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

JUN 6 1980

Ms. Patricia Moorhead
196 Palisade Avenue
Emerson, New Jersey 07630

Dear Ms. Moorhead:

This is in reply to your letter of April 17, 1980, to President Carter about nuclear power plants.

You may be interested in the enclosed statement of December 7, 1979, by the President on the Kemeny Commission Report on Three Mile Island. This includes the following:

> "The NRC has indicated, however, that it will pause in issuing any new licenses and construction permits in order to devote its full attention to putting its own house in order and tightening up safety requirements. I endorse this approach which the NRC has adopted, but I urge the NRC to complete its work as quickly as possible and in no event later than six months from today. Once we have instituted the necessary reforms to assure safety, we must resume the licensing process promptly so that the new plants we need to reduce our dependence on foreign oil can be built and operated."

Actions to improve the safety of nuclear power plants in operation were judged to be necessary immediately after the Three Mile Island accident. Such actions came from Bulletins and Orders issued to operators of nuclear power plants, from a report of the Lessons-Learned Task Force issued in July 1979, and from recommendations of the Emergency Preparedness Task Force. Many of the required immediate actions have already been taken by licensees and most are scheduled to be completed by the end of 1980. In addition, an Action Plan has been developed to provide a comprehensive and integrated plan for the actions now judged necessary by the Nuclear Regulatory Commission to correct or improve the regulation and operation of nuclear facilities based on the experience from the Three Mile Island accident and the official studies and investigations of the accident. Meanwhile, in order to avoid unnecessary delays, the Commissioners approved the issuance of NRC licenses for three nuclear power units to load fuel and, under specified conditions, to operate at low power levels for testing.

With regard to the cost of dismantling a nuclear power plant when its operating life is over, enclosed is the Summary of report NUREG/CR-0130, Vol. 1, on "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station" from Battelle Pacific Northwest Laboratory, June 1978. Decommissioning costs are treated in Section 2.9, and approaches to financing decommissioning are given in Section 2.4.

THIS DOCUMENT CONTAINS
POOR QUALITY PAGES

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You mentioned plants producing electricity from waste material. The Second National Energy Plan transmitted by the President to the Congress on May 7, 1979, includes the following:

> "Urban wastes contain large quantities of biomass that can be either burned or converted to premium fuels. Technologies for converting these wastes are commercially available, but marginal economics and institutional barriers are slowing their progress. Improved technology, higher costs for conventional solid waste disposal, and efforts to break down institutional barriers could make this technology both a source of energy and an efficient way to deal with solid waste."

However, the same document states: "The Nation's mid-term energy situation depends on successfully maintaining and expending the use of coal and nuclear power. These two sources are commercially available today and can be enlarged if the markets grow and their critical environmental and social problems are overcome."

Every effort is being made to ensure the public health and safety at all nuclear power plants that are currently in operation or that may start operation in the future.

Sincerely,

Harold Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosures:
White House Release
NUREG/CR-0130

FOR IMMEDIATE RELEASE DECEMBER 7, 1979

OFFICE OF THE WHITE HOUSE PRESS SECRETARY

THE WHITE HOUSE

STATEMENT BY THE PRESIDENT ON THE KEMENY COMMISSION REPORT ON THREE MILE ISLAND

Room 450, Old Executive Office Building

(AT 2:45 P.M. EST)

THE PRESIDENT: The purpose of this brief statment this afternoon is to outline to you and to the public, both in this country and in other nations of the world, my own assessment of the Kemeny Report recommendations on the Three Mile Island accident and I would like to add, of course, in the presentation some thoughts and actions of my own.

I have reviewed the report of the Commission, which I established to investigate the accident at the Three Mile Island nuclear power plant. The Commission, headed by Dr. John Kemeny, found very serious shortcomings in the way that both the Government and the utility industry regulate and manage nuclear power.

The steps that I am taking today will help to assure that nuclear power plants are operated safely. Safety, as it always has been and will remain, is my top priority. As I have said before, in this country nuclear power is an energy source of last resort. By this I meant that as we reach our goals on conservation, on the direct use of coal, on development of solar power and synthetic fuels, and enhanced production of American oil and natural gas, as we reach those goals, then we can minimize our reliance on nuclear power.

Many of our foreign allies must place much greater reliance than we do on nuclear power, because they do not have the vast natural resources that give us so many alternatives. We must get on with the job of developing alternative energy resources and we must also pass, in order to do this, the legislation that I have proposed to the Congress making an effort at every level of society to conserve energy. To conserve energy and to develop energy resources in our country are the two basic answers for which we are seeking. But we cannot shut the door on nuclear power for the United States.

