NUREG–0683
Supplement No. 3

Programmatic
Environmental Impact Statement
related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2

Docket No. 50–320

Final Supplement Dealing with
Post-Defueling Monitored Storage
and Subsequent Cleanup

GPU Nuclear, Inc.

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

August 1989

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ABSTRACT

1. Proposed Action and Location:
   DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES RESULTING FROM THE MARCH 28, 1979, ACCIDENT AT THREE MILE ISLAND NUCLEAR STATION, UNIT 2, LOCATED IN LONDONDERRY TOWNSHIP, DAUPHIN COUNTY, PENNSYLVANIA.

2. In accordance with the National Environmental Policy Act, the Commission's implementing regulations, and its April 27, 1981, Statement of Policy, the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2, NUREG-0683 (PEIS) is being supplemented. This supplement updates the environmental evaluation of cleanup alternatives published in the PEIS utilizing more complete and current information. This supplement evaluates the licensee's proposal to complete the current cleanup effort and place the facility into monitored storage for an unspecified period of time. The licensee has indicated that the likely disposition of the facility following the storage period would be decommissioning at the time Unit 1 is decommissioned. Specifically, the supplement provides an environmental evaluation of the licensee's proposal and a number of alternative courses of action from the end of the current defueling effort to the beginning of decommissioning. However, it does not provide an evaluation of the environmental impacts associated with decommissioning.

   The Nuclear Regulatory Commission staff has concluded that the licensee's proposal to place the facility in monitored storage will not significantly affect the quality of the human environment. Further, any impacts associated with this action are outweighed by its benefits. The benefit of this action is the ultimate elimination of the small but continuing risk associated with the conditions of the facility resulting from the March 28, 1979, accident.

SUMMARY

The final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2 was issued as NUREG-0683 by the U.S. Nuclear Regulatory Commission (NRC) in March 1981. That document (referred to as the PEIS) was intended to provide an overall evaluation of the environmental impacts that could result from cleanup activities at Three Mile Island Unit 2 (TMI-2). Following the publication of the PEIS, the Commission issued a Policy Statement on April 28, 1981, indicating that the NRC staff would evaluate and act on major cleanup proposals as long as the impacts associated with the proposed activities fell within the scope of the impacts already assessed in the PEIS.

The TMI-2 cleanup can be categorized into four fundamental activities: building and equipment decontamination; fuel removal and reactor coolant system decontamination; treatment of radioactive liquids; and packaging, handling, shipment, and disposal of radioactive wastes. Since the 1979 accident, the licensee's (GPU Nuclear's) cleanup program has resulted in substantial cleanup progress in each of these fundamental activities. In addition to having treated all of the water that contained radioactive materials as a result of the accident, facility decontamination efforts have been successful in returning most areas in the auxiliary and fuel-handling building (AFHB) to pre-accident radiological conditions, disposal of radioactive wastes has been actively proceeding, and defueling efforts through May 30, 1989, have resulted in removal of more than 87 percent of the damaged core. The licensee's projected completion date for the current defueling is late 1989 and that for the completion of the associated decontamination is August 1990.

The purpose of this supplement to the PEIS is to evaluate the potential environmental impacts of alternative approaches to completing the TMI-2 cleanup. This supplement evaluates the licensee's proposal and a number of alternative courses of action from the end of the current defueling effort to the beginning of decommissioning. The licensee has submitted a proposal to maintain the TMI-2 facility in a monitored storage mode (referred to by the licensee as "post-defueling monitored storage" [PDMS]) for a period of time following current efforts to remove the damaged fuel. In addition to removal of more than 99 percent of the fuel, major portions of the reactor building and the AFHB would be decontaminated before PDMS, but not to the extent that the cleanup could be considered complete. The facility would then be placed into monitored storage for an unspecified period of time during which no additional decontamination, other than that necessary to maintain the facility in a safe, stable condition, would be performed. The licensee has indicated that the likely disposition of the facility following the storage period would be decommissioning. Although the duration of the storage period has not been specified by the licensee, the NRC staff has evaluated delayed decommissioning

assuming a storage period of 23 years as a likely option. The NRC staff has also assumed that less than 1 year would be necessary for any additional work or preparations following PDMS but before the start of decommissioning. This plan is referred to in this document as "delayed decommissioning" because the initiation of the decommissioning process would begin following a storage period. During the subsequent decommissioning process, additional cleanup would be performed such that at the end of decommissioning the site would be suitable for unrestricted access. However, the impact of the decommissioning process is not evaluated in this supplement.

In accordance with the requirements of the National Environmental Policy Act (NEPA) and the Commission's implementing regulations, both the licensee's plan and alternative approaches were examined for their potential environmental impacts. Seven alternatives to the licensee's proposal were identified by the NRC staff: (1) delayed cleanup (a 23-year storage period followed by a 4-year cleanup period), (2) immediate cleanup (a 2-year period for engineering study and planning, followed by the continuation and completion of the cleanup at the 1983-1987 level of effort), (3) immediate cleanup/reduced effort (continued cleanup at a reduced level of effort from the end of defueling and maintained for a total period of 7 to 10 years), (4) immediate decommissioning (a 2-year period of preparation for decommissioning, which does not include decommissioning itself), (5) incomplete defueling[a] (an alternative similar to delayed decommissioning except that only 85 percent of the fuel would be removed before the facility was placed in storage), (6) additional cleanup before storage (additional cleanup before placing the facility in a 23-year storage period followed by the completion of the cleanup), and (7) no further cleanup for an indefinite period of time following defueling (the "no-action" alternative that is required by NEPA to be considered as part of all environmental impact statements).

The alternatives considered in this supplement do not all begin with common plant conditions, continue for an equal period of time, or end with the same set of plant conditions. For example, the evaluation of delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, and additional cleanup before storage includes a discussion of impacts associated with additional cleanup prior to decommissioning. At the time of commencement of decommissioning or refurbishing, these alternatives would result in the original PEIS endpoint criteria: (1) building and equipment decontamination to the point where general area dose rates approximate those in an undamaged reactor facility nearing the end of its operating life; (2) fuel removal and

(a) This alternative was evaluated before the licensee had removed greater than 85 percent of the fuel. Although the NRC staff recognizes that the licensee has removed greater than 85 percent of the fuel, the analysis of this alternative still serves as a bounding case.

decontamination of the reactor coolant system; (3) treatment of radioactive liquid wastes; and (4) packaging, shipping, and offsite disposal of radioactive wastes. Delayed decommissioning (the licensee's proposal), immediate decommissioning, and incomplete defueling would result in limited additional decontamination before the start of decommissioning. The remaining cleanup, to allow unrestricted access to the facility, would occur during decommissioning activities. However, decommissioning impacts are not evaluated in this supplement. For the no-action alternative, no additional decontamination after the completion of defueling and no efforts to prepare the facility for storage or decommissioning are postulated. The facility would be left in the post-defueling condition.

Table S.1 compares the major features of the licensee's proposal with those of the seven NRC staff-identified alternatives. The potential environmental impacts associated with the licensee's proposal of delayed decommissioning and five of the staff-identified alternatives are summarized in Table S.2. The sixth alternative (additional cleanup before storage) and the seventh alternative (the no-action alternative) are discussed in Section 3.7 but are not quantitatively evaluated. Table S.2 presents the range of the estimated occupational doses for the licensee's proposal and the quantitatively evaluated alternatives, the range of 50-year dose commitments to the hypothetical maximally exposed individual, the range of 50-year dose commitments to the offsite population living within a 50-mile (80-kilometer) radius of the TMI-2 site, the range of the estimated health effects of the five alternatives (including the estimated number of radiation-induced cancer fatalities and genetic disorders), the range of the estimated number of traffic accidents, injuries, and fatalities resulting from the alternatives, as well as the range in cost and the volume of radioactive waste for burial for the alternatives. All alternatives result in offsite exposures significantly below those allowed for operating facilities.

Estimates of the cancer mortality risks to workers and the general public were based on conservative assumptions (i.e., the estimates are probably higher than the risks that would actually occur). Delayed decommissioning was estimated to result in a maximum of 0.03 radiation-induced cancer fatalities in the worker population (i.e., the probability of a single cancer death occurring in the entire population of occupationally exposed workers as a result of delayed decommissioning operations is approximately 3 chances in 100). The number of radiation-induced cancer fatalities in the worker population for the five alternative actions ranges from 0.002 to 1.3. Radiation-induced cancer fatalities in the offsite population residing within 50 miles (80 kilometers) of the site were estimated to be 0.001 for delayed decommissioning (i.e., the probability of a single cancer death occurring in the entire offsite population of between 2.5 million and 3.3 million people is approximately 1 chance in 1000), and 0.0000004 to 0.001 for the five alternative actions (i.e., the probability of a single cancer death in the entire offsite population

TABLE S.1. Comparison of the Licensee's Proposal and the Seven NRC Staff-Identified Alternatives

	Removal of 99 Percent of Fuel	Additional Cleanup Before Storage	PDMS Preparation	Length of Storage, years	Alternate Lengths of Storage, years	Additional Cleanup, years	Achieve PEIS Definition for Completion of Cleanup	Decommissioning Preparation Period, years	Post-PDMS Disposition
Licensee's Proposal									
Delayed Decommissioning	Yes	No	Yes	23	<17 to 33	None	No	≤1	Decommission
Staff-Identified Alternatives									
Delayed Cleanup	Yes	No	Yes	23	<17 to 33	4	Yes	None	Decommission or refurbish
Immediate Cleanup	Yes	No	No	2 (engineering study)	None	3 to 4	Yes	None	Decommission or refurbish
Immediate Cleanup/ Reduced Effort	Yes	No	No	None	None	7 to 10	Yes	None	Decommission or refurbish
Immediate Decommissioning	Yes	No	No	None	None	None	No	≤2	Decommission
Incomplete Defueling	No (85%)	No	Yes	23	None	None	No	≤1	Decommission
Additional Cleanup Before Storage	Yes	Yes	Yes	23	None	2 to 3	Yes	None	Decommission or refurbish
No-Action Alternative									
No Further Cleanup Following Defueling	Yes	No	No	Indefinite	None	None	No	None	Continued, indefinite storage

TABLE S.2. Range of Impacts from the Licensee's Proposal and the NRC Staff-Identified Alternatives[a]

Occupational Dose	17 to 9400 person-rem
50-Year Dose Commitment to the Offsite Population	
Maximally exposed individual	
Bone	0.06 to 31 mrem
Total body	0.007 to 2.7 mrem
Offsite population within 50-mile radius	
Bone	0.03 to 22 person-rem
Total body	0.003 to 11 person-rem
Estimated Number of Radiation-Induced Cancer Fatalities[b]	
Worker population	0.002 to 1.3
Maximally exposed offsite individual	0.0000000009 to 0.0000003
Offsite population	0.0000004 to 0.001
Estimated Number of Radiation-Induced Genetic Disorders in Offsite Population	0.001 to 0.7
Estimated Number of Traffic Accidents, Injuries, and Fatalities During Transportation of Waste	
Accidents	0.007 to 7.2
Injuries	0.007 to 6.3
Fatalities	0.0006 to 0.5
Cost ($ millions)	17 to 510
Low-Level Waste Volume (cubic ft)	70 to 189,000

(a) Impacts associated with decommissioning are not included.
(b) Estimates assume a 23-year PDMS period during delayed decommissioning, delayed cleanup and incomplete defueling alternatives.

of 2.5 million to 3.3 million people is approximately 4 to 10,000 chances in 10 million). The statistically expected consequences of offsite radiation exposures due to the licensee's proposal or any of the quantitatively evaluated alternatives is zero.

The estimated number of traffic fatalities during waste shipments is 0.001 to 0.006 for delayed decommissioning (i.e., the probability of a fatal accident during all of the waste shipments is approximately 1 to 6 chances in 1000) and 0.0006 to 0.5 for the five alternative actions (i.e., the probability of a fatal accident during all waste shipments is approximately 6 to 5000 chances in 10,000).

The NRC staff has concluded, based on this evaluation and after considering comments on the draft supplement, that the licensee's proposed plan and the NRC staff-identified alternatives (with the exception of the no-action alternative) could each be conducted in conformance with applicable regulatory requirements and implemented without significant impact to the quality of the human environment. No alternative was found to be obviously superior to the licensee's proposal from an environmental impact perspective. In addition, the staff concluded that "no further cleanup following defueling," i.e., the no-action alternative, is not acceptable because it would indefinitely postpone decommissioning of the facility without specific approved exemptions from NRC regulations, would not result in the completion of cleanup, or in the elimination of the small but continuing risk associated with the TMI-2 facility. Accordingly, the staff concluded that the impacts associated with the licensee's proposal for long-term storage of the facility followed by decommissioning are outweighed by its benefits. The staff recognizes that the implementation of the licensee's proposal would result in substantial occupational dose savings and reduced transportation impacts over several of the alternatives considered. The benefit of this action is the ultimate elimination of the small but continuing risk associated with the condition of the facility resulting from the March 28, 1979, accident.

FOREWORD

This final supplement to the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2 (PEIS) was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (referred to as the NRC staff), pursuant to the Commission's April 27, 1981, Statement of Policy related to the PEIS and the requirements of the National Environmental Policy Act of 1969 (NEPA). Assistance was provided by the Pacific Northwest Laboratory under the direction of the staff; the contributors to the final supplement are listed in Appendix B. This final supplement addresses potential environmental impacts associated with the licensee's proposal to place the TMI-2 facility in storage after the completion of defueling (termed "post-defueling monitored storage" by the licensee) and with alternatives to the licensee's proposal.

Information for the final supplement was obtained from the licensee's Environmental Report and Final Safety Analysis Report (Metropolitan Edison Co. and Jersey Central Power & Light Co. 1974), from the licensee's Environmental Evaluation of TMI-2 Post-Defueling Monitored Storage (GPU 1987b), from the licensee's Post-Defueling Monitored Storage Safety Analysis Report (GPU 1988), from the staff's Final Environmental Impact Statement for the operating license (NRC 1976), from the staff's PEIS of March 1981 (NRC 1981), from Supplement 1 of October 1984 (NRC 1984), from Supplement 2 of June 1987 (NRC 1987), and from new information provided by the licensee (including responses to NRC staff questions and comments on the draft supplement) or independently developed by the staff. The staff met with the licensee to discuss items of information provided, to seek new information from the licensee that might be needed for an adequate assessment, and to ensure that the staff had a thorough understanding of the proposed action. In addition, the staff sought information from other sources that would assist in the evaluation, and visited and inspected the project site and vicinity. On the basis of the foregoing, the staff made an independent evaluation of alternatives for completing cleanup of the facility following defueling, including the licensee's proposal, and prepared this supplement to the PEIS.

A draft supplement completed in April 1988 was circulated to Federal, State, and local government agencies and to interested members of the public for comment. A summary notice of the availability of the draft supplement was published concurrently in the Federal Register (53 FR 15160). The original 45-day comment period was extended to 90 days at the request of the Commission's Advisory Panel for the Decontamination of TMI Unit 2 and several other interested persons (53 FR 20195). In addition, comments made at the Commission's Advisory Panel meetings were accepted for an additional 90 days. The information on which the supplement is based and all the comments received were made available to the public.[a] The comments were considered by the staff in preparing this final report.

The following Federal and State agencies were asked to comment on the draft supplement to the PEIS:

Federal Agencies

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Department of Agriculture
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Interior
U.S. Department of Labor
U.S. Department of Transportation
U.S. Federal Emergency Management Agency
U.S. Federal Energy Regulatory Commission
U.S. National Oceanic and Atmospheric Administration
U.S. Nuclear Regulatory Commission, Advisory Panel for the Decontamination of TMI Unit 2

State Agencies

Maryland Department of Health and Mental Hygiene
Maryland Department of Natural Resources
Maryland Department of State Planning
New Jersey Department of Environmental Protection
Pennsylvania Department of Environmental Resources
Pennsylvania Department of Health
Pennsylvania Department of Labor and Industry
Pennsylvania Department of Public Welfare
Pennsylvania Intergovernmental Council

The licensee, GPU Nuclear, was also provided a copy of the draft supplement.

The comments received from these agencies, the licensee, and the public, are included in Appendix A. After receipt and consideration of comments on the draft supplement, the staff prepared this final supplement to the PEIS, which includes a discussion of comments on the draft supplement, responses to the comments, and updated information based on the comments. Changes made in the draft supplement are designated by bars in the margins of this final supplement.

(a) NRC Public Document Room, 2120 L Street NW, Lower Level, Washington, DC 20555 and the State Library of Pennsylvania, Government Publications Section, Education Building, Commonwealth and Walnut Street, Harrisburg, PA 17126.

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CONTENTS

FIGURES

TABLES

NOMENCLATURE

accident-generated water - On February 27, 1980, an agreement executed among the City of Lancaster, Pennsylvania, Metropolitan Edison Company, and the NRC defined "accident-generated water" as:

- " Water that existed in the TMI-2 auxiliary, fuel-handling, and containment buildings including the reactor coolant system as of October 16, 1979, with the exception of water which as a result of decontamination operations becomes commingled with nonaccident-generated water such that the commingled water has a tritium content of 0.025 μCi/mL or less before processing.
- Water that has a total activity of greater than 1 μCi/mL prior to processing except where such water is originally nonaccident water and becomes contaminated by use in cleanup.
- Water that contains greater than 0.025 μCi/mL of tritium before processing."

actinides - the group of radioactive elements with atomic numbers 90 and above, including thorium, protactinium, uranium, neptunium, plutonium, americium, and curium.

activation products - radioactive materials that are created when stable substances are bombarded by neutrons. For example, cobalt-60 is formed from the neutron bombardment of the stable isotope cobalt-59.

additional cleanup before storage - an NRC staff-identified alternative to the licensee's proposal. Additional cleanup before storage involves the continuation of cleanup without completion (following removal of more than 99 percent of the fuel from the facility), followed by a period of storage and then the completion of the cleanup after the storage period.

AFHB - see auxiliary and fuel-handling building

Agreement States - States that have agreed to accept the responsibility of enforcing the provisions of Federal legislation for activity within their borders. The Commonwealth of Pennsylvania is an Agreement State with respect to the Clean Water Act, but not the Atomic Energy Act.

ALARA - an acronym for "as low as reasonably achievable." The term is defined in 10 CFR 20.1 (CFR 1988a) as "as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to the utilization of atomic energy in the public interest."

alpha radiation - an emission of particles (helium nuclei) from a material undergoing nuclear transformation. The particles have a nuclear mass number of four and a charge of plus two.

ambient radiation - surrounding radiation from multiple or distributed sources.

anadromous fish - fish that ascend freshwater streams from the sea to spawn.

attocurie - 1×10^{-18} curie, a unit for measuring radioactivity.

auxiliary and fuel-handling building (AFHB) - a building located at the TMI-2 facility. It is divided into two sections that are separated by a common wall. The auxiliary section contains tanks, pumps, piping, and other equipment to process and store water for the reactor coolant system and to treat radioactive wastes. The fuel-handling section contains large basins, or pools, for the storage of spent fuel.

background radiation - the level of radiation in an area which is produced by sources of radiation (mostly natural) other than the one of specific interest. Examples of such radiation sources are cosmic radiation and radioactive elements in the atmosphere, building materials, the human body, and the crust of the earth. In the Harrisburg area, the background radiation level is about 300 mrem/yr, not including any contribution from medical practice. (See Section 4.1.7.)

BEIR - Biological Effects of Ionizing Radiation. A set of reports by the National Academy of Sciences, Advisory Committee on the Biological Effects of Ionizing Radiation. (See also References, Section 8.0.)

benthic - dwelling on the bottom of a body of water.

beta particles - an electron or a positron (a particle with the same mass as an electron but with a positive charge rather than a negative one). Beta particles are commonly emitted from the nuclei of atoms undergoing nuclear transformation. Also referred to as beta radiation.

beta radiation - radiation consisting of beta particles.

biota - plant and animal life.

CFR - Code of Federal Regulations.

Ci - see curie.

collective 50-year dose commitment - the total radiation dose received by a population or group of individuals from an initial exposure through the succeeding 50 years. For exposures of greater than one year's duration, the collective 50-year dose commitment as used in this supplement represents the sum of 50-year dose commitments resulting from each year's exposure. The collective 50-year dose commitment is expressed in person-rem. (See person-rem.)

cumulative occupational dose - the total radiation dose to workers. It is determined by summing the product of the dose rate and the length of time the worker is exposed to the dose rate for all dose rates and all workers. The cumulative occupational dose is expressed in person-rem. (See person-rem.)

curie (Ci) - the special unit of activity. Activity is defined as the number of nuclear transformations occurring in a given quantity of material per unit of time. One curie of activity is 37 billion transformations per second.

decay products - the nuclides formed by the radioactive disintegration of a first nuclide (parent). Also called daughter products.

decommissioning - removing nuclear facilities safely from service and reducing residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license.

DECON - the decommissioning alternative in which equipment, structures and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.

defueling - the licensee's term for removal of more than 99 percent of the fuel from the TMI-2 facility.

delayed cleanup - an NRC staff-identified alternative to the licensee's proposal. Delayed cleanup involves maintaining the TMI-2 facility in post-defueling monitored storage (PDMS) for a period of time ranging from less than 17 years to 33 years after more than 99 percent of the fuel has been removed from the facility. After the storage period, the cleanup process would be resumed and completed in 4 years. Decommissioning and refurbishment activities are not considered as part of this alternative.

delayed decommissioning - the NRC staff's term for the licensee's (GPU Nuclear's) proposal to maintain the TMI-2 facility in post-defueling monitored storage (PDMS) for an unspecified period of time (assumed to be from less than 17 years to 33 years) after more than 99 percent of the fuel has been removed from the facility. After the storage period, the facility likely would be decommissioned. The NRC staff assumed that less than 1 year would be necessary for any decommissioning preparations following PDMS. (See PDMS.) Activities occurring after the initiation of decommissioning are not considered as part of the delayed decommissioning alternative.

demineralizer systems - processing systems in which synthetic ion exchange materials are used to remove impurities from water.

DOE - U.S. Department of Energy.

dose - a general term indicating the amount of energy absorbed from incident radiation by a unit mass of any material.

dose commitment - the integrated dose to an individual that results unavoidably from the intake of radioactive material. The individual begins receiving the dose at the time of intake and continues receiving a dose (at a decreasing dose rate) for a period of time (usually specified to be 50 years from intake).

dose rate - the dose (amount of energy absorbed by a unit mass) received per unit of time.

DOT - U.S. Department of Transportation.

emergency allocation - allocation of waste disposal volume by the DOE in commercial LLW burial sites because of unusual circumstances.

ENTOMB - the decommissioning alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting release for unrestricted use of the property.

EPA - U.S. Environmental Protection Agency.

EPICOR II - a filtration and demineralizer system designed to process some of the liquid radioactive waste resulting from the TMI accident. The system can be used on liquid waste containing up to 100 microcuries of radioactivity per milliliter of water.

ERDA - U.S. Energy Research and Development Administration, predecessor to the DOE.

etiology - the cause of disease or disorder as determined by medical diagnosis.

exposure - the condition of being made subject to the action of radiation; also, a measure of the ionization produced in air by x-ray or gamma radiation.

50-year dose commitment - the total radiation received from initial exposure through the succeeding 50 years.

fission - the spontaneous or induced disintegration of a heavy atom into two or more lighter atoms with an accompanying loss of mass that is converted into energy.

fission products - the nuclides formed by the division of a heavier nucleus, typically in a nuclear reactor. Isotopes of essentially all elements are produced by fission of fissile materials. Fission products are the main radioactive components of high-level radioactive wastes.

gal/min - gallons per minute.

gamma radiation - electromagnetic radiation of high energy (and short wavelength), emitted by nuclei undergoing internal changes. Gamma radiation has the highest energy and shortest wavelength in the electromagnetic spectrum and is capable of penetrating several inches of a solid such as concrete.

genetic effects of radiation - effects of radiation that alter the hereditary material and may therefore affect subsequent unexposed generations.

GPU or GPU Nuclear Corporation - the licensee at TMI-2, a subsidiary of General Public Utilities Corporation.

groundwater - water that exists or flows below the ground's surface (within the zone of saturation).

h - hour.

half-life - the time required for half of a given radioactive substance to decay.

Hanford Nuclear Reservation - a nuclear facility near Richland, Washington, that is operated by the DOE.

hectare - a metric unit of measure equal to 2.47 acres.

HEPA filter - high-efficiency particulate air filter.

immediate cleanup - an NRC staff-identified alternative to the licensee's proposal. Immediate cleanup involves the continuation and completion of the cleanup at the present level of effort following a 2-year period for engineering study that follows the removal of more than 99 percent of the fuel from the facility. Decommissioning and refurbishment activities are not considered as part of this alternative.

immediate cleanup/reduced effort - an NRC staff-identified alternative to the licensee's proposal. Immediate cleanup/reduced effort involves the continuation and completion of cleanup at a reduced level of effort for a period of 7 to 10 years following the removal of more than 99 percent of the fuel from the facility. Decommissioning and refurbishment activities are not considered as part of this alternative.

immediate decommissioning - an NRC staff-identified alternative to the licensee's proposal. Immediate decommissioning involves a 2-year period of preparation for decommissioning with no additional cleanup following the removal of more than 99 percent of the fuel from the facility. Activities occurring after the initiation of decommissioning are not considered as part of the immediate decommissioning alternative.

incomplete defueling - an NRC staff-identified alternative to the licensee's proposal. Incomplete defueling involves maintaining the TMI-2 facility in PDMS for a period ranging from less than 17 years to 33 years after 85 percent of the fuel has been removed from the facility. Following PDMS, a 1-year period would be necessary for decommissioning preparations. Activities occurring after the initiation of decommissioning are not considered as part of this alternative.

ion - an atom or molecule from which an electron has been removed (a positively charged ion) or to which an electron has become attached (a negatively charged ion).

ion exchange - in this document, a process for selectively removing a constituent from a waste stream by reversibly transferring ions from a liquid to an insoluble solid (the ion exchange media).

ion exchange media - resins or zeolite materials used in ion exchange processes.

ionization - the process by which a neutral atom or molecule acquires a positive or a negative charge by removal or attachment of an electron.

ionizing radiation - any form of radiation that generates ions in the irradiated material.

isotopes - nuclides with the same atomic number but with different atomic masses, therefore having the same chemical properties but different physical properties.

kg - kilogram.

L - liter.

licensee - the holder of a license issued by the NRC to possess or use radioactive materials. In the case of TMI-2, the license is held by GPU Nuclear Corporation.

LLD - lower limit of detection.

LLW - low-level waste; all radioactive waste materials that are not high-level or transuranic waste. Most TMI-2 wastes are of this type.

L/min - liters per minute.

maximally exposed individual - the hypothetical person who would receive the greatest possible radiation dose from a specific release. For atmospheric releases, this individual is assumed to breathe air at that offsite boundary location with the highest airborne concentration and to consume food products raised exclusively in that offsite boundary location receiving the maximum ground deposition of released radioactive material. For liquid releases, this individual is assumed to consume large quantities of river water and fish and to participate frequently in rivershore activities. In this supplement, the maximally exposed individual is also assumed to eat large quantities of Chesapeake Bay shellfish.

MCi - megacurie (one million curies); a unit for measuring radioactivity.

Memorandum of Understanding - an agreement between the NRC and DOE, whereby the DOE will accept certain categories of waste from the cleanup of TMI-2 for permanent disposal, either without cost or on a cost-reimbursement basis. (Memorandum of Understanding Between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy, Concerning the Removal and Disposal of Solid Nuclear Wastes from Cleanup of the Three Mile Island Unit 2 Nuclear Plant, March 15, 1982.)

μCi - microcurie (1×10^{-6} curie or one-millionth of a curie); a unit for measuring radioactivity.

μg - microgram (1×10^{-6} gram or one-millionth of a gram); a unit for measuring weight.

mg/L - milligrams per liter.

mL - milliliter.

maximum permissible concentration - the NRC-prescribed concentration limit for radioactive materials in 10 CFR 20, Appendix B (CFR 1988a). The MPCs are expressed as average radionuclide concentrations in air or water. Different MPC values apply to the public and to radiation workers.

mR - milliroentgen (1 x 10^{-3} roentgen or one-thousandth of a roentgen); a unit for measuring radiation exposure in air.

mrem - millirem (1 x 10^{-3} rem or one-thousandth of a rem); a unit of measuring radiation dose equivalent.

MSL - mean sea level.

NAS - National Academy of Sciences.

nCi - nanocurie (1 x 10^{-9} curie or one-billionth of a curie); a unit for measuring radioactivity.

NCRP - National Council on Radiation Protection and Measurement.

NEPA - National Environmental Policy Act of 1969.

neutron - an uncharged elementary particle found in the nucleus of every atom except hydrogen.

neutron capture - the process in which an atomic nucleus absorbs or captures a neutron.

no-action alternative - an alternative to the proposed action, which is required by the National Environmental Policy Act (NEPA) to be considered as part of all environmental impact statements. The no-action alternative for the period addressed by this supplement implies no action to prepare the facility for storage, for decommissioning, or for maintaining the facility or completing the cleanup following the completion of defueling.

NPDES - National Pollutant Discharge Elimination System.

NRC - U.S. Nuclear Regulatory Commission.

nuclide - a species of atom having a specific mass, atomic number, and nuclear energy state.

occupational radiation exposure - the radiation exposure to which workers at a nuclear facility are subjected during the course of their work.

ORNL - Oak Ridge National Laboratory.

PaDER - Commonwealth of Pennsylvania, Department of Environmental Resources.

pCi - picocurie (1×10^{-12} curie or one-trillionth of a curie); a unit for measuring radioactivity.

pCi/L - picocuries per liter.

PDMS - see post-defueling monitored storage.

PEIS - Final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Waste Resulting from March 28, 1979 Accident Three Mile Island Station, Unit 2, NUREG-0683, 1981.

penetration factor - the fraction of the particulates that would pass through a high-efficiency particulate air (HEPA) filter.

person-rem - the sum of the individual radiation doses (collective dose) received by members of a certain group or population. It may be calculated by multiplying the average dose per person by the number of persons. For example, a thousand persons, each exposed to 1 millirem (1/1000 rem), would have a collective dose of 1 person-rem.

photon - a quantity of energy emitted in the form of electromagnetic radiation. Gamma rays and x-rays are examples of photons.

population dose - the summation of individual radiation doses received by all those exposed to the radiation source or event being considered, and expressed as person-rem. The same as collective dose.

post-defueling monitored storage (PDMS) - the licensee's term for monitored storage of the TMI-2 facility following defueling (removal of more than 99 percent of the fuel from the TMI-2 facility). Monitored storage refers to the inspection, surveillance, and maintenance of the facility during the storage period. (See storage.)

ppm - parts per million.

primary system - see reactor coolant system.

PWR - pressurized water reactor. The TMI-2 reactor is of this type.

rad - a unit of absorbed dose of ionizing radiation.

radiation - energy in the form of electromagnetic rays (radiowaves, light, x-rays, gamma rays) or particles (electrons, neutrons, helium nuclei) sent out through space from atoms, molecules, or atomic nuclei as they undergo internal change. It may also result from particle and electromagnetic radiation interactions with matter.

radioactive contamination - radioactive material located in areas where it is not wanted.

radioactive decay - the spontaneous natural process by which an unstable radioactive nucleus releases energy or particles.

radioactivity - product of radioactive decay of an unstable atom.

radioisotopes - radioactive isotopes. (See also radionuclide and isotopes.)

radionuclide - an unstable nuclide that undergoes radioactive decay.

RCRA - Resource Conservation and Recovery Act.

reactor building - a containment building that houses the reactor vessel.

reactor coolant system - consisting of the reactor, the steam generators, the reactor coolant pumps, and the connecting piping. In an operating reactor, the heat produced by the reactor is transferred to the water coolant in the reactor vessel. The hot water is circulated through the steam generator tubes to produce steam. The reactor coolant pump is used to circulate the water coolant. The reactor coolant system is also called the primary coolant system or primary system.

rem - a unit of radiation dose equivalent that is proportional to the risk of biological injury.

resin liners - cylindrical metal containers used for the ion exchange media (resins and/or zeolites) during purification of contaminated water by ion exchange processes.

resins - solid or semisolid products of synthetic origin used in ion exchange processes for purification of liquids.

resuspension factor - the ratio of the amount of radioactive material in the air ($\mu Ci/m^3$) to the amount of loose radioactive material on a surface ($\mu Ci/m^2$).

roentgen (R) - unit of exposure (gamma or x-ray) in air. (One roentgen equals 2.58×10^{-4} coulomb per kilogram of air.)

SAFSTOR - the decommissioning alternative in which the nuclear facility is placed and maintained in such a condition that it can be safely stored, monitored, and subsequently decontaminated to levels that permit release for unrestricted use.

scabbling - an aggressive decontamination technique that removes concrete surface coatings with toothed pistons or a rotating drum.

SDS - submerged demineralizer system; a water-treatment system that uses a synthetic zeolite mineral as the ion exchange medium to remove radioactive isotopes that are present in the radioactively contaminated water it processes.

shielding - a barrier of solid or liquid material (e.g., lead, concrete, or water) that reduces the intensity of radiation passing through it. Shielding can be used to protect personnel from the damaging effects of ionizing radiation.

somatic effects of radiation - effects of radiation limited to the exposed individual, as distinguished from genetic effects, which may also affect subsequent unexposed generations. Somatic effects include cancers of various types.

source term - the list of radionuclides and the quantity of each radionuclide that is assumed to be present in a given mixture.

specific activity - quantity of radioactivity per unit mass, usually in picocuries per gram.

storage - for the purposes of this supplement, storage is defined as the placement of the TMI-2 facility into a passive monitored state for some unspecified time period before decommissioning or completion of the cleanup.

Supplement 1 - the first supplement to the PEIS (Final Supplement Dealing with Occupational Radiation Dose [NRC 1984]).

Supplement 2 - the second supplement to the PEIS (Final Supplement Dealing with Disposal of Accident-Generated Water [NRC 1987]).

technical specifications - limits and requirements that are set forth in the facility license.

TMI - Three Mile Island.

TMI-1 - Three Mile Island Unit 1; the NRC-licensed reactor operating on the TMI site.

TMI-2 - Three Mile Island Unit 2; the accident-damaged reactor undergoing cleanup on the TMI site.

TMI-2 Advisory Panel - an advisory panel established in 1980 by the NRC to serve as a means to communicate public concerns regarding the cleanup of TMI Unit 2 directly to the Commission. The TMI-2 Advisory Panel is composed of scientists, citizens, and representatives of local and state governments.

total body dose - the radiation dose to the total body, including the bones and all organs, from both external and internal radionuclides.

transuranics - elements having atomic numbers higher than that of uranium (92), including neptunium, plutonium, americium, and curium.

tritiated water - water in which one or both hydrogen atoms have been replaced by a tritium atom.

tritium - a radioactive isotope of hydrogen, containing two neutrons. The nonradioactive forms of hydrogen have 1 or zero neutrons. The half-life of tritium is 12.3 years.

unrestricted use - use of any area or facility without restriction because of prior contamination.

UNSCEAR - United Nations Scientific Committee on the Effects of Atomic Radiation.

U.S. Ecology - the operator of a commercial LLW burial site near Richland, Washington.

volume reduction factor - the ratio of the remaining volume over the initial volume.

water table gradient - the ratio of change in water table elevation over horizontal distance.

yr - year.

zeolites - any of various natural or synthesized silicate minerals used to purify water.

1.0 INTRODUCTION

In March 1981, the U.S. Nuclear Regulatory Commission (NRC) published the final Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Waste Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2, (NRC 1981), referred to in this document as the PEIS.

The PEIS was intended to provide an overall evaluation of the environmental impacts that could result from cleanup activities at Three Mile Island, Unit 2 (TMI-2), from the stabilization of plant conditions after the accident through the completion of cleanup, based on the information then available. The cleanup plan evaluated in the PEIS called for four fundamental activities: building and equipment decontamination; fuel removal and decontamination of the reactor coolant system; treatment of radioactive liquids; and packaging, handling, shipment, and disposal of radioactive wastes. Following the publication of the PEIS, the Commission issued a Policy Statement on April 28, 1981, indicating that the NRC staff would evaluate and act on major cleanup proposals as long as the impacts associated with the proposed activities fell within the scope of the impacts already assessed in the PEIS. Throughout the cleanup, the NRC staff has reviewed the licensee's proposed major cleanup activities to ensure that the activities are safe and that potential environmental impacts are within the range of impacts given in the PEIS.

Until now the PEIS had been supplemented twice (NRC 1984; NRC 1987) since its publication. Supplement 1 (NRC 1984) reevaluated the occupational dose estimates given in the 1981 PEIS because new information led the NRC staff to conclude that cleanup could result in greater occupational radiation exposure than was originally estimated. Supplement 2 (NRC 1987) updated the information presented in the PEIS regarding options for disposal of the water contaminated as a result of the accident (accident-generated water) and the environmental impacts that could result from disposal.

This document is the third supplement to the PEIS; its purpose is to address the environmental impacts associated with a proposal from the licensee, GPU Nuclear Corporation (GPU), to place the TMI-2 facility into storage at the conclusion of defueling (termed post-defueling monitored storage [PDMS] by the licensee).

Before entering PDMS, more than 99 percent of the fuel will have been removed from the reactor, the possibility of an inadvertent recriticality precluded, and the facility decontaminated to specific levels identified by the licensee as endpoint goals. The point in time when these activities will have been completed has been designated by the licensee and is referred to in this supplement as the "end of defueling." In addition, the reactor coolant system would have been decontaminated to a limited degree, (including fuel removal to the extent possible and draining of the system) treatment and disposal of radioactive liquids would be either completed or underway, and packaging and shipping of much of the radioactive wastes from the site would be completed. Of the four fundamental activities identified in the PEIS and listed above, only building and equipment decontamination would not be either substantially or actually completed. Of the buildings contaminated by the accident, only the reactor building and a few areas in the auxiliary and fuel-handling building (AFHB) would have general area radiation levels higher than those of an undamaged reactor facility nearing the end of its operating life.

The licensee proposes to leave the TMI-2 facility in storage for an unspecified period of time, quite likely until TMI-1 is ready for decommissioning. At that time, the licensee would prepare both TMI-1 and TMI-2 for decommissioning. The proposal of a PDMS period followed by preparations for decommissioning is referred to in this document as "delayed decommissioning."[a] Although the licensee has not identified the length of the storage period, the NRC staff has evaluated delayed decommissioning assuming a storage period to the end of the Unit-1 license, at which time both units presumably would be decommissioned. The present Unit-1 license expires on May 18, 2008. NRC regulations in 10 CFR 50.51 (CFR 1988a), allow the licensee to amend their license to continue operation until 2014. Therefore, if PDMS begins in 1991 and the licensee is allowed to amend their license so that it expires in 2014, then the duration of PDMS would be 23 years, the length of time between 1991 and 2013.

The licensee has stated (GPU 1987b) that PDMS was proposed (1) to allow for decay of radionuclides, thereby lowering the occupational exposures that might be incurred during any future efforts to recommission or decommission the facility, and (2) to allow for the development of improved decontamination technology and robotic technology that would have a beneficial impact on cost and occupational exposure levels during the remaining phases of cleanup.

The licensee has further indicated that during the PDMS period, the developing technology for radioactive waste packaging and volume reduction could result in a reduction in the total volume of radioactive waste generated following PDMS. In addition, the licensee has stated that placing the TMI-2 facility in storage until the decommissioning of TMI-1 would allow for a more efficient use of the decommissioning work force, as well as eliminating any possible impact of TMI-2 decontamination and decommissioning operations on the TMI-1 facility.

(a) This supplement evaluates the delayed decommissioning proposal from the completion of defueling up to the initiation of decommissioning. The impacts of decommissioning activities would be the subject of a separate analysis.

In accordance with the National Environmental Policy Act (NEPA), this supplement considers alternative actions to the licensee's proposal. Seven alternatives are evaluated: delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, immediate decommissioning, incomplete defueling, additional cleanup before storage, and no further cleanup following defueling (the "no-action" alternative). Delayed cleanup is similar to delayed decommissioning since both have a PDMS period. However, this alternative differs from the licensee's proposal in that following the storage period, the cleanup would be resumed and would continue until the conditions in the TMI-2 facility were similar to those in an operating facility (that has not undergone a serious accident) nearing the end of its life. Immediate cleanup is the continuation and completion of the cleanup at the 1983-1987 level of effort, beginning with a 2-year period for engineering and planning studies. Immediate cleanup/reduced effort is similar to immediate cleanup except that the cleanup would continue (although with a lower level of effort) from the end of defueling and would be maintained at a lower level of effort than was assumed for immediate cleanup for a total period of 7 to 10 years. Immediate decommissioning does not include a storage period, but instead involves approximately 2 years of preparation of the facility for decommissioning.[a] Incomplete defueling is similar to delayed decommissioning except that only 85 percent of the fuel would be removed from the facility before the facility was placed in storage.[b] Additional cleanup before storage is similar to delayed cleanup except that some additional decontamination and cleanup would be performed before the facility was placed in PDMS. The remaining cleanup would be completed following the storage period. The no-action alternative of no further cleanup following defueling involves the completion of defueling, but there would be no further efforts to complete the decontamination of the facility or to prepare the facility for storage or decommissioning. That is, the facility would be left in the post-defueling condition with no attempts to monitor or maintain the facility.

To properly compare alternatives for a proposal such as this, a common starting point and endpoint for the activities are desirable. However, the alternatives considered in this supplement do not all begin with common plant conditions, continue for an equal period of time, or end with the same set of plant conditions. For instance, the alternative of incomplete defueling assumes only 85 percent of the

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(a) Only those impacts occurring during the preparations for decommissioning are evaluated. The impacts of decommissioning are not considered in this supplement.

(b) This alternative was evaluated before the licensee had removed greater than 85 percent of the fuel. Although NRC staff recognizes that the licensee has removed greater than 85 percent of the fuel, the analysis of this alternative still serves as a bounding case.

fuel has been removed. The licensee's proposal and the other staff-identified alternatives assume 99 percent of the fuel has been removed. Also, the endpoints for delayed decommissioning (the licensee's proposal), immediate decommissioning, and incomplete defueling would result in limited additional area and equipment decontamination before the facility was decommissioned. For each of these alternatives, the remaining cleanup to allow unrestricted access to the facility would occur during decommissioning activities, which are outside the scope of this supplement. Delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, and additional cleanup before storage will result in (1) building and equipment decontamination to the point where general area dose rates approximate those in an undamaged reactor facility nearing the end of its operating life, (2) fuel removal and decontamination of the reactor coolant system, (3) treatment of radioactive liquid wastes, and (4) packaging, shipment, and offsite disposal of radioactive wastes. Following these activities, the facility would be decommissioned to allow unrestricted access. The impacts of the decommissioning activities are not evaluated in this supplement.

Because this document, like the impact statement it supplements, is programmatic in nature, it is not intended to provide a step-by-step work plan. However, the most probable sequences and methods for cleanup have been assumed in order to predict the resulting environmental impacts. The best available information has been used and documented in this analysis. Where there are uncertainties, conservative assumptions have been made and documented in the text and appendixes as appropriate.

