uncertain whether existing funding authorizations would be sufficient to allow States to effectively regulate the disposal of all solid coal wastes.

COAL WASTES MAY COST MORE TO DISPOSE OF THAN NUCLEAR WASTES

While available information indicates that coal waste disposal costs are higher than nuclear waste disposal costs, this cost comparison must be viewed with caution. Accurate disposal costs are not readily available, particularly for the nuclear fuel cycle, because some nuclear wastes have never been disposed of and actual disposal costs are unknown. In addition, disposal methods for many nuclear waste types are highly dependent on numerous factors including climate, hydrology, geology, waste preparation methods, chemical and mineral content, and radiation concentrations. However, based on the best available data and information developed by the Department of Energy, Nuclear Regulatory Commission, Environmental Protection Agency, and Office of Technology Assessment and assuming that coal solid wastes are classified as nonhazardous, disposal costs for coal wastes appear to be roughly three times more than for nuclear wastes. Coal waste disposal is estimated to cost between 3.73 and 4.28 mills/kilowatt hour (kwh), while nuclear waste disposal is estimated to cost between 0.80 to 1.28 mills/kwh, depending on the disposal method used and whether spent fuel is reprocessed or disposed of as a waste.

NUCLEAR WASTE DISPOSAL COSTS

Spent fuel, high-level, and transuranic wastes are expected to be the most costly of the nuclear fuel cycle wastes to dispose of. Costs will be incurred in preparing the wastes for disposal as well as in actually disposing of them. Comparatively, other nuclear waste disposal costs appear minimal. The following table shows the estimated disposal costs for each type of nuclear waste.

APPENDIX III

Estimated Cost for Disposing of Nuclear Fuel Cycle Wastes

Waste type	Costs: Once-through fuel cycle option (note a)	Costs: Reprocessing fuel cycle option (note a)
	(mills/kilowatt hour)	
Uranium mill tailings	b/0.03 to 0.06	b/0.03 to 0.06
Low-level waste	c/0.09	c/0.09
Spent fuel, high-level waste, and transuranic waste:		
Pre-disposal (note d)	0.45	0.73
Disposal (note e)	0.23 to 0.38	0.20 to 0.40
Total estimated disposal cost	0.80 to 0.98	1.05 to 1.28

a/Two options must be used since it is uncertain whether spent fuel or high-level waste, or both, will ultimately be disposed. The once-through fuel cycle option represents the disposal of spent fuel and the reprocessing fuel cycle option represents the reprocessing of fuel and disposal of high-level waste. Both options include the disposal of transuranic waste.

b/Based on NRC estimate contained in NUREG-0706. Low to high range used because current regulations do not require one disposal practice. This range represents alternatives that most closely simulate regulatory requirements.

c/Based on NRC estimate contained in NUREG/CR-2206. Figure represents a typical operating reactor--1,100MW, 80 percent operating capacity.

d/Based on DOE estimate contained in EIS-0046F. Predisposal costs include the storage of spent fuel and transuranics, preparation of the waste for disposal (both options), and transportation to the disposal site.

e/Based on DOE estimate contained in EIS-0046F. Disposal costs include owner's costs, construction costs, and operating costs in an 800-hectare Geologic Repository. Low to high range is used to show difference in costs depending on geologic media (still to be selected). Low estimate used is for salt, high is for basalt.

COAL WASTE DISPOSAL COSTS

Disposal of sulfur oxides accounts for over 50 percent of the coal fuel cycle waste disposal costs because they require use of costly pollution control equipment. The following table shows a breakdown of the estimated disposal cost for each type of waste produced in the coal fuel cycle.

Estimated Cost for Disposing of Coal Fuel Cycle Wastes

Waste type	Costs (mills/kwh)
Mining and cleaning (solid)	a/0.004 to 0.27
Sulfur oxides	b/2.21
Particulates	b/0.66
Bottom ash and fly ash	c/0.45
Scrubber sludge	c/0.41 to 0.69
Total estimated disposal cost	3.73 to 4.28

a/Computation based on: Office of Technology Assessment report "The Direct Use of Coal," April 1979; and a DOE report, "Energy Data Report, Preliminary Power Production, Fuel Consumption, and Installed Data Capacity for 1979," May 1980. Low to high range used to represent various disposal methods used.

b/Based on EPA report, "Environmental Regulations and the Electric Utility Industry," July 1981.

c/Based on Office of Technology Assessment report, "The Direct Use of Coal," April 1979.

ORGANIZATIONS VISITED

COAL MINING COMPANY

Peabody Coal Co., St. Louis, Missouri.

DEPARTMENT OF ENERGY FACILITIES

Albuquerque Operations Office, Albuquerque, New Mexico.

Oak Ridge National Laboratory, Oak Ridge, Tennessee.

ELECTRIC UTILITY COMPANIES

Commonwealth Edison Co., Chicago, Illinois.

Duquesne Light Co., Pittsburgh, Pennsylvania.

Northern States Power Co., Minneapolis, Minnesota.

Philadelphia Electric Co., Philadelphia, Pennsylvania.

Potomac Electric Power Co., Washington D.C.

Power Authority of the State of New York, New York, New York.

Public Service Company of Colorado, Denver, Colorado.

Southern California Edison Co., Rosemead, California.

Tennessee Valley Authority, Chattanooga, Tennessee.

Texas Utilities Generating Co., Dallas, Texas.

Toledo Edison Co., Toledo, Ohio.

ELECTRIC UTILITY ORGANIZATIONS

Atomic Industrial Forum, Washington, D.C.

Edison Electric Institute, Washington, D.C.

National Coal Association, Washington, D.C.

ENVIRONMENTAL ORGANIZATION

Public Lands Institute, Denver, Colorado.

FEDERAL AGENCIES

Department of Energy, Washington, D.C.

Department of Transportation, Washington, D.C.

Environmental Protection Agency, Washington, D.C.

Nuclear Regulatory Commission, Bethesda, Maryland.

Department of Interior, Washington, D.C.

RAILROAD ASSOCIATION

Association of American Railroads, Washington, D.C.

STATE AGENCIES

California Energy Commission, Sacramento, California.

Colorado Department of Health, Denver, Colorado.

Colorado Department of Natural Resources, Denver, Colorado.

Illinois Environmental Protection Agency, Springfield, Illinois.

Maryland Department of Health and Mental Hygiene, Baltimore, Maryland

New York State Department of Environmental Conservation, Albany, New York.

New York State Energy Office, Albany, New York.

Office of the Commmissioner of Health, Nashville, Tennessee.

Ohio Environmental Protection Agency, Columbus, Ohio.

Pennsylvania Department of Environmental Resources, Harrisburg, Pennsylvania.

Texas Air Control Board, Austin, Texas.

Texas Department of Health, Austin, Texas.

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