The recent events in Iran have shown us the clear, stark dangers that excessive dependence on imported oil holds for our nation. We must make every effort to lead this country to energy security. Every domestic energy source, including nuclear power, is critical if we are to be free as a country from our present over-dependence on unstable and uncertain sources of high priced foreign oil.

We do not have the luxury of abandoning nuclear power or imposing a lengthy moratorium on its further use. A nuclear power plant can displace 35,000 barrels of oil per day, or roughly 13 million barrels of oil per year. We must take every possible step to increase the safety of nuclear power production. I agree fully with the letter and the spirit and the intent of the Kemeny Commission recommendations, some of which are within my own power to implement, others of which rely on the Nuclear Regulatory Commission, or the NRC, or the utility industry itself.

To get the Government's own house in order I will take

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several steps. First, I will send to the Congress a reorganization plan to strengthen the role of the Chairman of the NRC, to clarify assignment of authority and responsibility and provide this person with the power to act on a daily basis as a chief executive officer, with authority to put needed safety requirements in place and to implement better procedures. The Chairman must be able to select key personnel and to act on behalf of the Commission during any emergency.

Second, I intend to appoint a new Chairperson of the Nuclear Regulatory Commission, someone from outside that agency, in the spirit of the Kemeny Commission recommendation. In the meantime, I have asked Commissioner Ahearne, now on the NRC, to serve as the Chairman. Mr. Ahearne will stress safety and the prompt implementation of the needed reforms.

In addition, I will establish an independent advisory committee to help keep me and the public of the United States informed of the progress of the NRC and the industry in achieving and in making clear the recommendations that nuclear power will be safer.

Third, I am transferring responsibility to the Federal Emergency Management Agency, the FEMA, to head up all off-site emergency activities, and to complete a thorough review of emergency plans in all the states of our country with operating nuclear reactors by June, 1980.

Fourth, I have directed the Nuclear Regulatory Commission and the other agencies of the Government to accelerate our program to place a resident Federal inspector at every reactor site.

Fifth, I am asking all relevant Government agencies to implement virtually all of the other recommendations of the Kemeny Commission. I believe there were 44 in all. A detailed factsheet is being issued to the public and a more extended briefing will be given to the press this afternoon.

With clear leadership and improved organization, the Executive Branch of Government and the NRC will be better able to act quickly on the crucial issues of improved training and standards, safety procedures, and the other Kemeny Commission recommendations. But responsibility to make nuclear power safer does not stop with the Federal Government. In fact, the primary day by day responsibility for safety rests with utility company management and with suppliers of nuclear equipment. There is no substitute for technically qualified and committed people working on the construction, the operation, and the inspection of nuclear power plants.

Personal responsibility must be stressed. Some one person must always be designated as in charge, both at the corporate level and also at the power plant site. The industry owes it to the American people to strengthen its commitment to safety.

I call on the utilities to implement the following changes; first, building on the steps already taken, the industry must organize itself to develop enhanced standards for safe design, operation, and construction of plants; second, the nuclear industry must work together to develop and to maintain in operation a comprehensive training, examination, and evaluation program for operators and for supervisors. This training program must pass muster with the NRC through accreditati of the training programs to be established.

Third, control rooms in nuclear power plants must be modernized, standardized, and simplified as much as possible, to permit

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better informed decision-making among regular operating hours and, of course, during emergencies.

I challenge our utility companies to bend every effort to improve the safety of nuclear power.

Finally, I would like to discuss how we manage this transition period during which the Kemeny recommendations are being implemented. There are a number of new nuclear plants now awaiting operating licenses or construction permits. Under law, the Nuclear Regulatory Commission is an independent agency. Licensing decisions rest with the Nuclear Regulatory Commission, and as the Kemeny Commission noted, it has the authority to proceed with licensing these plants on a case by case basis, which may be used as circumstances surrounding a plant or its application dictate.

The NRC has indicated, however, that it will pause in issuing any new licenses and construction permits in order to devote its full attention to putting its own house in order and tightening up safety requirements. I endorse this approach which the NRC has adopted, but I urge the NRC to complete its work as quickly as possible and in no event later than six months from today. Once we have instituted the necessary reforms to assure safety, we must resume the licensing process promptly so that the new plants we need to reduce our dependence on foreign oil can be built and operated.