Background information potentially affecting the cleanup is presented in Section 2.0 of this supplement. This information includes cleanup progress and conditions in the reactor building and the AFHB as of the end of May 1989, radiation source characteristics, and regulatory and administrative considerations. In Section 3.0, the licensee's proposal for delayed decommissioning and the seven NRC staff-identified alternatives to this proposal are described in detail, and the potential environmental impacts of the licensee's proposal and of each alternative are quantitatively evaluated (with the exception of the alternative of additional cleanup before storage and the no-action alternative, which are described but not quantitatively evaluated). These potential environmental impacts include radiation exposure to the offsite population from routine and accidental releases, occupational radiation dose, waste management impacts, transportation impacts, socioeconomic impacts, commitment of resources, and regulatory considerations. Section 4.0 discusses the potentially affected environment. Section 5.0 summarizes and compares the environmental impacts for the evaluated alternatives and discusses the potential for human health effects. The NRC staff's conclusions are presented in Section 6.0. The staff's responses to comments and questions on Draft Supplement 3 are presented in Section 7.0.

References are listed in Section 8.0, and the index is provided in Section 9.0. Appendix A contains copies of the comment letters received in response to comments on Draft Supplement 3, as well as sections from the transcripts of the TMI-2 Advisory Panel meetings (May, July, and September 1988) and the transcript of the NRC periodic briefing by the TMI-2 Advisory Panel (October 1988). Other appendixes list contributors and provide additional details on the methods of estimating the impacts.

2.0 BACKGROUND INFORMATION AFFECTING CLEANUP ALTERNATIVES

Section 2.1 summarizes the cleanup progress to the end of May 1989 and describes the conditions that will exist in the reactor building and the auxiliary and fuel-handling building (AFHB) at the end of defueling. Section 2.2 evaluates the inventory of radioactive material that is expected to be present in the facility at the end of defueling. The regulatory and administrative considerations affecting the cleanup after defueling is completed are addressed in Section 2.3.

2.1 CLEANUP PROGRESS AND CURRENT CONDITIONS

The 1979 accident at the TMI-2 facility involved a loss of reactor coolant and resulted in serious damage to the reactor fuel. When coolant was restored, radioactive contamination in the form of fuel debris and fission products was distributed by the cooling water throughout the reactor coolant system. A portion of the water, carrying fuel debris and fission products as dissolved and particulate material, escaped from the reactor coolant system and flowed into the reactor building basement. (A discussion of the inventory of radionuclides transported in the water is contained in Section 2.2.) Exposed surfaces in the reactor building and AFHB were contaminated with material in the reactor coolant and from radionuclides that became airborne as steam escaping from the reactor coolant system condensed during and shortly after the accident. After the accident, the water in the basement was heated by residual heat from the reactor vessel, evaporated, condensed on the walls, and drained down onto the floors and back into the basement. This period of evaporation and condensation contributed to the permeation of radionuclides into porous surfaces, such as concrete and the incorporation of radionuclides into corrosion layers as iron surfaces rusted. A more detailed account of the accident is contained in a U.S. Nuclear Regulatory Commission (NRC) report (NRC 1979a), Kemeny et al. (1979), and Rogovin and Frampton (1980).

The PEIS and previous supplements have evaluated the impact of activities necessary to reach the "completion of cleanup." As defined by the PEIS, the completion of cleanup will be achieved when four fundamental activities have been completed: (1) building and equipment decontamination to levels typical of an operating reactor nearing the end of its life, (2) fuel removal and decontamination of the reactor coolant system, (3) treatment of radioactive liquids, and (4) packaging, handling, shipment, and disposal of radioactive wastes. As envisioned by the PEIS, after the completion of cleanup, the facility would be decommissioned or refurbished.

The PEIS indicated that the general area radiation dose rates at the completion of cleanup would approach 10 mrem/h in most areas of the reactor building and AFHB. This is typical of commonly occupied areas in an undamaged reactor facility (one that has not undergone a severe accident) nearing the end of its operating life. The primary differences between an undamaged reactor facility at the end of its operational life and the condition of the TMI-2 facility following completion of the current defueling program are the relatively high levels of contamination that would still remain in the reactor building basement and the quantity of residual fuel that would remain in the reactor coolant system.

Within certain cubicles, shielded areas, and other infrequently occupied areas, radiation dose rates may be considerably higher both in undamaged facilities and in the TMI-2 facility. Radiation levels may be lowered in one of two ways: radiation sources may be shielded or they may be removed. Both portable shielding and radionuclide removal have been used in TMI-2 cleanup. Shielding, however, is a temporary measure to minimize dose to the workers. The radiation sources must ultimately be removed. In assessing the measures necessary to complete cleanup, the NRC staff has assumed that dose rates, in the absence of portable shielding, would need to be comparable to those of an undamaged reactor facility nearing the end of its operating life.

Although radiation levels at the completion of cleanup would be comparable to those of an undamaged reactor, the mix of radionuclides that contributes to the radiation levels in TMI-2 will differ substantially from the mix in an undamaged reactor. In most reactors, radiation levels are primarily due to cobalt-60 and other activation products. The radiation levels in the TMI-2 reactor are primarily due to cesium-137, a fission product.

In the following sections, a description of the cleanup progress to the end of May 1989 and the conditions that will exist at the end of defueling is given for four major areas: (1) the reactor building, (2) the reactor vessel, (3) the reactor coolant system, and (4) the AFHB.

2.1.1 Reactor Building Cleanup

The reactor containment building is uniquely designed and constructed to maintain its structural integrity (with almost no leakage) during a wide variety of accidents. The entire building is constructed of reinforced concrete lined with welded steel. The liner is painted with a corrosion-resistant paint to the level of the basement floor. The bottom of the building is covered with approximately 2 feet (0.6 meters) of poured concrete to form the floor of the reactor building basement. Piping and electrical system penetrations that enter the building are sealed to maintain their integrity through a variety of accident conditions.

The building is equipped with a two-train ventilation system, both trains having double-stage high-efficiency particulate air (HEPA) filters. These filters remove particulate material but allow gases to pass through.

A plan view of the reactor building is given in Figure 2.1. The three levels within the building are referred to by elevation above sea level: the 305-foot elevation (entry level), the 347-foot elevation (operating floor), and 282-foot elevation (referred to as the basement). Decontamination work to date has significantly reduced radiation fields in the reactor building. The emphasis during cleanup has been on removing debris, decontaminating, and shielding frequently traveled and frequently occupied areas. The specific conditions at each elevation are discussed separately in the following paragraphs.

The building is entered at the 305-foot elevation (Figure 2.2). When the building was first entered after the accident, the radiation dose rates at this elevation averaged 430 mrem/h in occupied portions. By the end of 1988, removal of debris, decontamination, placement of shielding, and the removal of the surface layer from floors and walls (scabbling) had reduced the general area exposure rates at this level to an average of about 60 to 70 mR/h. Decontamination using high- and low-pressure sprays of borated water appears to have reduced the amount of contamination on equipment and building surfaces. Effective, but temporary, dose rate reductions also have been achieved by placing shielding around some sources of high-level radiation, including the air coolers, elevator shaft, both stairwells, and some floor drains. Scabbling, an aggressive decontamination technique that removes concrete surface coatings with toothed pistons or a rotating drum, has removed additional contamination and reduced the general area dose rates. A large portion of the 305-foot elevation has been scabbled and the remaining rough surfaces sealed by applying an epoxy sealant to prevent recontamination of the concrete. Figure 2.2 shows the general area exposure rates (gamma radiation) as of May 1989. Most of the remaining radiation sources are difficult to remove and/or are in relatively inaccessible locations. Contamination is still present on structures such as the air coolers and floor drains that are currently shielded. Contamination is also present on electrical cables and trays, piping supports, and overheads.

The 347-foot elevation (Figure 2.3) is the operating floor formerly reached by an open stairway, an enclosed stairwell, and an elevator. Radiation dose rates resulting from the accident have prevented the refurbishment of the elevator and minimized use of the enclosed stairwell. A temporary stairway allows access to a portion of the enclosed stairwell. Shielding has been placed within the stairwell, reducing the dose rates. The reactor vessel defueling platform is accessed from the 347-foot elevation. Dose rates at the 347-foot elevation averaged 240 mrem/h in occupied portions following the accident. Essentially all the concrete floors at the 347-foot elevation have been scabbled and sealed. Shielding, removing debris,

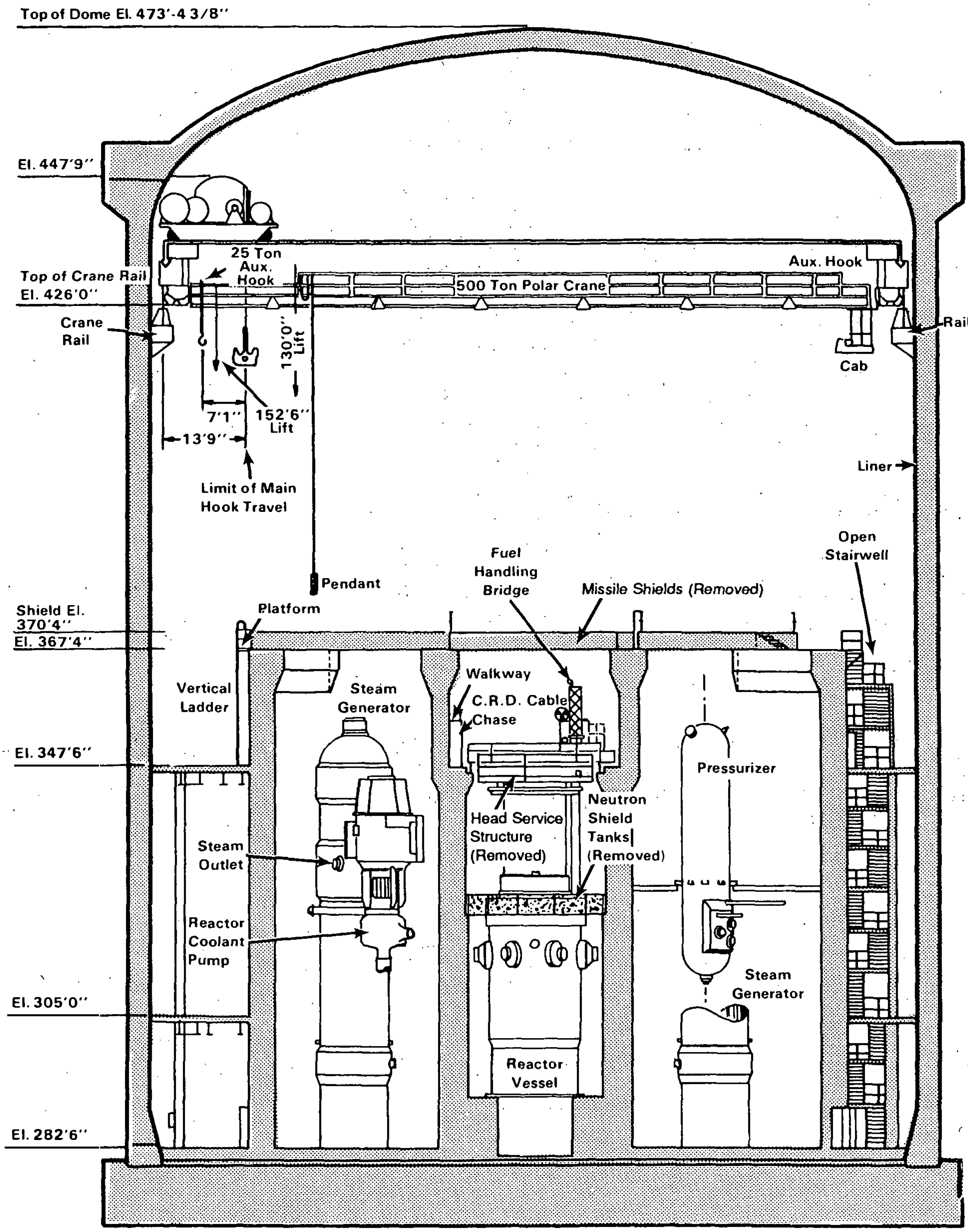

FIGURE 2.1. Reactor Building Cross Section

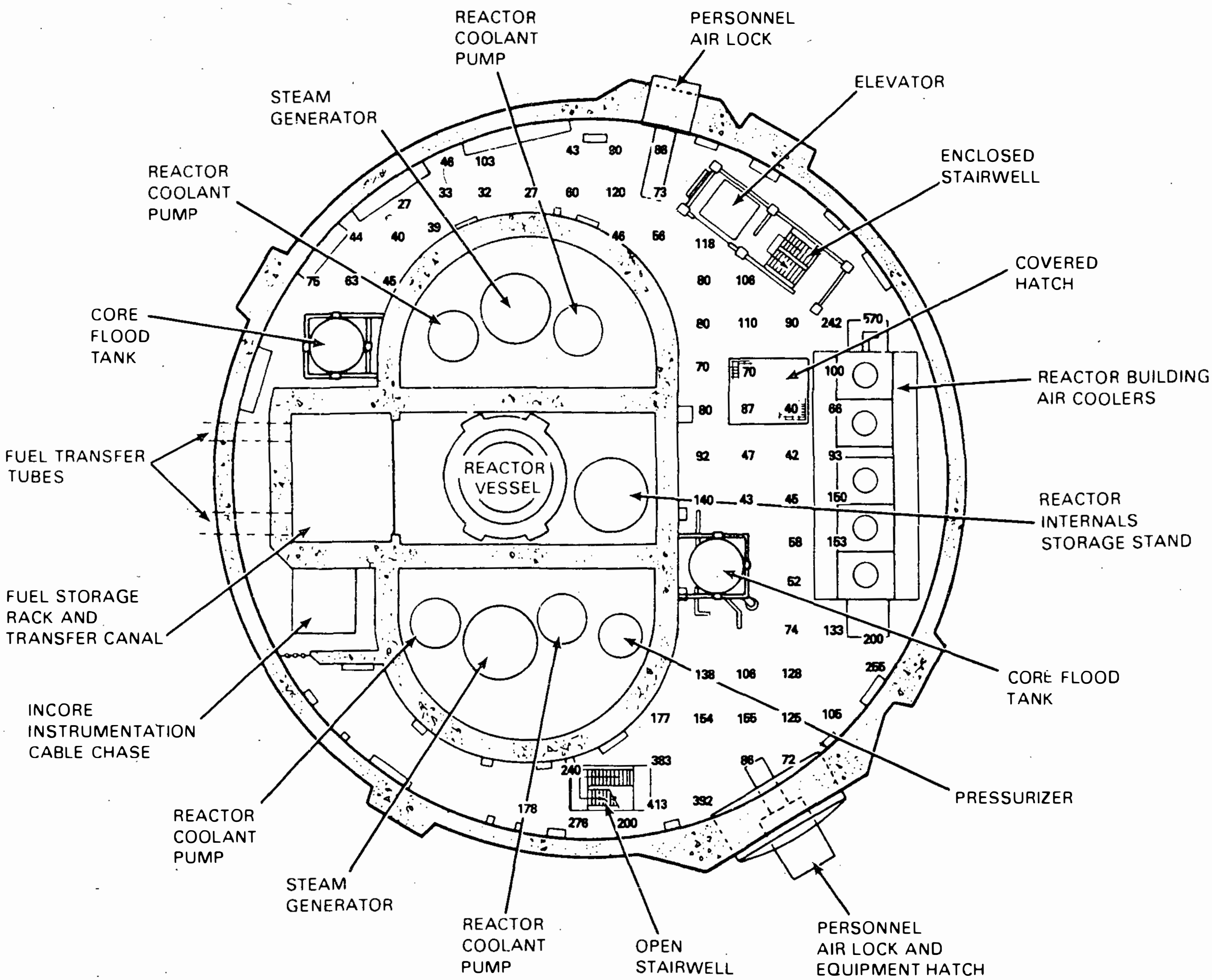

FIGURE 2.2. Map of the General Area Exposure Rates on the 305-Foot Elevation During May 1989, in mR/h for Gamma Radiation

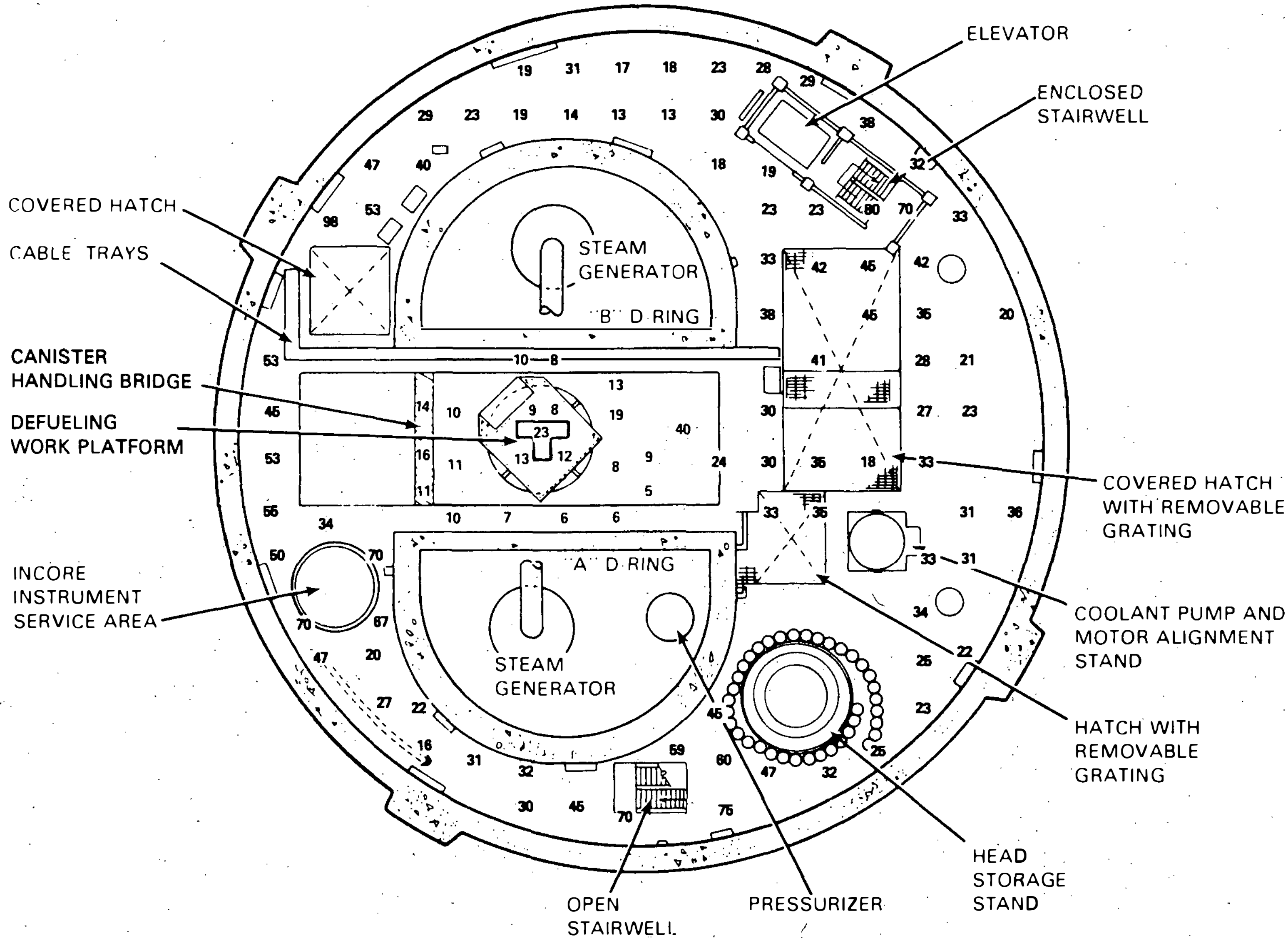

FIGURE 2.3. Map of the General Area Exposure Rates on the 347-Foot Elevation During May 1989, in mR/h for Gamma Radiation

decontaminating, and scabbling reduced the general area exposure rates to approximately 25 mR/h to 35 mR/h by May 1989, with less than 35 mR/h for most well-traveled areas and approximately 10 mR/h on the defueling platform. A map of the general area exposure rates (gamma radiation) during May 1989 is shown in Figure 2.3. Contamination is still present on shielded structures, as well as on electrical cable trays, piping supports, and other overhead components.

The polar crane located at the 426-foot elevation is reached by ladder or hoist from the 347-foot elevation. The elevation of the crane's cab is 418 feet, 6 inches. The polar crane, which is shown in Figure 2.1, was used to prepare for defueling and continues to be used to transport decontamination equipment, radioactive waste, and shielding materials within the reactor building. Dose rates at initial access to the polar crane after the accident averaged 120 mrem/h in occupied portions, but had been reduced to an exposure rate of about 80 to 90 mR/h by May 1989.

The 282-foot elevation is the reactor building basement (Figure 2.4). The basement is divided into two distinct areas that are separated by the circular portion of the D-ring shield walls. The area outside the D-ring shield walls contains large numbers of reactor control cables, various pumps and piping systems, the stairways, the reactor coolant drain tank (located in a shielded cubicle), and other equipment. During the accident, the major water flow path out of the reactor core was from the reactor coolant system, through the pressurizer relief valve, into the reactor coolant drain tank, and out the tank's vent line (through a ruptured blow-out disk) into the reactor building basement. This flow resulted in about 260,000 gallons (1,000,000 liters) of water covering the reactor basement to a depth of slightly more than 3.5 feet (1.1 meters). Water from the reactor building sprays, from additional reactor coolant, and from river-water inleakage through the building air coolers contributed approximately 360,000 gallons (1,400,000 liters) to the water level in the reactor building basement, raising it to a depth of approximately 8 feet (2.4 meters) (Munson and Harty 1985). Because the accident-generated water remained in the basement for several years, radionuclides concentrated on submerged surfaces and were absorbed into the basement's concrete floors and walls (other than the steel-lined, outer containment walls). In addition, a layer of sludge was deposited on the basement floor.

Since the accident, the water has been drained, extensively processed, and recycled for use in decontamination. Water used during decontamination procedures on the upper levels has flowed into the basement, dissolving additional contamination in the basement, which has been removed as the water was pumped out and processed. Disposal of the accident-generated water was the subject of Supplement 2 to the PEIS (NRC 1987) and is not discussed further here.

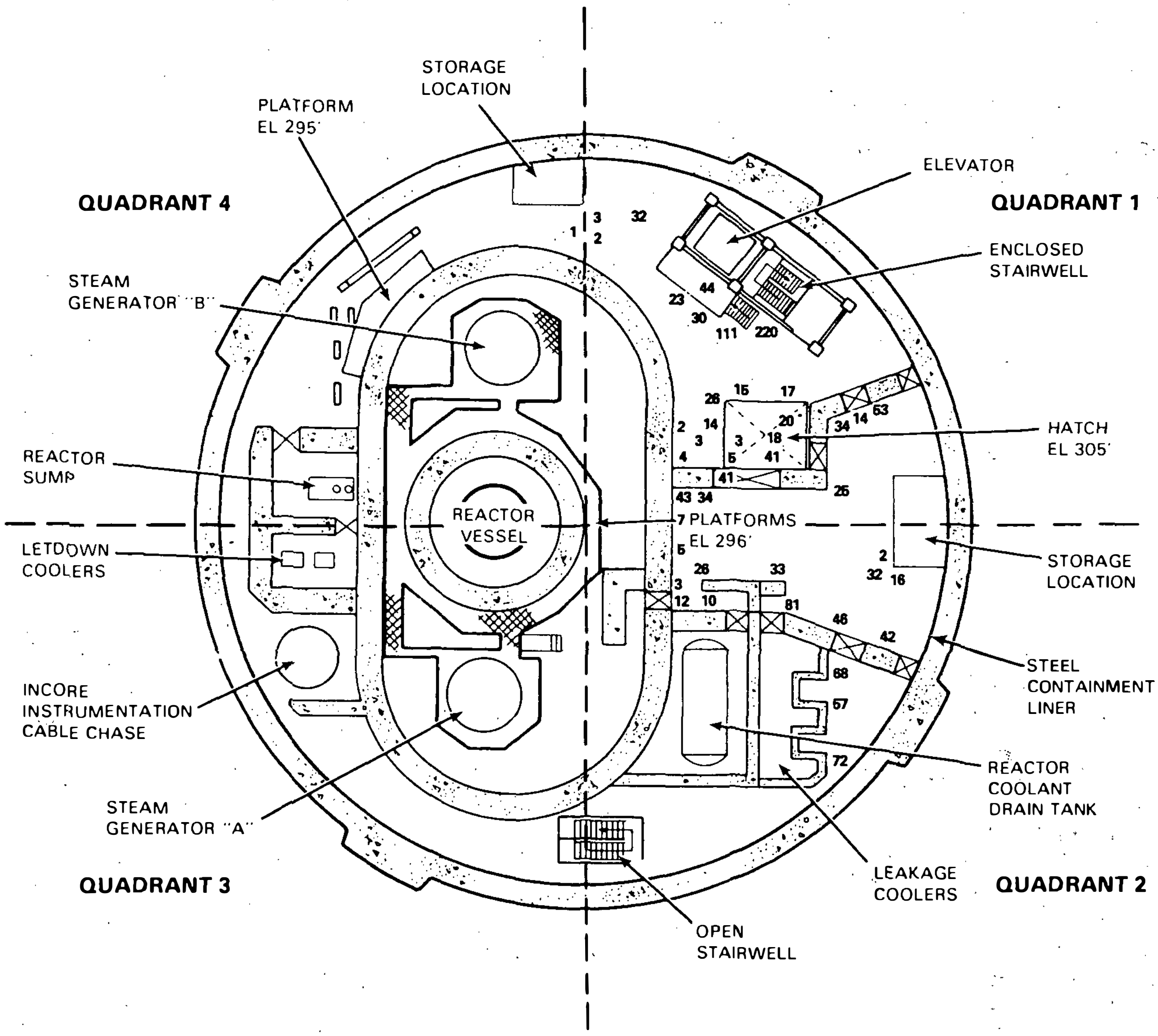

FIGURE 2.4. Map of the General Area Exposure Rates 4 to 7 Feet (1.2 to 2.1 Meters) Above the 282-Foot Elevation During May 1989, in R/h for Gamma Radiation

Cleanup activities that have been conducted in the basement to date include the following: radiation monitoring using instrumentation mounted on robots and strings of dosimeters suspended from the 305-foot elevation; video inspections using robots and cameras lowered on cables from the 305-foot elevation; collecting concrete cores using robots; flushing and pumping of the elevator shaft; high- and low-pressure flushing by robots; flushing from upper elevations; and scabbling sections of concrete walls using robots in an effort to remove the surface layer of contaminated concrete. The wall area from

4 to 7 feet (1.2 to 2.1 meters) above the basement floor was scabbled only in quadrants 1 and 2. During 1988, an attempt was made to leach activity from the concrete block wall of the enclosed stairway and elevator structure. This resulted in the removal of an estimated 33 percent of the cesium-137 inventory in the area treated, which represents a removal of 7 percent of the total inventory of the enclosed stairway and elevator structure.

Approximately 22,000 pounds (9900 kilograms) of wet sludge has been removed from approximately half of the basement floor, pumped into a tank located in the auxiliary building, and solidified for burial at a low-level waste (LLW) disposal site. Part of the liquid was returned to the basement, with a limited amount, approximately 1000 gallons (3800 liters), processed. A small quantity of fuel fragments, estimated to be between 3.7 and 7.1 pounds (1.7 and 3.2 kilograms), was deposited in the basement during the accident and has since mixed with solid materials in the sediment in the reactor building. Some of this material was most likely removed during sludge removal; however, because the amount removed cannot be accurately determined, it is conservatively assumed that 7.1 pounds (3.2 kilograms) of fuel remain dispersed in the basement.

A map of the radiation exposure rates in the basement during May 1989 is shown in Figure 2.4. Most of the data in this figure were obtained from contact readings (all measurements were made with a shielded directional probe). The radiation levels in the basement vary somewhat with elevation. This map represents conditions 4 to 7 feet (1.2 to 2.1 meters) above the floor of the basement. General area radiation exposure rates taken with a nondirectional probe would be lower than the contact exposure rates, but higher than the general area exposure rates identified in Figure 2.4. The highest measured radiation exposure rates (400 R/h to 1100 R/h before decontamination) in the reactor building basement were in the vicinity of the elevator shaft and enclosed stairwell. These structures, which are made of hollow concrete blocks, became saturated with the accident-generated water and absorbed radionuclides from the water. Analyses of core samples of the concrete block indicate that the contamination (primarily cesium-137) has completely penetrated the concrete block. Analyses of core samples from the concrete walls indicate that approximately 90 percent of the radioactivity (primarily cesium-137) in the concrete walls and the D-ring walls is within the first 1/8 inch (0.3 centimeter) to 1/4 inch (0.6 centimeter) of concrete.

Projected work to be performed before the completion of defueling includes pumping the remaining water from the basement and processing it through the submerged demineralizer system (SDS) and/or EPICOR II system (depending on the radioactivity level), and a final flushing and removal of sludge debris from the basement floor using robots.

In addition to large amounts of radioactive contamination in the concrete block stairwell/elevator structure and in the concrete walls and floor, the licensee has estimated that a maximum of 8600 pounds (3900 kilograms) of wet sludge (600 pounds [270 kilograms] of dry material) would remain after completion of the current defueling effort. Contamination also remains on insulation, equipment, and electrical boxes located in the basement.

The two D-ring areas are enclosed by D-ring-shaped walls (Figures 2.2, 2.3, and 2.4). The D-ring walls extend from the 282-foot elevation to the 367-foot, 4-inch elevation, although the "D" shape is not observed until the 305-foot elevation. The D-ring areas are designated as the "A" and the "B" D-rings and enclose various components of the reactor coolant system. The "A" D-ring contains one of the two steam generators, two of the four reactor coolant pumps, and the pressurizer. The "B" D-ring contains the second steam generator and the remaining two reactor coolant pumps. Data obtained from radiation monitoring with instruments and strings of dosimeters have demonstrated high levels of contamination on the components of the reactor coolant system as well as structural surfaces. Decontamination and dose reduction activities to date have included selective removal of insulation from reactor coolant system components and low-pressure flushing from the D-ring top, as well as some high-pressure flushing. These activities have only been slightly effective in reducing loose contamination on exposed surfaces. It appears that much of the activity is in the form of salt or mineral deposits, highly contaminated coatings or corrosion products bound to the equipment surfaces. The source of this contamination has been postulated to be from the multiple instrument leads from steam generator tubes which penetrate the manway and inspection port covers. Exposure rates in the "A" D-ring range from 80 mR/h at the 349-foot elevation to more than 10 R/h at the 295-foot elevation. Exposure rates in the "B" D-ring range from approximately 0.5 R/h at the 356-foot elevation to more than 20 R/h below the 330-foot elevation. Exposure rates at the lower elevations are increasingly influenced by sources in the basement.

2.1.2 Reactor Vessel Defueling and Disassembly

A comparison of Figures 2.5 and 2.6 illustrates the progress of defueling and disassembly to the end of 1988. Figure 2.5 is a cutaway view of the TMI-2 vessel showing the status of the disassembly and defueling process in October 1984.[a] This figure is explained on page 2.8 of Supplement 1 to the PEIS (NRC 1984). Figure 2.6 is a cutaway view of the TMI-2 reactor vessel as it looked on May 30, 1989. Reactor vessel defueling and disassembly through May 30, 1989, have included removing the reactor vessel head, the upper plenum assembly (the device that positions the control rods), the sections of the lower core support assembly, and most of the fuel. The head was

(a) A cutaway view of a typical, undamaged pressurized water reactor (PWR) vessel was shown in Figure 6.1 of the PEIS (NRC 1981).

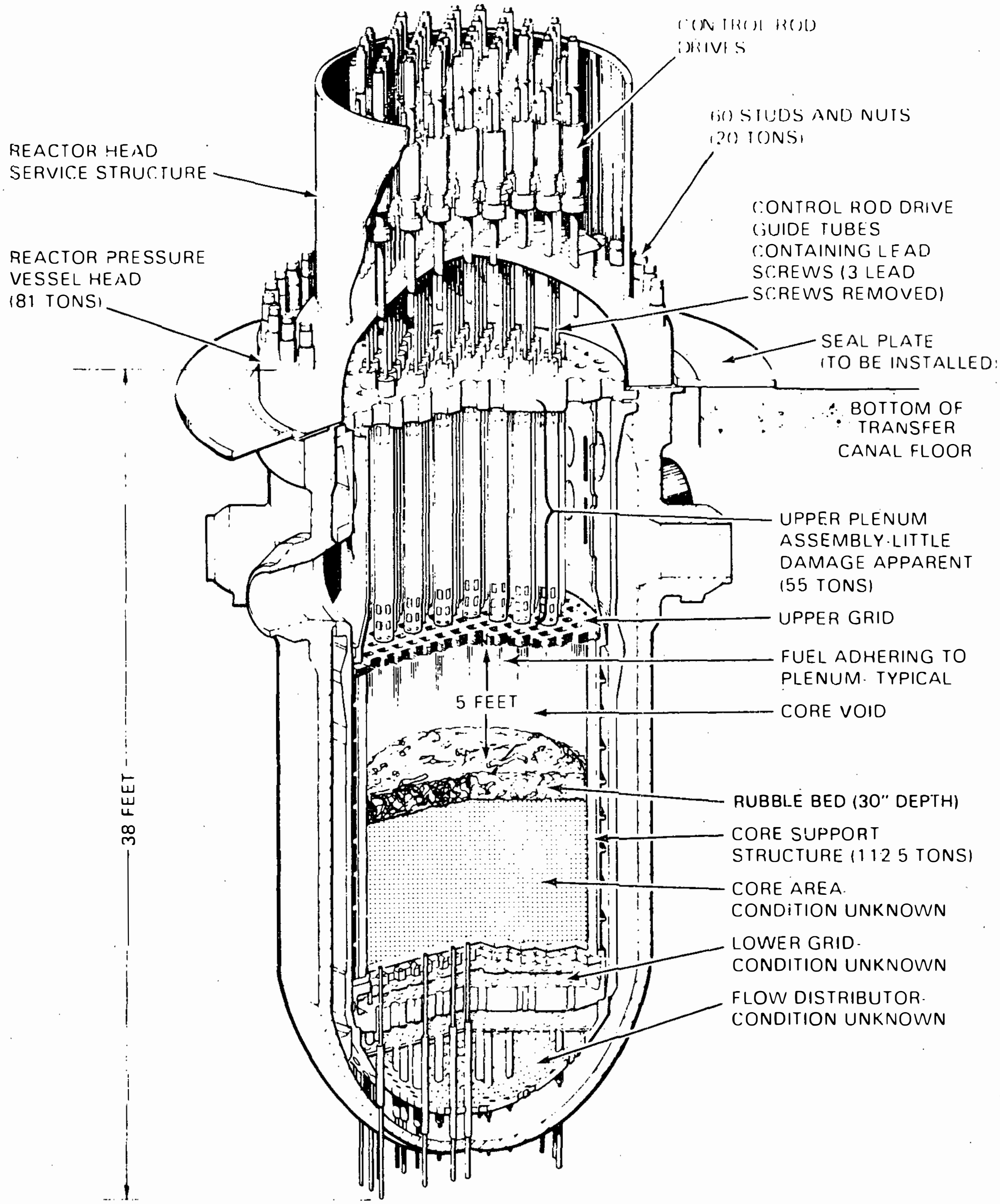

FIGURE 2.5. Cutaway View of TMI-2 Vessel Showing Status in October 1984

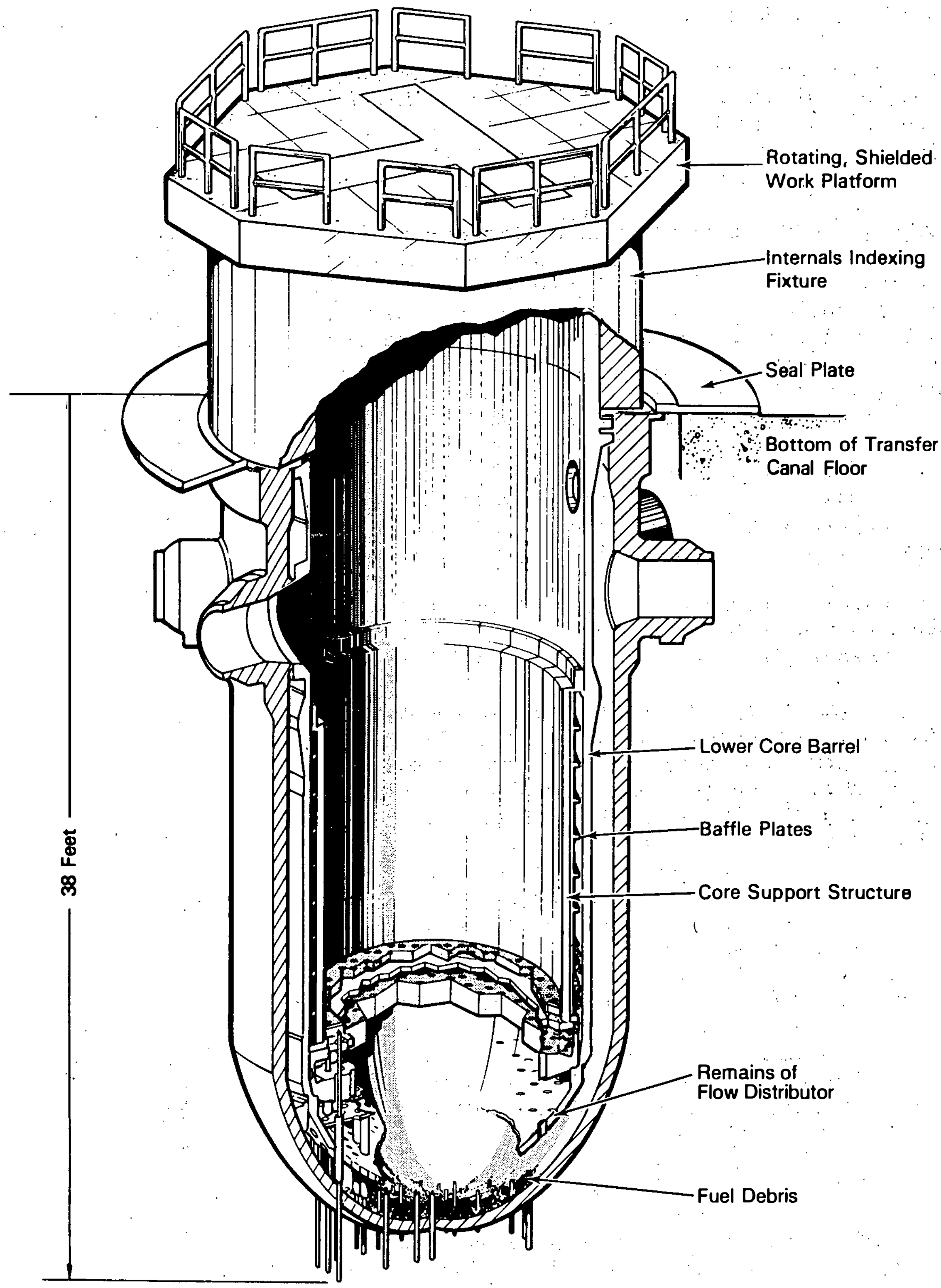

FIGURE 2.6. Cutaway View of TMI-2 Vessel on May 30, 1989

placed on a storage stand at a shielded location on the 347-foot level. The internals indexing fixture was installed after the reactor vessel head was removed. It remains on the reactor vessel, flooded to about 15.5 feet (4.7 meters) above the top of the core region. The defueling platform is located on top of the internals indexing fixture. A dam was installed across the fuel transfer canal to create a storage pool for the plenum assembly and the fuel canisters. The plenum assembly was removed intact and stored in the deep end of the fuel transfer canal under 5 feet (1.5 meters) of water. (Total depth of the water in this end of the fuel transfer canal is 20 feet [6.1 meters].) A water cleanup system was installed to clarify and decontaminate the water used for defueling operations.

The original core inventory contained 207,100 pounds (93,900 kilograms) of fuel (uranium oxide) and 78,200 pounds (35,500 kilograms) of structural and absorber material for a total of 285,300 pounds (129,000 kilograms). Including oxidation of the metals and the portions of the upper plenum structure that melted, the total post-accident core material is estimated to be 293,100 pounds (133,000 kilograms) (GPU 1988). An additional 4400 pounds (2000 kilograms) of new material, introduced as a result of defueling operations, and material from recently discovered damage to the reactor vessel internals increase the total post-accident core material estimate to 297,500 pounds (135,000 kilograms).

A total of 259,900 pounds (117,900 kilograms) of core material (fuel, structural material, and absorber material) had been removed from the reactor vessel as of May 30, 1989. This constitutes 87 percent of the total estimated post-accident core materials inventory. As of June 19, 1989, 259 canisters of damaged core material (211,000 pounds [95,700 kilograms]) had been shipped from TMI and 47 canisters were awaiting shipment. The amount shipped constitutes approximately 70 percent of the estimated core materials inventory. Table 2.1 shows the estimated distribution on May 30, 1989, of core material remaining in the reactor vessel. It does not include the estimated 400 pounds (180 kilograms) that is located outside the reactor coolant system. The current stages of defueling includes removal of fuel that is located in the bottom of the vessel and removal of portions of the core baffle plates to permit defueling of the region between the baffle plates and the core barrel. Fuel particles that were swept into the outlet nozzles of the reactor vessel may also be removed as part of defueling. Defueling will continue until all the fuel that can be practicably accessed throughout the reactor vessel has been removed.

The licensee has estimated that the quantity of residual fuel left in the reactor vessel following the completion of defueling may be 880 pounds (400 kilograms) (GPU 1988). The fuel that remains would be distributed among several locations in the form of a tightly adherent film, in granular form within cracks or crevices, or as a congealed mass (GPU 1988). After defueling, reactor internals may be

TABLE 2.1. Estimated Core Material Distribution in the Reactor Vessel as of May 30, 1989

Location	Estimated Quantity, pounds
Lower Core Region	200
Lower Core Support Assembly	5,400
Resolidified material	
Loose material (vacuumable)	
Loose material (rods and rocks)	
Lower Head	22,300
Monolith or fused material	
Post-accident loose material (nonvacuumable)	
Post-accident loose material (vacuumable)	
Newly relocated loose material (vacuumable)	
Newly relocated rods and rocks	
Core Former Region	9,300

returned to the vessel or stored in other suitable locations, such as under shielding in the refueling canal.

2.1.3 Reactor Coolant System Decontamination

A diagram of the reactor coolant system is shown in Figure 2.7. Directional radiation surveys performed by the licensee confirm that reactor fuel and fission products were dispersed throughout the reactor coolant piping system as finely divided particles and/or as plating on surfaces. During the accident, a small quantity of finely fragmented fuel was also released into the basement by reactor coolant escaping through the pressurizer relief valve to the reactor coolant drain tank and into the basement through a disk, which ruptured to relieve pressure in the reactor coolant drain tank. Directional surveys of the reactor coolant system components have permitted preliminary estimates of fuel present in these locations. Fuel has been removed and is currently being removed from some portions of the system, such as the steam generators. By the end of defueling, more than 99 percent of the fuel will have been removed from the facility. Possible residual fuel locations outside the reactor vessel and current licensee estimates of the fuel quantities remaining after defueling as presented in the licensee's safety analysis report on post-defueling monitored storage (PDMS) (GPU 1988) are listed in Table 2.2. The quantity of fuel at each of the locations in Table 2.2 was estimated by the licensee using a variety of methods, including gamma spectroscopy and path flow modeling.