The steps I am announcing today will help to insure the safety of nuclear plants. Nuclear power does have a future in the United States. It is an option that we must keep open. I will join with the utilities and their suppliers, the Nuclear Regulatory Commission, the executive departments and agencies of the Federal Government, and also the state and local governments to assure that the future is a safe one.

Now Dr. Frank Press, Stu Eizenstat, and John Deutsch will be glad to answer your questions about these decisions and about nuclear power and the future of it in our country. Frank?

END (AT 3:00 P.M. EST)

NUREG/CR-0130
Vol. 1

TECHNOLOGY, SAFETY AND COSTS OF DECOMMISSIONING A REFERENCE PRESSURIZED WATER REACTOR POWER STATION

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Manuscript Completed: May 1978
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Division of Engineering Standards
Office of Standards Development
U. S. Nuclear Regulatory Commission
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2.0 SUMMARY

The results of a study sponsored by the U.S. Nuclear Regulatory Commission (NRC) to conceptually decommission a large pressurized water reactor (PWR) power station are summarized in this section. The purpose of the study is to provide information on the available technology, the safety considerations, and the probable costs for decommissioning a large PWR power station after a 40-year operating life.

Decommissioning is defined, for a nuclear facility, as the measures taken at the end of the facility's operating life to assure the continued protection of the public from any residual radioactivity or other potential hazards present in the facility. Two basic approaches to decommissioning are considered:

- Immediate Dismantlement - Radioactive materials are removed and the station is decontaminated and disassembled during the four-year period following final cessation of power production operations. Upon completion, the property is released for unrestricted use.
- Safe Storage with Deferred Dismantlement - Radioactive materials and contaminated areas are secured and structures and equipment are maintained as necessary to assure the protection of the public from the residual radioactivity. During the period of Safe Storage, the facility remains limited to nuclear uses. Dismantlement is deferred until the radioactivity within the station has decayed to lower levels. Upon completion of dismantlement, the property is released for unrestricted use.

Deferred dismantlement, as used here, is a generic term that includes whatever actions are required at some future time to accomplish termination of the facility's nuclear license and the release of the property for unrestricted use. These actions can range from radiation surveys that show that the residual radioactivity has decayed to releasable levels, to disassembly and removal of radioactive material.

Immediate dismantlement is estimated to require about six years to complete, including two years of planning and preparation prior to final reactor shutdown, at a cost of $42 million, and accumulated occupational radiation dose, excluding transport operations, of about 1200 man-rem.

Preparations for Safe Storage are estimated to require about three years to complete, including 1-1/2 years for planning and preparation to prior final reactor shutdown, at a cost of $13 million and an accumulated occupational radiation dose of about 420 man-rem. The cost of continuing care during the Safe Storage period was estimated to be about $80 thousand annually. Accumulated occupational radiation dose during the Safe Storage period was estimated to range from about 10 man-rem for the first 10 years to about 14 man-rem after 30 years or more. All costs are given in terms of constant 1978 dollars.

The cost of decommissioning by Safe Storage with Deferred Dismantlement is estimated to be slightly higher than Immediate Dismantlement. Cost reductions resulting from reduced volumes of radioactive material for disposal, due to the decay of the radioactive contaminants during the deferment period, are offset by the accumulated costs of surveillance and maintenance during the Safe Storage period.

The decommissioning by permanent entombment of a PWR that had been operated for 20 to 30 years or more was found to be unsatisfactory because: 1) the radiation dose rates from the long-lived radionuclides ^{59}Ni and ^{94}Nb in the activated reactor vessel internals remain well above unrestricted release levels for a period of time far exceeding the known lifetime of any man-made structure, and 2) permanent entombment results in the proliferation of sites permanently committed to the containment of radioactive materials.

The principal incentive for deferring dismantlement comes from the reduction in radiation exposure that can be achieved. Compared with immediate dismantlement, deferral for ten years reduces the estimated total radiation dose by about 40%; for 30 years, by more than 60%. Deferral of dismantlement beyond 30 years does not produce a significant further reduction in total radiation dose since most of the dose is accumulated during the preparation for Safe Storage, rather than during Deferred Dismantlement.

The safety impacts of the decommissioning operations on the public were found to be small, compared with those of the operating power station. The principal impact on the public is the radiation dose resulting from the transport of radioactive materials to a disposal site.

2.1 KEY BASES AND ASSUMPTIONS

One of the key bases for this study is that the methods used to accomplish decommissioning utilize presently available technology. While a number of devices and techniques that are presently under development are discussed in the study, the results do not depend upon any breakthroughs or advances in present-day technology. Such advances would likely serve to reduce costs and occupational radiation exposure when fully developed and utilized.

The decommissioning effort is assumed to be carried out within the framework of existing regulations. No assumptions are made regarding what future regulatory requirements might be. It is recognized that future regulations could have significant impacts on the methods and results of this study. Efforts were made to follow the principle of minimizing exposures to radiation in developing the work sequences and for methods. The radiation dose rates used in the analyses are at the upper bound values that might be encountered, based on conservative estimates of the effectiveness of the chemical decontamination of the plant systems.

For Immediate Dismantlement, the decommissioning staff is assumed to be drawn largely from the operating personnel of the station, and is very familiar with the facility and its systems. Also, all craft labor assignments during decommissioning, except for demolition, are handled by plant maintenance mechanics who are qualified in all basic craft skills. This category of skilled worker is fairly common at operating reactor stations and eliminates the problems of craft jurisdiction frequently encountered on construction-type jobs.

The rate at which radiation levels diminish with time during the decommissioning efforts is assumed to be controlled by the half-life of ^{60}Co. The estimated radiation dose rates throughout the station are based on data measured at operating reactor stations during the first month of refueling and maintenance outages. Therefore, the radiation dose rates present during decommissioning operations that take place later than the initial month after reactor shutdown are reduced in proportion to the decay of ^{60}Co over that time interval.

The planning and preparations for decommissioning take place during the final two years of reactor operation, making it possible for the necessary approvals to be in place by the time the reactor is defueled and disabled, so that decommissioning work can commence without delay.

Decontamination of the dismantled facilities and the site is assumed to be performed as required to achieve levels of residual radioactivity sufficiently low to permit unrestricted use of the property.

The methods and procedures for decommissioning are selected to provide the required degree of radiation safety for the decommissioning worker and for the public, and are performed in a safety-conscious and cost-effective manner.

All materials, except spent reactor fuel, that are radioactively contaminated or are neutron-activated to levels above those permitting unrestricted use are packaged and shipped to a licensed burial site for disposal. These materials are assumed to be principally activated metals, activated metal corrosion products, and small quantities of fission products, with no significant quantities of transuranic materials. The spent reactor fuels are postulated to be shipped to an unspecified fuel repository.

The power station is assumed to contain a single reactor plant with no other nuclear facilities on the site. Thus, no support from shared facilities is assumed.

The results obtained in this study are specific to these bases and assumptions, and to other assumptions specifically stated throughout the report. Application of these results to situations where the conditions are different from those assumed in this study could produce erroneous conclusions.

2.2 REVIEW OF DECOMMISSIONING EXPERIENCE

A review of the documented cases of decommissioning of nuclear facilities shows that, while the facilities decommissioned were generally small and had operated for relatively short periods of time, the problems encountered tended to be common to all decommissioning undertakings. The review also shows that a wealth of experience exists within the nuclear industry regarding methods and equipment for accomplishing decommissioning, and that there are no major technical impediments to the successful decommissioning of large commercial power reactors.

2.3 STATUS OF REGULATORY GUIDANCE FOR DECOMMISSIONING

A review of existing regulations and guidelines shows that, in general, regulations are in place to cover the subject of decommissioning of a nuclear reactor power station. In many cases, the existing regulations do not speak specifically to the question of decommissioning but the regulations can readily be interpreted as being applicable. In these cases, modifications to the regulations to clearly define their applicability to decommissioning would be desirable.

Areas where more specific guidance could be helpful:

- Financial qualifications and responsibility for decommissioning, to more clearly define the commitments of the facility owner for achieving the final status of unrestricted use of the property. Specific definitions need to be established by the utility industry and its regulating agencies as to what are acceptable methods for providing funds for decommissioning.
- The advisability of burying the highly radioactive components from the reactor vessel in shallow land burial sites as permitted by current regulations is under consideration by the NRC, in light of the long-lived radionuclides and high levels of radioactivity present in some of those materials. Regulations may be needed that will define more clearly which materials can be disposed of and where they can be placed.
- Some centralization or at least a central indexing of all regulations pertaining to decommissioning in the Code of Federal Regulations would be very helpful.
- Existing guidance on what levels of residual radioactivity are permitted on materials, structures, and sites that can be released for unrestricted use tends to be some what fragmentary and does not have a common identifiable basis. Methodology is developed in this study that could

form that basis, predicated on a decision by regulatory agencies as to what constitutes an acceptable annual radiation dose to the maximally-exposed individual from such residual radioactivity in unrestricted use.