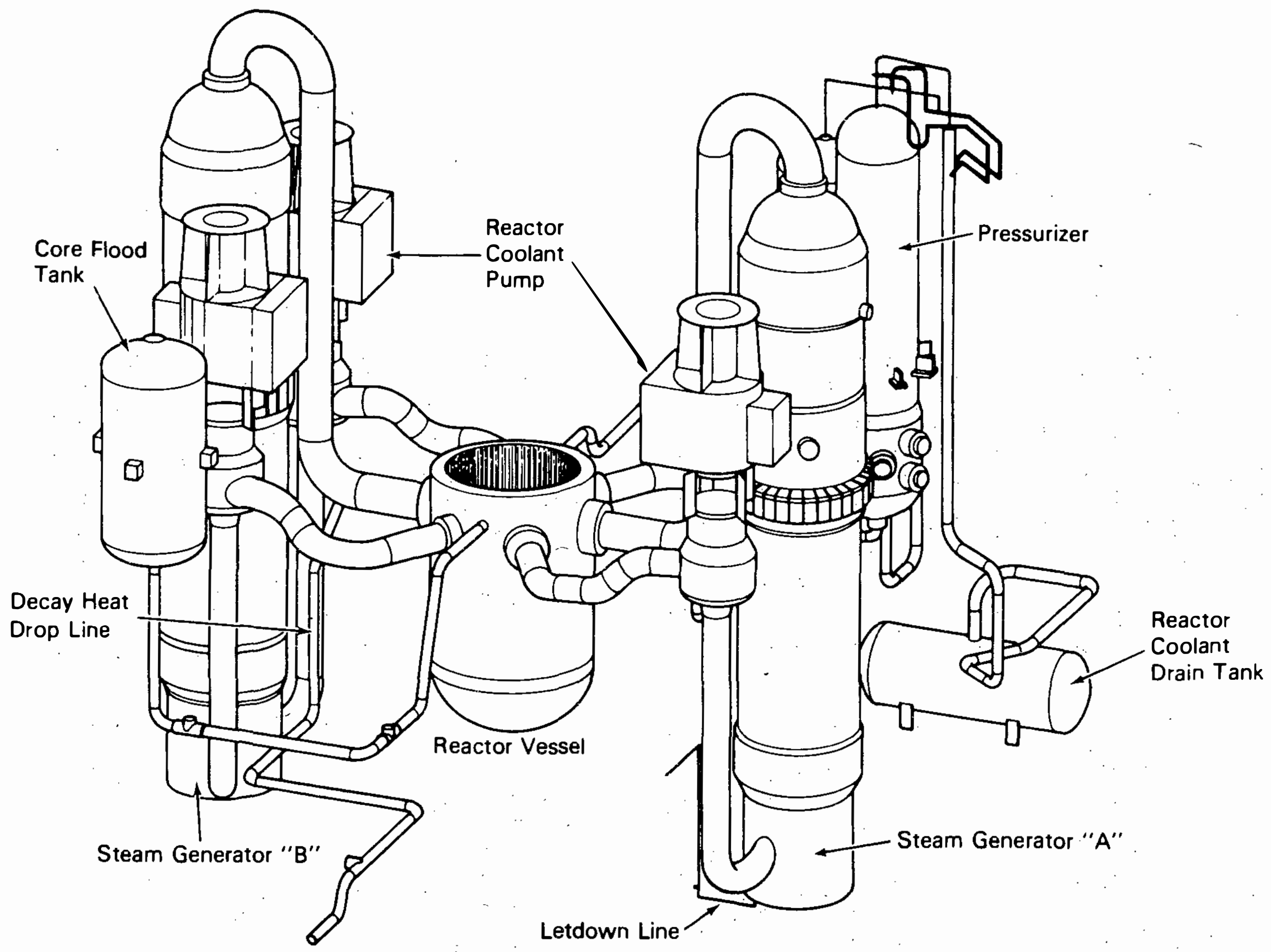

FIGURE 2.7. Reactor Coolant System Components (Source: GPU 1987b)

TABLE 2.2. Estimated Quantity of Fuel Remaining in the Facility at the End of Defueling (Source: GPU 1988)

Location	Quantity of Residual Core Debris[a] pounds	kilograms
Reactor Building		
Reactor coolant system		
Reactor vessel	882	400
Other	417	189
Reactor coolant pipes		
Reactor coolant pumps		
Steam generators		
Outside the reactor coolant system	13	6.1
Plenum assembly		
Reactor building		
Fuel transfer canal		
Auxiliary and Fuel-Handling Building		
Pipe systems, drains, floors, and sumps	12	5.4
Total[b]	1320	600

(a) These values represent an estimate of post-defueled plant conditions based on currently available data (GPU 1988).
(b) The totals may not be exact because of rounding.

2.1.4 Auxiliary and Fuel-Handling Building Cleanup

The auxiliary and fuel-handling building (AFHB) was also designed and constructed to maintain its structural integrity during a variety of accidents. However, unlike the reactor building, the AFHB was not designed to be leak-free during such conditions.

The AFHB is composed of two sections that are separated by a common wall. The auxiliary section contains tanks, pumps, piping, and other equipment to process and store water for the reactor coolant system and to treat radioactive wastes. The fuel-handling section contains large basins or pools for the storage of spent fuel, and equipment such as the cranes used to remotely handle the spent fuel. The general layout of the AFHB is shown in Figures 2.8 and 2.9. The truck bay area within the AFHB is shared with TMI-1.

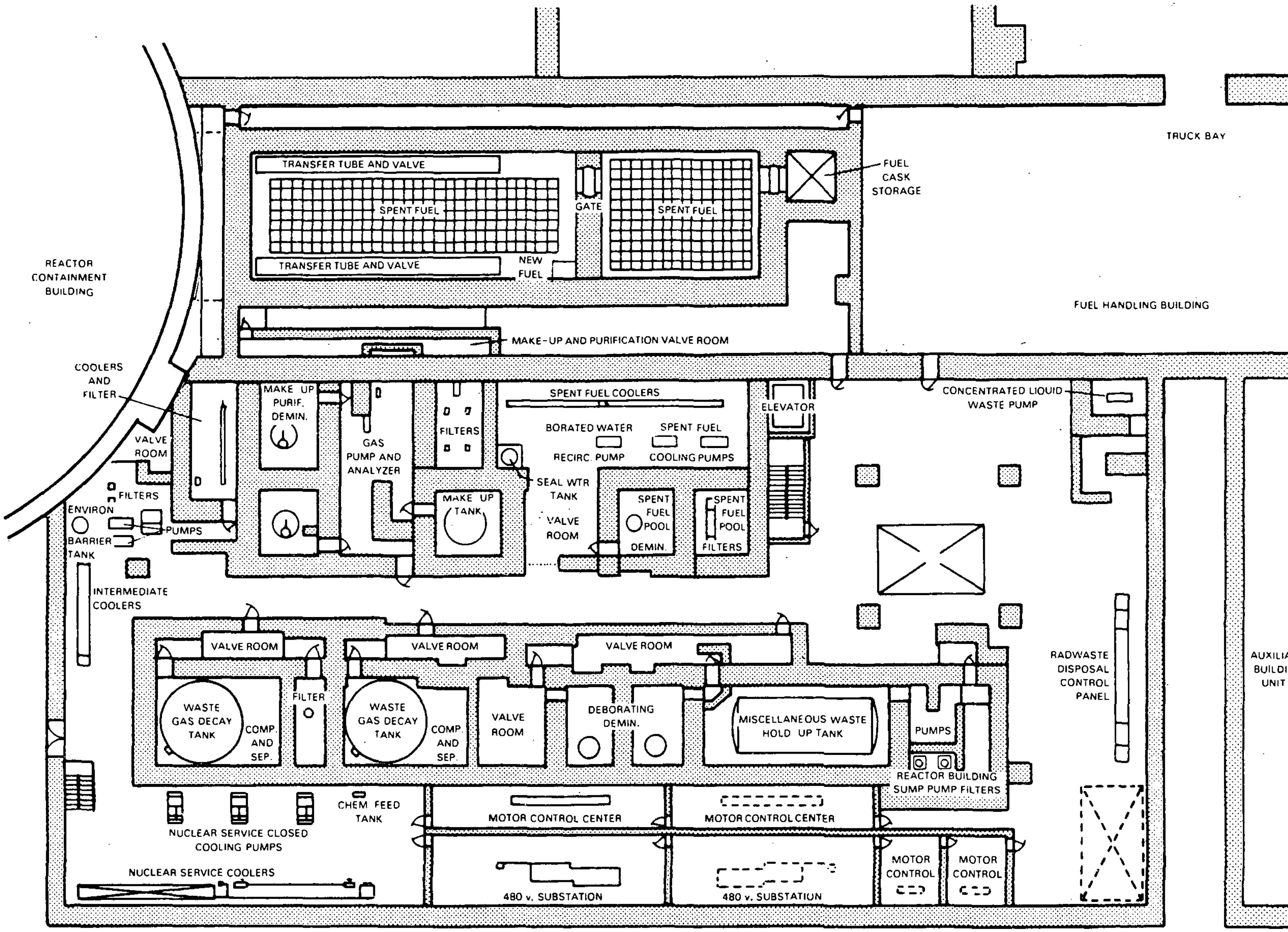

FIGURE 2.8. Plan View of Auxiliary and Fuel-Handling Building, 305-foot Elevation

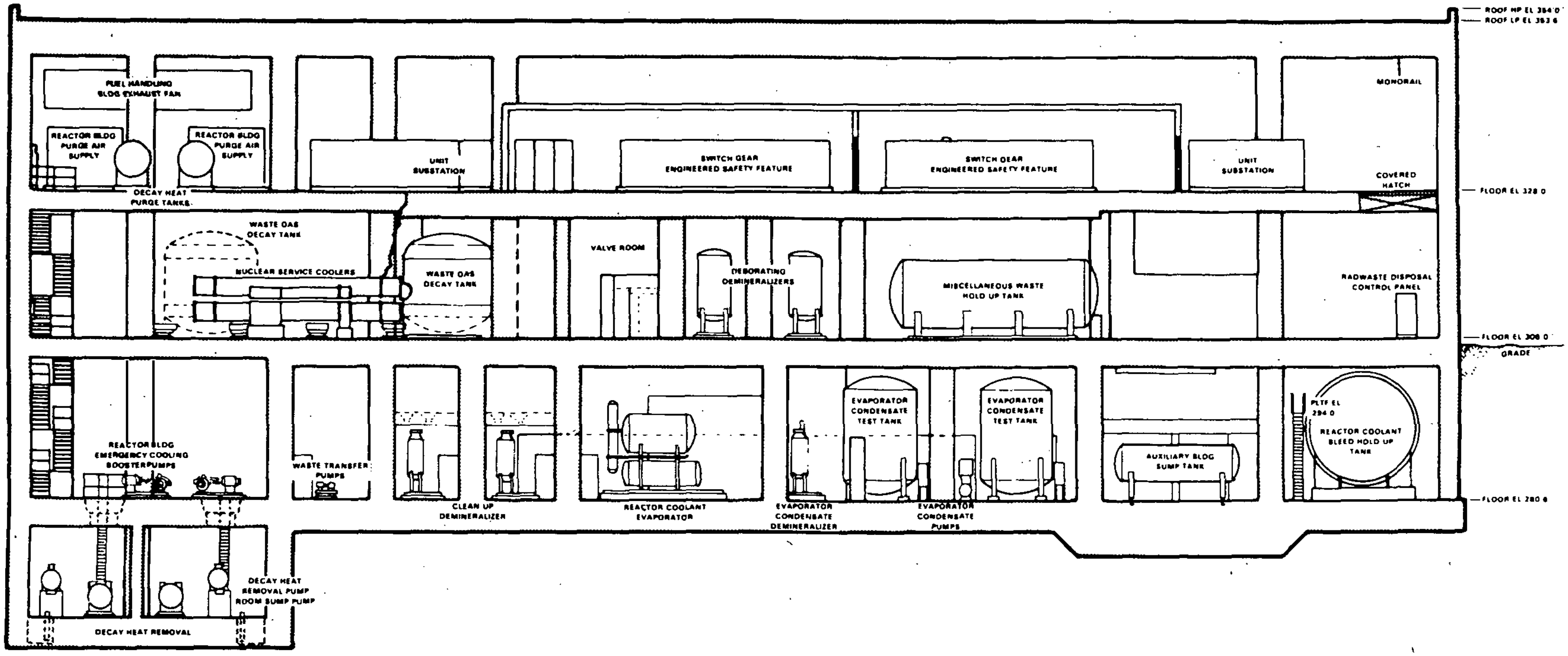

FIGURE 2.9. Cutaway View of Auxiliary and Fuel-Handling Building

The interior of the AFHB and 26 piping systems in the AFHB were also contaminated as a result of the accident, although less severely than the reactor building. Cleanup of the AFHB started shortly after the accident and is still under way. So far, considerable amounts of debris and contaminated equipment have been removed, contaminated systems have been flushed, and the building and remaining equipment are in the process of being decontaminated. Because most of the interior surfaces of the building (walls, floors, etc.) are constructed of uncoated concrete, radioactive materials have penetrated into the surfaces to varying depths. High- and low-pressure water sprays, wet vacuuming, scabbling (usually followed by an application of sealant), and manual wiping have reduced both the level of smearable contamination on building surfaces and the dose rates. Some temporary dose rate reduction has also been achieved by shielding radiation sources, such as floor drains, the elevator shaft, and various valves, piping, and pipe dead legs. Dose rates in halls and most normally occupied areas have been reduced considerably. The cubicle areas have proven to be the most difficult to decontaminate because of the concentration of equipment (tanks, filters, piping, etc.), the crowded work space, and the high contamination and high radiation levels. Some of the more highly contaminated components have been removed, however, and the radiation levels in most cubicles have been substantially reduced. By the end of 1988, 124 of the 136 contaminated cubicles in the AFHB were decontaminated so that general area radiation exposure rates within them are generally less than 15 mR/h. The licensee plans to decontaminate the remaining cubicles before the end of the current defueling effort. At this point, the general area exposure rates in the remaining cubicles will generally approach 15 mR/h.

The fuel-handling section of the AFHB has undergone extensive decontamination and refurbishment to prepare for defueling. At the present time, exposure rates throughout the fuel-handling section are generally less than 15 mR/h. All the contaminated temporary water-storage tanks have been removed from the "A" fuel pool, the pool liner cleaned, and new fuel canister racks and a canister dewatering system installed. However, contamination has been reintroduced to the fuel pool as a result of defueling operations. After defueling has been completed and the fuel has been shipped offsite, the fuel pools will be drained and again decontaminated.

Dose levels in the AFHB at the end of defueling are expected to be similar to those found in an undamaged reactor facility nearing the end of its life, except for a few of the cubicle areas.

The licensee estimates that less than 12 pounds (5 kilograms) of fuel are present in the pipe system, drains, floors, and sumps of the AFHB (GPU 1988).

2.2 SOURCE CHARACTERISTICS

The potential environmental impacts of cleanup activities at TMI-2 depend in part on the quantity and distribution of radionuclides present in the facility. Several methods have been used to determine the quantity and distribution of radionuclides, including direct measurements, sample analysis, and analysis of reactor operation and accident data. Identifying all the radionuclides present in the facility is difficult using measurement or sample-analysis techniques because (1) there are a large number of radionuclides associated with the fuel and (2) the relatively large quantities of cesium-137 and strontium-90 make detection of other radionuclides difficult. Estimates of the amounts of cesium-137 and strontium-90 present in the facility are based on measurements. However, the number and the quantity of the remaining radionuclides are estimated from the amounts present at the time of the accident, which in turn are estimated using computer models that are based on the original composition of the fuel and reactor core materials and on the operating history of the TMI-2 reactor.

The estimated inventory of radionuclides at the time of the accident has been calculated (GPU 1987a; Cunnane and Nicolosi 1982) using the ORIGEN-2 computer code. Table 2.3 provides the inventory of the longer-lived radionuclides estimated to be present at the time of the reactor shutdown on March 28, 1979. Table 2.3 also provides the estimated inventory, decay-corrected to January 1, 1990, that would have been present in the facility if no defueling or cleanup had taken place. The expected inventory of the decay products is also included.[a] Any isotope that would have been present in a quantity of less than 1 curie on January 1, 1990 (in the absence of defueling or cleanup) was not included.

The amount of radioactive material in TMI-2 at the completion of defueling will be considerably less than that shown in Table 2.3 because of defueling and cleanup. The majority of the radioactive material that was contained in the reactor vessel is being removed as the reactor vessel is defueled. The gaseous fission products that were released from the fuel to the containment atmosphere during the accident were later purged to the environment. Also, some of the water-soluble fission products that escaped from the reactor coolant system during and after the accident have been removed from the accident-generated water and shipped from the site in resin liners.

(a) Those radionuclides with decay products, which have reached equilibrium or are approaching equilibrium, are listed on the same line in Table 2.3. Radionuclides with extremely short-lived decay products, which have reached equilibrium (such as strontium-90/yttrium-90 or cesium-137/barium-137m), are referred to in the text by using the designation for the parent isotope.

TABLE 2.3. Inventory of Isotopes in the TMI-2 Facility Following the Accident, Decay-Corrected to January 1, 1990 (Assuming No Cleanup)

Radionuclide	Half-life[a]	Calculated Activity, Ci: March 28, 1979	Calculated Activity, Ci: January 1, 1990[b]
Tritium	12.3 y	8,800	4,800
Carbon-14	5,726 y	16	16
Manganese-54	312 d	26,000	4.3
Iron-55	2.68 y	103,000	6,500
Cobalt-60	5.27 y	98,000	24,000
Nickel-63	100 y	6,000	5,600
Selenium-79	65,000 y	3.3	3.3
Krypton-85	10.7 y	94,000	47,000
Strontium-90/Yttrium-90	28.8 y/2.7 d	750,000/760,000	580,000/580,000
Zirconium-93/Niobium-93m	1,500,000 y/13.6 y	16/0.15	16/6.8
Technetium-99	214,000 y	110	110
Ruthenium-106/Rhodium-106	368 d/30 s	53,000,000/5,400,000	32,000/32,000
Cadmium-113m	14 y	3.2	1.9
Antimony-125/Tellerium-125m	2.77 y/58 d	150,000/2,100	10,000/2,500
Tin-126/Antimony-126m	100,000 y/19 m	2.3/96	2.3/2.3

TABLE 2.3. (contd)

Radionuclide	Half-life[a]	Calculated Activity, Ci March 28, 1979	Calculated Activity, Ci January 1, 1990[b]
Cesium-134	2.06 y	260,000	7,000
Cesium-135	2,300,000 y	2.2	2.2
Cesium-137/Barium-137m	30.2 y/2.5 m	820,000/760,000	640,000/610,000
Cerium-144/Praseodymium-144m/ Praseodymium-144	284.5 d/7.2 m/17.3 m	24,000,000/-/ 24,000,000	1,600/24/1,600
Promethium-147	2.62 y	2,500,000	150,000
Samarium-151	90 y	18,000	17,000
Europium-152	13.6 y	44	25
Europium-154	8.8 y	7,600	3,300
Europium-155	4.9 y	47,000	10,000
Uranium-234	245,000 y	120	120
Uranium-235/Thorium-231	704,000,000 y/25.5 h	4/4	4/4
Uranium-236	23,400,000 y	3.6	3.6
Uranium-238/Thorium-234/ Protactinium-234m	4.47×10^9 y/24 d/1.17 m	27/27/27	27/27/27

TABLE 2.3. (contd)

Radionuclide	Half-life[a]	Calculated Activity, Ci: March 28, 1979	Calculated Activity, Ci: January 1, 1990[b]
Plutonium-238	87.7 y	760	700
Plutonium-239	24,100 y	9000	9000
Plutonium-240	6,570 y	2,400	2,400
Plutonium-241/Americium-241/ Uranium-237	14.4 y/432 y/6.75 d	160,000/19/ 13,500,000	95,000/2,200 2.3

(a) s = seconds; m = minutes; d = days; y = years.
(b) The values represent decay-corrected activities on January 1, 1990, assuming no defueling or cleanup effort had taken place.

Models of the transport and deposition of radionuclides released during the accident are being verified for many isotopes (for instance, cesium, strontium, antimony, ruthenium, and cerium) as a result of measurements. However, the mechanisms for and the degree of transport and deposition of all the isotopes present at the time of the accident are still unknown. Therefore, conservative assumptions were made in this report to estimate the maximum quantity and distribution of radioactive material expected to remain in the facility at the end of defueling. The results of this analysis are presented in Table 2.4. This table provides the estimated maximum quantity of each radionuclide assumed to be present after defueling (with the exception of the fraction of activated products assumed to be incorporated into metal material which would not be available for suspension). Table 2.4 also includes a brief description of the most probable location of each radionuclide that remains after defueling. The radionuclides remaining after defueling can be grouped into three major categories: activation products, fission products, and actinides. The assumptions that were used to generate Table 2.4 are described below for the radionuclides in each of the three categories.

2.2.1 Activation Products

Activation products such as carbon-14, manganese-54, iron-55, cobalt-60, and nickel-63 were formed in the reactor core region but outside the fuel by activation of stainless steel and other metal components. In operating reactors, small amounts of these activation products form in a corrosion film on the reactor piping. Additional amounts of these activation products are associated with the metal portions of the core and the reactor internals. It is assumed that, with the possible exception of carbon-14, most of the activation products in the TMI-2 facility are present as solid material removed with the fuel or incorporated into the stainless steel of the reactor vessel, plenum assembly, and remaining internals. However, a small amount would be in the form of particles, which would have been circulated through the reactor coolant system and caught in crevices or traps, or in the form of a corrosion film in the reactor coolant system piping and on the inside of the reactor vessel. For this analysis it is conservatively estimated that, with the exception of carbon-14, 1 percent[a] of the activity for each activation product will remain in the reactor building at the end of defueling with particles

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(a) This estimate is based on (1) cobalt-60 data from a study (Abel et al. 1986) of residual contamination within commercial nuclear power plants measured on piping and hardware, corrosion film scrapings, and concrete cores (the study considered only residual radionuclides transported from the reactor vessel and deposited through associated operating systems), and (2) a letter from M. B. Roche to the NRC, March 27, 1989. Subject: Additional Information on the Post-Defueling Monitored Storage Programmatic Environmental Impact Statement.

TABLE 2.4. Maximum Anticipated Inventory and General Location of Radionuclides at the End of Defueling[a]

Radionuclide	Activity on Site at the End of Defueling, Ci	Location
ACTIVATION PRODUCTS		
Carbon-14	1.0	Dispersed
	0.16	Fuel debris
Manganese-54	0.043	Activated metals in fuel debris or corrosion film on piping
Iron-55	65	Activated metals in fuel debris or corrosion film on piping
Cobalt-60	240	Activated metals in fuel debris or corrosion film on piping
Nickel-63	56	Activated metals in fuel debris or corrosion film on piping
FISSION PRODUCTS		
Gaseous fission products		
Krypton-85	190	Fuel debris
Tritium		
Tritium	1.9	Moisture in piping and concrete
Somewhat soluble fission products		
Selenium-79	0.22	Dispersed
	0.033	Fuel debris
Strontium-90/ Yttrium-90	2,400	Dispersed
	5,700	Fuel debris
Niobium-93m	0.46	Dispersed
	0.068	Fuel debris
Technetium-99	7.4	Dispersed
	1.1	Fuel debris

TABLE 2.4. (contd)

Radionuclide	Activity on Site at the End of Defueling, Ci	Location
Ruthenium-106/ Rhodium-106	160	Dispersed
	320	Fuel debris
Cadmium-113m	0.13	Dispersed
	0.019	Fuel debris
Antimony-125	70	Dispersed
	99	Fuel debris
Tellurium-125m	170	Dispersed
	25	Fuel debris
Tin-126/ Antimony-126m	0.15	Dispersed
	0.023	Fuel debris
Cesium-134	470	Dispersed
	37	Fuel debris
Cesium-135	0.15	Dispersed
	0.012	Fuel debris
Cesium-137/ Barium-137m	43,000	Dispersed
	3,400	Fuel debris
Samarium-151	1,100	Dispersed
	170	Fuel debris
Relatively insoluble fission products		
Zirconium-93	0.16	Fuel debris
Cerium-144/ Praseodymium-144	160	Fuel debris
Praseodymium-144m	0.24	Fuel debris
Promethium-147	1,500	Fuel debris
Europium-152	0.25	Fuel debris
Europium-154	33	Fuel debris
Europium-155	100	Fuel debris

TABLE 2.4. (contd)

Radionuclide	Activity on Site at the End of Defueling, Ci	Location
ACTINIDES		
Uranium-234	1.2	Fuel debris
Uranium-235/ Thorium-231	0.04	Fuel debris
Uranium-236	0.036	Fuel debris
Uranium-237	0.023	Fuel debris
Uranium-238/ Thorium-234/ Protactinium-234m	0.27	Fuel debris
Plutonium-238	7.0	Fuel debris
Plutonium-239	90	Fuel debris
Plutonium-240	24	Fuel debris
Plutonium-241	950	Fuel debris
Americium-241	22	Fuel debris

(a) The end of defueling (removal of more than 99 percent of the fuel) was assumed to occur January 1, 1990, for the purpose of estimating radioactive decay.

located in the reactor coolant system or as a corrosion film in the piping or vessel internals. The other 99 percent is assumed to have been removed during the defueling process or to be incorporated in the stainless steel composing the reactor coolant system, reactor vessel, plenum assembly, and internals; it is, therefore, inaccessible. Carbon-14, however, is soluble in some chemical forms; thus, for the purpose of this report, carbon-14 is considered along with the somewhat soluble fission products in Section 2.2.2.3.

2.2.2 Fission Products

Fission products were formed within the fuel elements by the nuclear fission of uranium-235 as the reactor operated. The transport and deposition of the fission products were dependent on the chemical and physical state of the radionuclide (e.g., whether soluble or insoluble material or gas). Fission products were considered in groups based on their chemical and physical properties. Where definitive information on the chemical state of a fission product was lacking, assumptions were made regarding the transport and deposition of the fission product. These assumptions were based on the information available from fuel measurements and contamination measurements throughout the reactor building, as well as on the physical state of the radionuclide. In this section, fission products are discussed in the following order: (1) gaseous fission products (krypton-85), (2) tritium, (3) somewhat soluble fission products (selenium-79, strontium-90, niobium-93m, technetium-99,[a] ruthenium-106, cadmium-113m, antimony-125, tellurium-125m, tin-126, cesium-134, cesium-135, cesium-137, and samarium-151), and (4) relatively insoluble fission products (zirconium-93, cerium-144, praseodymium-144m, promethium-147, europium-152, europium-154, and europium-155).

2.2.2.1 Gaseous Fission Products

The noble gas krypton-85 is formed by the fission process. In an undamaged reactor, krypton-85 remains in the fuel rods. During the accident 60 percent of the krypton-85 was released. It is expected that the remainder of the krypton-85 would have remained in association with the intact residual fuel rods. Effluent measurements indicate that small amounts of krypton-85 are being released as fuel removal operations are proceeding. Because less than 1 percent of the fuel will remain following defueling, it is conservatively estimated that 1 percent of the 40 percent of the krypton that was not released immediately following the accident will remain following completion of defueling.

2.2.2.2 Tritium

More than 90 percent of the tritium in a pressurized water reactor is produced within the reactor fuel by ternary fission of uranium. As a result of the accident, some of the tritium in the fuel was released to the containment atmosphere and subsequently vented to the environment as either tritium gas or water vapor. The remaining tritium became incorporated in the accident-generated water (as discussed in Supplement 2 to the PEIS) or was retained in the intact fuel rods. Disposal of the accident-generated water from the facility and completion of the current defueling effort will result in the removal of essentially all the remaining tritium. The environmental impacts of the disposal of the accident-generated water were evaluated in Supplement 2 and are not considered further in this document. The

(a) Some technetium-99 and antimony-125 may be present as activation products in metal components containing molybdenum or tin, respectively.

amount of tritium expected to be present in any remaining moisture inside the reactor building, AFHB, and tanks will be small. Conservative assumptions were made regarding the amount of tritium in the water that could be absorbed into the concrete walls and floors, and an estimate was made that 1.9 curies of tritium would be present in the reactor building following removal of the accident-generated water.[a] Additional small amounts could remain inside the reactor coolant system piping after the piping is drained.

2.2.2.3 Somewhat Soluble Fission Products

Fission products that are assumed to be at least partially soluble in water include selenium-79, strontium-90, niobium-93m, technetium-99, ruthenium-106, cadmium-113m, antimony-125, tellurium-125m, tin-126, cesium-134, cesium-135, cesium-137, and samarium-151. In addition, the activation product carbon-14, which is soluble in some chemical forms, is included in this discussion. The degree of solubility varies among the isotopes listed and depends on the chemical form of the isotope. Because these isotopes are known to exist as water soluble compounds in some circumstances, they were assumed to have been distributed in various degrees throughout the reactor building and the AFHB during the accident. Measurements have been made to estimate the amount of cesium-137 and strontium-90 present in various portions of the reactor building and the AFHB. Assumptions, listed below, were made regarding the distribution of the other somewhat soluble fission products.

Strontium-90 and cesium-137 concentrations have been determined by measurements, and samples have been taken throughout the two buildings. The measurements indicate that the major portion of the strontium-90 and cesium-137 in the reactor building (with the exception of the amount contained in the fuel) is located in the D-rings and in the concrete block wall surrounding the enclosed stairwell and elevator shaft in the reactor building basement. Table 2.5 lists the quantity of cesium-137 and strontium-90 estimated to be present in the D-rings and the basement of the reactor building. The sources of information for these estimates are indicated in the footnotes of the table. The data in the table reflect the efforts that have been made to leach radioactivity from the concrete block wall (see Section 2.1.1).

The licensee has conservatively estimated that the upper elevations of the reactor building (the 305-foot level and above, excluding the area below the 349-foot level of the D-rings) contain 5.6 curies of mixed isotopes loosely distributed. This quantity is negligible compared with the amount assumed to be present in the reactor

(a) Letter from M. B. Roche to the NRC, March 27, 1989. Subject: Additional Information on the Post-Defueling Monitored Storage Programmatic Environmental Impact Statement.

TABLE 2.5. Estimated Quantity of Cesium-137 and Strontium-90

Location	Cesium-137, Ci	Strontium-90, Ci
Concrete block wall	19,000[a]	910[b]
Sludge on basement floor	350[c]	400[c]
D-rings	17,000[c]	830[c]
Floors/walls/overhead structures	7,000[c]	300[c]
Total	43,350	2,440

(a) An estimated 20,000 curies of cesium-137 is present in the concrete block wall (GPU 1988). However, since this estimate was made, approximately 7 percent of the activity in the concrete block wall has been leached from the structure, leaving an estimated 19,000 curies.
(b) 21:1 ratio (based on leach rate tests [ANS 1988]) was applied to the cesium-137 curie estimate before leaching (20,000 curies) and a conservative 43 curies of strontium-90 (GPU. September 26, 1988. "Evaluation of Block Wall Leaching, 13 June - 17 August 1988." TB-88-11, Rev. 0, TMI-2 Technical Bulletin.) was assumed to have been removed during leaching of the concrete block wall.
(c) GPU 1988.

building. Although additional activity would be present on the leadscrews, the plenum, etc., such activity is largely incorporated into the metal parts in the form of activated metals and is not easily removed. At the completion of the current defueling effort, the amount of removable surface contamination in the AFHB (based on current measurement data) will be less than 1 curie of mixed isotopes. The amount of contamination remaining in the AFHB will thus be negligible in comparison to the amount present in the reactor building.

A ratio of 1:91 is used to estimate the amount of cesium-134 compared with cesium-137. This ratio assumes that the two isotopes are distributed similarly and is based on the ratio of cesium-134 to cesium-137 shown in Table 2.3 for January 1, 1989. Likewise, a ratio of 1:290,000 was used to estimate the amount of cesium-135 compared with cesium-137. Using the estimate of 43,350 curies of cesium-137 in the reactor building, the amounts of cesium-134 and cesium-135 estimated to be present in the reactor building are 470 curies of cesium-134 and 0.15 curie of cesium-135. It is assumed that their distribution is the same as that shown for cesium-137 in Table 2.5: 44 percent in the concrete block wall; 39 percent in the D-rings; 16 percent in the floor, concrete slab walls, and overhead structures in the basement; and 1 percent in the sludge on the floor of the basement.

Of the remaining isotopes assumed to be somewhat soluble, not all have been detected. However, analyses of water, sediment, and concrete in the reactor building basement indicate that 0.7 percent of the original core inventory of antimony-125 and 0.5 percent of the original core inventory of ruthenium-106 have been dispersed in the basement. It is possible that some of the other isotopes were dissolved in the water and were distributed within the building, only in smaller quantities than the cesium and strontium isotopes. Based on the estimated 6.7 percent of the cesium-137 distributed in the reactor building (43,350 curies of the 640,000 curies that would have been present on January 1, 1989, had no cleanup occurred), it is conservatively assumed that 6.7 percent of the carbon, selenium, niobium, technetium, cadmium, tellurium, tin, and samarium isotopes is distributed throughout the reactor building and AFHB. This estimate is considered conservative because the chemical forms of these isotopes are generally less soluble than cesium. It is further assumed that the distribution of these isotopes (including ruthenium and antimony) is similar to that of cesium-137, with 44 percent of the activity that is distributed in the reactor building located in the enclosed stairwell/elevator structure; 39 percent in the D-rings; 16 percent in the floor, concrete slab walls, and overhead structures; and the remaining 1 percent in the sludge on the basement floor.

In addition to being distributed within the building by being carried by the water, a fraction of the somewhat soluble isotopes is assumed to have remained in association with the fuel. Although the majority of the fuel will be removed during defueling, a fraction of the debris that was distributed throughout the reactor coolant system and in the reactor building basement will remain. The licensee has indicated that more than 99 percent of the fuel will have been removed from the facility by the end of defueling. According to Table 2.2, current estimates indicate that 1320 pounds (600 kilograms) of fuel debris will remain in the facility after defueling. The mass of uranium oxide originally in the reactor vessel is estimated to be 207,000 pounds (94,000 kilograms). Therefore, current estimates indicate approximately 0.6 percent of the fuel will remain. However, for the purposes of this analysis, a residual fuel inventory of 1 percent of the original mass of uranium oxide was assumed, which would correspond to 2070 pounds (940 kilograms). The fuel distribution is assumed to be similar (on a percent basis) to that shown in Table 2.2.

Isotopes that were somewhat soluble were probably leached to some extent from the fuel debris; the fraction leached would have varied with the solubility of the isotope. Based on measurements of fuel from the reactor vessel, it is assumed that 53 percent of the cesium originally present in 2070 pounds (940 kilograms) of residual fuel would have remained with the fuel debris, as well as 99.5 percent of the ruthenium, 99.3 percent of the antimony, and 98 percent of the strontium. To be conservative, it is assumed that close to 100 percent of the remaining somewhat soluble fission products (carbon, selenium, niobium, technetium, cadmium, tellurium, tin, and samarium) that would have originally been present in 2070 pounds (940 kilograms) of fuel would have remained with the fuel debris.

2.2.2.4 Relatively Insoluble Fission Products

The remaining fission products (zirconium-93, cerium-144, praseodymium-144m, promethium-147, europium-152, europium-154, and europium-155), which are considered highly insoluble, are assumed to remain totally in association with the fuel. Analyses of removed fuel tend to confirm this assumption. These isotopes would be removed almost completely by defueling, except for the small amounts distributed with the fuel particles through the reactor coolant system. The estimated number of curies for these isotopes is based on the percentage of the fuel (less than 1 percent) expected to remain in the facility after defueling.

2.2.3 Actinides

The actinides include uranium isotopes (uranium-234, uranium-235, uranium-236, uranium-237, and uranium-238), uranium decay products (thorium-231, thorium-234, protactinium-234m), and transuranics formed by neutron capture (plutonium-238, plutonium-239, plutonium-240, plutonium-241, and americium-241). These isotopes, like the insoluble fission products, are expected to remain in close association with the fuel. Radiochemical analysis of removed fuel tends to confirm the close association of these isotopes with the fuel. Small quantities of these isotopes were distributed with the fuel particles throughout the reactor coolant system. The estimated activity of each radionuclide remaining in the facility is based on the percentage of fuel (less than 1 percent) assumed to remain in the facility after defueling.

2.3 REGULATORY AND ADMINISTRATIVE CONSIDERATIONS

Cleanup of TMI-2, including any storage and disposal of waste, must be carried out in accordance with applicable Federal and State laws, regulations, and permits as discussed in the following sections.

2.3.1 U.S. Environmental Protection Agency Regulations

The U.S. Environmental Protection Agency (EPA) has the responsibility and authority to set standards for the release of radionuclides to the environment to protect the public from radioactivity. The EPA also has the authority to regulate the handling, storage, and disposal of hazardous nonradioactive materials. These authorities arise from various Federal laws and executive orders, including the Atomic Energy Act, the Clean Water Act, the Safe Drinking Water Act, the Resource Conservation and Recovery Act (RCRA), and the Clean Air Act.

Any release of radioactivity to the atmosphere or to any body of water must meet EPA's environmental standards for the uranium fuel cycle in 40 CFR 190, which require that "the annual dose equivalent does not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ of the body as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations" (CFR 1988b).

Any release of radioactivity to water of the United States, including the Susquehanna River, must meet EPA's National Interim Primary Drinking Water Standards in 40 CFR 141 that limit beta particle and photon radioactivity from manmade radionuclides in community water systems to that level which ". . . shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year" (CFR 1988b). This standard applies to concentrations at community water intakes downstream of the discharge point.

Wastes from cleanup of the reactor are not expected to meet the definition of hazardous waste requiring regulation under RCRA. Hazardous wastes are regulated by the EPA under 40 CFR 260-271 (CFR 1988b).

2.3.2 U.S. Nuclear Regulatory Commission Regulations

The NRC regulations in 10 CFR 20, "Standards for Protection Against Radiation," (CFR 1988a) apply to cleanup activities associated with the TMI-2 accident. These regulations specify allowable discharge concentrations of radioactivity in effluents to air and water in unrestricted areas. Maximum permissible concentrations (MPCs) for isotopes present in the TMI-2 facility are presented in Appendix C of this supplement to the PEIS.

The NRC regulations in 10 CFR 50, Appendix I (CFR 1988a) provide numerical guides for design objectives and limiting conditions for operation of light-water nuclear power reactors such that radioactive material in effluents released from these facilities to unrestricted areas be kept as low as is reasonably achievable. Conforming to the guidelines of this section of the NRC regulations is deemed a conclusive showing of compliance with the "as low as is reasonably achievable" requirements.

The NRC regulations in 10 CFR 71, "Packaging and Transportation of Radioactive Material," (CFR 1988a) apply to the packaging and shipment of radioactive wastes. Packaging and related requirements depend on radionuclide content. U.S. Department of Transportation (DOT) regulations in 49 CFR 171-179 (CFR 1988c) also apply to the packaging, marking and labeling, placarding, monitoring, accident reporting, and documenting of radioactive shipments.

Also, NRC regulations in 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," (CFR 1988a) apply to the disposal of cleanup wastes in a licensed LLW disposal site. Although these regulations pertain to the licensing, operation, and closing of a low-level commercial waste burial ground, they also contain specifications for the packaging, content, and characteristics of acceptable LLW. Low-level radioactive wastes are classified as Classes A, B, C, or unacceptable for near-surface disposal, depending on radioactive material content and concentration (see Appendix F) and on characteristics other than radioactivity.

The NRC regulates the storage of LLW at licensee sites. Because of waste volume limitations of the Low Level Waste Policy Act and its amendments (see Section 2.3.5 for a discussion of these acts), many sites have made provisions for storing LLW for periods beyond those normally required by operational considerations. The NRC has permitted this within carefully controlled limits, but has clarified its policy in Generic Letter 85-14,[a] which states: "It is the policy of the NRC that licensees should continue to ship waste for disposal at existing sites to the maximum extent practicable."

2.3.3 U.S. Nuclear Regulatory Commission Licensing Activities Affecting TMI-2

In May 1988, the Commission issued a license amendment that extensively revised the TMI-2 technical specifications, aligning licensing requirements with appropriate current, as well as future, plant conditions through the remainder of the current cleanup activities. The amendment allowed for the transition from the current defueling phase through the completion of defueling and offsite fuel shipment by adopting technical specifications that are applicable during specific phases or modes of the cleanup. Three distinct facility modes have been defined that correspond to the projected plant conditions as the facility cleanup progresses. By definition, Mode 1 represents the current period, during which defueling and other major tasks are in progress. The transition to Mode 2 will occur when as much fuel as is practicable has been removed from the reactor vessel and reactor coolant system components, the possibility of criticality in the reactor building is precluded, and no defueling canisters containing core material remain in the reactor building. The transition to Mode 3 will occur following the shipment of all canisters containing core material to an offsite location. Sixty days before an anticipated mode change, the licensee will submit a report providing the basis for the mode change to the NRC staff for review.

(a) A letter to all reactor licensees from the NRC, August 1, 1985. Subject: Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility.

In 1987, the licensee submitted a request for a license amendment that allows a post-defueling monitored storage (PDMS) period beginning when offsite waste shipments have been completed (Mode 3) and continuing for an unspecified period of time, quite likely until TMI-1 is ready for decommissioning. The licensee then likely will decommission both TMI-2 and TMI-1 simultaneously following the end of TMI-1 operation. NRC staff approval of PDMS would require publication of Final Supplement 3 to the PEIS, a safety evaluation report that reviews the licensee's August 1988 PDMS safety analysis report (GPU 1988), and issuance of a license amendment that permits PDMS. The licensee's safety analysis report provides a system-by-system review of the facility during the proposed storage period. The safety analysis report is currently being reviewed by the NRC and its contractors, and a safety evaluation report is being prepared to determine if PDMS will fall within the envelope of the impacts presented in the PEIS as supplemented. The NRC staff's safety evaluation in conjunction with Supplement 3 to the PEIS would form the basis for the license amendments authorizing PDMS.

2.3.4 U.S. Nuclear Regulatory Commission Decommissioning Regulations

Although it is not within the scope of this supplement to evaluate decommissioning of the TMI-2 facility, ultimately the facility will need to be decommissioned. On June 27, 1988, the Commission issued a final rule on decommissioning, which became effective on July 27, 1988 (53 FR 24018). The amended regulations set forth technical and financial criteria for decommissioning licensed nuclear facilities. The amended regulations address decommissioning, planning needs, timing, funding methods, and environmental review requirements.

The Commission's final rule on decommissioning specifically addresses three decommissioning alternatives: DECON, SAFSTOR, and ENTOMB (53 FR 24018).

DECON is the decommissioning alternative in which equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations.

SAFSTOR is the decommissioning alternative in which the nuclear facility is placed and maintained in such condition that it can be safely stored, monitored, and subsequently decontaminated (deferred decommissioning) to levels that permit release for unrestricted use. Benefits include a reduction in occupational exposure and possibly in waste volume. The licensee's proposal of a PDMS period is analogous in many ways to the safe storage period of the SAFSTOR decommissioning alternative.

ENTOMB is the decommissioning alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting release for unrestricted use of the property. TMI-2 is not likely to be a candidate for ENTOMB because it is likely that there would still be sufficient radioactive material (particularly long-lived radioisotopes including transuranics) that even after a period of 100 years unrestricted access would not be permitted.

The final decommissioning rule also indicates that continuing authority to possess a reactor in a decommissioned status is governed by the provisions of 10 CFR 50 "Domestic Licensing of Production and Utilization Facilities" (CFR 1988a) governing operating licenses, as appropriate. Requirements for limits on both occupational and offsite exposure are contained in 10 CFR 20 "Standards for Protection Against Radiation" (CFR 1998a).

The new decommissioning rule requires that the license holders of commercial nuclear power reactors submit a plan on or before July 26, 1990, to ensure that funds will be available to decommission the facility. This decommissioning funding plan is to specifically address the financial aspects of decommissioning. Financial assurance is to be provided by prepayment, an external sinking fund (into which deposits are made at least annually), or surety, insurance, or other guarantee method. Prepayment may be in the form of deposits of cash or liquid assets sufficient to pay decommissioning costs, in an account segregated from the licensee's assets and outside the licensee's administrative control. It may also be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. An external sinking fund is a fund established and maintained by setting funds aside periodically in an account segregated from licensee assets and outside the licensee's administrative control, in which the total amount of funds would be sufficient to pay decommissioning costs. An external sinking fund may also be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The surety or insurance method would guarantee that decommissioning costs will be paid should the licensee default. A surety method may be in the form of a surety bond, letter of credit, or line of credit. Any surety or insurance method used to provide financial assurance for decommissioning must meet specific conditions; for example, it must be payable to a trust established for decommissioning costs, and it must remain in effect until the license has been terminated.

On August 5, 1988, the licensee in a letter to the NRC[a] stated their plans to include in their decommissioning funding plan the funding for all activities involved in decommissioning TMI-2, starting

(a) See Comment Letter 28 in Appendix A.

from the PDMS condition. The NRC staff views this as a commitment by the licensee to provide a plan that outlines the activities involved in decommissioning the plant starting from the PDMS condition, as well as a funding plan that accounts for the funding of these activities during the decommissioning process. The NRC staff expects the licensee's funding estimate to be significantly in excess of the minimum amount required by the decommissioning rule.

The new decommissioning rule indicates that a preliminary decommissioning plan containing a cost estimate for decommissioning and an up-to-date assessment of the major technical factors that could affect planning for decommissioning must be submitted at or about 5 years before the projected end of operation. The licensee has formally indicated that the facility will be placed in storage until Unit 1 ceases operation at which time the facility will be decommissioned. Unless an earlier decision to decommission is made or the Unit 2 license is extended, a preliminary decommissioning plan would be required 5 years before the Unit 2 license expiration date and a decommissioning plan 4 years later. In addition, the decommissioning rule requires that an application to decommission a facility must be submitted within 2 years following the decision by the licensee to permanently cease operations. The application for the termination of the license must be accompanied or preceded by a proposed decommissioning plan. The rule requires that the proposed decommissioning plan include (1) the choice of the alternative for decommissioning with a description of the activities involved; (2) a description of controls and limits on procedures and equipment to protect occupational and public health and safety; (3) a description of the planned final radiation survey; (4) an updated cost estimate, a comparison of that estimate with the then-current funds set aside for decommissioning, and a plan for assuring the availability of adequate funds for completion of decommissioning; and (5) a description of technical specifications, quality assurance provisions, and physical security plan provisions in place during decommissioning.

With its application for a license amendment to authorize decommissioning, the licensee would also be required to submit a document entitled "Supplement to Applicant's Environmental Report - Post Operating License Stage." This document would update the "Applicant's Environmental Report - Operating License Stage" to reflect any new information or significant environmental change associated with the proposed decommissioning activities.

2.3.5 Low-Level Radioactive Waste Policy Amendments Act of 1985

The Low-Level Radioactive Waste Policy Amendments Act of 1985, H.R. 1083-Public Law 99-240, effectively limits the quantity of low-level radioactive waste that the licensee can dispose of without petitioning the U.S. Secretary of Energy for additional waste disposal capacity. The licensee already has received one such emergency allocation for waste that will result from the proposed disposal of the accident-generated water. Immediate cleanup without PDMS could require additional emergency allocations.

Another provision of the act requires that States, either alone or in regional compacts, develop regional low-level radioactive waste disposal facilities by December 31, 1992. Accordingly, the Commonwealth of Pennsylvania has entered into a regional compact, which has been ratified by Congress. No site for the LLW disposal facility has been selected although it has been indicated that the facility will be located in Pennsylvania. It is assumed for the purpose of this document that waste generated before 2001 would be shipped to an existing disposal facility. For the purpose of bounding the impact of LLW disposal, a facility near Richland, Washington, was assumed. For waste generated after 2001, a generic site 250 miles (400 kilometers) from TMI was assumed. This distance approximately corresponds to the distance between TMI-2 and the most extreme border of Pennsylvania. The lack of a specific site for the disposal facility does not hamper this environmental analysis because only the environmental impact of transportation to the site is addressed here. The impact of disposal at the site would be the subject of a separate analysis connected with licensing the site.

2.3.6 Permits

The licensee holds a National Pollutant Discharge Elimination System (NPDES) permit, issued by Commonwealth of Pennsylvania, Department of Environmental Resources (PaDER), on September 16, 1986. It covers discharge of nonradioactive pollutants into the Susquehanna River. Any deliberate discharge of water into the Susquehanna River must comply with the provisions of the permit. The NPDES permit limits pH, free chlorine, and heat, and requires monitoring of several other parameters at the primary outfall. Suspended solids, oil, and grease are also limited at other outfalls.

3.0 LICENSEE'S PROPOSAL FOR DELAYED DECOMMISSIONING AND NRC STAFF-IDENTIFIED ALTERNATIVES

This section evaluates the licensee's proposal and Nuclear Regulatory Commission (NRC) staff-identified alternatives. The licensee has proposed to place the TMI-2 facility in post-defueling monitored storage (PDMS) for a period of time following current efforts to remove the damaged fuel. The duration of the storage period has not been specified by the licensee; however, the licensee has indicated that the likely disposition of the facility following the storage period would be decommissioning at the time Unit 1 is decommissioned. The NRC staff has evaluated (as a likely option) a storage period lasting until TMI-1 is ready for decommissioning (estimated by the NRC staff to be 23 years, corresponding to the likely expiration date of the Unit-1 operating license). At the end of the 23-year period, a short period of time (estimated by the NRC staff to be less than 1 year) would be necessary for any decommissioning preparations. This proposal of a storage period followed by decommissioning preparations is referred to as "delayed decommissioning" in this document. In addition to the proposed 23-year storage period, the impacts of varying storage periods (from less than 17 years to 33 years) are evaluated as part of the delayed decommissioning proposal. This report evaluates only the period of time up to the initiation of decommissioning. The impacts of decommissioning would be the subject of a separate analysis.

There are seven alternatives to the licensee's proposal, as identified by the NRC staff. Table 3.1 contains a comparison of the major features of the licensee's proposal for delayed decommissioning and the alternatives identified by the NRC staff.

The first alternative, "delayed cleanup," incorporates a storage period of 23 years. However, this alternative differs from delayed decommissioning in that at the end of the 23-year storage period, the cleanup would be completed to the point that conditions in the TMI-2 facility would be similar to those in an undamaged reactor facility nearing the end of its operating life. The facility would then be decommissioned or refurbished following the completion of the cleanup, however, the impacts of decommissioning or refurbishment are not evaluated in this supplement. The impacts of varying storage periods (from less than 17 years to 33 years) were evaluated as part of the delayed cleanup alternative.

The second alternative, "immediate cleanup," is the continuation and completion of the cleanup at the 1983 to 1987 level of effort after a 2-year period for engineering and planning studies. Following immediate cleanup, the facility would be either decommissioned or refurbished; the impacts of decommissioning or refurbishment are not evaluated in this supplement.

TABLE 3.1. Comparison of the Licensee's Proposal and the Seven NRC Staff-Identified Alternatives

	Removal of 99 Percent of Fuel	Additional Cleanup Before Storage	PDMS Preparation	Length of Storage, years	Alternate Lengths of Storage, years	Additional Cleanup, years	Achieve PEIS Definition for Completion of Cleanup	Decommissioning Preparation Period, years	Post-PDMS Disposition
Licensee's Proposal									
Delayed Decommissioning	Yes	No	Yes	23	<17 to 33	None	No	≤1	Decommission
Staff-Identified Alternatives									
Delayed Cleanup	Yes	No	Yes	23	<17 to 33	4	Yes	None	Decommission or refurbish
Immediate Cleanup	Yes	No	No	2 (engineering study)	None	3 to 4	Yes	None	Decommission or refurbish
Immediate Cleanup/ Reduced Effort	Yes	No	No	None	None	7 to 10	Yes	None	Decommission or refurbish
Immediate Decommissioning	Yes	No	No	None	None	None	No	≤2	Decommission
Incomplete Defueling	No (85%)	No	Yes	23	None	None	No	≤1	Decommission
Additional Cleanup Before Storage	Yes	Yes	Yes	23	None	2 to 3	Yes	None	Decommission or refurbish
No-Action Alternative									
No Further Cleanup Following Defueling	Yes	No	No	Indefinite	None	None	No	None	Continued, indefinite storage

The third alternative, "immediate cleanup with a reduced level of effort" (immediate cleanup/reduced effort), is similar to the immediate cleanup alternative, except that the cleanup would continue at a reduced level of effort from the end of defueling for a total length of 7 to 10 years. Following completion of the cleanup, the facility would be either decommissioned or refurbished; the impacts of decommissioning or refurbishment are not evaluated in this supplement.

The fourth alternative, "immediate decommissioning," does not include a storage period, but instead involves preparations for decommissioning the facility. The preparation period would require approximately 2 years following the completion of defueling. The impacts of decommissioning are not evaluated in this supplement but would be the subject of a separate analysis.

The fifth alternative, incomplete defueling, is identical in schedule to the delayed decommissioning proposal, with a 23-year period of storage and a 1-year period of decommissioning preparations; however, it is assumed that only 85 percent of the fuel would be removed before the facility was placed into PDMS.[a]

The sixth alternative, "additional cleanup before storage," is similar to delayed cleanup except that some additional decontamination would be performed before PDMS. The remaining cleanup would be completed following the storage period. Following cleanup, the facility would be either decommissioned or refurbished, although the impacts of decommissioning or refurbishment are not evaluated in this supplement. Because this alternative is actually a combination of the immediate cleanup or immediate cleanup/reduced effort alternative and the delayed cleanup alternative, it is discussed, but not quantitatively evaluated.

The seventh alternative, "no further cleanup following defueling" (the "no-action" alternative, which is required by the National Environmental Policy Act [NEPA] of 1969 to be considered as part of all environmental impact statements) was also considered, but was not evaluated quantitatively. This alternative involves the completion of defueling, but no further efforts to complete the decontamination of the facility or to prepare the facility for storage or for decommissioning. The facility would be left indefinitely in the post-defueling condition.

(a) This alternative was evaluated before the licensee had removed greater than 85 percent of the fuel. Although the NRC staff recognizes that the licensee has removed greater than 85 percent of the fuel, the analysis of this alternative still serves as a bounding case.

Although it may be convenient to adopt common starting points and endpoints in comparing alternatives, the alternatives considered in this supplement do not all begin with common plant conditions, continue for an equal period of time, or end with the same set of plant conditions. For instance, the alternative of incomplete defueling assumes only 85 percent of the fuel has been removed, whereas the licensee's proposal and the remaining staff-identified alternatives assume 99 percent of the fuel has been removed. Also, the endpoint for delayed decommissioning (the licensee's proposal), immediate decommissioning, and incomplete defueling would result in limited additional area and equipment decontamination before the facility was decommissioned; the remaining cleanup to allow unrestricted access to the facility, would occur during decommissioning activities. By comparison, delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, and additional cleanup before storage would result in (1) building and equipment decontamination to the point where general area dose rates approximate those in an undamaged reactor facility nearing the end of its operating life, (2) fuel removal and decontamination of the reactor coolant system, (3) treatment of radioactive liquid wastes, and (4) packaging of radioactive wastes and shipment of the wastes to an offsite disposal facility. Because the no-action alternative does not involve any type of continued action, no endpoint is postulated.

Although comparison of alternatives that do not have common starting points and endpoints is difficult, the staff finds that the selection of realistic alternatives is appropriate.

Four activities are expected to be performed before the start of each of the alternatives and concurrent with the removal of fuel: (1) decontaminating building and equipment surfaces to levels approximating the licensee's established goals (listed in Table 3.2), (2) packaging and disposing of radioactive wastes associated with decontamination activities, (3) removing the accident-generated water from the reactor building and the auxiliary and fuel-handling building (AFHB), and (4) quantifying the residual fuel left in the reactor coolant system and the reactor building following the current defueling efforts. Although it is possible that some of these activities may be continued through the initial years of each of the alternatives, as discussed later, the environmental impacts of these activities as well as those associated with the disposal of the accident-generated water have been evaluated in the PEIS and previous supplements (NRC 1981, 1984, and 1987) and will not be reevaluated in this document.

The licensee's proposal for delayed decommissioning and the five quantitatively evaluated staff-identified alternatives (delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, immediate decommissioning, and incomplete defueling) are evaluated in Sections 3.1 through 3.6. The evaluations include descriptions of the alternatives and the assessment of the potential environmental

TABLE 3.2. Licensee's Radiological Goals for the TMI-2 Facility at the End of Defueling[a]

Area	General Area Exposure Rate, mR/h
Reactor Building[b]	
Refueling canal	<15
Elevation 347 foot and above (except D-ring and NW-seal table)	<30
Elevation 347 foot and above	
D-ring	<70
NW-seal table	<70
Elevation 305 to 347 foot	<70
Basement (elevation 282 to 305 foot)	<35,000[c]
Auxiliary and Fuel-Handling Building[b]	
Corridors	<2.5
Other areas	<50
Other Buildings	
Turbine building	<2.5
Chemical cleaning building (except EPICOR II pump area to be left operable)	<2.5
Service building containment drain tank area	<2.5

(a) Sources: GPU 1987b; and letter from F. R. Standerfer, GPUN, to the NRC, December 4, 1987. Subject: Post-Defueling Monitored Storage Environmental Evaluation Comment Responses. (4410-87-L-0179/0245P).
(b) The exposure rates given for these buildings refer to the general area and exclude "hot spots" (e.g., the stairwell and elevator shaft in the reactor building basement) and locked high-radiation areas (e.g., seal injection valve room and makeup and purification demineralizer room).
(c) Although the licensee's goal is <35,000 mR/h, the actual conditions in the reactor building basement following the completion of the current scope of the cleanup activities are expected to range from 1 R/h to >100 R/h based on the success (resulting from accessibility and ALARA considerations) of those activities in the various areas of the reactor building basement.

impacts, including radiation exposure to the offsite population from routine and accidental releases, occupational radiation dose, waste management impacts (including transportation impacts), socioeconomic impacts, commitment of resources, and regulatory considerations. The alternatives of additional cleanup before storage and no further cleanup following defueling (the no-action alternative) are discussed in Section 3.7, although the impacts are not quantitatively evaluated.

Activities that would occur during decommissioning or refurbishing of the facility are not discussed in this supplement. These activities would be the subject of a separate regulatory action by the NRC, as specified in the decommissioning rule and discussed in Section 2.3.4.

3.1 DELAYED DECOMMISSIONING (POST-DEFUELING MONITORED STORAGE FOLLOWED BY PREPARATIONS FOR DECOMMISSIONING)

Delayed decommissioning, as proposed by the licensee, is described in Section 3.1.1. The offsite dose evaluation is discussed in Section 3.1.2, the occupational dose estimates in Section 3.1.3, the waste management impacts including those from transportation in Section 3.1.4, the socioeconomic impacts in Section 3.1.5, commitment of resources in Section 3.1.6, and regulatory considerations in Section 3.1.7.

3.1.1 Description of the Delayed Decommissioning Proposal

Delayed decommissioning involves preparing the facility for storage, maintaining the facility in monitored storage, and preparing the facility for decommissioning at the end of the storage period. A period of 1 year (beginning in early 1990) was assumed for the preparations for PDMS. The facility would then be placed in PDMS in early 1991. The licensee has not specified the duration of the storage period. However, the licensee has indicated that the likely disposition of the facility following the storage period would be decommissioning at the time Unit 1 is decommissioned. The present Unit-1 license expires on May 18, 2008. NRC regulations, 10 CFR 50.51 (CFR 1988a), allow the licensee to amend their license to continue operation until 2014. Therefore, if PDMS begins in 1991 and the licensee is allowed to amend their license so that it expires in 2014, then the duration of PDMS would be 23 years, the length of time between 1991 and 2014.

A period following PDMS of 1 year or less would be used to prepare the facility for decommissioning. No large-scale cleanup would occur following storage or preceding decommissioning. After the storage period has been completed, the TMI-2 facility would be decommissioned along with the Unit-1 facility; however, the impacts associated with decommissioning are not evaluated in this supplement.

In addition to the 23-year storage period proposed by the licensee, the NRC staff has included in its evaluation, storage periods ranging in duration from less than 17 years to 33 years. A period of less than 17 years assumes the possibility that the licensee would decide to remove the facility from storage and decommission it before the Unit-1 or Unit-2 operating licenses expired. A period of 5 years was used for the analyses in this supplement to bound the impacts associated with a short storage period. A period of 17 years corresponds to the end of the current Unit-1 operating license, May 18, 2008. A period of approximately 19 years corresponds to the end of the Unit-2 license, November 4, 2009. A period of 30 years corresponds to the length of storage assumed in the licensee's PDMS safety analysis report (GPU 1988) for the estimate of occupational dose. Finally, the upper estimate for the storage period of 33 years (until 2024) corresponds to an additional 10-year extension to a 40-year license for Unit 1.

The following sections address the status of TMI-2 systems during PDMS, preparations required for PDMS, the surveillance and maintenance activities occurring during PDMS, and the preparations for decommissioning following the conclusion of PDMS.

3.1.1.1 System Status During PDMS

To maintain TMI-2 in a storage mode, the facilities and systems at TMI-2 would be placed into one of four classifications before PDMS: (1) operable for PDMS support, (2) operable for site support, (3) deactivated and preserved for future use, or (4) deactivated but not preserved.

Systems that would remain operable for PDMS support include the ventilation systems in the reactor building and the AFHB and some parts of the water processing systems and the fire protection system. Some of these systems would be modified to support PDMS. For example, fire detection sensors would be operational throughout the plant except on deactivated equipment; however, the remote monitoring capability for the fire protection system, currently located in the TMI-2 control room, may require relocation.

Service facilities outside the protected area fence that are useful for site support would remain operable. Such facilities include the solid waste handling and packaging facility and the laundry/respirator facility. The environmental monitoring program, including wells and air monitoring stations, would be maintained.[a] Areas within the AFHB that are shared with TMI-1 (e.g., the truck bay) would remain

(a) The environmental monitoring program at TMI is a site program and as such undergoes continuous review and modification in response to changing site and Unit-1 and Unit-2 facility conditions. This process is expected to continue during PDMS.

operable, although an identifiable boundary between TMI-1 and TMI-2 would be established and maintained.

Systems that are expected to have a future value to TMI-2, regardless of its disposition, would be deactivated and preserved (preventive maintenance would be applied to protect and preserve the system components). The only system identified to be preserved for future use following PDMS is the mechanical components of the polar crane.

Systems and equipment that would not be needed during the storage period and that would not be expected to have a further value to the facility would be deactivated; however, no action would be taken to ensure their future availability.

In general, aqueous systems, such as the fuel transfer canal, reactor coolant system, and the submerged demineralizer system (SDS), would be drained. However, yard hose stations for fire protection would be capable of being returned to service for emergency use. Filters and demineralizer resin beds would be removed and disposed of, as practicable. Systems containing residual fuel material, including sections of the reactor coolant system, would be deactivated and sealed as necessary to contain the radioactive material. Noncontaminated systems would be deactivated in a similar manner except that sealing would not be required. Fuel transfer tubes would be sealed to maintain containment integrity. The vessel head would remain at its present shielded storage location. The plenum would be stored dry in the deep end of the fuel transfer canal and shielded to reduce the radiation dose to the surrounding areas. The service structure, defueling platform, and internals indexing fixture would remain in their present locations on the reactor vessel.

3.1.1.2 Preparations for PDMS

Before the start of the PDMS period, the following activities will have occurred or be underway: (1) removal of greater than 99 percent of the fuel, (2) reduction of radiation levels to the licensee's established goals (Table 3.2), (3) packaging and disposing of radioactive waste associated with decontamination activities, (4) quantification of the residual fuel, and (5) removal of water from the reactor coolant systems and spent fuel pools. In addition, specific preparations for PDMS would include planning and engineering, equipment/system deactivation, modification and activation of PDMS support systems, pre-PDMS fire inspections, and pre-PDMS radiation surveys. The final phase of preparation activities would include extensive monitoring to provide a data base to ensure that plant conditions and trends are documented and well understood (GPU 1987b). It is anticipated that the preparation phase will last between 6 months and 1 year.

Several activities that are not considered a part of delayed decommissioning are expected to continue through the preparation phase and possibly after commencement of PDMS. For instance, during the initial stages of PDMS, disposal of the accident-generated water may be occurring. Thus, some storage locations for the water, including the fuel pools in the AFHB, may not have been drained at the time the facility is placed in PDMS. In addition, systems and facilities necessary to support this activity (e.g., the processed water storage tanks) would not be placed in a final storage configuration until possibly after implementation of PDMS. Some decontamination of the accident-generated water support system during the early stages of PDMS would be necessary. In addition, the licensee anticipates that some radioactive wastes that would be generated during the decontamination process may need to be shipped and the disposal of the accident-generated water may need to be completed during the early part of the PDMS period, as well as activities to complete the transfer of records for the fuel debris that was shipped to the Department of Energy. The impacts of processing and disposing of the accident-generated water and the impact of the waste shipments associated with the current decontamination process were evaluated in the PEIS and previous supplements (NRC 1981, 1984, and 1987) and thus they will not be reevaluated in this document.

3.1.1.3 Activities During PDMS

During PDMS, the reactor building and the AFHB would be locked; however, periodic entries would be made to inspect, monitor, and maintain the facility. Additional entries would be made in response to emergencies (e.g., fire). Entries might also be made to acquire additional data and plan the future disposition of the facility.

The reactor building would be maintained at atmospheric pressure. Before each entry, it would be ventilated at a maximum 50,000 cubic feet per minute (1400 cubic meters per minute) to ensure that the building atmosphere meets personnel protection standards for breathing and that radiation doses would be maintained as low as reasonably achievable (ALARA). The ventilated air would be discharged through double-stage high-efficiency particulate air (HEPA) filters, and the discharged air would be monitored. Some passive airflow due to changes in atmospheric pressure (an estimated 10 air exchanges per year in the absence of ventilation) is predicted to occur between active ventilations. Passive airflow would occur through a breather system utilizing a single-stage HEPA filter.[a] Effluents would be monitored by periodically performing an assay of the HEPA filter. Passive airflow in the AFHB would also be expected through the station

(a) Letter from J. J. Byrne, GPU Nuclear, to W. D. Travers, NRC, February 2, 1988. Subject: PDMS Environmental Evaluation Information (4410-88-M-0043).

vent. If necessary, before entries, the AFHB atmosphere would be actively ventilated through HEPA filters.

Inspection and monitoring in both buildings would be performed routinely to identify changes in radiation level, water intrusion, or other off-normal conditions; to verify containment of contamination; and to provide for equipment surveillance as required by the plant's technical specifications. Throughout the storage period, radiological survey results would be collected, reviewed, and evaluated for trends to detect any changes in radiological conditions.

The radiological monitoring would consist of air sampling, loose surface contamination sampling, and radiation dose rate surveys. In addition, thermoluminescent dosimeters would be placed in fixed locations for a period of time and then collected to monitor radiation dose rates. It is anticipated that routine radiological surveys would normally be performed only in areas where radiation levels, contamination levels, and other factors permit routine access. The expected radiological conditions in the reactor building would allow regular personnel access for inspection and maintenance at the 305-foot and the 347-foot elevations. Routine surveys would not normally be performed in areas of high radiation or high contamination, sealed areas, or other normally inaccessible areas unless access were required for some other purpose. Surveys at the boundary of such areas would be performed to ensure containment of contamination.

The licensee's anticipated initial schedule for inspection and monitoring activities within the reactor building and AFHB is shown in Table 3.3. It is expected that an initial program of data acquisition and assessment would be necessary to ensure that plant conditions and trends were documented and well understood. During this time, workers would enter the reactor building and AFHB monthly to perform radiological surveys and visual inspections. Abnormal conditions, although not expected, would be investigated and corrected, and the inspection frequency adjusted as appropriate. The inspection and monitoring frequency would be determined by experience and need. The licensee anticipates that the inspection and monitoring frequency might decrease after the first few years if data accumulated from the inspections and surveys indicate that there were no unexpected or adverse changes in building conditions or radiation levels over long periods of time. In addition, the need for pre-entry ventilation of the reactor building and the AFHB would be evaluated based on the air sampling results.

Maintenance activities would include the calibration and repair of instrumentation required by the plant's technical specifications and the repair of ventilation systems and changing of filters, as necessary. In addition, preventive maintenance of mothballed equipment is anticipated.

TABLE 3.3. Anticipated Initial Schedule for Inspection and Monitoring Activities[a]

Monitoring/Inspection	Frequency	Worker Entry Required
Reactor Building		
Radiological survey Air sampling Surface contamination surveys Dose rate surveys Thermoluminescent dosimeter placement	Monthly	Yes
Visual surveys General conditions	Monthly	Yes
Sump level monitoring[b]	Continuous	No
Fire detection	Continuous	No
Auxiliary and Fuel-Handling Building		
Radiological survey Air sampling Surface contamination surveys Dose rate surveys Thermoluminescent dosimeter placement	Monthly	Yes
Visual surveys General conditions Animal intrusion Housekeeping	Monthly	Yes
Sump level monitoring[b]	Continuous	No
Fire detection	Continuous	No

(a) Source: GPU 1987b.
(b) The continuous sump level monitoring is via an alarm function. Remote level measuring devices are not planned.

No active program of building or equipment decontamination would be necessary during storage unless radiation surveys indicated that contamination had spread. In these cases, it might be necessary to perform decontamination. In addition, some decontamination might be required to support maintenance or inspection activities. Wastes that were generated as a result of PDMS activities would be routinely processed and shipped to an offsite disposal site.

Water-processing capabilities would be available to dispose of rainwater inleakage, groundwater inleakage, and condensation (resulting from high humidity conditions). The licensee indicated that a discharge of 5000 gallons (19,000 liters) annually could be expected during PDMS.[a] This estimate was based on experience and accounted for the reduction in decontamination and defueling activities during PDMS. Water inleakage is not expected to occur in the reactor building, which is designed to contain radionuclides and prevent inleakage under a variety of extreme environmental conditions. Current experience indicates that any inleakage would occur at the building joint between the service building and the air intake tunnel, at the construction joint in the basement of the AFHB, at the electrical penetration in the southwest corner of the control building (281-foot elevation), and at the fire service penetration on the east wall of the turbine building (300-foot elevation). The licensee indicated that inleakage of groundwater and precipitation are anticipated to be the major sources of liquids during PDMS, although some water used for small decontamination jobs can also be expected (GPU 1987b). To the extent that the inleakage becomes contaminated by any residual contamination on floors or in sumps, it would be processed before it was discharged. Decontamination solutions and inleakage would be collected in the auxiliary building sump. Periodically, liquids in the sump that are not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (see Appendix C to this supplement) and the licensee's technical specification limits[b] would be pumped to the auxiliary building sump tank and then to the miscellaneous waste holdup tank, or directly from the sump to the miscellaneous waste holdup tank. When the tank was nearly full, the water would be processed through the EPICOR II system, which will be available during PDMS and is located in the chemical cleaning building. The processed

(a) Letter from F. R. Standerfer to the NRC, March 11, 1987. Subject: Environmental Evaluation for TMI-2 Post-Defueling Monitored Storage (4410-87-L0025).

(b) Appendix B of the Recovery Technical Specifications states that the licensee will maintain releases within 10 CFR 20 limits (CFR 1988a) and "will not exceed a small fraction of the limits." The proposed technical specification change for PDMS indicates that, "The concentration of radioactive material released at any time from the unit to unrestricted areas shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2" (GPU 1988).

water would be sampled and disposed of in accordance with the TMI-2 technical specifications.

The licensee's current environmental monitoring program would continue throughout the storage period. The reactor building atmosphere would be continuously monitored when the ventilation system was running. During those periods when the ventilation system is not running, any discharge through the passive breather vent line would be filtered by a HEPA filter. The HEPA filter would be periodically assayed. The offsite environmental monitoring program would also be continued pursuant to the technical specifications. Groundwater monitoring would be performed quarterly. The licensee's radiological environmental operating plan would be fully operational, undergo continuous review, and be modified if necessary in response to changing site or plant conditions that could affect the environment.

3.1.1.4 Preparations for Decommissioning

Following PDMS, preparations for decommissioning would occur. It is estimated that the preparations for decommissioning would require no more than 1 year. The preparation efforts might include measurements of residual fuel, more encompassing general area radiation measurements than would be performed during PDMS, measurements of surface contamination, measurement of the degradation of systems or components that isolate fuel and contamination, and the cleanup of systems and locations (including any that exhibited movement of contamination or are in areas that might need to be accessible during decommissioning). No large-scale cleanup operations would occur during this period unless it was demonstrated that such a need existed. At the end of the preparation period, the decommissioning process would begin. The impacts associated with additional cleanup (to levels associated with an undamaged reactor facility nearing the end of its operating life) would be considered part of decommissioning. The mode of decommissioning is not yet specified, and the impacts of decommissioning are not evaluated in this document.

3.1.2 Offsite Dose Evaluation for Delayed Decommissioning

The evaluation of radiation dose to the offsite population as a result of the delayed decommissioning alternative includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.1.2.1 Routine Atmospheric Releases

The magnitude and impact of routine atmospheric releases of radioactive material will vary, depending on the stage of the delayed decommissioning. These stages, as described in Section 3.1.1, include preparations for PDMS, PDMS, and preparations for decommissioning.

Table 3.4 shows the 50-year dose commitment[a] to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine atmospheric releases during the three stages of delayed decommissioning. The 50-year dose commitment to the maximally exposed member of the public results from inhalation of air, consumption of food products, and external exposure as a result of the routine atmospheric releases. The maximally exposed individual is assumed to breathe air at the offsite boundary location of highest airborne concentration (0.34 miles [0.55-kilometers] west) and to consume food products raised exclusively in the offsite boundary location that receives the maximum ground deposition of the released radioactive material. The maximally exposed individual is in the age group that receives the highest dose. The collective 50-year dose commitment is also estimated for the populations listed in Table 3.4 that live within the 50-mile (80-kilometer) radius as a result of inhalation of air, consumption of food products, and external exposure. Table 3.4 also shows the dose attributable to TMI-2 received by the population outside the 50-mile (80-kilometer) radius from inhalation, external exposure, and consumption of food products exported from within the 50-mile (80-kilometer) radius. The collective dose to the population and the dose to the maximally exposed individual are calculated for the entire duration of the delayed decommissioning stages under consideration.

The 50-year dose commitment to the maximally exposed member of the public, the collective 50-year dose commitment to the population living within a 50-mile (80-kilometer) radius, and the collective 50-year dose commitment to the population living outside the 50-mile (80-kilometer) radius are given in Table 3.4 for a storage period of 23 years, as well as for storage periods of 5 and 33 years. In addition, the dose commitments are estimated for the 1-year period of decommissioning preparations following a 23-year storage period and the 1-year period following storage periods of 5 and 33 years.

The bases for the dose calculations are given in Appendix E. The specific assumptions that were used during the calculation of the impacts for each of the stages during delayed decommissioning are discussed in the following sections.

Preparations for PDMS. The preparations for PDMS are expected to take place concurrently with the completion of defueling and are not expected to increase the amount of airborne contamination. Thus, the routine releases that would be expected to result from PDMS preparations would not be distinguishable from releases expected during the final stage of defueling or from releases currently occurring, except

(a) The 50-year dose commitment is the total radiation received from the initial exposure through the succeeding 50 years.

TABLE 3.4. 50-Year Dose Commitments from Routine Atmospheric Releases Resulting from Delayed Decommissioning[a]

Stages of Delayed Decommissioning	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2		Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
				Population Size, millions	Dose, person-rem	
PDMS Preparations	1	Bone	0.001	2.5	0.0005	0.0002
		Total body	0.0001		0.0004	0.00004
PDMS	23	Bone	23	2.5 to 3.3	13	1.2
		Total body	1.9		7.8	0.3
	5	Bone	6	2.5 to 2.7	2.4	0.5
		Total body	0.5		1.3	0.2
	33	Bone	30	2.5 to 3.7	19	1.3
		Total body	2.6		11	0.4
Decommissioning Preparations	1, following 23-yr PDMS	Bone	0.01	3.3	0.005	0.0003
		Total body	0.0004		0.0005	0.00001
	1, following 5-yr PDMS	Bone	0.02	2.7	0.006	0.0007
		Total body	0.0005		0.0006	0.00004
	1, following 33-yr PDMS	Bone	0.01	3.7	0.004	<0.00001
		Total body	0.0003		0.0006	<0.000001

(a) Does not include dose associated with decommissioning.

that the amount of tritium and alpha radiation released would be significantly less because the defueling process would be complete and the water would have been drained (or would be in the process of being drained) from the facility. Current releases are shown in Table 3.5 for the period January 1, 1987, to September 30, 1988. Airborne discharges during this period were less than 0.03 percent of the technical specification limits. These release rates and quantities are consistent with results reported for previous calendar quarters.

During PDMS. During PDMS, the reactor building atmosphere would be ventilated through double-stage HEPA filters before each entry, as noted in Section 3.1.1.3. Entries might occur as frequently as once a month. The amount of radioactivity released during ventilation is based on an estimate of the fraction of radioactive material on surfaces in the reactor building that could become suspended in the reactor building atmosphere. Four major sources of potentially suspendible contamination are identified, based on the information presented in Sections 2.1 and 2.2: (1) the enclosed stairwell/elevator structure; (2) the sludge residue on the reactor building basement floor (which may have a greater potential for mobility as it dries during PDMS); (3) the remaining surface contamination on the concrete

TABLE 3.5. Average Annual Airborne Discharges Based on Releases During the Period January 1, 1987, to September 30, 1988[a]

Radionuclide	Average Annual Activity Released, Ci
Tritium	25.0
Gross alpha	0.00000008
Unidentified beta/gamma radiation	0.000049
Cesium-137	0.000016
Cesium-134	0.0000004

(a) The average annual airborne discharge was determined by averaging releases from seven quarterly reports (January 1, 1987, to September 30, 1988) and multiplying by four. Quarterly release information was obtained from; letters from F. R. Standerfer to the NRC "Semi-Annual Radioactive Effluent Release Report," August 28, 1987 (4410-87-L-0132); February 29, 1988 (4410-88-L-0027); August 29, 1988 (4410-88-L-0142) and letter from F. R. Standerfer to the NRC, November 29, 1988, Subject: Quarterly Dose Assessment Report Update - Third Quarter 1988 (4410-88-L-0184).

slab walls, equipment, overhead structures, etc.; and (4) the surface contamination on the walls and the equipment located in the D-rings.

The staff conservatively assumed that a fraction of the radionuclides absorbed within the stairwell/elevator structure would migrate to the surface of the concrete block as the structure dried. Studies indicate that cesium migrates to some extent as cement-based solids dry (Arora and Dayal 1986). To conservatively bound this phenomenon, one-eighth (approximately 13 percent) of all radioactive material in the structure was assumed to be available for suspension.[a] Although studies with strontium (Arora and Dayal 1986) indicate that it does not migrate as easily as cesium, it is conservatively assumed that one-eighth of the strontium-90 and all other isotopes assumed to have been dispersed through the reactor building and present in the concrete block migrate near to the surface and are available for suspension in the reactor building atmosphere.

Because the suspension of radioactive material from the dried sludge in the reactor building basement has not been investigated, the staff has conservatively assumed that 100 percent of the radioactive material in the sludge (including the 7.1 pounds [3.2 kilograms] of fuel debris assumed to be present on the basement floor) would be available for suspension in the reactor building atmosphere over the entire length of the storage period although only a fraction would become suspended at a given time. In addition, one-tenth of the radioactive material in the concrete slab walls, equipment, and overhead structures and in the D-ring structures and equipment is assumed to be near the surface and available for suspension over the entire length of the storage period.

A resuspension factor (the ratio of air contamination [$\mu Ci/m^3$] to the surface contamination [$\mu Ci/m^2$]) was used to estimate the amount of surface contamination that may become airborne. Resuspension factors quoted by the International Atomic Energy Agency (IAEA) in Technical Report Series No. 20 vary from 0.000002/meter to 0.003/meter (Clayton 1970). Dunster (1962) indicates that "for controlled areas the lower figure of 0.000002/meter is certainly safe for long term use." Because there will be little or no traffic in the reactor building during PDMS (especially in the basement where most of the contamination is located) and no forced ventilation (except before worker entries), the lower figure was used and conservatively applied to the entire air volume of the basement.

(a) This fraction is based on the conservative assumption that the activity in the first 1/2 inch (1.3 centimeters) of the concrete block becomes available for resuspension over time. Because much of the concrete block is available to the atmosphere on two sides, 1/2 inch (1.3 centimeters) on each side accounts for one-eighth of the activity in the structure.

For forced ventilation, double-stage HEPA filters will be used to remove particulate radioactive material. The fraction of the radioactive particulate material that penetrates a single-stage HEPA filter is conservatively assumed to be 0.01 (NRC 1979b). For double-stage HEPA filters, this fraction is assumed to decrease to 0.0001.[a] In addition to the 12 forced ventilation releases assumed each year, the air in the reactor building is expected to passively exchange to some degree with the outside air because of changes in atmospheric pressure. As discussed in Section 3.1.1.3, an estimated 10 passive air exchanges per year would occur between active ventilations. Passive air exchange would occur through a single-stage HEPA filter. A penetration factor of 0.01 was used for the single-stage HEPA filters during passive air-exchange releases.

The amount of radioactive material calculated to be released annually into the atmosphere during PDMS is shown in Table D.1 of Appendix D for the first year of release. Estimates of releases in subsequent years are based on the releases during the first year and account for radioactive decay.

Preparations for Decommissioning. The routine airborne releases during preparations for decommissioning following PDMS are expected to be similar to those during preparations for PDMS. The activities expected include measurements of residual fuel, surface contamination levels, general area radiation, and degradation of systems or components that isolate fuel and contamination. In addition, cleanup of systems or locations that have exhibited movement of contamination or intrusion of water would occur. These activities are not expected to result in a release of radioactive material in excess of the amounts currently released or amounts released during preparations for PDMS. Radioactive decay would have reduced the amount of radioactive material in the facility, and some isotopes might have decayed to negligible amounts. In addition, it is likely that improved techniques

(a) Forced ventilation will be through two HEPA filters in series. Each has an in-place tested efficiency of at least 99.95 percent for removal of particulates of 0.3-micron (0.0003-millimeter) diameter. Therefore, only a fraction, 0.0005, of the particulates in the building atmosphere would pass through the first stage and a similar fraction (0.00000025 of the initial particulates) would pass through the second stage to the atmosphere. However, Regulatory Guide 1.140 (NRC 1979b), which gives guidelines for operating nuclear power plants, specifies a very conservative penetration factor of 0.01 (corresponding to 99-percent efficiency) for filtration systems that test, in place, to an efficiency of 99.95 percent or more. Although Regulatory Guide 1.140 gives no additional credit for HEPA filters in series, because of the extensive conservatism, the penetration fraction through each stage of HEPA filters was assumed to be 0.01, thus giving an overall penetration factor of 0.0001.

and equipment would be available for any decontamination or cleanup work that was deemed necessary, thus further reducing the potential for airborne contamination.

To estimate radionuclide releases into the atmosphere during the period of preparations for decommissioning, it was assumed that some radionuclides in the reactor building would become airborne because of the activities of workers in the building and that a fraction of these radionuclides would escape into the atmosphere through the double-stage, HEPA-filtered ventilation system. Because the reactor coolant system would be sealed during this period (as discussed earlier), it was assumed that the source of any activity suspended in the reactor building would be radionuclides dispersed throughout the facility (found mostly in the reactor building basement), including the 7.1 pounds (3.2 kilograms) of fuel assumed to remain on the reactor building basement floor. In addition, it was assumed that the preparations for decommissioning would be accomplished in a period of less than 1 year.

To ensure a conservative approach to calculating the offsite radiation dose from the period of decommissioning preparations following PDMS, airborne effluents were based on the release rates shown in Table 3.5 for particulates (unidentified beta/gamma, cesium, and alpha). These release rates were reduced to account for radioactive decay during PDMS. The quantity of each radionuclide assumed to be available for suspension in the reactor building was used to determine the quantity released from the facility by scaling to the alpha or unidentified beta/gamma particulate release rate, as appropriate. The calculated release rates were assumed to occur over the entire 1-year period. The release rates calculated for atmospheric releases during the 1-year period of preparations for decommissioning are shown in Table D.2 of Appendix D.