2.4 APPROACHES TO FINANCING DECOMMISSIONING

A recent NRC survey of state public utility commissions found that the preferred approach to providing funds for decommissioning was to treat the anticipated decommissioning costs as a negative salvage value for purposes of calculating depreciation on the nuclear power station. Several approaches were suggested for handling the monies so collected. These ranged from the establishment of a separate sinking fund with annual payments made from revenues, with the fund independent from and unavailable for use by the utility, to allowing the utility to invest the money in its own new facilities. In this latter case, the utility could then issue securities against those unencumbered facilities as the need for decommissioning funds arose, thus minimizing the overall cost to the electricity consumer of providing funds for decommissioning.

2.5 SITE AND FACILITY DESCRIPTION

The site used in these analyses is a generic one typical of a midwestern or southeastern river site, developed for use in a family of studies devoted to the decommissioning of nuclear fuel cycle facilities being performed for the NRC by Battelle-Northwest. The reactor used as the reference facility in this study is the Portland General Electric Company's TROJAN Nuclear Plant, a 1175 MW(e) station. The nuclear steam supply system is a four-loop pressurized water reactor manufactured by the Westinghouse Electric Company, and is generally representative of the current generation of large PWRs. Sufficient descriptive information is presented for the facility to permit the development of the detailed work plans, costs estimates and radiation dose estimates that are the results of this study.

2.6 CHARACTERIZATION OF THE RADIONUCLIDE INVENTORY

Levels of radioactivity and dose rates from activated reactor components, from contamination deposited throughout the plant, and from the site soil surface are calculated and/or derived from existing data. The radionuclides that are the principal contributors to external occupational radiation exposure are: immediately after reactor shutdown, ^{58}Co and ^{60}Co; during the four year period of Immediate Dismantlement and during Safe Storage, ^{60}Co; after 100 years or more, ^{59}Ni and ^{94}Nb. The amount of radioactivity present in the activated reactor components at the time of reactor shutdown is calculated to be nearly 5 million curies. The calculated radiation dose rates of ^{60}Co from the activated reactor components ranged from a maximum at the core shroud of 300,000 to 500,000 R/hr to 2 to 5 R/hr at the reactor pressure vessel wall. The calculated radiation dose rates from ^{59}Ni and ^{94}Nb have maximum values in the core shroud of about 100 mR/hr and 2 R/hr, respectively. Dose rates at locations throughout the facility range from 100 to 200 R/hr on ion exchange resins and 30 to 50 R/hr on the steam generators to a few mR/hr in many areas, based on a composite of data from operating plants.

Annual atmospheric releases from operating PWRs vary widely, depending on such factors as the plant operating conditions, the design of the plant gaseous effluent clean-up systems, and the plant size. For this study, the ground contamination levels and mixtures of radionuclides on the site resulting from deposition of atmospheric releases from the plant during 40 years of normal operation are calculated and compared using two data bases (generic annual release information and measured annual release information). The variation in the calculated contamination levels on the site surface that results from using the different sets of radioactive gaseous release data is illustrated.

2.7 ACCEPTABLE CONTAMINATION LEVELS FOR UNRESTRICTED USE OF THE DECOMMISSIONED REFERENCE PWR

A methodology for determining acceptable residual radioactive contamination levels for unrestricted use of the decommissioned reference PWR facility and/or site is presented and example acceptable contamination levels are calculated in this study. The methodology is based on the concept that no member of the public will be allowed to receive an annual dose in excess of a limit yet to be established by U.S. regulatory agencies. These acceptable contamination levels, or disposition criteria, are based on an assumed range of 1 to 25 millirem per year. The effect of radioactive decay upon the acceptable levels of residual radionuclides both in the facility and on the site is demonstrated by calculating these criteria for the radionuclide mixture present at reactor shutdown and for radioactive decay times of 10, 30, 50, and 100 years.

For the facility, surface radioactive contamination measurements are used in determining whether unrestricted use can be permitted, thus units of surface contamination are presented for the acceptable release levels. Surface contamination values are converted into units of radioactivity per gram of soil sample by assuming mixing of the radiation source with dry soil to depths of 1 and 15 cm. After 40 years of normal PWR operation, the residual radioactive contamination is assumed to be mixed to a depth of 1 cm from natural processes. When the site is released, the residual radioactive contamination is assumed to be mixed to a depth of 15 cm as farming activities begin.

A summary of the calculated radioactive contamination levels that result in an annual dose of one millirem to any organ of any individual calculated in this study is given in Table 2.7-1. These levels are used in determining the extent of decontamination required to decommission the reference PWR by Immediate Dismantlement and by Safe Storage with Deferred Dismantlement.