3.1.2.2 Routine Liquid Releases

The magnitude and impact of the routine liquid releases of radioactive material will also vary depending on the stage of delayed decommissioning. Table 3.6 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine liquid releases during the three stages of delayed decommissioning. The maximally exposed individual is the member of the public that drinks the largest amount of Susquehanna River water, consumes the greatest quantity of fish taken from the river, and participates heavily in rivershore activities. In addition, this individual is assumed to consume shellfish from Chesapeake Bay at the maximum rate of shellfish consumption for the mid-Atlantic region, 97 pounds per year or 44 kilograms per year (Rupp, Miller, and Baes 1980). The collective 50-year dose commitment is calculated for the population within a 50-mile (80-kilometer) radius that drinks Susquehanna River

TABLE 3.6. 50-Year Dose Commitments from Routine Liquid Releases Resulting from Delayed Decommissioning[a]

Stages of Delayed Decommissioning	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual: Susquehanna River Water, Fish, Activities, mrem	Dose to Maximally Exposed Offsite Individual: Chesapeake Bay Shellfish, mrem	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Population, thousands	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Dose, person-rem	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Population, millions	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
PDMS Preparations	1	Bone	0.001	0.00009	340	0.02	2.5	0.0002	0.04
		Total body	0.0003	0.000003		0.0003		0.000006	0.001
PDMS	23	Bone	0.02	0.0003	350 to 460	0.06	2.5 to 3.3	0.001	0.2
		Total body	0.02	0.00005		0.007		0.0001	0.02
	5	Bone	0.005	0.00006	350 to 370	0.01	2.5 to 2.7	0.0001	0.03
		Total body	0.004	0.00001		0.001		0.00001	0.004
	33	Bone	0.03	0.0004	350 to 510	0.09	2.5 to 3.7	0.002	0.3
		Total body	0.03	0.00007		0.01		0.0003	0.04
Decommissioning Preparations	1, following 23-yr PDMS	Bone	0.004	0.00005	460	0.01	3.3	0.0002	0.03
		Total body	0.003	0.000008		0.001		0.00003	0.004
	1, following 5-yr PDMS	Bone	0.004	0.00005	370	0.009	2.7	0.0001	0.02
		Total body	0.003	0.000008		0.001		0.00002	0.003
	1, following 33-yr PDMS	Bone	0.004	0.00005	510	0.01	3.7	0.0003	0.04
		Total body	0.003	0.000008		0.001		0.00004	0.006

(a) Does not include dose associated with decommissioning.

water (the population living downstream of TMI that is assumed to obtain their drinking water from the Susquehanna River, as shown in Table 3.6), consumes fish inhabiting the river, and participates in swimming, boating, and rivershore activities. The dose to the entire population within the 50-mile (80-kilometer) radius from the consumption of shellfish from the Chesapeake Bay is also given. The dose estimated for the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The 50-year dose commitment to the maximally exposed member of the public, the collective 50-year dose commitment to the population living within a 50-mile (80-kilometer) radius, and the collective 50-year dose commitment to the population living outside the 50-mile (80-kilometer) radius are given in Table 3.6 for a storage period of 23 years, as well as for storage periods of 5 and 33 years. In addition, the dose commitments are estimated for a 1-year period of decommissioning preparations following a 23-year storage period and a 1-year period following storage periods of 5 and 33 years.

The bases for the dose calculations, including the flow rate assumed for the Susquehanna River, are given in Appendix E. The specific assumptions that were used during the calculation of the impacts for each of the stages during delayed decommissioning are discussed in the following sections.

<u>Preparations for PDMS</u>. The preparations to place the TMI-2 facility into PDMS, which are expected to take place concurrently with the completion of defueling, are not expected to increase the amount of waterborne contamination. Thus, the routine releases that would be expected to result from preparations for PDMS would not be distinguishable from releases expected during the final stage of defueling or those currently occurring. (The release of tritium is considered a part of the accident-generated water disposal.) Current liquid releases are shown in Table 3.7 for the period January 1, 1987, to September 30, 1988. Liquid discharges during this time were less than 0.0002 percent of the technical specification limits. These release rates and quantities are consistent with results reported for previous calendar quarters.

<u>During PDMS</u>. The evaluation of offsite doses during PDMS resulting from the routine liquid releases is based on 5000 gallons (19,000 liters) of groundwater, precipitation inleakage, and small amounts of decontamination liquids released each year.[a] The amount of radioactive material assumed to be released annually in liquid releases during PDMS is shown in Table D.3 of Appendix D.

(a) It is possible that liquids may be accumulated for several years before they are processed or released. However, this analysis is based on an annual average release of 5000 gallons (19,000 liters).

TABLE 3.7. Average Annual Liquid Discharges Based on Releases During the Period January 1, 1987, to September 30, 1988[a]

Radionuclide	Average Annual Activity Released, Ci
Tritium	0.0039
Strontium-90 and unidentified beta/gamma radiation	0.00036
Cesium-134	0.000005
Cesium-137	0.00028

(a) The average annual liquid discharge was determined by averaging releases from seven quarterly reports (January 1, 1987 to September 30, 1988) and multiplying by four. Quarterly release information was obtained from; letters from F. R. Standerfer to the NRC "Semi-Annual Radioactive Effluent Release Report," August 28, 1987 (4410-87-L-0132); February 29, 1988 (4410-88-L-0027); August 29, 1988 (4410-88-L-0142) and letter from F. R. Standerfer to the NRC, November 29, 1988, Subject: Quarterly Dose Assessment Report Update - Third Quarter 1988 (4410-88-L-0184).

As indicated in Section 3.1.1.3, any inleakage that becomes contaminated by residual contamination on the floors or in sumps and is not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a; see Appendix C to this supplement) and the licensee's technical specification limits (see Section 3.1.1.3) would be pumped to the miscellaneous waste holdup tank and subsequently processed through the EPICOR II system.

The concentration of radionuclides in any liquids directly releasable would be equal to or less than the limits specified in 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a). Liquids released following processing through the EPICOR II system would have radionuclide concentrations below the 10 CFR 20 limits. Because the contaminated liquids will consist of a mixture of radionuclides and the concentrations of each of the radionuclides is currently unknown, the concentration limit for the mixture is based on the limit specified in Appendix B for the radionuclide in the mixture having the lowest concentration limits (according to Footnote 3.a. of Appendix B). Although there is a potential that each of the dispersed radionuclides listed in Table 2.4 could be present in the mixture,[a] the isotopes that are currently identifiable and measurable are cesium-134, cesium-137, and strontium-90. The most restrictive concentration limit for these three isotopes is 0.00004 µCi/mL (insoluble fraction).[b] Thus, this limit was applied as the concentration limit for the radionuclides in the liquids and was adjusted on a weight percentage for all radionuclides that could potentially be present in the liquid.

Preparations for Decommissioning. Liquid releases to the Susquehanna River will also occur during the expected 1-year preparation period for decommissioning following PDMS. Although it is not certain that preparations for decommissioning will generate any additional liquids (over the PDMS average of 5000 gallons [19,000 liters] per year), it is possible that some liquids may be generated during the decontamination of systems or locations where movement of contamination was found. Therefore, the staff assumed maximum releases of 20,000 gallons (76,000 liters) for the year (four times as much as estimated for a year of PDMS). Liquids that are not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a) and the licensee's technical specification limits would be processed through the EPICOR II system.

The concentration of radionuclides in any liquids directly releasable would be equal to or less than the limits specified in 10 CFR 20, Appendix B, Table II Column 2 (CFR 1988a). Liquids released following processing through the EPICOR II system would have radionuclide concentrations below the 10 CFR 20 limits. The amount of radioactive material assumed to be released in the liquids during the year of decommissioning preparations was estimated using the same methodology given previously for routine liquid releases during PDMS. Radionuclides specifically associated with fuel debris (see Table 2.4) were again not considered because it is assumed that they would be isolated in the reactor coolant system and connected piping systems or located in the reactor building basement, which is not expected to receive any inleakage or be the site of further decontamination. The amount of radioactive material assumed to be released during the 1-year period of decommissioning preparations is shown in Table D.4 of Appendix D.

(a) Radionuclides specifically associated with the fuel debris (see Table 2.4) were not considered because it is assumed that they would be isolated in the reactor coolant system and connected piping systems, or located in the reactor building basement, which is not expected to receive any inleakage.

(b) Although 10 CFR 20, Appendix B, does give lower concentration limits for the soluble fraction than for the insoluble fraction, the latter was used in this analysis because it gives the most conservative release rates.

3.1.2.3 Accidental Atmospheric Releases

The potential for accidents resulting in airborne releases of radionuclides during delayed decommissioning was evaluated. Three potential accidents resulting in an atmospheric release were developed from the list of potential accidents given in the PEIS (NRC 1981): a fire in the stairwell/elevator structure, the rupture of a HEPA filter during decontamination activities, and the spill of decontamination solution in the reactor building.[a] The potential for these accidents during the three stages of delayed decommissioning was evaluated. If the potential existed for a specific accident, the impact of the accident was quantitatively evaluated to determine the effect on the offsite populations.

Table 3.8 shows the results of this evaluation. The table lists the 50-year dose commitments to the maximally exposed member of the public to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental atmospheric releases during each stage of delayed decommissioning where there was a potential for an accident. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius resulted from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

Accidents occurring during preparations for PDMS are similar to those evaluated in the PEIS and are not evaluated further in this supplement, as explained below in greater detail. Accidents occurring during PDMS were assumed to occur early in the storage period. Thus, the dose commitments shown in Table 3.8 apply to storage periods of varying lengths. Dose commitments for accidents occurring during the period of decommissioning preparations, however, were estimated for the 1-year period following a 23-year storage period, as well as for the 1-year periods following storage periods of 5 and 33 years.

The specific assumptions used to determine the potential for each of the above-listed accidents during the stages of delayed decommissioning and the assumptions used to quantify the impact from the

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(a) Recriticality was not considered a credible accident because the licensee must demonstrate that recriticality is not credible before the start of PDMS. Most of the remaining fuel debris would be sealed in piping or enclosed in components located in the reactor building. The reduced amount of fuel debris remaining, its dispersed distribution, and the lack of a moderator would preclude criticality during the storage period.

TABLE 3.8. 50-Year Dose Commitments from Accidental Atmospheric Releases During Delayed Decommissioning[a]

Stages of Delayed Decommissioning	Accident Description	Dose Location	Maximally Exposed Offsite Individual, mrem	50-Mile Radius of TMI-2: Population Size, millions	50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
PDMS	Fire in stairwell (start of PDMS)	Bone	13	2.5	0.8	0.1
		Total body	1.6		0.4	0.04
Decommissioning Preparations	Fire in stairwell					
	following 23-yr PDMS	Bone	0.07	3.3	0.009	0.0001
		Total body	0.008		0.006	0.0001
	following 5-yr PDMS	Bone	0.08	2.7	0.007	0.001
		Total body	0.02		0.004	0.0004
	following 33-yr PDMS	Bone	0.06	3.7	0.008	0.0001
		Total body	0.006		0.005	<0.00001
	HEPA filter failure					
	following 23-yr PDMS	Bone	0.08	3.3	0.009	0.0002
		Total body	0.003		0.0008	0.00001
	following 5-yr PDMS	Bone	0.2	2.7	0.007	0.001
		Total body	0.005		0.0006	0.00005
	following 33-yr PDMS	Bone	0.08	3.7	0.009	0.0001
		Total body	0.002		0.0008	<0.000001

(a) Does not include dose associated with accidents during decommissioning.

potential accidental atmospheric releases are discussed in the following sections.

Preparations for PDMS. The potential for accidental releases during preparations for PDMS is expected to be similar to or less than the accident potential during the latter stages of defueling, which was evaluated in the PEIS and is not evaluated further in this supplement. The preparations to place the TMI-2 facility into PDMS are similar to and are combined with the current cleanup activities and are not expected to increase the potential for releasing airborne contamination even if an accident should occur.

During PDMS. The fire in the stairwell/elevator structure was identified as the only accident that could occur during PDMS that would result in an atmospheric release of radionuclides. Although a fire is considered unlikely during PDMS since combustible materials and ignition sources are not expected to be present, the accident scenario involving a fire was evaluated using the following conservative assumptions: that the accident would occur early in the storage period, before appreciable decay of the radionuclides occurred; that 20 percent of the stairwell/elevator structure below the 8-foot (2.4-meter) mark would be involved in the fire; that 20 percent of the activity in the stairwell/elevator structure would be involved in the fire, although the contamination in the structure is not distributed uniformly; and that the 7.1 pounds (3.2 kilograms) of fuel debris thought to remain on the floor of the basement after desludging would also be involved in the fire (even though desludging has occurred in the area of the stairwell/elevator structure and measurements taken before desludging indicated that fuel debris is not located near the stairwell/elevator structure). The fraction of activity to be released into the reactor building atmosphere during the burning of the contaminated material was assumed to be 0.0005, based on studies by Mishima and Schwendiman (1973). The amount released from the building would be further reduced because the HEPA filters would remove at least 99 percent of the radioactive particulates. The fraction of the radioactive particulate material that would penetrate the single-stage HEPA filter used when the reactor building was secured but not actively ventilated was conservatively assumed to be 0.01 (NRC 1978). The amount of radioactive material calculated for release during this accident is shown in Table D.5 of Appendix D.

Preparations for Decommissioning. Two of the three potential accidents identified above for possible atmospheric releases could occur during preparations for decommissioning following PDMS: a fire in the stairwell/elevator structure and a HEPA-filter failure during decommissioning preparations. The third accident, the spill of decontamination solution in the reactor building, was not considered credible since the amount of decontamination solution used during this period of time would be relatively minor.

The analysis of the effect of a potential fire in the stairwell/ elevator structure was based on assumptions similar to those given in this section for PDMS. However, the amount of activity assumed to be present is less because of the 23-year period of radioactive decay. In addition, a double-stage HEPA filter would be used because the reactor building would be continuously ventilated; thus, the fraction of radioactive material released from the reactor building atmosphere was conservatively assumed to be 0.0001. The amount of radioactive material assumed to be released during this accident is shown in Table D.6 of Appendix D.

High-efficiency particulate air (HEPA) filters may fail because of physical damage such as puncture, because of extreme pressure differentials, and because of water damage over a long period of time. For this reason, periodic in-place testing of HEPA filters is required; however, for the purposes of accident analysis, the failure of both stages of a double-stage HEPA filter (the probability of this event occurring is very low) was assumed to occur. A failure of the HEPA filters in one of the ventilation trains would be discovered because of the increased radiation levels recorded by the ventilation stack monitor; the ventilation would then be closed off or diverted to the other ventilation train. However, a 1-hour interval between failure and corrective action was conservatively assumed because of the expected low radiation levels during this period of time. A release rate was assumed that was similar to the routine release rates previously estimated but multiplied by 10,000 to account for the loss of the HEPA filters. The maximum amount of radioactive material estimated to be released during this type of accident is shown in Table D.7 of Appendix D.

3.1.2.4 Accidental Liquid Releases

The potential for accidents resulting in liquid releases of radionuclides during delayed decommissioning was evaluated. A single potential accident resulting in a liquid release was developed from the list of potential accidents given in the PEIS and supplements. This accident involved the rupture of a tank containing liquid that had been treated at least partially to remove radioactive material. The potential for this accident during the three stages of delayed decommissioning was evaluated as discussed in the following sections.

Preparations for PDMS. The potential for accidental liquid releases during preparations for PDMS is expected to be similar to or less than the accident potential during the latter stages of defueling (evaluated in the PEIS [NRC 1981]). The preparations for PDMS are similar to and are combined with the current cleanup activities. They are not expected to increase the potential for releasing waterborne contamination even if an accident should occur.

During PDMS. During PDMS, water-processing capabilities would be available to dispose of the small amount of liquid (assumed to be 5000 gallons [19,000 liters]) produced by inleakage, condensation, and small amounts of decontamination. Liquids that are not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a), would be collected in the miscellaneous waste holdup tank, transferred to the chemical cleaning building, and then processed through the EPICOR II system before final sampling and discharge. Based on the environmental assessment prepared by the NRC staff on the use of the EPICOR II system at TMI-2 (NRC 1979c), there are no credible accidents that would result in a liquid release during the transfer or processing of the liquids produced during PDMS. The operating history of this system in the intervening time has not altered this conclusion. In addition, any leakage from the miscellaneous waste holdup tank in the AFHB would be contained in the AFHB.

Preparations for Decommissioning. Although the licensee has not made any detailed plans for the period of preparations for decommissioning, it is assumed that during this period, only small amounts of contaminated liquids would be generated in support of the preparations for decommissioning. This small amount of contaminated liquid along with the liquid produced by inleakage and condensation would be collected in the miscellaneous waste holdup tank, transferred to the chemical cleaning building, and processed through the EPICOR II system before final sampling and discharge. Based on the environmental assessment prepared by the NRC staff on the use of the EPICOR II system at TMI-2 (NRC 1979c), there are no credible accidents that would result in a liquid release during the transfer or processing of the small quantity of liquids produced during the decommissioning preparation activities.

3.1.3 Occupational Radiation Dose Evaluation for Delayed Decommissioning

The occupational radiation dose from placing the TMI-2 facility in PDMS, maintaining it for a period of 23 years, and then preparing the facility for decommissioning is estimated to be 86 to 230 person-rem, as shown in Table 3.9. Table 3.9 also presents occupational dose estimates assuming 5 years of PDMS (31 to 92 person-rem) and 33 years of PDMS (110 to 280 person-rem). These doses are in addition to the occupational radiation dose already received and the dose required to complete defueling.

The estimates presented in Table 3.9 are based on a task-by-task analysis of the work to be done. Ranges of values are presented for each task because of the uncertainties in the specific methods and technology used to perform tasks. A discussion of the methodology used to estimate the occupational doses is found in Appendix H.

3.1.4 Waste Management Considerations of Delayed Decommissioning

The quantity, radiation level, and classification of waste that would be produced as a result of delayed decommissioning were evaluated on the basis of current regulatory requirements. Preparations for PDMS would generate additional compacted, dry radioactive waste, which would be either Class A or Class B, as defined by 10 CFR 61 (CFR 1988a; see Section 2.3.2 and Appendix F for a discussion of waste classification). The estimated ratio of Class A to Class B waste would be approximately 20:1. Maintenance of the reactor in PDMS could generate waste consisting of HEPA filters and disposable protective clothing. Although treatment of water and decontamination solutions would generate additional waste that could be Class A, B, or C, the quantities would be rather small and it is expected that they would be stored onsite until a sufficient volume was generated to make a full shipment.

Table 3.10 shows the estimated range of quantities of waste expected to be generated during preparations for PDMS, during 23 years of PDMS, and during the 1-year period for decommissioning preparations following PDMS. Waste volume estimates for 5 years and 33 years of PDMS are also provided in Table 3.10. The longer the PDMS storage period, the greater the estimated waste volumes.

Activities during the 1-year period of decommissioning preparations between the end of PDMS and the beginning of decommissioning are discussed in Section 3.1.1.4. Waste volumes were assumed to be equivalent to the waste generated during 1 year of PDMS.

TABLE 3.9. Occupational Radiation Dose Estimates for Delayed Decommissioning[a]

Task Description	Occupational Dose, person-rem		
	23-year PDMS	5-year PDMS	33-year PDMS
Pre-PDMS preparation	2.0 to 20	2.0 to 20	2.0 to 20
Maintenance of facility in PDMS[b]	74 to 190	20 to 50	95 to 240
Radioactive waste handling	5.3 to 8.3	2.3 to 3.5	5.9 to 9.1
1-year preparations for decommissioning	4.6 to 12	7.0 to 18	3.6 to 9.4
Total[c]	86 to 230	31 to 92	110 to 280

(a) Does not include dose associated with decommissioning.
(b) Does not include the dose while making inspections and evaluations in order to plan post-PDMS work.
(c) The totals may not be exact because of rounding.

TABLE 3.10. Waste Volume Estimates for Delayed Decommissioning[a]

	Total Waste Volume					
	23-year PDMS		5-year PDMS		33-year PDMS	
Class of Waste[b]	ft^3	m^3	ft^3	m^3	ft^3	m^3
Preparations for PDMS						
Class A or B	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7
PDMS						
Class A dry radioactive waste	690 to 2300	20 to 65	150 to 500	4.3 to 14	990 to 3300	28 to 93
Class B or C air filters	0 to 1400	0 to 41	0 to 310	0 to 8.8	0 to 2100	0 to 58
Class A, B, or C residue from liquid waste treatment	120 to 460	3.4 to 13	25 to 100	0.71 to 2.8	170 to 660	4.8 to 19
1-Year Preparation Prior to Decommissioning						
Class A dry radioactive waste	30 to 100	0.9 to 2.8	30 to 100	0.9 to 2.8	30 to 100	0.9 to 2.8
Class B or C air filters	0 to 63	0 to 1.8	0 to 63	0 to 1.8	0 to 63	0 to 1.8
Class A, B, or C residue from liquid waste treatment	5 to 20	0.1 to 0.6	5 to 20	0.1 to 0.6	5 to 20	0.1 to 0.6

(a) Does not include waste volumes associated with decommissioning.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

For delayed decommissioning, the staff assumed that waste generated before the year 2001 would be shipped to a currently licensed site and that waste generated during and after 2001 would be shipped to a regional site. The currently licensed site was assumed to be the facility operated by U.S. Ecology near Richland, Washington. An unspecified site 250 miles (400 kilometers) from the plant was assumed for the regional disposal site, as discussed in Section 2.3.5. The impact of the waste after disposal at either of these sites is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the waste disposal sites.

It is possible that some of the waste generated could exceed Class C limits, in which case it could not be accepted by a licensed burial site. The licensee, however, has a unique agreement with the U.S. Department of Energy that allows such wastes to be transferred to the DOE on a cost-reimbursement basis. (It is under this agreement, known as the Memorandum of Understanding,[a] that the fuel is being transferred to the DOE Idaho Falls site.)

The environmental impact of transporting waste generated during delayed decommissioning was estimated by assuming that the Class A waste was packaged in 217-cubic-foot (6.1-cubic-meter) containers with shielding that was equivalent to 2.7 inches (6.9 centimeters) of lead. All other waste was assumed to be Class C and transported in 14-cubic-foot (4.0-cubic-meter) casks, which provide the equivalent of 4.5 inches (11 centimeters) of lead. Casks with these dimensions are currently licensed for such use and are also licensed for shipment of Class B wastes. Table 3.11 summarizes the estimated number of shipments of Class A waste and unspecified (Class A, B, or C) waste to the Richland, Washington, site and the regional disposal site for delayed decommissioning with 23 years, 5 years, or 33 years of PDMS. For the purposes of estimating impacts, it was assumed that the unspecified waste would all be Class C waste.

The methodology for the assessment of shipping impacts is described in Appendix F. Table 3.12 provides a summary of shipping impacts for delayed decommissioning assuming PDMS periods of 23 years, 5 years, and 33 years. Shipping impact estimates are given as total population dose and truck crew dose resulting from transportation to disposal sites; number of traffic accidents, injuries, and fatalities; population dose from transportation accidents; and transportation costs.

(a) *Memorandum of Understanding Between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy Concerning the Removal and Disposition of Solid Nuclear Wastes from Cleanup of the Three Mile Island Unit 2 Nuclear Plant*, March 15, 1982.

TABLE 3.11. Estimated Number of Waste Shipments for Delayed Decommissioning[a]

PDMS Period	Number of Shipments: Richland, WA	Number of Shipments: Regional Disposal Site
23-year PDMS		
Class A	2 to 6	2 to 6
Unspecified waste[b]	1 to 6	1 to 8
5-year PDMS		
Class A	1 to 4	---[c]
Unspecified waste[b]	1 to 3	---[c]
33-year PDMS		
Class A	2 to 6	3 to 11
Unspecified waste[b]	1 to 6	1 to 14

(a) Does not include shipments during decommissioning.
(b) Unspecified waste was considered to be Class C waste.
(c) A regional disposal site is not expected to be available during delayed cleanup with a 5-year period of PDMS.

Transportation of this waste would result in the exposure of some members of the public to a very low radiation dose. The principally exposed group would be the truck crews; however, others would also be exposed, such as those present at truck stops, travelers on the highways, and residents along the highways. The total transportation dose for delayed decommissioning with a 23-year storage period, excluding the dose from accidents that may occur during shipments, is expected to be 0.5 to 2.4 person-rem. The truck crews would receive the greatest portion of this dose, 0.3 to 1.6 person-rem.

As with transportation of any materials, there is a possibility that incidents during transportation may result in traffic accidents with or without injuries or fatalities. The estimated number of traffic accidents that might occur during the entire shipping program for delayed decommissioning with a 23-year storage period was 0.02 to 0.1 (the probability of an accident during the entire shipping program is between approximately 2 and 10 chances in 100), depending on the final waste volume. The staff estimated the number of injuries occurring during this shipping program at about 0.02 to 0.08 (the probability of an injury accident during the entire shipping program is between approximately 2 and 8 chances in 100) and the number of fatalities at about 0.001 to 0.006 (the probability of a fatal accident during the entire shipping program is between approximately 1 and 6 chances in

TABLE 3.12. Summary of Transportation Impacts for Delayed Decommissioning[a]

PDMS Duration	Dose Resulting from Transporation to Disposal Site, person-rem: Total	Population[b]	Truck Crew	Traffic Accidents: Number of Accidents	Number of Injuries	Number of Fatalities	Population Dose from Transportation Accidents, person-rem	Transportation Costs, $ millions
23-year	0.5 to 2.4	0.2 to 0.8	0.3 to 1.6	0.02 to 0.1	0.02 to 0.08	0.001 to 0.006	0.00003 to 0.0002	0.025 to 0.11
5-year	0.3 to 1.2	0.1 to 0.4	0.2 to 0.8	0.01 to 0.05	0.01 to 0.04	0.001 to 0.004	0.00003 to 0.00008	0.014 to 0.047
33-year	0.5 to 2.6	0.2 to 0.9	0.3 to 1.7	0.03 to 0.1	0.02 to 0.09	0.001 to 0.007	0.00003 to 0.0002	0.027 to 0.12

(a) Does not include transportation impacts associated with decommissioning.
(b) Dose to persons who live or work in the vicinity of the highway, persons who travel on the highway used for shipments, and bystanders at truck stops.

1000). Appendix F provides additional details regarding the analysis of transportation accidents.

There is also a small probability that accidents may be severe enough to result in the breach of a waste container and release of some of the waste. To determine the risk of radiation exposure from a damaged waste container, the staff used a model that estimates the population dose by multiplying accident frequencies (the expected number of accidents) by accident consequences. Using this methodology, which is described more fully in Appendix F and the referenced documents, the staff estimated that a dose of about 0.00003 to 0.0002 person-rem would result from accidents during shipment of all the waste generated during delayed decommissioning with a 23-year storage period.

The transportation costs are discussed in Section 3.1.6.

3.1.5 Socioeconomic Impacts of Delayed Decommissioning

The direct socioeconomic impacts of delayed decommissioning were evaluated. The basis for this evaluation is included in Appendix G. The socioeconomic impacts of delayed decommissioning are expected to be slight. The 1987-1988 work force of approximately 1150 would continue to be reduced, to a work force of 100 to 125 in the first year of PDMS and of 70 to 75 during subsequent years. The 1-year period of preparations for decommissioning would be completed with a considerably smaller staff than currently in use but larger than the PDMS staff. The staffing level for this phase would depend on the amount of activity that would be deemed necessary to prepare the facility for decommissioning.

Approximately 70 percent of the current work force resides in the Harrisburg-Lebanon-Carlisle labor market (Cumberland, Dauphin, Lebanon, and Perry Counties) and 25 percent in Lancaster County. In these areas, the economic impact of the reduced labor force might be most noticeable. Licensee-funded jobs in this area are expected to support approximately half again the number of jobs in the surrounding communities. However, because the reduction in employment at the beginning of PDMS amounts to 0.2 percent of the local baseline employment, the impact should be minor.

The annual labor cost for the 1988 staffing level is about $57.5 million per year, which would be reduced to $5.0 million to $6.3 million for the first year and $3.5 million to $3.8 million per year during the remainder of PDMS. The impact on the total income of the local communities is expected to be about twice the payroll level, $10 million to $13 million for the first year, about $7 million to $8 million per year thereafter.

3.1.6 Commitment of Resources During Delayed Decommissioning

The principal resources committed in the delayed decommissioning of TMI-2 will be money and radioactive burial ground space. Other resources, such as energy and ion exchange resins, will be relatively minor.

The cost of delayed decommissioning has been evaluated by the NRC staff using 1988 dollars. The cost of delayed decommissioning for a 23-year period of PDMS is $92 million to $100 million, as presented in Table 3.13. Table 3.13 also presents cost estimates for delayed decommissioning assuming 5 years of PDMS ($29 million to $35 million) and 33 years of PDMS ($130 million to $140 million). These estimates include labor costs, waste transportation charges (Section 3.1.4), and waste disposal costs.

Staffing levels and labor costs for the delayed decommissioning proposal are discussed in Section 3.1.5. Uncertainties in the labor cost are due to inflation, overhead costs, and uncertainties in staffing requirements. The greatest uncertainty in the labor cost will be the staffing required to complete the 1-year period of decommissioning preparations, as discussed in Section 3.1.5. The staff assumed that the staffing level for the period of decommissioning preparations would be approximately twice the level necessary during PDMS (approximately 140 to 150 workers), resulting in a labor cost of $7.0 million to $7.5 million. A small additional cost may result from training these workers before the 1-year period of decommissioning preparations. However, this cost is not readily quantified.

TABLE 3.13. Projected Cost of Delayed Decommissioning[a]

Type of Cost	Projected Cost for Lengths of PDMS, $ million[b]		
	23-year	5-year	33-year
Labor Costs			
Preparations for PDMS	3.2 to 6.3	3.2 to 6.3	3.2 to 6.3
First year of PDMS	5.0 to 6.3	5.0 to 6.3	5.0 to 6.3
Remaining years of PDMS	77 to 83	14 to 15	110 to 120
1 year of preparations for decommissioning	7.0 to 7.5	7.0 to 7.5	7.0 to 7.5
Waste Disposal Costs			
Pre-PDMS and PDMS waste	0.05 to 0.22	0.01 to 0.06	0.06 to 0.31
Post-PDMS waste[c]	0.002 to 0.009	0.002 to 0.009	0.002 to 0.009
Waste Transportation Costs	0.025 to 0.11	0.014 to 0.047	0.027 to 0.12
Total[d]	92 to 100	29 to 35	130 to 140

(a) Does not include cost of decommissioning.
(b) In 1988 dollars.
(c) Waste generated during the 1-year period of decommissioning preparations.
(d) The totals may not be exact because of rounding.

The costs for both present and future low-level waste (LLW) disposal are 1988 rates. The 1988 disposal charge is approximately $50 per cubic foot ($1800 per cubic meter) plus surcharges for higher-than-normal radiation dose rates or curie content. These rates were raised approximately 18 percent from 1987 to 1988. Future rates are highly uncertain, especially disposal rates at a regional repository. Cost estimates might be too low if there is significant escalation in waste disposal requirements for waste handling and packaging or waste disposal costs.

The required LLW burial ground space is estimated as follows: 950 to 4600 cubic feet (27 to 130 cubic meters) for 23 years of storage; 310 to 1300 cubic feet (8.8 to 37 cubic meters) for 5 years of storage; and 1300 to 6400 cubic feet (37 to 180 cubic meters) for 33 years of storage.

Waste disposal costs are related not only to waste volume and classification, about which there are uncertainties at present, but also to the technology used to dispose of the waste. Current waste disposal technology involves shallow land burial. Many of the regions are considering alternative technologies, such as disposal in concrete bunkers and other engineered structures. Such alternative technologies may be more costly.

Waste transportation costs are also closely related to the cost of energy and the distance between the disposal site and the TMI site. Accordingly, costs for transportation of waste to a regional site will be less than those for transportation to the currently operated disposal facility near Richland, Washington.

3.1.7 Regulatory Considerations of Delayed Decommissioning

There are no regulatory considerations that would prevent the licensee from implementing long-term monitored storage of the facility or from placing the facility in decommissioning at the completion of the storage period. The PEIS supplement is part of the required evaluation necessary before the TMI-2 license can be amended. In addition to preparing the supplement, which provides a review of the environmental impacts of the licensee's proposal, the NRC staff is in the process of reviewing the licensee's safety analysis report on PDMS (GPU 1988).

3.2 DELAYED CLEANUP (POST-DEFUELING MONITORED STORAGE FOLLOWED BY COMPLETION OF CLEANUP)

Delayed cleanup, as currently envisioned by the NRC staff, is described in Section 3.2.1. The offsite dose evaluation is discussed in Section 3.2.2, the occupational dose estimates in Section 3.2.3, the waste management impacts including those from transportation in Section 3.2.4, the socioeconomic impacts in Section 3.2.5, commitment of resources in Section 3.2.6, and regulatory considerations in Section 3.2.7.

3.2.1 Description of the Delayed Cleanup Alternative

Delayed cleanup involves preparing the facility for storage, maintaining the facility in monitored storage, and at the end of the storage period completing the cleanup to the point that the dose rates in the TMI-2 facility are similar to those in an undamaged reactor facility at the end of its operating life. Thus, the alternative of delayed cleanup is identical to the licensee's proposal described in Section 3.1 except for those activities following the storage period. The cleanup process after storage would complete the process of decontaminating the facility, removing residual fuel, and disposing of radioactive wastes. The reactor would either be decommissioned or refurbished under a separate regulatory action not covered by the PEIS or the supplements.

The NRC staff has primarily evaluated the environmental impact of delayed cleanup based on a storage period of 23 years. However, the impacts resulting from storage periods ranging from 5 to 33 years are also evaluated and the results are presented as a range similar to that presented for delayed decommissioning in Section 3.1.

3.2.1.1 Preparations for PDMS and PDMS

The status of TMI-2 systems during PDMS, preparations required for PDMS, and the surveillance and maintenance activities occurring during PDMS are the same as those during delayed decommissioning, discussed in Sections 3.1.1.1, 3.1.1.2, and 3.1.1.3, respectively.

3.2.1.2 Cleanup Following PDMS

For the delayed cleanup alternative, it is assumed that following PDMS, the facility will be decontaminated to levels expected in an undamaged reactor facility at the end of its operating life before decommissioning or refurbishment begins. In addition, the following conditions are assumed: (1) a full 4 years would be necessary for cleanup and would include the time required to assemble a work force and train them regarding facility conditions, (2) the development and planning stage for the cleanup processes would occur during the latter years of the PDMS period, (3) modest advances in robotic technology would have occurred during the intervening storage period, (4) radiation dose rates would decrease during PDMS because of radioactive decay, and (5) a regional repository within 250 miles (400 kilometers) of the site would be available to accept the waste following storage periods that were longer than 10 years.

To progress from conditions at the end of defueling to the completion of cleanup will require additional decontamination of the reactor coolant system and the reactor building, including shipment and disposal of the resulting waste. Some additional work will be required in the AFHB, although by the time defueling is completed, radiation dose rates in many areas will generally be at the level of those in an undamaged reactor facility at the end of its operating life, as discussed in Section 2.1. The NRC staff has considered the principal activities during cleanup following PDMS to include further decontamination of the reactor coolant system and general cleanup of the reactor building, especially the basement and the D-ring areas. A description of the reactor coolant system cleanup and the decontamination of the reactor building follows.

Reactor Coolant System Cleanup. The selection of methods and processes for additional reactor coolant system decontamination is expected to depend on the technology available, the results of current measurements and those in the latter years of PDMS, and the future disposition of the facility.

A discussion of possible methods for the decontamination of the reactor coolant system components is found in the PEIS (NRC 1981) and Supplement 1 (NRC 1984). For the purpose of this evaluation, it is assumed that the reactor coolant system decontamination would involve some mechanical decontamination, followed by a general chemical decontamination. Mechanical decontamination would be performed in accessible areas such as the steam generator channel heads and pressurizer; it could involve vacuuming and the use of slightly abrasive methods such as grit blasting. Some use would probably be made of shielded work areas, long-handled tools, and power tools, although robotics could possibly be used for specific tasks.

Chemical decontamination methods are assumed to require placing the head or some other cover on the reactor vessel, filling the reactor coolant system with aqueous solutions, and circulating those solutions for a period of time with continuous filtration and chemical treatment to remove contamination. Various modifications to the reactor coolant system would be made to introduce and remove solutions. Valve lineups would be verified before beginning decontamination. Post-decontamination radiation surveys would also be performed. The NRC staff has assumed that solutions would be processed in a modified, shielded area of the AFHB and solidified for offsite disposal. Chemical decontamination is discussed further in Chapter 6 of the PEIS (NRC 1981) and Section 2.1.3 of Supplement 1 (NRC 1984).

Although the exact decontamination process has not yet been defined, the NRC staff has assumed that such a procedure would reduce radiation dose rates from reactor coolant system components to levels that are typical of an undamaged reactor facility at the end of its operating life. Any highly radioactive spots left by the mechanical and chemical decontamination methods would be removed by cutting out the pipe or component to complete cleanup.

Reactor Building Cleanup. The current general area dose rates on the 305-foot elevation and the 347-foot elevation (see Section 2.1.1) indicate that some additional decontamination work would probably be required at these locations. In addition, the temporary shielding around equipment, such as the air coolers, ducts, floor hatches, lower section of the open stairwell, and the polar crane operator station, would need to be removed and additional decontamination and/or equipment removal performed. Electrical cables and trays, piping supports, and overhead structures are also expected to require decontamination or removal.

The most difficult area in the reactor building to decontaminate would be the basement and the D-ring areas. Cleanup of the basement is expected to require the removal of the concrete-block stairwell/elevator structure. This structure is reinforced with metal and would require aggressive methods to dismantle. It is expected that a combination of techniques, including robotic application of high-pressure water, water-air, or water-abrasive mixtures, might be used to dismantle sections of the structure. A plasma arc torch might also be adapted for robotic application. If robotics were not available to accomplish all demolition tasks, those tasks would be left until most of the contaminated material was removed, and shielding would be placed so that workers could perform the tasks with long-handled tools. The handling and removal of the waste resulting from demolition would require considerable worker time in the building. Workers would also be required to raise, lower, maintain, and modify the robots. Some spread of airborne contamination might result from demolition of the stairwell; additional building cleanup following dismantlement of the stairwell would probably be required.

The basement still contains debris such as tool boxes and construction materials that would require removal. Removal of this debris, as well as removal of insulation, equipment, and electrical boxes in the basement, could be performed robotically. Although packaging the waste and attaching the hoisting equipment using the robots may be slow, these methods would probably be used for most of the more highly contaminated material in conjunction with conventional dose reduction methods such as the use of long-handled tools and shield walls. Some manual handling during packaging operations on the upper elevations would be required. New access hatches could be cut through the floor on the 305-foot elevation. Once radiation dose rates were sufficiently low to permit entry into the basement, additional radiation surveys would be performed and the remaining sources of contamination, which might be inaccessible using the robots, could be removed using manual methods.

Decontamination of the D-ring areas would also be necessary. As discussed in Section 2.1.1, the activity in the D-rings appears to be in the form of salt and/or mineral deposits, highly contaminated coatings, and corrosion products bound to the equipment surfaces. In order to decontaminate the equipment surfaces, the remaining insulation would be removed and packaged as radioactive waste. The exposed surfaces of the reactor coolant system pieces and components could be cleaned by high pressure water flushing. More aggressive techniques might also be required, including ultra-high-pressure water flush or abrasive blasting of components and scabbling of concrete surfaces. It is also quite likely that removal of some of the reactor coolant system components and/or associated piping would be necessary to completely clean the D-ring areas.

3.2.2 Offsite Dose Evaluation for Delayed Cleanup

The evaluation of radiation dose to the offsite population as a result of the delayed cleanup alternative includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.2.2.1 Routine Atmospheric Releases

The magnitude and impact of routine atmospheric releases of radioactive material will vary depending on the stage of the cleanup. These stages, as described in Section 3.2.1, include preparations for PDMS, PDMS, and cleanup following PDMS. Table 3.14 shows the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine atmospheric releases during the three stages of delayed cleanup. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The 50-year dose commitments shown in Table 3.14 were estimated for a storage period of 23 years, as well as for storage periods of 5 and 33 years. In addition, the dose commitments were also estimated for a 4-year period of cleanup following a 23-year storage period and 4-year periods following storage periods of 5 and 33 years.

The specific assumptions that were used during the calculation of the impacts for each of the stages during delayed cleanup are discussed in the following sections.

Preparations for PDMS. As explained in Section 3.1.2.1, the preparations to place the TMI-2 facility into PDMS are expected to take place concurrent with the completion of defueling. These activities are not expected to increase the amount of airborne contamination. Thus, the routine releases that would be expected to result

TABLE 3.14. 50-Year Dose Commitments from Routine Atmospheric Releases Resulting from Delayed Cleanup[a]

Stages of Delayed Cleanup	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
PDMS Preparations	1	Bone	0.001	2.5	0.0005	0.0002
		Total body	0.0001		0.0004	0.00004
PDMS	23	Bone	23	2.5 to 3.3	13	1.2
		Total body	1.9		7.8	0.3
	5	Bone	6	2.5 to 2.7	2.4	0.5
		Total body	0.5		1.3	0.2
	33	Bone	30	2.5 to 3.7	19	1.3
		Total body	2.6		11	0.4
Cleanup	4, following 23-yr PDMS	Bone	1.2	3.3	0.8	0.02
		Total body	0.03		0.07	0.001
	4, following 5-yr PDMS	Bone	2.1	2.7	0.9	0.06
		Total body	0.05		0.08	0.004
	4, following 33-yr PDMS	Bone	1.0	3.7	0.9	<0.001
		Total body	0.03		0.08	<0.0001

(a) Does not include dose associated with decommissioning or refurbishment.

from preparations to place the facility in PDMS would not be distinguishable from releases expected during the final stage of defueling or from releases currently occurring, except as discussed in Section 3.1.2.1.

<u>During PDMS</u>. Routine atmospheric releases of radionuclides during PDMS are expected to be the same as those described in Section 3.1.2.1 for PDMS during delayed decommissioning.

<u>Cleanup Following PDMS</u>. The routine airborne releases during cleanup following PDMS are expected to be similar to those occurring during the defueling period. However, aggressive decontamination efforts that might occur during certain cleanup activities could result in an increased release of radioactive material. Aggressive decontamination includes mechanical decontamination operations such as those that would likely occur in the basement during the decontamination or removal of the concrete-block stairwell/elevator structure. These operations might increase the amount of activity in the reactor building atmosphere, thus increasing the amount of activity released from the facility. However, 23 years of radioactive decay would have reduced the amount of radioactive material in the facility and some isotopes would have decayed to negligible amounts. In addition, improved techniques and equipment would likely be available for decontamination work to further reduce the potential for airborne contamination.

To estimate radionuclide releases into the atmosphere during the cleanup period following PDMS, the staff assumed that some of the radionuclides in the reactor building would become airborne during decontamination processes and a fraction of these radionuclides would escape into the atmosphere through the double-stage, HEPA-filtered ventilation system. To ensure a conservative approach to calculating the offsite radiation dose from the cleanup period following PDMS, airborne effluents were based on a release rate two orders of magnitude (100 times) larger than the average annual release rates during the present cleanup effort shown in Table 3.5 for particulates (unidentified beta/gamma, cesium, and alpha). These release rates were assumed for the period of time that the aggressive decontamination operations were occurring. It is conservatively assumed that these operations occur over a cumulative period of 1-year duration. During the remaining time, airborne effluent releases are assumed to be of the same magnitude as the rates shown in Table 3.5 which are comparable to the present rate of release. However, both release rates would be reduced to account for 23 years of radioactive decay. The quantity of each radionuclide assumed to be available for suspension in the reactor building[a] was used to determine the quantity released from the facility by scaling to the appropriate particulate release rate. The annual release rates calculated for atmospheric releases during cleanup following a 23-year PDMS are shown in Table D.8 of Appendix D.