TABLE 2.7-1. Summary of Example Disposition Criteria for the Reference PWR and the Reference Site

		Acceptable Residual Contamination Levels for an Annual Dose Limit of 1 mrem per Year		
		Facility	Soil Contamination[b]	
	Time After Shutdown (Years)	Surface Contamination (μCi/m²)	Mixed to 1 cm (pCi/g)	Mixed to 15 cm (pCi/g)
PWR Facility[a]	0	2.3×10^{-1}	--	--
	100	3.2×10^{-1}	--	--
Site (GESMO)	0	1.4×10^{-2}	9.4×10^{-1}	6.2×10^{-2}
	100	1.1×10^{-2}	7.4×10^{-1}	4.9×10^{-2}
Site (NUREG-0218)	0	1.1×10^{-2}	7.4×10^{-1}	4.9×10^{-2}
	100	6.6×10^{-3}	4.4×10^{-1}	2.9×10^{-2}

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[a] In the facility, surface contamination levels are assumed to be used to determine the necessary decommissioning procedures. All wastes generated during the decommissioning procedures are assumed to go to a nuclear waste burial site for disposal.

[b] At plant shutdown, assuming no mechanical mixing in the soil, the radiation source is assumed to be in the top 1 cm of surface. After decommissioning, plowing for farming mixes the radiation source to a depth of 15 cm.

2.8 RADIATION EXPOSURE ESTIMATES

Estimates of accumulated occupational radiation dose range from over 1200 man-rem for Immediate Dismantlement to over 400 man-rem for placing the facility in Safe Storage, with an additional 10 to 14 man-rem for surveillance and maintenance during postulated periods of continuing care that range in length from 10 to 100 years. Radiation dose associated with Deferred Dismantlement depends upon when the dismantlement takes place.
Relatively little reduction in accumulated occupational radiation dose is estimated to result from deferment of the decommissioning sequence beyond 30 years, and virtually no reduction results from deferments beyond 50 years.

The individual estimates of occupational radiation dose for the various phases of decommissioning are summarized in Table 2.8-1.

TABLE 2.8-1. Summary of the Estimated External Occupational Radiation Doses for Decommissioning the Reference PWR

Decommissioning Mode	Time After Reactor Shutdown (Years)	Estimated Dose (Man-rem)[a]
Immediate Dismantlement	0	1200
Safe Storage:[b]		
Preparations for Safe Storage	0	420
Continuing Care	10	10
	30	14
	50	14
	100	14
Deferred Dismantlement	10	330
	30	24
	50	2
	100	1
Total for Safe Storage[b] with Deferred Dismantlement in year:	10	760
	30	460
	50	440
	100	430

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[a] Estimates of man-rem of radiation dose have been rounded to two significant figures.

[b] Safe Storage consists of three phases: Preparations for Safe Storage, Continuing Care, and Deferred Dismantlement

Additional radiation dose is received by truck drivers, garagemen, trainmen, onlookers and the general public as a result of transporting the spent fuel and the radioactive materials to disposal sites. These radiation doses are summarized in Table 2.8-2.

TABLE 2.8-2. Radiation from Transport of Radioactive Materials from Decommissioning

	Radiation Doses from Transport (man-rem)[a]	
	Immediate Dismantlement	Preparations for Safe Storage
Occupational:		
Truck Transport	99	10
Rail Transport	3.5	3.5
TOTAL	100	14
Public:		
Truck Transport	21	2.1
Rail Transport	1	1
TOTAL	22	3

(a) All values are rounded to 2 significant figures.

2.9 DECOMMISSIONING COSTS

All costs are given in terms of 1978 dollars and 25% contingency is included in the values presented.

Immediate Dismantlement is estimated to cost just over $42 million. The major contributors to the total are summarized in Table 2.9-1. The cost for shipment and disposal of radioactive materials, including transportation only for spent fuel, is about 33% of the total decommissioning cost. About 27% of the total decommissioning cost is due to staff labor, not including contractor and demolition labor. Demolition of the decontaminated structures is estimated to be about 19% of the total decommissioning costs. Since demolition of the decontaminated structures is not required by NRC regulations, the total decommissioning cost could be reduced by 19% by not demolishing the structures.