3.2.2.2. Routine Liquid Releases

The magnitude and impact of routine liquid releases of radioactive material will also vary depending on the stage of delayed cleanup. Table 3.15 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine liquid releases during the three stages of delayed cleanup. The dose pathways to the maximally exposed individual and to the offsite populations include the drinking of Susquehanna River water, consumption of fish inhabiting the river, participation in rivershore activities, and consumption of shellfish from the Chesapeake Bay, as described in Section 3.1.2.2. The dose to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The 50-year dose commitments are also estimated for storage periods of 5 and 33 years, as shown in Table 3.15. In addition, the dose commitments were estimated for a 4-year cleanup period following a 23-year storage period and 4-year cleanup periods following storage periods of 5 and 33 years.

The specific assumptions that were used during the calculation of the impacts for each of the stages during delayed cleanup are discussed in the following sections.

Preparations for PDMS. As explained in Section 3.1.2.2, the preparations to place the TMI-2 facility into PDMS are expected to take place concurrently with the completion of defueling. These preparations are not expected to increase the amount of waterborne contamination. Thus, the routine releases that would be expected to result from preparations to place the facility in PDMS would not be distinguishable from releases expected during the final stage of

(a) Quantities available for resuspension include 10 percent of the activation products, 10 percent of the fuel debris distributed throughout the piping of the reactor coolant system during decontamination of the reactor coolant system, and 100 percent of the radionuclides dispersed throughout the facility (and mostly found in the reactor building basement and D-ring areas), including the 7.1 pounds (3.2 kilograms) of fuel assumed to remain on the reactor building basement floor.

TABLE 3.15. 50-Year Dose Commitments from Routine Liquid Releases Resulting from Delayed Cleanup[a]

Stages of Delayed Decommissioning	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual: Susquehanna River Water, Fish, Activities, mrem	Dose to Maximally Exposed Offsite Individual: Chesapeake Bay Shellfish, mrem	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Population, thousands	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Dose, person-rem	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Population, millions	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
PDMS Preparations	1	Bone	0.001	0.00009	340	0.02	2.5	0.0002	0.04
		Total body	0.0003	0.000003		0.0003		0.000006	0.001
PDMS	23	Bone	0.02	0.0003	350 to 460	0.06	2.5 to 3.3	0.001	0.2
		Total body	0.02	0.00005		0.007		0.0002	0.02
	5	Bone	0.005	0.00009	350 to 370	0.02	2.5 to 2.7	0.0002	0.04
		Total body	0.004	0.00001		0.001		0.00002	0.004
	33	Bone	0.03	0.0004	350 to 510	0.09	2.5 to 3.7	0.002	0.3
		Total body	0.03	0.00007		0.01		0.0003	0.04
Cleanup	4, following 23-yr PDMS	Bone	0.2	0.006	460	1.3	3.3	0.03	3.7
		Total body	0.1	0.0004		0.07		0.002	0.2
	4, following 5-yr PDMS	Bone	0.2	0.006	370	1.1	2.7	0.02	2.9
		Total body	0.1	0.0004		0.06		0.001	0.2
	4, following 33-yr PDMS	Bone	0.2	0.006	510	1.4	3.7	0.04	5.2
		Total body	0.1	0.0004		0.08		0.003	0.3

(a) Does not include dose associated with decommissioning or refurbishment.

defueling or from releases currently occurring, except as discussed in Section 3.1.2.2.

During PDMS. Routine liquid releases of radionuclides during PDMS are expected to be the same as those described in Section 3.1.2.2. The methodology used to calculate the liquid release rates is identical to that given in Section 3.1.2.2. The annual liquid release rates calculated for PDMS are the same as those shown in Table D.3 of Appendix D.

Cleanup Following PDMS. Liquid releases to the Susquehanna River will also occur during the 4-year period expected for the cleanup following PDMS. The liquids will be composed largely of water used for decontamination: from the flushing and decontamination of the reactor coolant system and the reactor coolant drain tank, and from the removal of contamination from other areas of the facility. Liquids that are not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a), and the licensee's technical specifications would be processed through the EPICOR II system. Maximum releases of 250,000 gallons (950,000 liters) per year were assumed, based on information given in the PEIS. The concentration of radionuclides in any liquids directly releasable would be equal to or less than the limits specified in 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a). Liquids released following processing through the EPICOR II system would have radionuclide concentrations below the 10 CFR 20 limits. The amount of radioactive material assumed to be released as liquid during cleanup following PDMS was estimated using the same methodology given for routine liquid releases during PDMS. Radionuclides associated with both dispersed isotopes and fuel debris were considered (see Table 2.4). The decay of radionuclides during PDMS was accounted for in the calculations. The amount of radioactive material calculated to be released annually in liquid releases during cleanup following PDMS is shown in Table D.9 of Appendix D.

3.2.2.3 Accidental Atmospheric Releases

The potential for each of the three accidents listed in Section 3.1.2.3 to result in an airborne release of radionuclides was evaluated for each stage of the delayed cleanup alternative. If the potential existed for a specific accident, the impact of the accident on the offsite populations was evaluated quantitatively.

Table 3.16 shows the results of this evaluation. The table lists the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental atmospheric releases during each stage of the delayed cleanup where there was a potential for an accident. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption

TABLE 3.16. 50-Year Dose Commitments from Accidental Atmospheric Releases During Delayed Cleanup[a]

Stages of Delayed Cleanup	Accident Description	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
PDMS	Fire in stairwell (start of PDMS)	Bone	13	2.5	0.8	0.1
		Total body	1.6		0.4	0.04
Cleanup	Fire in stairwell					
	following 23-yr PDMS	Bone	0.07	3.3	0.009	0.0001
		Total body	0.008		0.006	0.0001
	following 5-yr PDMS	Bone	0.08	2.7	0.007	0.001
		Total body	0.02		0.004	0.0004
	following 33-yr PDMS	Bone	0.06	3.7	0.008	0.0001
		Total body	0.006		0.005	<0.00001
	HEPA filter failure					
	following 23-yr PDMS	Bone	89	3.3	9.7	0.3
		Total body	9.7		6.9	0.1
	following 5-yr PDMS	Bone	140	2.7	7.7	1.4
		Total body	15	4.8	0.5	
	following 33-yr PDMS	Bone	70	3.7	8.3	0.1
		Total body	8.1		6.0	<0.01
	Decontamination liquid spill					
	following 23-yr PDMS	Bone	0.2	3.3	0.08	0.001
		Total body	0.006		0.004	<0.00001
	following 5-yr PDMS	Bone	0.4	2.7	0.04	0.002
		Total body	0.008		0.002	0.0001
	following 33-yr PDMS	Bone	0.2	3.7	0.09	<0.0001
		Total body	0.005		0.005	<0.00001

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

Accidents occurring during preparations for PDMS are similar to those evaluated in the PEIS and are not evaluated further in this supplement. Accidents occurring during PDMS were conservatively assumed to occur early in the storage period. Thus, the dose commitments shown in Table 3.16 apply to storage periods of varying lengths. Dose commitments estimated for accidents during cleanup following PDMS, however, were estimated for the 4-year period following a 23-year storage period, as well as for the 4-year period following storage periods of 5 and 33 years.

The specific assumptions used to determine the potential for each of the accidents listed in Section 3.1.2.3 during the stages of delayed cleanup and the assumptions used to quantify the impact from the potential accidental atmospheric releases are discussed in the following sections.

Preparations for PDMS. The potential for accidental atmospheric releases during preparations for PDMS is expected to be similar to or less than the accident potential during the latter stages of defueling, which was evaluated in the PEIS. The preparations to place TMI-2 into PDMS are similar to and are combined with the current cleanup activities. They are not expected to increase the potential for releasing airborne contamination even if an accident should occur.

During PDMS. The potential for accidental atmospheric releases was evaluated for PDMS as discussed in Section 3.1.2.3 for PDMS during delayed decommissioning. The same potential and the same impacts exist for accidental atmospheric releases during PDMS in delayed cleanup. The fire in the stairwell/elevator structure was identified as the only accident that could occur during PDMS that would credibly result in an atmospheric release of radionuclides.

Cleanup Following PDMS. All three of the potential accidents resulting in atmospheric releases that are identified and listed in Section 3.1.2.3 could result in atmospheric releases during cleanup following PDMS. The analysis of the potential impact from a fire in the stairwell/elevator structure was based on the same assumptions as those given in Section 3.1.2.3 for preparations for decommissioning in the licensee's proposal for delayed decommissioning.

As explained in Section 3.1.2.3, HEPA filters may fail because of physical damage such as puncture, because of extreme pressure differentials, and because of water damage over a long period of time. For this reason, periodic in-place testing is required; however, for the purposes of accident analysis, the failure of both stages of a double-stage HEPA filter (a very low probability) was assumed to occur at the most critical time during the cleanup process, when the largest amount of airborne contamination would be present in the reactor building. This was assumed to be during demolition of the stairwell/elevator structure. Although it is expected that precautions would be taken to minimize airborne contamination, a fraction of the radionuclide inventory (0.01 percent) was assumed for this analysis to become uniformly dispersed in the reactor building air. A failure of the HEPA filters in one of the ventilation trains would be discovered because of the increased radiation levels recorded by the ventilation stack monitor and the ventilation would be closed off or diverted to the other ventilation train. However, assuming a maximum ventilation rate of 25,000 cubic feet per minute (710 cubic meters per minute) and a 10-minute interval between failure and corrective action, an estimated 250,000 cubic feet (7100 cubic meters) of air would have been ventilated with a fraction (0.125) of the airborne activity that would be suspended in the reactor building. The maximum amount of radioactive material calculated to be released during this type of accident is shown in Table D.10 of Appendix D.

The consequences of an atmospheric release from an accidental spill of decontamination solution from the reactor coolant system were discussed in the PEIS. The consequences are reevaluated in this report based on the quantity of radionuclides (activation products and radionuclides associated with fuel debris) assumed to remain in the reactor coolant system after the end of the PDMS period. For this evaluation, it was assumed that during the decontamination process, 10 percent of the maximum possible amount of activity in the untreated decontamination solution could be spilled before corrective action would be taken. Of this 10 percent, 0.1 percent of the spilled activity was assumed to become airborne. The fraction of the airborne radioactive material that would penetrate the double-stage HEPA filters was conservatively assumed to be 0.0001. The amount of radioactive material calculated to be released during this type of accident is shown in Table D.11 of Appendix D.

3.2.2.4 Accidental Liquid Releases

The potential for accidents resulting in liquid releases of radionuclides during delayed cleanup was evaluated. As discussed in Section 3.1.2.4, the evaluated accident involved the rupture of a tank containing liquid that had been treated at least partially to remove radioactive material. The potential for this accident during the three stages of delayed cleanup is discussed in the following sections. The impact of the accident was evaluated quantitatively for the cleanup period following PDMS, the only stage of delayed cleanup where the evaluation indicated that an accidental liquid release could occur.

Table 3.17 shows the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental liquid releases during each stage of delayed cleanup where there was a potential for an accident. The dose pathways to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius include the drinking of Susquehanna River water, consumption of fish taken from the river, participation in rivershore activities, and consumption of shellfish from the Chesapeake Bay, as described in Section 3.1.2.2. The dose commitment to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The assumptions used to determine the potential for an accidental liquid release of radionuclides during the stages of delayed cleanup and those used to quantitatively evaluate the impact from an accidental liquid release during the cleanup period following PDMS are discussed in the following sections.

<u>Preparations for PDMS</u>. The potential for accidental liquid releases during preparations for PDMS is expected to be similar to or less than the accident potential during the latter stages of defueling, which was evaluated in the PEIS and is not evaluated further in this supplement. The preparations to place the TMI-2 facility into PDMS are similar to and are combined with the current cleanup activities. They are not expected to increase the potential for releasing waterborne contamination even if an accident should occur.

<u>During PDMS</u>. No credible accidents that would result in a liquid release during the transfer or processing of liquids accumulated during the PDMS period were identified, as discussed in Section 3.1.2.4.

<u>Cleanup Following PDMS</u>. In evaluating this alternative, the staff assumed that during the cleanup any liquids not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a) and the licensee's technical specification limits would be processed through the EPICOR II system before being released. However, it is possible that under some circumstances large quantities of water would be stored in an outside 11,000-gallon (42,000-liter) storage tank before being released. Although this water would have been processed before being placed in the storage tank, the accident analysis presented here assumes that partially processed water (e.g., water that had been processed through a spent resin column) is placed in an 11,000-gallon (42,000-liter) storage tank while awaiting sampling analysis. The assumed pathway for an accidental waterborne release involves the rupture of the storage tank with the entire inventory released to the Susquehanna River. In Supplement 2 a similar accident was evaluated, assuming that the entire inventory of the tank spilled directly into the river, even though it was considered unlikely that more than a few thousand gallons would reach the Susquehanna River via normal runoff channels. The concentration of each radionuclide that could be in the water (based on the list of radionuclides in Table 2.4) was conservatively estimated to be comparable to the

TABLE 3.17. 50-Year Dose Commitments from Accidental Liquid Releases During Cleanup Phase of Delayed Cleanup[a]

Accident Description	Dose Location	Dose to Maximally Exposed Offsite Individual: Susquehanna River Water, Fish, Activities, mrem	Dose to Maximally Exposed Offsite Individual: Chesapeake Bay Shellfish, mrem	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Population, thousands	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Dose, person-rem	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Population, millions	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
Storage tank rupture during cleanup following 23-year PDMS	Bone	0.002	0.0001	460	0.03	3.3	0.0008	0.1
	Total body	0.0003	0.000008		0.0006		0.00005	0.007
Storage tank rupture during cleanup following 5-year PDMS	Bone	0.002	0.0001	370	0.02	2.7	0.0003	0.07
	Total body	0.0003	0.000008		0.0004		0.00002	
Storage tank rupture during cleanup following 33-year PDMS	Bone	0.002	0.0001	510	0.03	3.7	0.001	0.1
	Total body	0.0003	0.000008		0.0007		0.00006	0.008

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

concentration given in Table 2.2 of Supplement 2[a] (for the case where 40 percent of the total stored accident-generated water had been processed). The lower limit of detection was assumed for those radionuclides not detected in the accident-generated water. The amount of radioactive material calculated to be released during this accident is shown in Table D.12 of Appendix D.

3.2.3 Occupational Radiation Dose Evaluation for Delayed Cleanup

The occupational radiation dose from placing the TMI-2 facility in PDMS, maintaining PDMS for 23 years, and then completing cleanup is estimated to be 1500 to 4000 person-rem, as shown in Table 3.18. Table 3.18 also presents occupational dose estimates assuming 5 years of PDMS (3300 to 8400 person-rem) and 33 years of PDMS (1300 to 3300 person-rem). These doses are in addition to the occupational dose already received and the dose required to complete defueling. The occupational dose estimates are higher for shorter periods of PDMS because (1) the labor-intensive post-PDMS cleanup activities would be performed under higher exposure rates and (2) it is likely that robotic technology would be less developed.

TABLE 3.18. Occupational Radiation Dose Estimate for Delayed Cleanup[a]

	Occupational Dose, person-rem		
Task Description	23-year PDMS	5-year PDMS	33-year PDMS
Pre-PDMS preparation	2.0 to 20	2.0 to 20	2.0 to 20
Maintenance of facility in PDMS[b]	74 to 190	20 to 50	95 to 240
AFHB cleanup	12 to 30	58 to 120	9.3 to 23
Reactor coolant system decontamination	16 to 410	47 to 820	13 to 330
Reactor building basement general cleanup	310 to 680	600 to 1300	250 to 540
Reactor building cubicle cleanup	250 to 560	570 to 1300	200 to 440
Reactor building blockwall removal	11 to 230	70 to 540	8.9 to 190
D-ring dose reduction	110 to 230	320 to 690	84 to 180
D-ring final decontamination	170 to 360	330 to 730	130 to 280
Dome and polar crane decontamination	3.0 to 5.9	8.9 to 18	2.3 to 4.7
Reactor building 347-foot elevation cleanup	53 to 120	160 to 360	42 to 98
Reactor building 305-foot elevation cleanup	83 to 180	250 to 560	65 to 140
Engineering support	24 to 59	53 to 120	19 to 47
Health physics support	200 to 570	480 to 1300	160 to 450
Radioactive waste handling	210 to 330	329 to 490	170 to 260
Total[c]	1500 to 4000	3300 to 8400	1300 to 3300

(a) Does not include dose associated with decommissioning or refurbishment.
(b) Does not include the dose to make inspections and evaluations in order to plan post-PDMS work.
(c) The totals may not be exact because of rounding.

(a) Except for the concentration of tritium, which during the cleanup following PDMS would be greatly reduced from the amount present in the accident-generated water (as given in Table 2.4 of Supplement 2).

The estimates presented in Table 3.18 are based on a task-by-task analysis of the work to be done. They are presented as ranges of values because of the uncertainties in the cleanup process and the technology that will be available when post-storage cleanup is performed. The range of values occurs because of uncertainties in the location and depth of penetration of the contamination, the robotic technology that will be available, and the approach to cleanup that will be taken. For example, it is not known if workers would need to enter the basement during decontamination, and if waste would have to be manually packaged when removed from the basement. A discussion of the methodology used to calculate the occupational doses is found in Appendix H.

The estimates are somewhat lower than the estimates given in Supplement 1 to the PEIS for delayed cleanup involving an interim monitored storage phase. The principal reason is that the estimates in Supplement 1 did not include as extensive a use of robotics as now appears likely. However, robotics currently are being used effectively by the licensee in desludging and scabbling the basement; their use following PDMS is considered likely.

3.2.4 Waste Management Considerations of Delayed Cleanup

The quantity, radiation level, and classification of waste that would be produced by delayed cleanup have been evaluated on the basis of current regulatory requirements. Preparations for PDMS would generate additional compacted, dry radioactive waste, which would be Class A or B waste, as defined by 10 CFR 61 (CFR 1988a) (see Section 2.3.2 and Appendix F for a discussion of waste classification). The estimated ratio of Class A to Class B waste would be approximately 20:1. Maintenance of the reactor in the PDMS configuration could generate waste consisting of HEPA filters and disposable protective clothing. Treatment of water and decontamination solutions would generate additional waste that could be Class A, B, or C. However, the quantities would be rather small and it is expected that they would be stored onsite until a sufficient volume is generated to make a full shipment. Table 3.19 shows the estimated range of quantities of waste expected to be generated during preparations for PDMS and during PDMS periods of 23, 5, and 33 years.

Cleanup activities following PDMS will generate waste from a number of processes, including decontamination of the reactor coolant system, removal of contaminated portions of the reactor vessel head and control rod drive mechanisms, removal of the stairwell and elevator shaft in the basement, and removal of temporary shielding that has been placed in the reactor building. These activities will also generate secondary waste consisting of disposable protective clothing, tools, etc. The estimated volumes and classes of waste that would be generated during final cleanup following PDMS are shown in Table 3.20.

TABLE 3.19. Waste Volume Estimates for PDMS Preparations and PDMS During Delayed Cleanup[a]

	Total Waste Volume					
	23-year PDMS		5-year PDMS		33-year PDMS	
Class of Waste[b]	ft^3	m^3	ft^3	m^3	ft^3	m^3
Preparations for PDMS						
Class A or B	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7
PDMS						
Class A dry radioactive waste	690 to 2300	20 to 65	150 to 500	4.3 to 14	990 to 3300	28 to 93
Class B or C air filters	0 to 1400	0 to 41	0 to 310	0 to 8.8	0 to 2100	0 to 58
Class A, B, or C residue from liquid waste treatment	120 to 460	3.4 to 13	25 to 100	0.71 to 2.8	170 to 660	4.8 to 19

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

For delayed cleanup, the staff has assumed that waste generated before the year 2001 would be disposed of at a currently licensed site and waste generated during and after 2001 would be disposed of at a regional site. The currently licensed site was assumed to be the facility operated by U.S. Ecology near Richland, Washington. An unspecified site 250 miles (400 kilometers) from the plant was assumed for the regional disposal site, as discussed in Section 2.3.5. The impact of the waste after disposal at either of these sites is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the waste disposal sites.

It is possible that some of the waste generated could exceed Class C limits, in which case it could not be accepted by a licensed burial site. However, the licensee has a unique agreement with the U.S. Department of Energy that allows such wastes to be transferred to the DOE on a cost-reimbursement basis, as explained in Section 3.1.4.

The environmental impact of transporting waste generated during delayed cleanup was estimated, assuming use of the waste containers specified in Section 3.1.4. Table 3.21 summarizes the estimated number of shipments of Class A waste and unspecified (Class A, B, or C) waste to the Richland, Washington, site and the regional disposal site for delayed cleanup with storage periods of 23, 5, and 33 years. For the purposes of estimating impacts, it was assumed that the unspecified waste would all be Class C waste.

The methodology for assessing shipping impacts is described in Appendix F. Table 3.22 provides a summary of shipping impacts for

TABLE 3.20. Waste Volume Estimates for Cleanup Following PDMS During Delayed Cleanup[a]

Class of Waste[c]	23-year PDMS[b] Total Waste Volume ft^3	m^3
Class A	91,000 to 120,000	2,600 to 3,400
Class C	19,000 to 33,000	540 to 930
Class A, B, or C	9,600 to 29,000	270 to 810
Greater than Class C	Some possible	Some possible

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste volumes for delayed cleanup following 5 years and 33 years of PDMS are assumed to be the same.
(c) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

TABLE 3.21. Estimated Number of Waste Shipments for Delayed Cleanup[a]

PDMS Period	Number of Shipments: Richland, WA	Number of Shipments: Regional Disposal Site
23-year PDMS		
Class A	2 to 6	423 to 564
Unspecified waste[b]	1 to 6	202 to 444
5-year PDMS		
Class A	422 to 561	---[c]
Unspecified waste[b]	202 to 439	---[c]
33-year PDMS		
Class A	2 to 6	424 to 568
Unspecified waste[b]	1 to 6	202 to 450

(a) Does not include shipments during decommissioning.
(b) Unspecified waste was considered Class C waste.
(c) A regional disposal site is not expected to be available during delayed cleanup with a 5-year period of PDMS.

delayed cleanup assuming 23, 5, or 33 years of PDMS. Shipping impact estimates are given for total population dose and truck crew dose resulting from transportation to disposal sites; number of traffic accidents, injuries, and fatalities; the population dose from transportation accidents; and transportation costs.

Transportation of this waste would result in the exposure of some members of the public to a very low radiation dose. The principally exposed group would be the truck crews; however, others would also be exposed, such as those present at truck stops, travelers on the highways, and residents along the highways. The total transportation dose for delayed cleanup with a 23-year storage period, excluding the dose from accidents that may occur during shipments, is expected to be 9.7 to 19 person-rem. The truck crews would receive the greatest portion of this dose, 6.5 to 13 person-rem.

As with transportation of any materials, there is a possibility that incidents during transportation may result in traffic accidents with or without injuries or fatalities. The estimated number of traffic accidents that might occur during the entire shipping program for delayed cleanup with a 23-year storage period was 0.6 to 1.1, depending on the final waste volume. The staff estimated the number of injuries occurring during this shipping program at about 0.3 to 0.6

TABLE 3.22. Summary of Transportation Impacts for Delayed Cleanup[a]

PDMS Duration	Dose Resulting from Transporation to Disposal Site, person-rem			Traffic Accidents			Population Dose from Transportation Accidents, person-rem	Transportation Costs, $ millions
	Total[b]	Population[c]	Truck Crew	Number of Accidents	Number of Injuries	Number of Fatalities		
23-year	9.7 to 19	3.2 to 6.3	6.5 to 13	0.6 to 1.1	0.3 to 0.6	0.03 to 0.05	0.0009 to 0.002	1.1 to 1.8
5-year	91 to 170	31 to 56	60 to 110	4.5 to 7.2	3.9 to 6.3	0.3 to 0.5	0.005 to 0.01	4.2 to 6.8
33-year	9.7 to 19	3.2 to 6.4	6.5 to 13	0.6 to 1.1	0.4 to 0.6	0.03 to 0.05	0.0009 to 0.002	1.1 to 1.8

(a) Does not include transportation impacts associated with decommissioning or refurbishment.
(b) The totals may not be exact because of rounding.
(c) Dose to persons who live or work in the vicinity of the highway, persons who travel on the highway used for shipments, and bystanders at truck stops.

(the probability of an injury accident during the entire shipping program is between approximately 3 to 6 chances in 10) and the number of fatalities at about 0.03 to 0.05 (the probability of a fatality during the entire shipping program is between approximately 3 to 5 chances in 100). Appendix F provides additional details regarding the analysis of transportation accidents.

There is also a small probability that accidents may be severe enough to result in the breach of a waste container and release of some of the waste, as discussed in Section 3.1.4. The staff estimated that a dose of about 0.0009 to 0.002 person-rem would result from accidents during shipment of all the waste generated during delayed cleanup with a 23-year storage period.

The transportation costs are discussed in Section 3.2.6.

3.2.5 Socioeconomic Impacts of Delayed Cleanup

The direct socioeconomic impacts of delayed cleanup were evaluated. The basis for the evaluation is included in Appendix G. The socioeconomic impacts of delayed cleanup are expected to be slight. The 1987-1988 work force of approximately 1150 would continue to be reduced to a work force of 100 to 125 in the first year of PDMS and 70 to 75 during subsequent years. Cleanup following PDMS would probably be completed with a somewhat smaller staff than currently in use but larger than the PDMS staff. The staffing level for this phase has been assumed by the staff to be between 50 and 100 percent of the size of the 1987-1988 defueling work force. However, the exact size would depend on available technology and future plans for the facility.

Approximately 70 percent of the current work force resides in the Harrisburg-Lebanon-Carlisle labor market (Cumberland, Dauphin, Lebanon, and Perry Counties) and 25 percent in Lancaster County. In these areas, the economic impact of the reduced labor force might be most noticeable. Licensee-funded jobs in this area are expected to support approximately half again the number of jobs in the surrounding communities. However, because the employment reduction at the beginning of PDMS amounts to 0.2 percent of the local baseline employment, the impact should be minor.

The annual labor cost for the 1987-1988 staffing level is about \$57.5 million per year, which would be reduced to \$5.0 million to \$6.3 million for the first year and \$3.5 million to \$3.8 million per year during the remainder of PDMS. For the 4-year cleanup following PDMS, the labor cost is estimated to be \$120 million to \$230 million. The impact to the total income of the local communities is expected to be about twice the payroll level, \$12 million to \$13 million for the first year, about \$7 million to \$8 million per year thereafter during PDMS, and \$240 million to \$460 million for the 4-year cleanup following PDMS.

3.2.6 Commitment of Resources During Delayed Cleanup

The principal resources committed in the delayed cleanup of TMI-2 will be money and radioactive burial ground space. Other resources, such as energy and ion exchange resins, will be relatively minor.

The cost estimates for delayed cleanup are in 1988 dollars for the purpose of comparison with other alternatives, although it is recognized that most of the resources required will be needed at the time of facility cleanup following PDMS. The cost of delayed cleanup for the 23-year period of PDMS is $210 million to $340 million, as shown in Table 3.23. Table 3.23 also presents cost estimates for delayed cleanup assuming 5 years of PDMS ($150 million to $270 million) and 33 years of PDMS ($250 million to $370 million). These estimates include the labor costs addressed in Section 3.2.5, the waste transportation charges addressed in Section 3.2.4, and the waste disposal costs discussed below.

Uncertainties in the labor cost are due to inflation, overhead costs, and uncertainties in staffing requirements. The greatest uncertainty in the labor cost will be the staffing required to

TABLE 3.23. Cost of Delayed Cleanup[a]

Type of Cost	Projected Cost for Lengths of PDMS, $ million[b] 23-year	5-year	33-year
Labor Costs			
Preparations for PDMS	3.2 to 6.3	3.2 to 6.3	3.2 to 6.3
First year of PDMS	5.0 to 6.3	5.0 to 6.3	5.0 to 6.3
Remaining years of PDMS	77 to 83	14 to 15	110 to 120
4 years of cleanup following PDMS	120 to 230	120 to 230	120 to 230
Waste Disposal Costs			
Pre-PDMS and PDMS waste	0.05 to 0.2	0.01 to 0.06	0.06 to 0.3
Post-PDMS cleanup waste	6.0 to 9.2	6.0 to 9.2	6.0 to 9.2
Waste Transportation Costs	1.1 to 1.8	4.2 to 6.8	1.1 to 1.8
Total[c]	210 to 340	150 to 270	250 to 370

(a) Does not include cost of decommissioning or refurbishment.
(b) In 1988 dollars.
(c) The totals may not be exact because of rounding.

complete the cleanup after PDMS, as discussed in Section 3.2.5. It was further assumed that any robotic costs would reduce the labor cost; therefore, they are not estimated as a separate cost. This estimate could be much too high if major portions of the work could be performed by relatively inexpensive, unsupervised robots. An additional cost may result from retraining workers before the resumption of cleanup operations. This cost, which would mostly be seen in additional training expense, is also not readily quantified.

The LLW disposal costs for both present and future waste disposal are 1988 rates. The 1988 disposal charge is approximately $50 per cubic foot ($1800 per cubic meter) plus surcharges for higher-than-normal radiation dose rates or curie content. These rates were raised approximately 18 percent from 1987 to 1988. Future rates are highly uncertain, especially disposal rates at a regional repository. Costs might be too low if there is significant escalation in waste disposal requirements, requirements for waste handling and packaging, or waste disposal costs. The required waste burial ground space is estimated to be 121,000 to 187,000 cubic feet (3420 to 5310 cubic meters) for 23 years of PDMS; 120,000 to 184,000 cubic feet (3410 to 5210 cubic meters) for 5 years of PDMS; and 121,000 to 189,000 cubic feet (3430 to 5360 cubic meters) for 33 years of PDMS.

Waste disposal costs are related not only to waste volume and classification, about which there are uncertainties at present, but also to the technology used to dispose of the waste. Current waste disposal technology involves shallow land burial. Many of the regions are considering alternative technologies, such as disposal in concrete bunkers and other engineered structures. Such alternative technologies may be more costly.

Waste transportation costs are closely related to the cost of energy and the distance between the disposal site and the TMI site. Accordingly, costs for transportation of waste to a regional site will be less than those for transportation to the currently operated disposal facility near Richland, Washington.

3.2.7 Regulatory Considerations of Delayed Cleanup

There are no regulatory considerations that would prevent the licensee from implementing long-term monitored storage of the facility, as discussed in Section 3.1.7. The post-storage cleanup activities of this alternative could be requested by the licensee and permitted under a license amendment at a later time.

3.3 IMMEDIATE CLEANUP

Immediate cleanup, as currently envisioned by the NRC staff, is described in Section 3.3.1. The offsite dose evaluation is discussed in Section 3.3.2, occupational dose estimates in Section 3.3.3, waste management impacts including those from transportation in Section 3.3.4, socioeconomic impacts in Section 3.3.5, commitment of resources in Section 3.3.6, and regulatory considerations in Section 3.3.7.

3.3.1 Description of the Immediate Cleanup Alternative

Immediate cleanup involves continuation of the cleanup process at the 1983-1987 level of effort, using a work force the size of the 1987-1988 work force. However, the staff has assumed that a 2-year period between the completion of defueling and the continuation of the cleanup would be necessary for the licensee to complete an engineering study in preparation for continued cleanup as well as to return the work force to the 1987-1988 levels. The engineering study was assumed to start in early 1990 following the current defueling phase. Following the 2-year period for engineering study (ending in 1992), immediate cleanup could be performed over a period of 3 to 4 years. After completion of the cleanup, the facility could be either refurbished or decommissioned. Although the cleanup would be considered to be complete (i.e., achieving radiation levels comparable to an undamaged reactor facility nearing the end of its operating life), it is possible that the licensee would choose not to decommission or refurbish the facility immediately but would place the facility in storage until TMI-1 is ready for decommissioning. For this reason, a period of storage following the completion of cleanup is also evaluated. Decommissioning or refurbishing impacts, however, are not evaluated in this supplement.

3.3.1.1 Two-year Engineering Study

The current defueling effort, expected to result in the removal of more than 99 percent of the fuel, would be complete before the engineering study phase. In addition, the four activities discussed in Section 3.0 will have occurred or be underway: decontamination of the building and equipment surfaces to levels approximating the licensee's established goals (see Table 3.2), packaging and disposal of radioactive wastes associated with decontamination activities, removal of the accident-generated water from the reactor building and the AFHB, and quantification of the residual fuel remaining in the facility. Activities such as those conducted during preparations for PDMS (e.g., the deactivation and preservation of equipment, the sealing of fuel transfer tubes, and extensive monitoring of the facility to provide a data base for plant trends, as discussed in Section 3.1) would not be conducted before the engineering study. During the engineering study, the ventilation systems and fire detection systems would remain in their current operating state.

The major emphasis during this 2-year period would be on conducting an engineering analysis to prepare for immediate cleanup. Limited amounts of decontamination work might be performed, but only in support of the engineering analysis. In addition, personnel would be hired and trained in order to return the work force to the size of the 1987-1988 work force.

3.3.1.2 Cleanup

Following the 2-year engineering study, cleanup of the facility would continue, which would require 3 to 4 years to complete.

The cleanup processes are assumed to be similar to those projected by the staff in evaluating the delayed cleanup alternative in Section 3.2.1.1. The differences are as follows: (1) a 2-year period for planning and engineering development would be necessary before the cleanup process; (2) a period of 3 to 4 years would be necessary for cleanup, rather than a full 4 years, because any additional time required to assemble a work force and train them regarding facility conditions would have largely occurred during the engineering study; (3) advances in robotic technology that would have occurred during an intervening PDMS period would probably not be available following the engineering study; (4) radiation dose rates would not be reduced significantly during the engineering study; and (5) wastes would be shipped to a currently licensed site (assumed to be the facility operated by U.S. Ecology near Richland, Washington).

3.3.1.3 Potential Storage Period Following Cleanup

Following cleanup, the dose rates in the facility would be similar to dose rates in an operating reactor facility (one that has not undergone a serious accident) at the end of its useful life. At this point, the facility would be ready for decommissioning or refurbishment. However, it is possible that the licensee would not immediately decommission or refurbish the facility. For this reason, the impacts of a storage period following the completion of cleanup were evaluated. Only a brief preparation period would be necessary before storage and the preparations would be performed as part of the cleanup process. The storage period following immediate cleanup would essentially be equivalent to the PDMS period discussed in Section 3.1.1.3. The ventilation system, the facility monitoring and inspection program, and the environmental monitoring program would all be maintained in a manner similar to that described in Section 3.1.1.3. However, because the amount of contamination in the facility would be considerably less than during PDMS (as discussed in Section 3.3.2.1), entries were assumed to be once a quarter from the initiation of the storage period. A storage period of 18 to 19 years was assumed, based on the expected 5 to 6 years necessary to complete the cleanup (including the 2-year engineering study and the 3- to 4-year cleanup) and on the expected expiration of the Unit-1 license in 2014.

3.3.2 Offsite Dose Evaluation for Immediate Cleanup

The evaluation of the radiation dose to the offsite population as a result of the immediate cleanup alternative includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.3.2.1 Routine Atmospheric Releases

The magnitude and impact of routine atmospheric releases of radioactive material will vary depending on the stage of the immediate cleanup process. These stages, as described in Section 3.1.1, include (1) the 2-year engineering study, (2) the cleanup process, and (3) the potential period of storage following immediate cleanup. Table 3.24 shows the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine atmospheric releases during the three stages of immediate cleanup. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The specific assumptions used during the calculation of the impacts for each of the cleanup stages during immediate cleanup are discussed in the following sections.

Two-Year Engineering Study. Fewer entries will be made into the reactor building than are currently made, and no activities are expected during the 2-year engineering study, other than those performed in support of the study. In addition, it is assumed that the ventilation system would remain operable during the 2-year period for the engineering study. Thus, the atmospheric releases from the facility during the 2-year engineering study are assumed to be similar to those during the current defueling period, as shown in Table 3.5. The annual release rates for the 2-year period for engineering study are shown in Table D.13 of Appendix D.

Cleanup. The routine releases of radioactive material from the TMI-2 facility occurring by atmospheric pathways during cleanup are also not expected to differ much from those occurring during the defueling period (see Table 3.5). Some rise in effluent concentrations, however, may be experienced during aggressive decontamination efforts, such as those that might accompany the decontamination or removal of the concrete-block stairwell/elevator structure. These operations could increase the amount of activity in the reactor

TABLE 3.24. 50-Year Dose Commitments from Routine Atmospheric Releases Resulting from Immediate Cleanup[a]

Stages of Immediate Cleanup	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
Engineering Study	2	Bone	0.05	2.5	0.01	0.002
		Total body	0.001		0.001	0.0001
Cleanup	4	Bone	2.3	2.6	1.0	0.04
		Total body	0.06		0.09	0.004
Potential Post-cleanup Storage	18	Bone	4.3	2.8 to 3.3	3.3	0.2
		Total body	0.5		2.3	0.1

(a) Does not include dose associated with decommissioning or refurbishment.

building atmosphere, thus increasing the amount of activity released from the facility through the double-stage HEPA filters.

Radionuclide releases from the reactor building into the atmosphere during immediate cleanup were estimated by applying the same method as that used to estimate releases for the cleanup period following PDMS (Section 3.2.2.1). However, the quantity of radionuclides released was adjusted to account for a 2-year period of radioactive decay rather than a 23-year period. The annual release rates calculated for atmospheric releases during a 4-year cleanup period are shown in Table D.14 of Appendix D.

Potential Storage Period Following Cleanup. It is possible that the licensee will choose to place TMI-2 in storage until TMI-1 is ready for decommissioning, rather than decommissioning or refurbishing the facility immediately after completion of the cleanup. Thus, the impacts of an atmospheric release during an 18-year storage period were evaluated. Radionuclide releases from the reactor building into the atmosphere during the potential storage period following immediate cleanup were estimated by applying the same method as that used to estimate releases from PDMS during delayed decommissioning (Section 3.1.2.1); however, the storage period was assumed to be only 18 years and the amount of activity contained in the reactor building would be substantially less than that assumed for the PDMS storage period. It was assumed that less than 5 percent of the radioactivity present in the stairwell/elevator structure and in the sludge remaining on the basement floor at the end of defueling would still remain in the basement following the cleanup. All of the remaining material in these locations was assumed to be available for suspension into the air. It was further assumed that less than 20 percent of the radioactivity present on the floor, concrete slab walls, and overhead structures, in the basement, and in the D-ring areas would remain following immediate cleanup. Of the remaining material in these locations, 10 percent (2 percent of the total) was assumed to be available for suspension into the air. A decontamination factor of 10, the ratio of the original level of radioactivity to the level that remains after decontamination, was assumed for both activation and fission products in the reactor coolant system piping and the reactor vessel. It was further assumed that none of the remaining activity in the reactor coolant system piping and the reactor vessel would be present in a resuspendible form. The annual release rates calculated for atmospheric releases during the potential 18-year storage period following cleanup are shown in Table D.15 of Appendix D.

3.3.2.2 Routine Liquid Releases

The magnitude and impact of routine liquid releases of radioactive material will also vary depending on the stage of the immediate cleanup process. Table 3.25 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the

TABLE 3.25. 50-Year Dose Commitments from Routine Liquid Releases Resulting from Immediate Cleanup[a]

Stages of Immediate Cleanup	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual: Susquehanna River Water, Fish, Activities, mrem	Dose to Maximally Exposed Offsite Individual: Chesapeake Bay Shellfish, mrem	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Population, thousands	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Dose, person-rem	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Population, millions	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
Engineering Study	2	Bone	0.002	0.00003	340	0.006	2.5	0.00009	0.02
		Total body	0.002	0.000004		0.0005		0.000009	0.002
Cleanup	4	Bone	0.2	0.006	360	1.1	2.6	0.02	2.9
		Total body	0.1	0.0004		0.06		0.001	0.2

(a) Does not include dose associated with decommissioning or refurbishment.

population outside the 50-mile (80-kilometer) radius as a result of routine liquid releases during the three stages of immediate cleanup. The dose pathways to the maximally exposed individual and to the offsite populations include the drinking of Susquehanna River water, consumption of fish inhabiting the river, participation in rivershore activities, and consumption of shellfish from the Chesapeake Bay, as described in Section 3.1.2.2. The dose to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The specific assumptions used in calculating the impacts for each of the stages during immediate cleanup are discussed in the following sections.

Two-Year Engineering Study. Liquid releases during the 2-year engineering study would come from inleakage from groundwater and precipitation or from any decontamination liquid that would be generated during this period. The quantity of liquid expected for annual release during this time is equivalent to the annual release during PDMS, that is, 5000 gallons (19,000 liters). The methodology used to calculate the annual liquid release rates is identical to that described in Section 3.1.2.2 for PDMS. The amount of radioactive material assumed to be released annually in liquid releases during the engineering study is shown in Table D.16 of Appendix D.

Cleanup. Liquid releases to the Susquehanna River would occur during the 4-year period expected for immediate cleanup. The liquids would largely consist of water used during the decontamination process to flush and decontaminate the reactor coolant system and the reactor coolant drain tank, as well as to remove contamination in other areas of the facility. Before they were released, the liquids would be processed through the EPICOR II system. Maximum releases of 250,000 gallons (950,000 liters) a year were assumed, based on information given in the PEIS. The methodology used to calculate the annual liquid release rates is identical to that used for the calculation of liquid release rates during cleanup following PDMS for the delayed cleanup alternative (Section 3.2.2.2), except that only a 2-year period for radioactive decay was assumed. The amount of radioactive material assumed to be released annually in liquid releases during the cleanup is shown in Table D.17 of Appendix D.

Potential Storage Period Following Cleanup. As discussed in Section 3.1.2.1, during PDMS, a discharge rate of 5000 gallons (19,000 liters) annually was assumed. A somewhat smaller rate could be assumed for the potential storage period following immediate cleanup because the volume would result only from water inleakage and would not include small quantities of water used for decontamination. However, the cleanup process would have removed contamination from the areas where any inleakage is expected (Section 3.1.1.3), and since no decontamination would occur during this time, it is unlikely that the accumulated liquids would contain measurable levels of contamination.

3.3.2.3 Accidental Atmospheric Releases

The potential for each of the three accidents listed in Section 3.1.2.3 to result in an airborne release of radionuclides was evaluated for each stage of the immediate cleanup alternative. If the potential existed for a specific accident, the accident's impact on the offsite population was evaluated quantitatively.

Table 3.26 shows the results of this evaluation. The table lists the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental atmospheric releases during each stage of immediate cleanup where there was a potential for an accident. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The following sections discuss the specific assumptions used to determine the potential for each of the accidents listed in Section 3.1.2.3 during the stages of immediate cleanup and the assumptions made for the quantification of the impact from the potential accidental atmospheric releases.

Two-Year Engineering Study. The only credible accident identified for the 2-year engineering study is a fire in the stairwell. The analysis of the impacts from this accident was based on assumptions similar to those found in Section 3.1.2.3 for the preparations for decommissioning. However, the level of radioactive contamination will be greater than during the decommissioning preparations because the accident is assumed to occur during the first year of the engineering study. The amount of radioactive material assumed to be released during this accident is shown in Table D.18 of Appendix D.

Cleanup. All three of the potential accidents resulting in atmospheric releases that were identified and listed in Section 3.1.2.3 could result in atmospheric releases during the cleanup period of the immediate cleanup alternative.

For the fire in the stairwell/elevator structure during immediate cleanup, the fraction of activity in the structure that is assumed to be released is the same as that for a fire during PDMS (described in Section 3.1.2.3). However, during immediate cleanup, double-stage HEPA filters would be used routinely in each train of the reactor building ventilation system. Thus, for a fire in the stairwell/elevator structure, the fraction of radioactive particulates

TABLE 3.26. 50-Year Dose Commitments from Accidental Atmospheric Releases During Immediate Cleanup[a]

Stages of Immediate Cleanup	Accident Description	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
Engineering Study	Fire in stairwell	Bone	0.2	2.5	0.01	0.001
		Total body	0.02		0.007	0.0003
Cleanup	Fire in stairwell	Bone	0.2	2.6	0.01	0.001
		Total body	0.02		0.007	0.0003
	HEPA filter failure	Bone	150	2.6	12.0	1.4
		Total body	16		8.4	0.5
	Decontamination liquid spill	Bone	0.4	2.6	0.07	0.001
		Total body	0.008		0.004	0.0001
Potential Post-cleanup Storage	Fire in stairwell	Bone	2.4	2.8	0.2	0.02
		Total body	0.3		0.2	<0.001

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

penetrating the HEPA filter was conservatively estimated at 0.0001 (see Section 3.1.2.3). In addition, the released inventory was adjusted to account for 2 years of radioactive decay. The amount of radioactive material calculated for release during this accident is shown in Table D.19 of Appendix D.

The accidental failure of both stages of a double-stage HEPA filter (an event with a very low probability of occurring) was assumed to occur at the most critical time during the immediate cleanup process; that is, during the postulated demolition of the stairwell/elevator structure (as in the cleanup following PDMS, Section 3.2.2.3). Both the assumptions given in Section 3.2.2.3 and the inventory of radionuclides were assumed to be the same for the cleanup stage of immediate cleanup, except that the inventory was adjusted to account for only a 2-year period of radioactive decay. The maximum amount of radioactive material calculated for release during this accident is shown in Table D.20 of Appendix D.

The consequences of an atmospheric release from an accidental spill of reactor coolant system decontamination solution inside the reactor building are discussed in Section 3.2.2.3 for the cleanup following PDMS. The assumptions made for the occurrence of this accident during the cleanup stage of immediate cleanup are the same as those presented in Section 3.2.2.3 for cleanup following PDMS, except that the inventory was adjusted to account for only a 2-year period of radioactive decay. The amount of radioactive material calculated to be released from the reactor building during this accident is shown in Table D.21 of Appendix D.

<u>Potential Storage Period Following Cleanup</u>. Of the accidents evaluated above for the immediate cleanup period, only the fire in the stairwell/elevator shaft was evaluated for the potential period of storage following PDMS. The assumption made previously, that 5 percent of the activity in the stairwell/elevator structure and fuel debris in basement sludge would remain following immediate cleanup, was used as a basis for the accident evaluation by conservatively assuming that the entire 5 percent of the radioactivity was involved during the fire. Single-stage HEPA filters were conservatively estimated to allow release of only a fraction (0.01) of the airborne inventory. In addition, the inventory was adjusted to account for 6 years of radioactive decay. The amount of radioactive material calculated for release during this accident is shown in Table D.22 of Appendix D.

3.3.2.4 Accidental Liquid Releases

The potential for accidents resulting in liquid releases of radionuclides during immediate cleanup was evaluated. As discussed in Section 3.1.2.4, the accident evaluated involved the rupture of a tank containing liquid that had been treated at least partially to remove radioactive material. The impact of the accident was evaluated quantitatively for the cleanup period, the only stage of immediate cleanup where the evaluation indicated that an accidental liquid release could occur.

Table 3.27 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental liquid releases during each stage of immediate cleanup where there was a potential for an accident. The dose pathways to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius include the drinking of Susquehanna River water, consumption of fish taken from the river, participation in rivershore activities, and consumption of shellfish from the Chesapeake Bay, as described in Section 3.1.2.2. The dose commitment to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The following sections discuss the specific assumptions used to determine the potential for an accidental liquid release of radionuclides during the stages of immediate cleanup and the assumptions used to quantitatively evaluate the impact from an accidental liquid release during the cleanup stage of immediate cleanup.

Two-Year Engineering Study. No accidental liquid releases were considered for the 2-year engineering study because no credible accidents would result in a liquid release during the transfer or processing of the liquids produced. The reasons are the same as those given in Section 3.1.2.4 for PDMS during the delayed decommissioning alternative.

Cleanup. The assumed pathway for an accidental liquid release of radionuclides during cleanup is the same as that assumed for cleanup following PDMS in the delayed cleanup alternative (see Section 3.2.2.4); that is, the release of contaminated water to the Susquehanna River from the rupture of an 11,000-gallon (42,000-liter) storage tank. The assumptions used to evaluate the impact of this accident are the same as those made in Section 3.2.2.4, except that the inventory was adjusted to account for only 2 years of radioactive decay prior to the accident. The amount of radioactive material calculated for release during this accident is shown in Table D.23 of Appendix D.

Potential Storage Period Following Cleanup. No accidents involving liquid releases were identified on the basis of the information given in Section 3.3.2.2 for liquid releases during the potential storage period following cleanup.

TABLE 3.27. 50-Year Dose Commitments from Accidental Liquid Releases During Cleanup Phase of Immediate Cleanup[a]

		Dose to Maximally Exposed Offsite Individual		Population Within 50-Mile Radius of TMI-2				Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
				Susquehanna River Water, Fish, Activities		Chesapeake Bay Shellfish		
Accident Description	Dose Location	Susquehanna River Water, Fish, Activities, mrem	Chesapeake Bay Shellfish, mrem	Population, thousands	Dose, person-rem	Population, millions	Dose, person-rem	
Storage tank rupture	Bone	0.002	0.0001	360	0.02	2.6	0.0004	0.07
	Total body	0.0003	0.000008		0.0005		0.00002	0.004

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

3.3.3 Occupational Radiation Dose Evaluation for Immediate Cleanup

The occupational radiation dose expected during the cleanup process described for the immediate cleanup alternative is estimated to be between 3700 and 9400 person-rem, as shown in Table 3.28. This estimate includes the doses for the 2-year engineering study and the 3- to 4-year cleanup period. This is the dose required to achieve radiation levels similar to those in an undamaged reactor nearing the end of its life and is in addition to the occupational radiation dose already received and the dose required to complete the defueling period. If a decision is made to put the reactor into storage for 18 years after cleanup, as discussed in Section 3.3.1, an additional 10 to 17 person-rem of dose would be incurred.

The estimates given in Table 3.28 are based on a task-by-task analysis of the work to be done and are presented as a range of values because of the uncertainties in the cleanup process and technology. The range is wide because of uncertainties in the location and depth

TABLE 3.28. Occupational Radiation Dose Estimates for Immediate Cleanup[a]

Task Description	Occupational Dose, person-rem
2-year engineering study	16 to 40
AFHB cleanup	65 to 140
Reactor coolant system decontamination	53 to 920
Reactor building basement general cleanup	670 to 1500
Reactor building cubicle cleanup	650 to 1400
Reactor building blockwall removal	77 to 610
D-ring dose reduction	360 to 780
D-ring final decontamination	370 to 820
Dome and polar crane decontamination	10 to 20
Reactor building 347-foot elevation cleanup	190 to 410
Reactor building 305-foot elevation cleanup	290 to 630
Engineering support	60 to 130
Health physics support	550 to 1400
Radioactive waste handling	360 to 550
Post-cleanup monitored storage (18 years)	10 to 17[b]
Total[c]	3700 to 9400

(a) Does not include dose associated with decommissioning or refurbishment.
(b) Not included in the total.
(c) The totals may not be exact because of rounding.

of penetration of contamination and in the methods that would be used for reactor coolant system decontamination. In addition, uncertainties exist regarding the effectiveness of the robots for performing many of the tasks. A discussion of the methodology used to calculate occupational doses is found in Appendix H.

This estimate is lower than the estimate that was presented for immediate cleanup in Supplement 1 to the PEIS. This is because the Supplement 1 estimate did not take into account the use of robotics to any appreciable extent. However, robotics currently are being used effectively by the licensee in desludging and scabbling concrete in the basement. The current estimate is within the range of the estimate presented in Supplement 1 for cleanup employing robotics.

3.3.4 Waste Management Considerations of Immediate Cleanup

During the 2-year engineering study, small amounts of LLW will be generated. Subsequent cleanup activities will generate waste from a number of processes, including decontamination of the reactor coolant system, removal of contaminated portions of the reactor vessel head and control rod drive mechanisms, removal of the stairwell/elevator structure in the basement, and removal of temporary shielding that has been placed in the reactor building. These activities will also generate secondary waste consisting of disposable protective clothing, tools, and equipment. The estimated volumes and classes of waste that would be generated during the 2-year engineering study and during the cleanup period are shown in Table 3.29. Quantities of waste generated during the potential 18-year storage period following cleanup would be small and were not quantified.

For immediate cleanup, the staff has assumed that the waste generated before the year 2001 would be disposed of at a currently licensed site, which was assumed to be the facility operated by U.S. Ecology near Richland, Washington. The impact of the waste after disposal at the LLW site is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the waste disposal site.

It is possible that some of the waste generated could exceed maximum Class C limits, in which case it could not be accepted by a licensed burial site. However, the licensee has a unique arrangement with the U.S. Department of Energy that allows such wastes to be transferred to the DOE on a cost-reimbursement basis, as explained in Section 3.1.4.

The environmental impact of transporting the waste generated during immediate cleanup was estimated from the curie estimates given in Section 2.2. The staff assumed that the waste would be shipped in the same containers that were assumed for delayed decommissioning (Section 3.1.4). Wastes were assumed to be shipped to the licensed LLW disposal site near Richland, Washington, with 421 to 559 shipments

TABLE 3.29. Waste Volume Estimates for Immediate Cleanup[a]

Class of Waste[b]	Total Waste Volume ft^3	Total Waste Volume m^3
2-Year Engineering Study		
Class A dry radioactive waste	60 to 200	1.7 to 5.7
Class B or C air filters	0 to 130	0 to 3.5
Class A, B, or C residue from liquid waste treatment	10 to 40	0.3 to 1.1
Cleanup Activities		
Class A waste	91,000 to 120,000	2,600 to 3,400
Class B waste	19,000 to 33,000	540 to 930
Class A, B, or C waste	9,600 to 29,000	270 to 810
Greater than Class C waste	Some possible	Some possible

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

of Class A waste and 201 to 438 additional shipments of unspecified waste (Class A, B, or C). For the purpose of assessing transportation impacts, it was assumed that the unspecified waste would all be Class C waste.

The methodology for the assessment of shipping impacts is described in Appendix F. Transportation of this waste would result in the exposure of some members of the public to a very low radiation dose. The principal exposed group would be the truck crews; however, others could also be exposed such as those present at truck stops, travelers on the highways, and residents along the highways. The total transportation dose, excluding the dose from accidents that may occur during shipments, is expected to be 91 to 170 person-rem. The truck crews would receive the greatest portion of this dose, an estimated 60 to 110 person-rem.

As with transportation of any materials, there is a possibility that incidents during transportation may result in traffic accidents with or without injuries or fatalities. The estimated number of traffic accidents that might occur during the entire shipping program for immediate cleanup was 4.5 to 7.2, depending on the final waste volume. The staff estimated the number of injuries occurring over this shipping program at about 3.9 to 6.3 and the number of fatalities at about 0.3 to 0.5 (the probability of a fatality during the entire shipping program is between approximately 3 to 5 chances out of 10). Appendix F provides additional details regarding the analysis of transportation accidents.

There is also a small probability that accidents may be severe enough to result in the breach of a waste container and release of some of the waste, as explained in Section 3.1.4. The staff estimated that a dose of about 0.005 to 0.01 person-rem would result from accidents during the shipment of all of the waste generated during immediate cleanup.

3.3.5 Socioeconomic Impacts of Immediate Cleanup

The direct socioeconomic impacts of immediate cleanup were evaluated. The basis for the evaluation is included in Appendix G. The socioeconomic impacts of the immediate cleanup alternative are expected to be minor. The staff assumed that the current work force would be increased gradually during the engineering study as workers were rehired until the 1987-1988 level of 1150 workers (or slightly fewer) was achieved. This work force would be maintained for a period of 3 to 4 additional years beyond the 2-year engineering study. At the completion of cleanup, the employment level could change significantly, depending on the disposition of the facility (i.e., post-cleanup storage, decommissioning, or refurbishment). If the facility is placed into post-cleanup storage, the number of workers required is assumed to be the same as that required for PDMS (100 to 125 in the first year of post-cleanup storage and 70 to 75 during subsequent years).

Approximately 70 percent of the current work force resides in the Harrisburg-Lebanon-Carlisle labor market (Cumberland, Dauphin, Lebanon, and Perry Counties) and 25 percent in Lancaster County. This distribution would not be expected to change significantly during cleanup or post-cleanup storage. These jobs are expected to support approximately half again the number in the surrounding communities, as outlined in Appendix G.

The labor cost would be about \$29 million to \$43 million per year during the engineering study, \$57.5 million per year for 1150 workers during the 3- to 4-year cleanup period, and \$5.0 million to \$6.3 million for the first year of a post-cleanup storage with \$3.5 million to \$3.8 million for each year thereafter. The impact to the total income of the local communities from immediate cleanup is expected to be approximately twice the payroll level.

3.3.6 Commitment of Resources During Immediate Cleanup

The principal resources committed in the immediate cleanup of TMI-2 would be money and radioactive burial ground space. Other resources, such as energy and ion exchange resins, will be relatively minor.

The NRC staff evaluated the cost of immediate cleanup using 1988 dollars. The estimated cost of immediate cleanup ($240 million to $330 million), as presented in Table 3.30, includes the labor costs addressed in Section 3.3.5, the waste transportation charges addressed in Section 3.3.4, and the waste disposal costs discussed below. If the facility was placed in post-cleanup storage for 18 years after cleanup (as discussed in Section 3.3.1), an estimated additional $68 million to $74 million in cost would be incurred.

Uncertainties in the labor cost are due to the duration of cleanup, inflation, uncertainties in estimating nonlabor overhead costs, and uncertainties in staffing requirements. The staff assumed that a work force the size of the defueling work force could complete the cleanup in a total of 3 to 4 years following the engineering study. It was further assumed that the cost of any new robots would reduce the labor cost; therefore, they are not estimated as a separate cost.

Burial ground volume, the other significant resource required in the immediate cleanup alternative, would be required for the disposal of 120,000 to 183,000 cubic feet (3400 and 5190 cubic meters) of low-level radioactive waste. The waste disposal costs are based on 1988

TABLE 3.30. Cost of Immediate Cleanup[a]

Type of Cost	Projected Cost, \$ million[b]
Labor Costs	
2-year engineering study	58 to 86
3 to 4 years of cleanup	170 to 230
Waste Disposal Costs	
120,000 ft^3 to 183,000 ft^3 (including decontamination wastes)	6.0 to 9.2
Waste Transportation Costs	4.2 to 6.7
Total[c]	240 to 330

(a) Does not include cost of decommissioning or refurbishment.
(b) In 1988 dollars.
(c) The totals may not be exact because of rounding.

rates of $50 per cubic foot ($1800 per cubic meter) plus surcharges for wastes with higher-than-normal radiation dose rates or curie content. Uncertainties in waste disposal costs arise from uncertainties in waste volume and future waste disposal costs.

3.3.7 Regulatory Considerations of Immediate Cleanup

There are no significant regulatory considerations for immediate cleanup. The NRC staff would continue to review major cleanup activities for approval. There are also no regulatory considerations that would prevent the licensee from implementing storage of the facility, refurbishing the facility or from placing the facility in decommissioning at the completion of cleanup.

3.4 IMMEDIATE CLEANUP/REDUCED EFFORT

The alternative of immediate cleanup with reduced levels of effort (immediate cleanup/reduced effort) is described in Section 3.4.1. The offsite dose evaluation is discussed in Section 3.4.2, occupational dose estimates in Section 3.4.3, waste management impacts including those from transportation in Section 3.4.4, socioeconomic impacts in Section 3.4.5, commitment of resources in Section 3.4.6, and regulatory considerations in Section 3.4.7.

3.4.1 Description of the Immediate Cleanup/Reduced Effort Alternative

The alternative of immediate cleanup/reduced effort involves the continued cleanup of the TMI-2 facility without stopping operations for an engineering planning study. The cleanup would be accomplished over a 7- to 10-year period of time. In addition, a work force would be used that was smaller than the 1987-1988 defueling work force and smaller than the work force for the immediate cleanup alternative. After completion of the cleanup, the facility could be either refurbished or decommissioned. Although the cleanup would be considered complete (i.e., achieving radiation levels comparable to those in an undamaged reactor facility nearing the end of its operating life), it is possible that the licensee would choose not to immediately decommission or refurbish the facility but would place the facility in storage until the time that TMI-1 was ready for decommissioning. Thus, a period of storage following the completion of cleanup was also evaluated. The impacts of refurbishing or decommissioning, however, are not evaluated in this supplement.

3.4.1.1 Cleanup with Reduced Effort

The current defueling effort is expected to result in the removal of more than 99 percent of the fuel before the start of immediate cleanup/reduced effort. In addition, it was assumed that the following activities would have occurred or would be underway before starting immediate cleanup/reduced effort: decontamination of the building and equipment surfaces to levels approximating the licensee's established goals (Table 3.2), packaging and disposal of radioactive wastes associated with decontamination activities, removal of the accident-generated water from the reactor building and the AFHB, and quantification of the residual fuel remaining in the facility. Activities such as those conducted during preparations for PDMS would not be performed (e.g., deactivation and preservation of equipment, sealing of fuel transfer tubes, and extensive monitoring of the facility to provide a data base for plant trends, as discussed in Section 3.1). The ventilation systems and fire detection systems would remain in their current operating state.

Cleanup would be continued following the current defueling effort. Initial efforts would be directed to the completion of the decontamination of the AFHB and various locations in the reactor building while an engineering study of the continuation of the reactor building decontamination is conducted. Following completion of the engineering study, cleanup would continue at a slower rate than that assumed for the immediate cleanup alternative. In addition, the number of workers would be substantially reduced from previous levels and would be lower than the levels assumed for immediate cleanup (Section 3.3). At this reduced rate, cleanup would take 7 to 10 years to complete.

The cleanup activities are assumed to be similar to those projected by the staff for evaluating cleanup during the delayed cleanup alternative (see Section 3.2.1.1). The differences are as follows: (1) a period of 7 to 10 years would be necessary for cleanup at the reduced level of effort; (2) engineering studies would be performed during the early years of cleanup, concurrently, with additional decontamination of the AFHB and various locations in the reactor building; (3) advances in robotic technology that would have occurred during an intervening PDMS period possibly would not be available during the 7- to 10-year period for immediate cleanup/reduced effort; (4) radiation doses would not be reduced by a PDMS period; and (5) wastes would be shipped to a currently licensed site (assumed to be the facility operated by U.S. Ecology near Richland, Washington) because a regional repository within 250 miles (400 kilometers) of the site is not expected to be available.

3.4.1.2 Potential Storage Period Following Cleanup

Following the cleanup process, the dose rates in the facility would be similar to dose rates in an undamaged reactor facility at the end of its operating life. At this point, the facility would be ready for decommissioning or refurbishment. However, it is possible that the licensee would not immediately decommission or refurbish the facility. For this reason, impacts were evaluated for a storage period following completion of cleanup. A 14- to 17-year period of storage following the completion of cleanup was evaluated based on a

7- to 10-year cleanup period and the expected expiration of the Unit-1 license in 2014. Only a brief preparations period would be necessary before storage and this would be accomplished as part of the cleanup process. The storage period following immediate cleanup/reduced effort would essentially be equivalent to the post-cleanup storage period described in Section 3.3.1.3 for the immediate cleanup alternative.

3.4.2 Offsite Dose Evaluation for Immediate Cleanup/Reduced Effort

The evaluation of the radiation dose to the offsite population as a result of immediate cleanup/reduced effort includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.4.2.1 Routine Atmospheric Releases

The magnitude and impact of routine atmospheric releases of radioactive material will vary depending on the stage of immediate cleanup/reduced effort. These stages, as described in Section 3.4.1, would include a 7- to 10-year period of cleanup at a reduced level of effort and a potential 14- to 17-year storage period following completion of the cleanup.

Table 3.31 shows the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine atmospheric releases during immediate cleanup/reduced effort. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The specific assumptions that were used during the calculation of the impacts for each of the stages during immediate cleanup/reduced effort are discussed in the following sections.

Cleanup with Reduced Effort. The routine releases of radioactive material from the TMI-2 facility occurring by atmospheric pathways during the cleanup process are not expected to differ much from those occurring during the defueling period (see Table 3.5). However, some rise in effluent concentrations may be experienced during aggressive decontamination efforts, as discussed in Section 3.2.2.1 for the delayed cleanup alternative. Thus, radionuclide releases were estimated largely by using the same procedures as those used for the delayed cleanup alternative (see Section 3.2.2.1), except that a

TABLE 3.31. 50-Year Dose Commitments from Routine Atmospheric Releases Resulting from Immediate Cleanup/Reduced Effort[a]

Stages of Immediate Cleanup/ Reduced Effort	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
Cleanup	10	Bone	2.6	2.5 to 2.9	0.8	0.1
		Total body	0.07		0.06	0.006
Potential Post-cleanup Storage	14	Bone	3.0	2.9 to 3.3	2.3	0.2
		Total body	0.3		1.6	0.05

(a) Does not include dose associated with decommissioning or refurbishment.

period of 10 years was assumed (rather than a 4-year period) and no radioactive decay resulting from a storage period would occur. Release rates during nine of the years were assumed to be similar to the current release rates shown in Table 3.5. During one of the years, release rates were assumed to be two orders of magnitude higher than current release rates to account for the potentially greater release rates during aggressive decontamination methods. Although the annual release rates during immediate cleanup/reduced effort are expected to be of the same magnitude as the release rates during the 3- to 4-year period of immediate cleanup, the release from immediate cleanup/reduced effort will continue over a period of 7 to 10 years. The annual release rates calculated for atmospheric releases during the cleanup period are shown in Table D.24 of Appendix D.

Potential Storage Period Following Cleanup. The impact of a potential storage period following immediate cleanup/reduced effort is similar to the impact for the potential storage period following immediate cleanup (Section 3.3.2.1). The major difference is that the storage period for immediate cleanup/reduced effort is assumed to last 14 to 17 years, while the storage period following immediate cleanup is assumed to last 18 to 19 years. The annual release rates calculated for atmospheric releases during the potential storage period following cleanup are shown in Table D.25 of Appendix D.

3.4.2.2 Routine Liquid Releases

Table 3.32 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine liquid releases during immediate cleanup/reduced effort. The dose pathways to the maximally exposed individual and to the offsite populations include the drinking of Susquehanna River water, consumption of fish inhabiting the river, participation in rivershore activities, and the consumption of shellfish from the Chesapeake Bay, as described in Section 3.1.2.2. The dose to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The specific assumptions that were used during the calculation of the impacts for each of the stages during immediate cleanup/reduced effort are discussed in the following sections.

Cleanup with Reduced Effort. Liquid releases will occur during the 7- to 10-year period assumed for immediate cleanup/reduced effort. The source and quantity of liquids will be as discussed in Section 3.3.2.2 for immediate cleanup. However, the release will occur over 7 to 10 years and there will be no period of radioactive decay before the start of the alternative. The annual release rates calculated for liquid releases during the cleanup period are shown in Table D.26 of Appendix D.

TABLE 3.32. 50-Year Dose Commitments from Routine Liquid Releases Resulting from Immediate Cleanup/Reduced Effort[a]

Stage of Immediate Cleanup/ Reduced Effort	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual: Susquehanna River Water, Fish, Activities, mrem	Dose to Maximally Exposed Offsite Individual: Chesapeake Bay Shellfish, mrem	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Population, thousands	Population Within 50-Mile Radius of TMI-2: Susquehanna River Water, Fish, Activities: Dose, person-rem	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Population, millions	Population Within 50-Mile Radius of TMI-2: Chesapeake Bay Shellfish: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
Cleanup	10	Bone	0.2	0.006	340 to 400	1.0	2.5 to 2.9	0.02	2.8
		Total body	0.1	0.0004		0.06		0.001	0.2

(a) Does not include dose associated with decommissioning or refurbishment.

Potential Storage Period Following Cleanup. As discussed in Section 3.1.2.1, during the period of PDMS, a discharge rate of 5000 gallons (19,000 liters) annually was assumed. A somewhat lesser rate could be assumed for the potential storage period following immediate cleanup/reduced effort because the volume would result only from water inleakage and would not include small quantities of water used for decontamination. However, the cleanup process would have removed contamination from the areas where any inleakage is expected. Since no decontamination would occur during this period, it is unlikely that accumulated liquids would contain measurable levels of contamination.

3.4.2.3 Accidental Atmospheric Releases

The potential for the three accidents listed in Section 3.1.2.3 to result in an airborne release of radionuclides for the immediate cleanup/reduced effort alternative was evaluated. If the potential existed for a specific accident, the impact of the accident on the offsite population was evaluated quantitatively.

Table 3.33 shows the results of this evaluation. The table lists the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental atmospheric releases during immediate cleanup/reduced effort. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The specific assumptions used to determine the potential for each of the accidents listed in Section 3.1.2.3 during immediate cleanup/reduced effort and the assumptions made for the quantification of the impact from the accidental atmospheric releases are discussed in the following sections.

Cleanup with Reduced Effort. The potential for accidents resulting in the atmospheric release of radionuclides during the cleanup phase of immediate cleanup/reduced effort is the same as that for the corresponding stage of the immediate cleanup alternative discussed in Section 3.3.2.3. The three potential accidents resulting in airborne releases that were developed from the list of potential accidents given in the PEIS (described in Section 3.1.2.3) have a probability of occurring during the cleanup process. These three accidents are a fire in the stairwell/elevator structure, the rupture of a double-stage HEPA filter during decontamination efforts, and the spill of decontamination solution in the reactor building. The assumptions

TABLE 3.33. 50-Year Dose Commitments from Accidental Atmospheric Releases During Immediate Cleanup/Reduced Effort[a]

Stages of Immediate Cleanup/ Reduced Effort	Accident Description	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2		Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
				Population Size, millions	Dose, person-rem	
Cleanup	Fire in stairwell	Bone	0.2	2.5	0.01	0.001
		Total body	0.02		0.007	0.0004
	HEPA filter failure	Bone	150	2.5	13.0	1.0
		Total body	17		8.8	0.5
	Decontamination liquid spill	Bone	0.4	2.5	0.07	0.002
		Total body	0.008		0.004	0.0001
Potential Post-cleanup storage	Fire in stairwell	Bone	2.4	2.9	0.2	0.02
		Total body	0.2		0.2	0.01

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

made for the evaluation of the impact of each accident occurring during the cleanup period are the same as those given in Section 3.3.2.3 for the same accidents occurring during the cleanup period of the immediate cleanup alternative. The maximum amounts of radioactive material calculated to be released to the atmosphere from a fire in the stairwell/elevator structure, a HEPA filter failure, and a spill of decontamination solution are given in Tables D.27, D.28, and D.29, respectively, in Appendix D.

Potential Storage Period Following Cleanup. Of the accidents evaluated, only the fire in the stairwell/elevator shaft was deemed to be a potential accident during a 14-year storage period. It was assumed that 5 percent of the radioactivity in the stairwell/elevator structure and in the fuel debris in the basement sludge would remain following the cleanup period. The accident was evaluated by using the assumptions in Section 3.3.2.3 for a fire during the potential storage period following immediate cleanup, except the releases were adjusted to account for 10 years of radioactive decay. The amount of radioactive material assumed to be released during this accident is shown in Table D.30 of Appendix D.

3.4.2.4 Accidental Liquid Releases

Table 3.34 shows the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental liquid releases during the cleanup stage of immediate cleanup/reduced effort, the only stage in which there is a potential for an accident. The dose pathways to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius include the drinking of Susquehanna River water, consumption of fish taken from the river, participation in rivershore activities, and the consumption of shellfish from Chesapeake Bay, as described in Section 3.1.2.2. The dose commitment to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

The specific assumptions used to determine the potential for an accidental liquid release of radionuclides during immediate cleanup/reduced effort and the assumptions made for the quantification of the impact from the accidental liquid releases are discussed in the following sections.

Cleanup with Reduced Effort. The assumed pathway for an accidental liquid release of radionuclides during the cleanup period is the same as that assumed for the cleanup period following PDMS for the delayed cleanup alternative (see Section 3.2.2.4); that is, the release of contaminated water to the Susquehanna River based on the

TABLE 3.34. 50-Year Dose Commitments from Accidental Liquid Releases During Cleanup Phase of Immediate Cleanup/Reduced Effort[a]

		Dose to Maximally Exposed Offsite Individual		Population Within 50-Mile Radius of TMI-2				Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
		Susquehanna River Water, Fish, Activities, mrem	Chesapeake Bay Shellfish, mrem	Susquehanna River Water, Fish, Activities		Chesapeake Bay Shellfish		
Accident Description	Dose Location			Population, thousands	Dose, person-rem	Population, millions	Dose, person-rem	
Storage tank	Bone	0.002	0.0001	340	0.02	2.5	0.0004	0.07
rupture	Total body	0.0003	0.000008		0.0005		0.00002	0.004

(a) Does not include dose associated with accidents during decommissioning or refurbishment.

rupture of an 11,000-gallon (42,000-liter) storage tank. The amount of radioactive material calculated for release during this accident is shown in Table D.31 of Appendix D.

Potential Storage Period Following Cleanup. No accidents involving liquid releases were identified on the basis of the information given in Section 3.4.2.2 for liquid releases during the potential storage period following immediate cleanup/reduced effort.

3.4.3 Occupational Radiation Dose Evaluation for Immediate Cleanup/Reduced Effort

The occupational radiation dose expected during the cleanup process described for immediate cleanup/reduced effort is estimated to be between 3700 and 9300 person-rem, as shown in Table 3.35. The estimate includes the doses for cleanup over 7 to 10 years and is essentially the same as the immediate cleanup doses found in Section 3.3.3, except no doses are included for the 2-year engineering study. This is the dose required to achieve radiation levels similar to those in an undamaged reactor facility nearing the end of its operating life; this dose is in addition to the occupational radiation dose already received and the dose required to complete the defueling period.

If a decision was made to put the reactor into storage for 14 years after cleanup, as discussed in Section 3.4.1, an additional 8.3 to 14 person-rem of dose would be incurred.

The estimates given in Table 3.35 are based on a task-by-task analysis of the work to be done and are presented as a range of values because of the uncertainties in the cleanup process and technology. The range is wide because of uncertainties in the location and depth of penetration of contamination and in the methods of reactor coolant system decontamination. In addition, uncertainties exist regarding the effectiveness of the robots for performing many of the tasks. A discussion of the methodology used to calculate occupational doses is found in Appendix H.

3.4.4 Waste Management Considerations of Immediate Cleanup/Reduced Effort

Cleanup activities will generate waste from a number of processes, including decontamination of the reactor coolant system, removal of contaminated portions of the reactor vessel head and control rod drive mechanisms, removal of the stairwell and elevator shaft in the basement, and removal of temporary shielding that has been placed in the reactor building. These activities will also generate secondary waste consisting of disposable protective clothing, tools, and equipment. The estimated volumes and classes of waste that would be generated during the cleanup period are shown in Table 3.36.

TABLE 3.35. Occupational Radiation Dose Estimates for Immediate Cleanup/Reduced Effort[a]

Task Description	Occupational Dose, person-rem
AFHB cleanup	65 to 140
Reactor coolant system decontamination	53 to 920
Reactor building basement general cleanup	670 to 1500
Reactor building cubicle cleanup	650 to 1400
Reactor building blockwall removal	77 to 610
D-ring dose reduction	360 to 780
D-ring final decontamination	370 to 820
Dome and polar crane decontamination	10 to 20
Reactor building 347-foot elevation cleanup	190 to 410
Reactor building 305-foot elevation cleanup	290 to 630
Engineering support	60 to 130
Health physics support	550 to 1400
Radioactive waste handling	360 to 550
Post-cleanup monitored storage (14 years)	8.3 to 14[b]
Total[c]	3700 to 9300

(a) Does not include dose associated with decommissioning or refurbishment.
(b) Not included in the total.
(c) The totals may not be exact because of rounding.

Quantities of waste generated during the potential 14-year storage period following cleanup would be small and were not quantified.

For immediate cleanup/reduced effort, the staff assumed that the waste generated before the year 2001 (thus, through the end of the cleanup period) would be disposed of at a currently licensed site. The currently licensed site was assumed to be the facility operated by U.S. Ecology near Richland, Washington. The impact of the waste after disposal at the LLW site is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the waste disposal site.

It is possible that some of the waste generated could exceed maximum Class C limits, in which case it could not be accepted by a licensed burial site. The licensee, however, has a unique arrangement with the U.S. Department of Energy that allows such wastes to be transferred to the DOE on a cost-reimbursement basis.

TABLE 3.36. Waste Volume Estimates for Immediate Cleanup/Reduced Effort[a]

Class of Waste[b]	Total Waste Volume ft^3	Total Waste Volume m^3
Class A	91,000 to 120,000	2,600 to 3,400
Class C	19,000 to 33,000	540 to 930
Classes A, B, or C	9,600 to 29,000	270 to 810
Greater than Class C waste	Some possible	Some possible

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

The environmental impact of transporting the waste generated during immediate cleanup/reduced effort was estimated from the curie estimates given in Section 2.2. The staff assumed that the waste would be shipped in the same containers that were assumed for delayed decommissioning (Section 3.1.4). Wastes were considered to be shipped to the licensed LLW disposal site near Richland, Washington, with 421 to 559 shipments of Class A waste and between 201 and 438 additional shipments of unspecified waste (Class A, B, or C). For the purpose of assessing transportation impacts, it was conservatively assumed that the unspecified waste would all be Class C waste.

The methodology for the assessment of shipping impacts is described in Appendix F. Transportation of this waste would result in the exposure of some members of the public to a very low radiation dose. The principal exposed group would be the truck crews; however, others could also be exposed, such as those present at truck stops, travelers on the highways, and residents along the highways. The total transportation dose, excluding the dose from accidents that may occur during shipments, is expected to be 91 to 170 person-rem. The truck crews would receive the greatest portion of this dose, 60 to 110 person-rem.

As with transportation of any materials, there is a possibility that incidents during transportation may result in traffic accidents with or without injuries or fatalities. The estimated number of traffic accidents that might occur during the entire shipping program for immediate cleanup/reduced effort was 4.5 to 7.2, depending on the final waste volume. The staff estimated the number of injuries occurring over this shipping program at 3.9 to 6.3 and the number of fatalities at 0.3 to 0.5 (the probability of a fatality during the entire shipping program is between approximately 3 and 5 chances out of 10). Appendix F provides additional details regarding the analysis of transportation accidents.

There is also a small probability that accidents may be severe enough to result in the breach of a waste container and release of some of the waste, as explained in Section 3.1.4. The staff estimated that a dose of about 0.005 to 0.01 person-rem would result from accidents during the shipment of all of the waste generated during immediate cleanup/reduced effort.

3.4.5 Socioeconomic Impacts of Immediate Cleanup/Reduced Effort

The direct socioeconomic impacts of immediate cleanup/reduced effort were evaluated. The basis for the evaluation is included in Appendix G. The socioeconomic impacts are expected to be minor. The staff estimated that the number of workers required to complete cleanup would be 50 to 75 percent (approximately 580 to 860 persons) of the number involved in the 1987-1988 defueling and decontamination efforts. At the completion of cleanup, the employment level could change significantly depending on the disposition of the facility. One option available at the end of the cleanup is to put the reactor into post-cleanup storage for 14 years, as discussed in Section 3.4.1. The number of workers required during this option is assumed to be the same as that required for PDMS: 100 to 125 in the first year of post-cleanup storage and 70 to 75 during subsequent years.

Approximately 70 percent of the current work force resides in the Harrisburg-Lebanon-Carlisle labor market (Cumberland, Dauphin, Lebanon, and Perry Counties) and 25 percent in Lancaster County. This distribution would not be expected to change significantly during cleanup or post-cleanup storage. These jobs are expected to support approximately half again the number in the surrounding communities, as outlined in Appendix G.

The labor cost would be about $29 million to $43 million per year for 580 to 860 workers. The impact on the total income of the local communities from immediate cleanup/reduced effort is expected to be approximately twice the payroll level.

3.4.6 Commitment of Resources During Immediate Cleanup/Reduced Effort

The principal resources committed in immediate cleanup/reduced effort would be money and radioactive burial ground space. Other resources, such as energy and ion exchange resins, will be relatively minor.

The NRC staff has evaluated the cost of this cleanup using 1988 dollars. The estimated cost of immediate cleanup/reduced effort ($210 million to $450 million), as presented in Table 3.37, includes the labor costs addressed in Section 3.4.5, the waste transportation

TABLE 3.37. Cost of Immediate Cleanup/Reduced Effort[a]

Type of Cost	Projected Cost, $ million[b]
Labor Costs	
7 to 10 years of cleanup	200 to 430
Waste Disposal Costs	
120,000 ft^3 to 183,000 ft^3 (including decontamination wastes)	6.0 to 9.2
Waste Transportation Costs	4.2 to 6.7
Total[c]	210 to 450

(a) Does not include cost of decommissioning or refurbishment.
(b) In 1988 dollars.
(c) The totals may not be exact because of rounding.

charges addressed in Section 3.4.4, and the waste disposal costs discussed below. If the reactor is placed in post-cleanup storage for 14 years following cleanup, as discussed in Section 3.4.1, an additional $54 million to $59 million in cost would be incurred.

Uncertainties in the labor cost are the result of the duration of cleanup, inflation, uncertainties in estimating nonlabor overhead costs, and uncertainties in staffing requirements. The staff assumed that a work force 50 to 75 percent of the defueling work force could complete the cleanup in 7 to 10 years. The staff further assumed that the cost of any new robots would reduce the labor cost; therefore, they are not estimated as a separate cost.

Burial ground volume, the other significant resource required in the immediate cleanup/reduced effort alternative, would be required for the disposal of 120,000 to 183,000 cubic feet (3400 to 5190 cubic meters) of low-level radioactive waste. The waste disposal costs are based on 1988 rates of $50 per cubic foot ($1800 per cubic meter) plus surcharges for wastes with higher-than-normal radiation dose rates or curie content. Uncertainties in waste disposal costs arise from uncertainties in waste volume and future waste disposal costs.

3.4.7 Regulatory Considerations of Immediate Cleanup/Reduced Effort

There are no significant regulatory considerations for immediate cleanup/reduced effort. The NRC would continue to review major cleanup activities for approval. There are also no regulatory considerations that would prevent the licensee from implementing storage of the facility, refurbishing the facility, or placing the facility in decommissioning at the completion of cleanup.

3.5 IMMEDIATE DECOMMISSIONING

Immediate decommissioning, as envisioned by the NRC staff, is described in Section 3.5.1. The offsite dose evaluation is discussed in Section 3.5.2, occupational dose estimates in Section 3.5.3, waste management impacts including those of transportation in Section 3.5.4, socioeconomic impacts in Section 3.5.5, commitment of resources in Section 3.5.6, and regulatory considerations in Section 3.5.7.

3.5.1 Description of the Immediate Decommissioning Alternative

For the immediate decommissioning alternative, the staff evaluated only the preparations to decommission the TMI-2 facility. Operations occurring during the decommissioning of the facility were not evaluated. The term "immediate" is used to denote that the preparations for decommissioning would take place during and following the completion of the current defueling effort and would not be preceded by a storage period. The preparations would be a combination of the preparations for PDMS described in Section 3.1.1.2 and the preparations for decommissioning following PDMS as discussed in Section 3.1.1.4. Preparations would include planning and engineering (including the preparation of a proposed decommissioning plan), equipment/system deactivation, and predecommissioning fire inspections. Small amounts of decontamination might be performed in support of preparation activities. In addition, extensive plant characterization would be conducted to ensure that plant conditions and trends were documented. It is important to note that not all of the activities described as preparation efforts for decommissioning discussed in Section 3.1.1.4 would be conducted during immediate decommissioning preparations since many of these activities would not be necessary in the absence of a storage period (e.g., the measurement of the degradation of systems or components that isolate fuel and contamination and the cleanup of systems and locations that have exhibited movement of contamination). Additional decontamination cleanup (other than the small amounts described above) would not be a part of the immediate decommissioning alternative; rather, it would be part of the decommissioning process and will not be evaluated here.

Although preparation of a decommissioning plan could require several years' effort and approval of the plan could require an additional 2 years, for purposes of evaluation, the preparation phase is evaluated based on a duration of 2 years. A 2-year period for decommissioning preparations could be deemed the upper limit for plant-related activities necessary for decommissioning; that is, the length of time necessary to implement this alternative should the licensee immediately come forward with a decommissioning plan.

3.5.2 Offsite Dose Evaluation for Immediate Decommissioning

The evaluation of the radiation dose to the offsite population as a result of the immediate decommissioning alternative includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.5.2.1 Routine Atmospheric Releases

Table 3.38 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine atmospheric releases during immediate decommissioning. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The preparations for immediate decommissioning would take place during and following the completion of the current defueling effort. Preparation activities would not be expected to increase the amount of airborne contamination beyond that currently being released. The release rates were estimated using the methodology that was used for the decommissioning preparations period for the delayed decommissioning alternative, which was based on the current release rates (as discussed in Section 3.1.2.1). However, radioactive decay during an intervening storage period was not considered. The amount of radioactive material calculated to be released annually is shown in Table D.32 of Appendix D.

3.5.2.2 Routine Liquid Releases

Table 3.39 shows the 50-year dose commitment to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of routine liquid releases during preparations for immediate decommissioning. The dose pathways to the maximally exposed individual and to the offsite populations include the drinking of Susquehanna River water, consumption of fish from the river, participation in rivershore activities, and consumption of shellfish from Chesapeake Bay, as described in Section 3.1.2.2. The dose to the population outside the 50-mile (80-kilometer) radius is attributed solely to the consumption of Chesapeake Bay shellfish.

TABLE 3.38. 50-Year Dose Commitments from Routine Atmospheric Releases Resulting from Immediate Decommissioning[a]

Stage of Immediate Decommissioning	Duration, years	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
Decommissioning Preparations	2	Bone	0.05	2.5	0.01	0.002
		Total body	0.001		0.0009	0.0001

(a) Does not include dose associated with decommissioning.

TABLE 3.39. 50-Year Dose Commitments from Routine Liquid Releases Resulting from Preparations for Immediate Decommissioning[a]

		Dose to Maximally Exposed Offsite Individual		Population Within 50-Mile Radius of TMI-2				Dose to Population Outside 50-Mile Radius of TMI-2 from Chesapeake Bay Shellfish, person-rem
				Susquehanna River Water, Fish, Activities		Chesapeake Bay Shellfish		
Duration, years	Dose Location	Susquehanna River Water, Fish, Activities, mrem	Chesapeake Bay Shellfish, mrem	Population, thousands	Dose, person-rem	Population, millions	Dose, person-rem	
2	Bone	0.007	0.00009	340	0.02	2.5	0.0002	0.05
	Total body	0.006	0.00002		0.002		0.00003	0.006

(a) Does not include dose associated with decommissioning.