TABLE 2.9-1. Estimated Cost for Immediate Dismantlement

Cost Item	$ Million[a]	Percent of Total
Fuel Shipment	3.084	7.3
Equipment	1.028	2.4
Supplies	1.949	4.6
Power	4.375	10.4
Activated Materials	3.418	8.1
Contaminated Material	6.479	15.4
Radioactive Waste	0.866	2.0
Staff Labor	11.233	26.7
Contractor Services	0.680	1.6
Demolition Services	8.012	19.0
Nuclear Insurance	1.000	2.4
TOTAL (rounded)	42.1	

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[a] Number of figures shown is for computational accuracy and does not imply precision to the nearest one thousand dollars.

The preparations for Safe Storage are estimated to cost just under $13 million. The major contributors to the total are summarized in Table 2.9-2. Shipment and disposal of radioactive materials, including transportation only for spent fuel, account for about 30% of the total preparations cost. Staff labor contributes about 36% of the total cost, with contractor services making up another 3%.

TABLE 2.9-2. Estimated Cost of Preparations for Safe Storage

Cost Items	$ Million[a]	Percent of Total
Fuel Shipment	3.084	24.4
Equipment	0.094	0.7
Supplies	1.114	8.8
Power	2.331	18.5
Radioactive Waste	0.680	5.4
Staff Labor	4.564	36.2
Contractor Services	0.381	3.0
Nuclear Insurance	0.368	2.9
TOTAL (rounded)	12.6	

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[a] Number of figures shown is for computational accuracy and does not imply precision to the nearest one thousand dollars.

The cost of continuing care during the period of Safe Storage is estimated to be $80,000 per year.

The cost of Deferred Dismantlement, starting after intervals of 10, 30, 50 and 100 years after final reactor shutdown has been estimated in constant 1978 dollars to be $37 million, $37 million, $31 million and $30 million, respectively. The lesser costs after the longer intervals are the result of having less contaminated material for packaging, shipment and burial due to decay of the radionuclides.

The total cost of Safe Storage with partial dismantlement and eventual Deferred Dismantlement is estimated to be essentially the same as for Safe Storage without partial dismantlement. The principal difference is in the time distribution of expenditures.

The total cost in constant dollars for each of the decommissioning choices is summarized in Table 2.9-3.

TABLE 2.9-3. Total Estimated Costs for Possible Decommissioning Choices

Decommissioning Mode	Decommissioning Costs ($ millions)[a][b]				
	Number of Years After Reactor Shutdown Dismantlement is Deferred				
	0	10	30	50	100
Immediate Dismantlement	42.1	--	--	--	--
Preparations for Safe Storage	--	12.6	12.6	12.6	12.6
Continuing Care	--	0.6	2.2	3.7	7.8
Deferred Dismantlement	--	37.0	37.0	30.5[c]	30.4[c]
Total Decommissioning Cost	42.1	50.2	51.8	46.8	50.8

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[a] Values include a 25% contingency.

[b] Values are in constant 1978 dollars.

[c] These reduced values result from lesser amounts of contaminated materials for burial in a licensed disposal site.

2.10 OCCUPATIONAL AND PUBLIC SAFETY

Radiological and nonradiological safety impacts from normal decommissioning operations and potential accidents are identified and evaluated for Immediate Dismantlement and Safe Storage decommissioning modes for the reference PWR. The safety evaluation includes consideration of radiation dose to the public from normal operations and postulated accidents, occupational radiation exposure, industrial-type accidents and potential chemical pollutants. The safety evaluation utilizes current data and methodology, along with engineering judgment when necessary, to estimate the required input information and the resulting safety impacts. The approach used to evaluate all the safety aspects of a particular decommissioning activity is believed to be conservative.

The results of the safety evaluation of normal decommissioning operations are summarized in Table 2.10-1. The principal radiation dose to the public

TABLE 2.10-1. Summary of Safety Analysis for Decommissioning the Reference PWR

Type of Safety Concern	Source of Safety Concern	Units	Immediate Dismantlement	Safe Storage with Deferred Dismantlement After			
				10 Years	30 Years	50 Years	100 Years
Public Safety[a]							
Radiation Exposure	Decommissioning Operations	man-rem	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Transportation	man-rem	22	(c)	(c)	(c)	(c)
	Safe Storage	man-rem	--	neg.[b]	neg.[b]	neg.[b]	neg.[b]
Occupational Safety							
Serious Lost-time Injuries	Decommissioning Operations	total no.	4.0	4.9	4.9	4.9	4.9
	Transportation	total no.	1.1	1.2	1.2	1.2	1.2
	Safe Storage	total no.	--	0.96	1.2	1.4	1.9
Fatalities	Decommissioning Operations	total no.	0.029	0.029	0.029	0.029	0.029
	Transportation	total no.	0.068	0.075	0.075	0.075	0.075
	Safe Storage	total no.	--	0.00087	0.0026	0.0045	0.0087
Radiation Exposure	Decommissioning Operations	man-rem	1200	760	460	440	430
	Transportation	man-rem	100	(c)	(c)	(c)	(c)
	Safe Storage	man-rem	--	10	14	14	14

(a) Radiation doses from postulated accidents are not included.

(b) neg. = negligible. Radiation doses to the public from normal continuing care activities were not analyzed in detail, but are expected to be significantly smaller than those from decommissioning operations.

(c) Not estimated.

materials from the reactor station to disposal facilities. The estimated dose to the public resulting from decommissioning operations and from Safe Storage is extremely small.

Less than 5 lost-time injuries from industrial-type accidents are predicted to occur during the decommissioning effort, with one additional injury predicted to result from transportation operations. Essentially no fatalities are predicted to occur as a result of decommissioning operations, including transportation.

2.11 CONCLUSIONS AND RECOMMENDATIONS

Decommissioning of a large nuclear reactor power station is technically feasible with present-day technology. Further development of special equipment such as the plasma torch and the arc saw could lead to reductions in cost and occupational radiation exposure.

Existing regulations appear to cover decommissioning. However, some modifications and/or additions that speak specifically to the requirements for decommissioning would be helpful. Centralization or a central indexing of regulations that apply to decommissioning would also be helpful.

The estimated occupational radiation dose resulting from decommissioning is at most roughly equivalent to the dose resulting from about three typical refueling and maintenance outages, and thus does not appear to be prohibitively large. The impact of decommissioning on the safety of the public is vanishingly small, with no significant risk to the public identified.

In terms of constant dollars Immediate Dismantlement is the least expensive choice for decommissioning. While there is incentive to defer dismantlement due to the reduction in occupational radiation dose that can be achieved, the costs of surveillance and maintenance during Safe Storage increase the total cost linearly with time. On the other hand, a present value analysis of decommissioning costs indicates an incentive to defer dismantlement for as long as possible, providing the discount rate always exceeds the inflation rate. In practice, the choice will probably be made based on a detailed analysis of which approach is most financially advantageous to the station owner.

The acceptability of disposal of highly radioactive and/or long-lived materials by burial in a shallow land burial facility is under consideration by NRC and needs to be determined. If placement of these materials in a deep geologic disposal facility similar to that postulated for high-level radioactive wastes is required in the future, decommissioning costs will be increased by nearly $2 million.

If the bulk of the non-activated, contaminated stainless steel can be decontaminated to levels sufficiently low to permit unrestricted reuse of that material, a savings of about $1-1/4 million can be realized. However, the appropriate definitions of levels of radioactivity that would be permitted on such materials when released for unrestricted use are not presently available.

Certain types of data that are useful in decommissioning analyses are essentially non-existent at this time. Some measurements on activated stainless steel that has been irradiated for an extended period of time (>10 years) to determine the growth of such long-lived radionuclides as ^{59}Ni and ^{94}Nb would be valuable for confirmation of calculations. Similarly, measurements of the growth of radionuclides in the biological shield concrete would be helpful in evaluating the radiation dose rates that might be encountered from the activated shield. In particular, the levels of ^{152}Eu and ^{154}Eu resulting from trace amounts of europium present in the concrete are important contributions to the total radiation dose rate from the concrete. In addition, studies to determine the actual levels of radioactivity on the soil surfaces surrounding operating reactor facilities would help to characterize in a realistic manner the residual radioactivity that might be present after 40 years of operation, and would help to quantify the decontamination effort that might be required to release the site for unrestricted use.

Careful attention to simplifying the problems of remote maintenance and eventual dismantlement during the design phase of a reactor project would be effective in reducing costs and in reducing occupational radiation exposure during maintenance operations as well as during decommissioning.

72
NRC

Fwd

196 Palisade Ave
Emerson NJ 07630
April 17, 1980

Dear Mr President,

Since 3MI no new regulations regarding nuclear power plants have been passed. Now 3 more plants are going to begin operating. Until new standards are implemented I feel no new plant should open.

Also, you KNOW these plants have a limited lifetime, how much will it cost to dismantle ONE? Who will pay for its dismantling? The money spent on building (& what will be spent on dismantling) nuclear power plants should be invested in plants run on renewable sources. I am not talking about solar but plants where electricity is produced from waste material - its a fairly simple process AND in time pays itself off - ~~now~~ this cannot be said for ~~the~~ NUKES.

Yours Truly
Patricia Moorhead