During preparations for immediate decommissioning, liquid releases will result from groundwater and precipitation inleakage as well as from small amounts of decontamination liquids. Although the quantity of liquid produced during decontamination processes is likely to be small, a maximum annual release of 20,000 gallons (76,000 liters) was assumed, as described in Section 3.1.2.2 for liquid releases during delayed decommissioning preparations. Liquids that are not directly releasable pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a) and the licensee's technical specification limits would be processed through the EPICOR II system. The annual release rates were estimated using the same methodology used for estimating routine liquid releases during the decommissioning preparations for delayed decommissioning (Section 3.1.2.2). However, radioactive decay during an intervening storage period was not considered. The amount of radioactive material calculated to be released annually is shown in Table D.33 of Appendix D.

3.5.2.3 Accidental Atmospheric Releases

The potential for each of the three accidents listed in Section 3.1.2.3 to result in an airborne release of radionuclides was evaluated for the immediate decommissioning alternative. The fire in the stairwell/elevator structure and the HEPA filter failure were deemed to be the only potential accidents. The impact of these accidents on the offsite population was evaluated quantitatively.

Table 3.40 shows the results of this evaluation. The table lists the 50-year dose commitments to the maximally exposed member of the public, to the total population within a 50-mile (80-kilometer) radius of the TMI-2 site, and to the population outside the 50-mile (80-kilometer) radius as a result of accidental atmospheric releases during the immediate decommissioning alternative. The dose commitments to the maximally exposed member of the public and to the population within the 50-mile (80-kilometer) radius result from external exposure, inhalation, and the consumption of food products, as discussed in Section 3.1.2.1. The dose commitment to the population outside the 50-mile (80-kilometer) radius results from external exposure, inhalation, and the consumption of food products exported from within the 50-mile (80-kilometer) radius.

The assumptions used to quantitatively evaluate the impacts of these accidents are similar to those given in Section 3.1.2.3 for preparations for decommissioning for the delayed decommissioning alternative, except that radioactive decay during an intervening storage period was not considered. The amounts of radioactive material calculated for release during the fire and the HEPA filter failure accidents are presented in Tables D.34 and D.35, respectively, in Appendix D.

TABLE 3.40. 50-Year Dose Commitments from Accidental Atmospheric Releases During Preparations for Immediate Decommissioning[a]

Accident Description	Dose Location	Dose to Maximally Exposed Offsite Individual, mrem	Population Within 50-Mile Radius of TMI-2: Population Size, millions	Population Within 50-Mile Radius of TMI-2: Dose, person-rem	Dose to Population Outside 50-Mile Radius of TMI-2, person-rem
Fire in stairwell	Bone	0.2	2.5	0.008	0.001
	Total body	0.02		0.005	0.0004
HEPA filter failure	Bone	0.2	2.5	0.008	0.001
	Total Body	0.006		0.0007	0.00007

(a) Does not include dose associated with accidents during decommissioning.

3.5.2.4 Accidental Liquid Releases

Radioactively contaminated liquids that could not be released directly to the environment (pursuant to 10 CFR 20, Appendix B, Table II, Column 2 (CFR 1988a) and the licensee's technical specifications) would be collected in the miscellaneous waste holdup tank, transferred to the chemical cleaning building, and processed through the EPICOR II system before final sampling and discharge. Based on the use of the EPICOR II system at TMI-2 (NRC 1979c), there are no credible accidents that would result in a liquid release during the transfer or processing of the small amounts of liquids produced during the decommissioning preparation activities (see Section 3.1.2.4 for a discussion of the accidental releases during PDMS).

3.5.3 Occupational Radiation Dose Evaluation for Immediate Decommissioning

The occupational radiation dose to prepare the TMI-2 facility for immediate decommissioning is estimated to be between 17 and 41 person-rem, as shown in Table 3.41. The dose estimate in Table 3.41 is in addition to the occupational radiation dose already received and that required to complete defueling.

The estimates presented in Table 3.41 are based on a task-by-task analysis of the work to be done. They are presented as a range of values because of the uncertainties in the specific activities that would occur during the 2 years of preparations for immediate decommissioning. A discussion of the methodology used to calculate occupational doses is found in Appendix H.

TABLE 3.41. Occupational Radiation Dose Estimates for Preparations for Immediate Decommissioning (2-year duration of activities)[a]

Task Description	Occupational Dose, Person-rem
Radioactive waste handling	0.7 to 1.1
2-year decommissioning preparation activities	16 to 40
Total[b]	17 to 41

(a) Does not include dose associated with decommissioning.
(b) The totals may not be exact because of rounding.

3.5.4 Waste Management Considerations of Immediate Decommissioning

The quantity, radiation level, and classification of waste that would be produced during preparations for immediate decommissioning were evaluated on the basis of current regulatory requirements. Activities performed during this 2-year period are discussed in Section 3.5.1. Estimated volumes and classes of waste that would be generated during preparations for immediate decommissioning are presented in Table 3.42. The bases for the estimates are found in Appendix F.

For the immediate decommissioning alternative, the staff has assumed that the waste would be disposed of at a currently licensed site, assumed to be the facility operated by U.S. Ecology near Richland, Washington. The impact of the waste after disposal at this site is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the waste disposal site. The staff assumed that the waste would be shipped in the same containers as those described in Section 3.1.4 for the delayed decommissioning alternative. It was estimated that 1 shipment of Class A waste and 1 to 2 shipments of Class C waste would be made to the currently licensed site.

The methodology for the assessment of shipping impacts is described in Appendix F. Transportation of this waste would result in the exposure of some members of the public to a very low radiation dose. The principally exposed group would be the truck crews; however, others would also be exposed, such as those present at truck stops, travelers on the highways, and residents along the highways. The total transportation dose, excluding the dose from accidents that may occur during shipments, is expected to be 0.3 to 0.5 person-rem. The truck crews would receive the greatest portion of this dose, 0.1 to 0.3 person-rem.

TABLE 3.42. Waste Volume Estimates for Preparations for Immediate Decommissioning[(a)]

Class of Waste[(b)]	Total Waste Volume ft^3	Total Waste Volume m^3
Class A dry radioactive waste	60 to 200	1.7 to 5.7
Class B or C air filters	0 to 130	0 to 3.5
Class A, B, or C residue from liquid waste treatment	10 to 40	0.3 to 1.1

(a) Does not include waste volumes associated with decommissioning.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

As with transportation of any materials, there is a possibility that incidents during transportation may result in traffic accidents with or without injuries or fatalities. The estimated number of traffic accidents that might occur during the entire shipping program for immediate decommissioning preparations was 0.007 to 0.02 (the probability of an accident during the entire shipping program is between approximately 7 and 20 chances in 1000), depending on the final waste volume. The staff estimated the number of injuries occurring during this shipping program at about 0.007 to 0.01 (the probability of an injury accident during the entire shipping program is between approximately 7 and 10 chances in 1000) and the number of fatalities at about 0.0006 to 0.001 (the probability of a fatality during the entire shipping program is between approximately 6 and 10 chances in 10,000). Appendix F provides additional details regarding the analysis of transportation accidents.

There is a small probability that accidents may be severe enough to result in the breach of a waste container and release of some of the waste, as discussed in Section 3.1.4. The staff estimated that a population dose of about 0.00002 to 0.00003 person-rem would result from accidents during shipment of all the waste generated during preparations for immediate decommissioning.

3.5.5 Socioeconomic Impacts of Immediate Decommissioning

The direct socioeconomic impacts of preparations for the immediate decommissioning alternative were evaluated. The basis for the evaluation is included in Appendix G. The socioeconomic impacts of the immediate decommissioning alternative are expected to be minor. The NRC staff assumed that the work force employed during the 2-year period would be twice as large as that employed during the first years of PDMS for the delayed decommissioning alternative; that is, 200 to 250 workers during the first year and 140 to 150 during the second year. However, it is expected that the exact staffing level would depend on the specific activities that would be conducted during the preparations of the facility for decommissioning.

Approximately 70 percent of the current work force resides in the Harrisburg-Lebanon-Carlisle labor market (Cumberland, Dauphin, Lebanon, and Perry Counties) and 25 percent in Lancaster County. This distribution would not be expected to change significantly during decommissioning preparations. These jobs are expected to support approximately half again the number in the surrounding communities, as outlined in Appendix G.

The labor cost would be about $17 million to $20 million during the 2-year period of preparations for decommissioning. The impact on the total income of the local communities from the immediate decommissioning alternative is expected to be approximately twice the payroll level, $34 million to $40 million.

3.5.6 Commitment of Resources During Immediate Decommissioning

The principal resources committed in the preparations for immediate decommissioning of TMI-2 would be money and radioactive burial ground space. Other resources, such as energy and ion exchange resins, would be relatively minor.

The NRC staff evaluated the cost of the preparations for immediate decommissioning using 1988 dollars. The estimated cost of preparations for immediate decommissioning ($17 million to $20 million) as presented in Table 3.43, includes the labor costs addressed in Section 3.5.5, the waste transportation charges addressed in Section 3.5.4, and the waste disposal costs discussed below.

Uncertainties in the labor cost are due to the duration of decommissioning preparations, inflation, uncertainties in estimating nonlabor overhead costs, and uncertainties in staffing requirements.

Burial ground volume, the other significant resource required for the immediate decommissioning alternative, would be required for the disposal of 70 to 370 cubic feet (2.0 to 10 cubic meters) of low-level radioactive waste. The waste disposal costs are based on 1988 rates of $50 per cubic foot ($1800 per cubic meter) plus surcharges for wastes with higher-than-normal radiation dose rates or curie content. Uncertainties in waste disposal costs arise from uncertainties in waste volume and future waste disposal costs.

TABLE 3.43. Projected Cost of Preparations for Immediate Decommissioning[a]

Type of Cost	Projected Cost, $ million[b]
Labor Costs 2-year preparation period	17 to 20
Waste Disposal Costs 70 ft^3 to 370 ft^3 (including decontamination wastes)	0.004 to 0.02
Waste Transportation Costs	0.009 to 0.018
Total[c]	17 to 20

(a) Does not include cost of decommissioning.
(b) In 1988 dollars.
(c) The totals may not be exact because of rounding.

3.5.7 Regulatory Considerations of Immediate Decommissioning

There are no regulatory considerations that would prevent the licensee from implementing preparations for the immediate decommissioning of the facility. The licensee would, however, be required to submit a decommissioning plan 2 years after the decision to permanently cease operations and decommission the facility.

3.6 INCOMPLETE DEFUELING

Incomplete defueling, as envisioned by the NRC staff, is described in Section 3.6.1. The offsite dose evaluation is discussed in Section 3.6.2, occupational dose estimates in Section 3.6.3, waste management impacts including those of transportation in Section 3.6.4, socioeconomic impacts in Section 3.6.5, commitment of resources in Section 3.6.6, and regulatory considerations in Section 3.6.7. A description of possible variations within the alternative of incomplete defueling is given in Section 3.6.8.

3.6.1 Description of the Incomplete Defueling Alternative

The alternative of incomplete defueling involves the removal of less than 99 percent of the fuel from the TMI-2 reactor vessel, reactor coolant system, and associated piping. Several assumptions are made for the analysis of this alternative as discussed in this section.

First, it is assumed that the licensee is unable to remove the 30 percent of the fuel that was remaining in the reactor vessel on January 6, 1989.[a] Thus, 15 percent of the total core debris (fuel, structural material, and absorber material) would remain in the reactor vessel following completion of the current defueling, corresponding to approximately 44,000 pounds (20,000 kilograms) of fuel. The estimated quantity of fuel in the remainder of the facility (outside the reactor vessel) is given in Table 2.2 (Section 2.1.3).

The second major assumption is that a criticality analysis of the remaining fuel indicates no possibility of a criticality. The improbability of a criticality would also need to be demonstrated for any potential accident occurrence. However, it is likely that with 15 percent of the fuel remaining additional precautions, such as installation of a neutron absorber or cutting and capping piping into the containment building, would be necessary to preclude criticality.

(a) This alternative was evaluated before the licensee had removed greater than 85 percent of the fuel. Although the NRC staff recognizes that the licensee has removed greater than 85 percent of the fuel, the analysis of this alternative still serves as a bounding case.

A third assumption is that the reactor vessel would be sealed, either by replacing the head onto the reactor vessel, by sealing the internals indexing fixture, or by some other method so that there would be little or no communication between the air in the reactor vessel and the air in the reactor building.

This section evaluates the impact of incomplete defueling of the reactor vessel in conjunction with the licensee's proposal for delayed decommissioning. The activities occurring during incomplete defueling are thus assumed to be similar to the activities proposed by the licensee for the delayed decommissioning, as evaluated in Section 3.1. However, only 85 percent of the fuel will have been removed in preparation for the incomplete defueling alternative, as opposed to the 99 percent of the fuel assumed to be removed before the delayed decommissioning alternative. Specifically, after defueling of the reactor vessel to the point that 85 percent of the fuel has been removed, preparations would be made to place the facility into PDMS (as described in Section 3.1.1.2). Additional preparations such as installation of a neutron absorber or cutting and capping piping to preclude criticality might be necessary. It is assumed that the facility would remain in storage until TMI-1 was ready for decommissioning, estimated by the staff for the purposes of this analysis to be a period of 23 years (corresponding to a 40-year period following the issuance of the TMI-1 operating license). At the end of the storage period, a short period of time (estimated by the NRC staff to be less than 1 year) would be necessary for any decommissioning preparations. Then, the facility would be decommissioned. No large-scale cleanup and no additional defueling would occur following storage or preceding decommissioning.

The following sections address the preparations required for PDMS, the surveillance and maintenance activities occurring during PDMS, and the preparations for decommissioning following the conclusion of PDMS. Although the incomplete defueling alternative was developed to closely parallel the delayed decommissioning alternative, the impact of the removal of only 85 percent of the fuel was also considered for the four NRC staff-identified alternatives discussed previously. These impacts are briefly addressed in Section 3.6.8.

3.6.1.1 Preparations for PDMS

The PDMS preparation period would begin as the current defueling effort was finishing. Greater than 85 percent of the fuel would have been removed from the reactor vessel. At the start of the PDMS preparations period, the decontamination of building and equipment surfaces to radiation levels approximating the licensee's established goals (Table 3.2) and the packaging and disposal of radioactive wastes associated with the decontamination activities would be largely complete. At this time, the reactor vessel would be covered and sealed with the reactor vessel head or the internals indexing fixture or by some other mechanism. The water would be drained from the spent fuel pools and would be removed for reprocessing. Preparations would likely be made to ensure that the remaining fuel would not become critical. Such preparations could include installing a neutron absorber, or cutting and capping the piping systems that go into the reactor building. Additional preparations (as discussed in Section 3.1.1.2) would include equipment/system deactivation, modification and activation of PDMS support systems, pre-PDMS fire inspections, pre-PDMS radiation surveys, completion of the post-defueling survey, area decontamination, and disposal of remaining liquid and solid waste inventories. Shielding would be placed as necessary to reduce dose rates from the drained systems. It is anticipated that this preparation phase would last between 6 months and 1 year.

3.6.1.2 Activities During PDMS

As described in Section 3.1.1.3, activities during PDMS would include periodic entries to inspect, monitor, and maintain the facility. In addition to the types of inspections discussed in Section 3.1.1.3, inspections of the seals on the reactor vessel would be made to ensure that the contamination in the reactor vessel was isolated from the remainder of the building. Inspections of any equipment that had been installed to preclude criticality would also be made.

3.6.1.3 Preparations for Decommissioning

Following PDMS, preparations would be made to decommission the facility. The period of preparations for decommissioning is estimated to require less than 1 year and would include measurements of residual fuel, general area radiation, surface contamination, and the degradation of systems or components that isolate fuel and contamination. Preparations would also include the cleanup of systems and locations, including any that exhibited movement of contamination. However, no large-scale cleanup operations would occur unless it was demonstrated that a need existed for additional cleanup. No additional defueling of the reactor vessel would occur. At the end of the preparations period, the facility would be decommissioned. The impacts associated with additional cleanup (to levels associated with an undamaged reactor facility nearing the end of its operating life) as well as additional defueling would be considered as part of decommissioning and are not discussed here.

3.6.2 Offsite Dose Evaluation for Incomplete Defueling

The evaluation of radiation dose to the offsite population as a result of the incomplete defueling alternative includes an assessment of the dose from routine atmospheric releases, routine liquid releases, accidental atmospheric releases, and accidental liquid releases of radioactive material.

3.6.2.1 Routine Atmospheric Releases

The routine atmospheric releases of radioactive material during the incomplete defueling alternative are estimated to be the same as those shown in Table 3.4 and described in Section 3.1.2.1 for each stage of the delayed decommissioning alternative. These stages, as described in Section 3.6.1 for the incomplete defueling alternative, include preparations for PDMS, PDMS, and preparations for decommissioning. The assumptions that were used for the evaluation of the impacts for each of the stages of the incomplete defueling alternative are discussed in the following sections.

Preparations for PDMS. The preparations to place the TMI-2 facility into PDMS are expected to take place concurrently with the completion of defueling and are not expected to result in any increased release of airborne contamination beyond the range of current releases shown in Table 3.5 for the period January 1, 1987, to September 30, 1988. The specific assumptions that were used for the calculation of the impacts from preparations for PDMS as a result of incomplete defueling are the same as those discussed in Section 3.1.2.1 for preparations for PDMS for the delayed decommissioning alternative.

During PDMS. The assumptions used in evaluating the impacts of atmospheric releases during the PDMS period of incomplete defueling are the same as those described in Section 3.1.2.1. The additional fuel in the reactor vessel is not expected to contribute to releases from the facility because it would be sealed inside the reactor vessel, reactor coolant system, and associated components.

Preparations for Decommissioning. The assumptions used in evaluating the impacts of incomplete defueling during preparations for decommissioning are the same as those described in Section 3.1.2.1 for preparations for decommissioning for the delayed decommissioning alternative. The additional fuel in the reactor vessel is not expected to contribute to releases from the facility since it will continue to be sealed inside the reactor vessel.

3.6.2.2 Routine Liquid Releases

The routine liquid releases of radioactive material during incomplete defueling will be the same as those shown in Table 3.7 and described in Section 3.1.2.2 for each stage of the delayed decommissioning alternative. These stages, as described in Section 3.6.1 for the incomplete defueling alternative, include preparations for PDMS, PDMS, and preparations for decommissioning. The assumptions that were used in evaluating the impacts for the stages of the incomplete defueling alternative are discussed in the following sections.

Preparations for PDMS. The preparations for PDMS are expected to take place concurrently with the completion of defueling and are not expected to result in any increased release of liquid contamination beyond the range of current releases shown in Table 3.7 for the period of January 1, 1987, to September 30, 1988. The specific assumptions used in calculating impacts from preparations for PDMS as a result of incomplete defueling are the same as those discussed in Section 3.1.2.2 for preparations for PDMS during the delayed decommissioning alternative.

During PDMS. The assumptions that were used for the evaluation of the impacts of liquid releases during PDMS for the incomplete defueling alternative are the same as those described in Section 3.1.2.2. The additional fuel in the reactor vessel is not expected to contribute to the magnitude of contamination levels in liquid releases from the facility because the fuel would be sealed inside the reactor vessel, reactor coolant system, and associated components.

Preparations for Decommissioning. The assumptions that were used for the evaluation of the impacts of liquid releases during preparations for decommissioning for the incomplete defueling alternative are the same as those described in Section 3.1.2.2 for preparations for decommissioning for the delayed decommissioning alternative. The additional fuel in the reactor vessel is not expected to contribute to the contamination levels in liquid releases from the facility because the fuel will continue to be sealed inside the reactor vessel and no additional defueling is expected to occur during this period.

3.6.2.3 Accidental Atmospheric Releases

The potential for each of the three accidents listed in Section 3.1.2.3 to result in an airborne release of radionuclides was evaluated for each stage of the incomplete defueling alternative. The potential for these accidents was the same as that discussed in Section 3.1.2.3 for the delayed decommissioning alternative. The impacts of the potential accidents during each stage of incomplete defueling were the same as the impacts listed in Table 3.8 for delayed decommissioning. The assumptions that were used to determine the potential for each of the accidents during the stages of incomplete defueling and those made for quantifying the impacts are discussed in the following sections.

Preparations for PDMS. As discussed in Section 3.1.2.3, the potential for accidental releases during preparations for PDMS is expected to be similar to the potential during defueling, which was evaluated in the PEIS. The preparations for PDMS would be a continuation of current cleanup activities and are not expected to increase the potential for release of airborne contamination if an accident should occur, even with the presence of additional fuel in the reactor vessel.

During PDMS. The fire in the stairwell/elevator structure was identified as the only accident that could occur during PDMS that would result in an appreciable atmospheric release of radionuclides. The impact of this accident and the assumptions made to determine the impact would be identical to those discussed in Section 3.1.2.3. The additional fuel remaining in the reactor vessel would not alter the impact of this accident because only the enclosed stairwell/elevator structure and the fuel debris in the basement would be involved in the fire.

Preparations for Decommissioning. Two potential accidents were identified as resulting in atmospheric releases during the preparations for decommissioning following PDMS: a fire in the stairwell/elevator structure and a failure of both stages of a double-stage HEPA filter. Because the fuel remaining in the reactor vessel would be sealed and separated from the reactor building atmosphere, it would not be involved in the fire and would not be present in the reactor building atmosphere during the HEPA filter failure. Thus, the assumptions used for the release calculations would be the same as those evaluated in Section 3.1.2.3.

3.6.2.4 Accidental Liquid Releases

An evaluation was made of the potential for accidents resulting in liquid releases of radionuclides during the incomplete defueling alternative. As discussed in Section 3.1.2.4, the accident evaluated was the rupture of a tank containing liquid that had been treated at least partially to remove radioactive material. No potential for this accident was determined for any of the three stages of the incomplete defueling alternative. This conclusion was based on the same assumptions discussed in Section 3.1.2.4 for the delayed decommissioning alternative.

3.6.3 Occupational Radiation Dose Evaluation for Incomplete Defueling

The occupational radiation doses resulting from the incomplete defueling of the reactor vessel will be similar to those shown in Table 3.9 for the 23-year period of PDMS although some additional occupational dose may be received during the preparation for storage and during storage, depending on the methods that would be required to preclude criticality. These doses are in addition to the occupational radiation dose already received and that necessary to complete removal of 85 percent of the fuel, but do not include the dose that would be received during removal of the remaining 15 percent of the fuel. The dose to the workers in the reactor building from the remaining 15 percent of the fuel during preparations for PDMS, PDMS, and preparations for decommissioning was calculated by the licensee[(a)] to be approximately 1 percent of the dose from the activated metals in the reactor vessel. The licensee's calculations were verified by the NRC staff using the computer code MCNP (Los Alamos National Laboratory 1981).

3.6.4 Waste Management Considerations of Incomplete Defueling

Waste management impacts for incomplete defueling would be similar to those presented in Section 3.1.4 for delayed decommissioning since no additional fuel would be removed during this alternative. The amount of waste generated is shown in Table 3.10. The number of waste shipments is given in Table 3.11, and the impacts of transporting the waste are shown in Table 3.12. No additional waste shipments or associated impacts would result from the remaining 15 percent of the fuel because the fuel would not be removed during either the preparations for PDMS, PDMS, or the preparations for decommissioning.

3.6.5 Socioeconomic Impacts from Incomplete Defueling

Socioeconomic impacts for incomplete defueling would be similar to those discussed in Section 3.1.5 for delayed decommissioning. No additional workers would be needed, since the fuel would not be removed during this alternative.

3.6.6 Commitment of Resources During Incomplete Defueling

The commitment of resources for the work force and the waste disposal costs for the incomplete defueling alternative would be similar to those discussed in Section 3.1.6 and shown in Table 3.13 for delayed decommissioning. However, an additional expense would accompany the design, purchase, and installation of equipment that might be used to preclude criticality (such as a neutron absorber).

3.6.7 Regulatory Considerations of Incomplete Defueling

The major regulatory consideration would involve demonstration by the licensee that criticality was precluded even if an accident should occur. In addition, the regulatory considerations given in Section 3.1.7 for the delayed decommissioning alternative would apply.

3.6.8 Impact of Incomplete Defueling of the Reactor Vessel on NRC Staff-Identified Alternatives

The impact of the removal of only 85 percent of the fuel was considered for the NRC staff-identified alternatives of delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, and immediate

(a) GPU Nuclear. March 28, 1989. "Dose Rates from a Drained Reactor Vessel." TB-89-04, Rev. 0, TMI-2 Technical Bulletin.

decommissioning. The impacts of leaving 15 percent of the fuel, which vary significantly among the alternatives, are briefly discussed in this section.

3.6.8.1 Description of Incomplete Defueling During Alternative Activities

For incomplete defueling as a part of delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort, the activities would be the same as those described in Sections 3.2.1, 3.3.1, and 3.4.1, respectively, with the following exceptions. The removal of the remaining 15 percent of the fuel likely would be one of the earliest activities initiated during the cleanup phase of delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort. This activity would necessitate either refilling the reactor vessel with water (in the case of delayed cleanup) or possibly not draining the system initially (in the cases of immediate cleanup and immediate cleanup/reduced effort). The methods used to remove the fuel would be similar to the methods currently being used by the licensee, although advanced robotic methods possibly could be available during the defueling that would take place during the delayed cleanup period following PDMS. The cleanup period could be from 3 months to 1 year longer than assumed previously, to account for the removal of the remaining fuel.

The activities during immediate decommissioning would not be different from those given in Section 3.5.1, even if 15 percent of the fuel remains in the reactor vessel. The facility would be prepared for decommissioning in the same manner discussed in Section 3.5.1.

3.6.8.2 Offsite Dose Evaluation During Incomplete Defueling for Remaining Alternatives

Additional offsite doses would be likely during the cleanup period following PDMS for the delayed cleanup alternative and during immediate cleanup and immediate cleanup/reduced effort as a result of incomplete defueling. This dose would result from defueling activities as the remaining 15 percent of the fuel is removed. The offsite doses from routine atmospheric releases and liquid releases are not expected to be any higher than current release rates during the defueling process. Releases during delayed cleanup are expected to be lower than current releases because of the decay during the storage period. The cleanup periods, however, could be approximately 3 months to 1 year longer than those assumed in Sections 3.5.2, 3.5.3, and 3.5.4. This would increase the 50-year dose commitment to the public because of the longer period of release.

Offsite doses for the immediate decommissioning alternative with 15 percent of the fuel remaining are not expected to be different from those presented for immediate decommissioning in Section 3.5.2 because the fuel would not be removed before decommissioning begins.

The offsite dose resulting from accidents would not vary for the immediate decommissioning alternative or for the PDMS period of the delayed cleanup alternative. For the case where more than 1 percent of the fuel is left at the time of decontamination of the reactor coolant system, however, the impact of a spill of decontamination solution in the reactor building during the cleanup period of delayed cleanup, immediate cleanup, or immediate cleanup/reduced effort could be somewhat greater than those estimated in Sections 3.2.2.3, 3.3.2.3, and 3.4.2.3, respectively. The impact would depend on the amount of fuel remaining when decontamination solutions were used for reactor coolant system decontamination.

3.6.8.3 Occupational Dose Impacts

Occupational doses resulting from incomplete defueling for the alternatives of delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort would be similar to those presented in Sections 3.2.3, 3.3.3, and 3.4.3, respectively, except for the dose associated with removal of 15 percent of the fuel during cleanup activities. These doses would be similar to the occupational doses currently being received during defueling activities. For the year 1988, when most of the cleanup efforts were associated with defueling, an occupational dose of 917 person-rem was observed. An occupational dose of this magnitude could be expected if the removal of the remaining 15 percent of the fuel required an additional year. If the fuel removal process required less than a year to complete, a smaller dose would be expected. There would be some dose savings for the removal of fuel during the delayed cleanup alternative because of radioactive decay in the intervening period of PDMS.

Occupational doses for immediate decommissioning would be similar to those presented in Section 3.5.3 because the dose from the fuel remaining in the reactor vessel will be small compared with the dose from the activated metals in the reactor vessel.

3.6.8.4 Waste Management Impacts

Waste management impacts resulting from leaving 15 percent of the fuel during the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives would be greater than the impacts assessed in Sections 3.2.4, 3.3.4, and 3.4.4, respectively. The core material as well as associated waste generated during the removal of the core material would have to be shipped offsite. The nonfuel wastes would be shipped to the nearest available LLW disposal site. The core material would not be accepted at a LLW disposal site; either the agreement with the U.S. Department of Energy that allows transfer of wastes exceeding Class C limits to the U.S. Department of Energy would have to be renegotiated or other arrangements would be necessary. It is possible that a commercial spent-fuel repository or storage facility would be in operation at the time of cleanup following the storage period of the delayed cleanup alternative.

No additional waste management impacts would result from the additional 15 percent of the fuel that would remain during immediate decommissioning because it is expected that no additional waste would be generated during immediate decommissioning. The waste management impacts for this alternative would not be different from the impacts assessed in Section 3.5.4.

3.6.8.5 Socioeconomic Impacts

Incomplete defueling during the delayed cleanup, immediate cleanup, or immediate cleanup/reduced effort alternatives would increase the socioeconomic impacts discussed in Sections 3.2.5, 3.3.5, and 3.4.5, respectively, because additional work would be necessary during these alternatives to remove the remaining 15 percent of the fuel. An increase in the size of the work force most likely would not be necessary, but the amount of time necessary to complete the cleanup would increase. It is estimated that an additional 3 months to 1 year would be needed to remove the remaining fuel.

The socioeconomic impact of incomplete defueling as part of the immediate decommissioning alternative would not be different from the impacts presented in Section 3.5.5 because no changes are expected in the size of the work force or in the amount of time necessary to complete the preparations for decommissioning.

3.6.8.6 Commitment of Resources

The impact of leaving 15 percent of the fuel would alter the resource commitments for delayed cleanup (Section 3.2.6), immediate cleanup (Section 3.3.6), and immediate cleanup/reduced effort (Section 3.4.6) because of the increased waste disposal needs and the additional time required to remove the fuel, as discussed above. For delayed cleanup, an additional expense could be included for the design, purchase, and installation of equipment used to preclude criticality.

The waste disposal needs and labor costs during incomplete defueling as part of the immediate decommissioning alternative would be the same as the impacts discussed in Section 3.5.6 for the immediate decommissioning alternative. However, an additional cost would be expected for the design, purchase, and installation of equipment used to preclude criticality.

3.6.8.7 Regulatory Considerations

The major regulatory consideration for incomplete defueling associated with delayed cleanup, immediate cleanup, immediate cleanup/

reduced effort, and immediate decommissioning would involve demonstration by the licensee that criticality was precluded even in the event of an accident. In addition, the regulatory considerations given for each of the alternatives in Sections 3.2.7, 3.3.7, 3.4.7, and 3.5.7, respectively, would apply.

3.7 ALTERNATIVES CONSIDERED BUT NOT QUANTITATIVELY EVALUATED

Two alternatives to the licensee's proposal were identified by the NRC staff, but not quantitatively evaluated: (1) additional cleanup before storage and (2) no further cleanup following defueling (the no-action alternative required by NEPA). These alternatives are described in this section, and the impacts associated with each alternative are discussed.

3.7.1 Additional Cleanup Before Storage

The alternative of additional cleanup before storage involves pre-PDMS decontamination efforts to further reduce radiation dose rates and radionuclide inventories beyond the licensee's stated goals for PDMS. This alternative actually is a set of alternatives that vary in the degree to which the facility is decontaminated before being placed into storage. One such alternative is the prompt completion of cleanup on the upper elevations of the reactor building and contaminated areas in the AFHB, followed by storage. At the end of the storage period, the cleanup of the facility (including the basement and the D-rings) would be completed. A second alternative is prompt cleanup of the upper elevations of the reactor building concurrently with the decontamination or removal of the enclosed stairwell/elevator structure from the basement. Further cleanup of the D-rings and the remaining basement areas would follow storage. The staff assumed for this alternative that an engineering study would be necessary in preparation for continued cleanup. Such a study would take the form of either a period of time before the additional cleanup starts, similar to the period for engineering study discussed in Section 3.3 for the immediate cleanup alternative or the initial stages of the additional cleanup would proceed at a reduced level of effort similar to the immediate cleanup/reduced effort alternative discussed in Section 3.4.

The alternative of additional cleanup before storage can be divided into four stages: (1) a period for engineering study (or decontamination at a reduced effort during the engineering study), (2) an initial cleanup before storage, (3) a storage period, and (4) a final cleanup. The final cleanup would be followed by either decommissioning or refurbishment. The impacts of additional cleanup before storage, which are discussed below for each of the four stages, were found to fall within the range of the impacts calculated for immediate cleanup (Section 3.3), for immediate cleanup/reduced effort (Section 3.4), and for delayed cleanup (Section 3.2).

An engineering study phase, or additional decontamination at a reduced level of effort, would occur following the completion of the current defueling effort. The impacts during the engineering study phase would be similar to those during the engineering study for the immediate cleanup alternative (Section 3.3); however, the duration of the study would be shorter for the alternative of additional cleanup before storage. The NRC staff estimates that a period of 6 months to less than 1 year would be necessary to plan the additional cleanup to be performed before storage. An engineering study could also occur at the same time that areas on the upper elevations of the reactor building and in the AFHB were being decontaminated. The impacts of this action would be similar to the impacts during the first year of the immediate cleanup/reduced effort alternative discussed in Section 3.4.

Based on the results of the engineering study, the tasks performed during the initial cleanup before storage could vary. It is possible that these tasks would include prompt cleanup of the upper elevations in the reactor building and contaminated areas in the AFHB. Prompt cleanup or removal of the enclosed stairwell/elevator structure in the reactor building basement might also be included. These tasks were also considered as part of the immediate cleanup alternative, and the impacts of these tasks were estimated for immediate cleanup in Section 3.3. The additional cleanup before storage would likely require less than 2 years to complete (in comparison to 4 years for immediate cleanup).

Following the cleanup period, the facility would be placed in storage. Preparations for storage (as discussed in Section 3.1.1.2 for PDMS) would occur during the last part of the cleanup period. Impacts to the offsite population during storage would be somewhat less than those calculated for PDMS during the delayed cleanup alternative in Section 3.2 because exposure rates in the decontaminated areas of the reactor building would have been reduced as a result of the additional cleanup. This would also result in an occupational dose savings during this period. However, because of the limited work activity during storage (see Section 3.1.1.3), this small savings is not significant in comparison to the total occupational dose that would be received. Airborne contamination levels in the reactor building and the associated environmental releases may also be slightly lower during storage following additional cleanup than that presented for PDMS without additional cleanup (e.g., Section 3.1.2 for delayed cleanup). The reduced releases would result from the reduction in the amount of radioactive contamination in the facility during the additional cleanup stage. If removal of the stairwell was part of the additional cleanup before storage, the potential impact of the fire in the stairwell structure during PDMS would be eliminated.

The impacts of the cleanup period following storage would be somewhat less than impacts calculated for the cleanup following PDMS during the delayed cleanup alternative in Section 3.2. It is quite likely that areas decontaminated during the additional cleanup before storage would become recontaminated during the final cleanup following PDMS; however, the overall amount of cleanup would be less.

Because the alternative of additional cleanup before storage is actually a combination of immediate cleanup, immediate cleanup/reduced effort, and delayed cleanup, the environmental impacts of additional cleanup before storage would fall within the range of the impacts calculated for the immediate cleanup or immediate cleanup/reduced effort alternatives and the impacts calculated for the delayed cleanup alternative. These impacts include offsite dose, occupational dose, waste management, socioeconomic impacts, and cost. Accordingly, the alternative of additional cleanup before storage is not evaluated further in this document.

A variation on this alternative is additional cleanup before storage followed by storage and then preparations for decommissioning without additional cleanup. The impacts of this alternative of additional cleanup before storage are also bounded by the impacts of the alternatives discussed in this supplement and, thus will not be evaluated further.

3.7.2 No Further Cleanup Following Defueling (No-Action Alternative)

As noted previously in the PEIS and its supplements, the no-action alternative must be evaluated to fulfill the requirements of NEPA. The no-action alternative, for the period addressed by this supplement, implies no further action to complete the cleanup. Thus, following completion of the current defueling effort, no further efforts would be made to complete the decontamination of the facility or to prepare the facility for storage or for decommissioning. The facility would be left in the post-defueling condition with no attempts to monitor releases or maintain the facility. Entries would not be made into the facility. The HEPA filters would not be inspected or replaced and fire detection systems would not be monitored.

This alternative was not quantitatively evaluated because it has never been NRC policy to allow licensees to abandon a facility. Furthermore, implementation of this alternative would indefinitely postpone decommissioning of the facility without specific approved exemptions from NRC regulations. The NRC staff has maintained, as a matter of policy, that the cleanup must ultimately be completed and the facility decommissioned. The no-action alternative would not result in the completion of cleanup, the decommissioning of the facility, or the ultimate return to unrestricted access. The small but continuing risk associated with conditions of the facility resulting from the March 28, 1979, accident would not be eliminated. Therefore, the NRC staff considers the no-action alternative unacceptable, and it is not evaluated further in this report.

4.0 AFFECTED ENVIRONMENT

This section briefly describes the environment (including the population) that could be affected by the licensee's proposed action and alternatives evaluated in this supplement. This information has been taken primarily from the PEIS (NRC 1981). However, population distribution estimates have been updated since the PEIS was published and include populations projected beyond the year 1981. Other sections have been reviewed and information updated as appropriate.

Four geographic areas that potentially could be affected by the cleanup and storage activities have been identified: (1) the area in the vicinity of the TMI site, (2) the area downstream including the Susquehanna River and the Chesapeake Bay, (3) the transportation routes used for movement of materials to and from the site, and (4) the offsite disposal locations. In addition, there is a population that resides in an area outside the TMI vicinity that receives radiation dose attributable to the TMI-2 cleanup from inhalation, external exposure, and consumption of food products exported from within the 50-mile (80-kilometer) radius as well as from the consumption of shellfish from the Chesapeake Bay area.

4.1 THREE MILE ISLAND SITE VICINITY

The TMI site vicinity is the area within approximately a 12-mile (20-kilometer) radius of TMI. However, for purposes of evaluating radiation doses, the area within a 50-mile (80-kilometer) radius is considered. Figures 4.1 and 4.2 show the location of the site and its relationship to population centers and municipalities in the area.

The area surrounding TMI is predominantly rural and supports farming operations. The soils in the vicinity, combined with favorable physiographic and climatological features, produce higher-than-average crop yields for the Commonwealth of Pennsylvania. Field crops, such as corn and wheat, as well as dairy, poultry, and livestock operations are predominant.

4.1.1 Population Distribution

In spite of extensive agricultural operations, the population density within the 12-mile radius in 1980 was about 570 persons per square mile (220 persons per square kilometer), substantially higher than the population density for Pennsylvania as a whole. Several municipalities are located within the area; the largest city, 12 miles (20 kilometers) to the northwest, is Harrisburg with a population of about 53,000 (in 1980). Urban development is concentrated around population centers and along major transportation corridors.

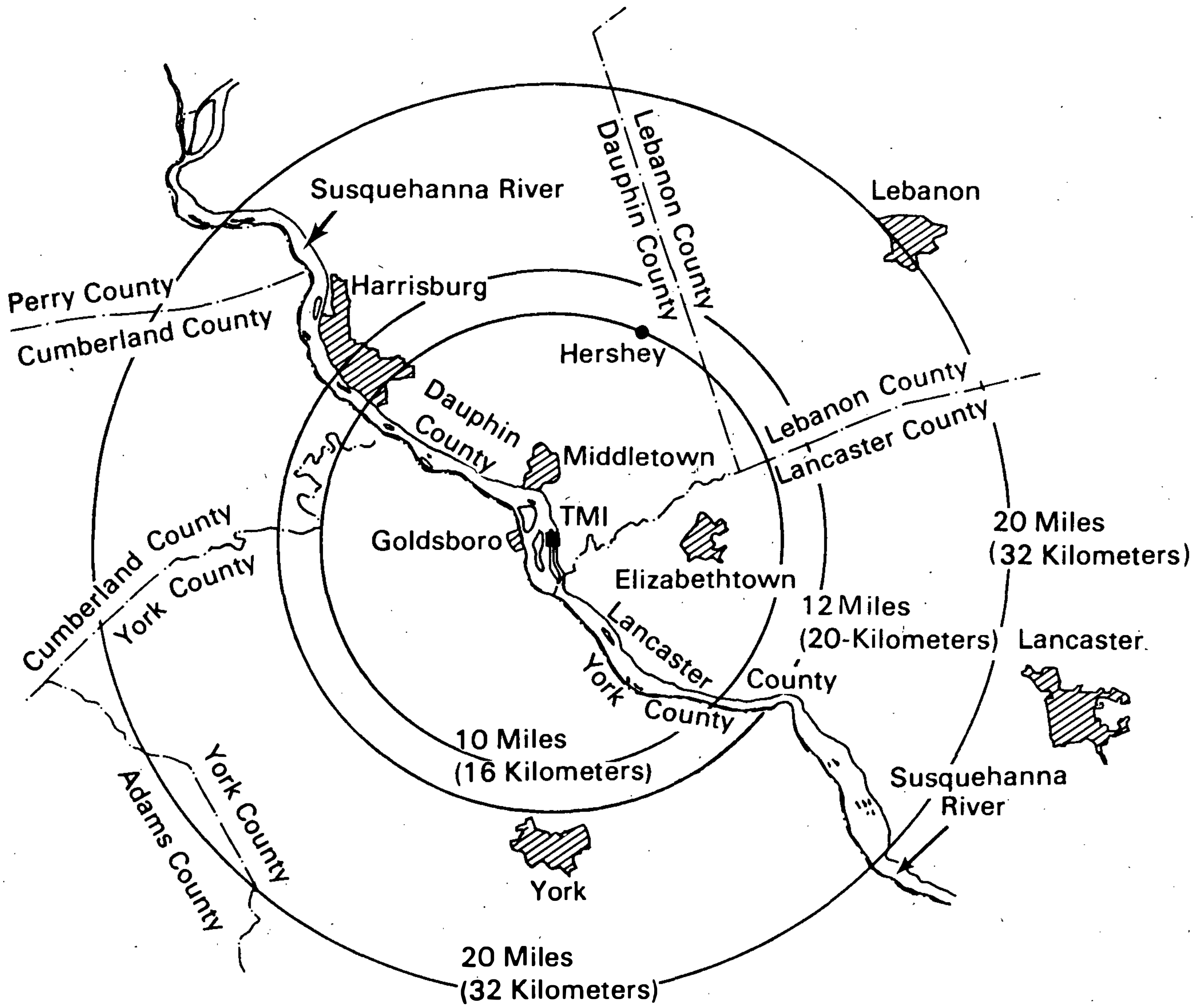

FIGURE 4.1. Map of the Area Within a 10-Mile (16-Kilometer), a 12-Mile (20-Kilometer), and a 20-Mile (32-Kilometer) Radius of the Three Mile Island Site

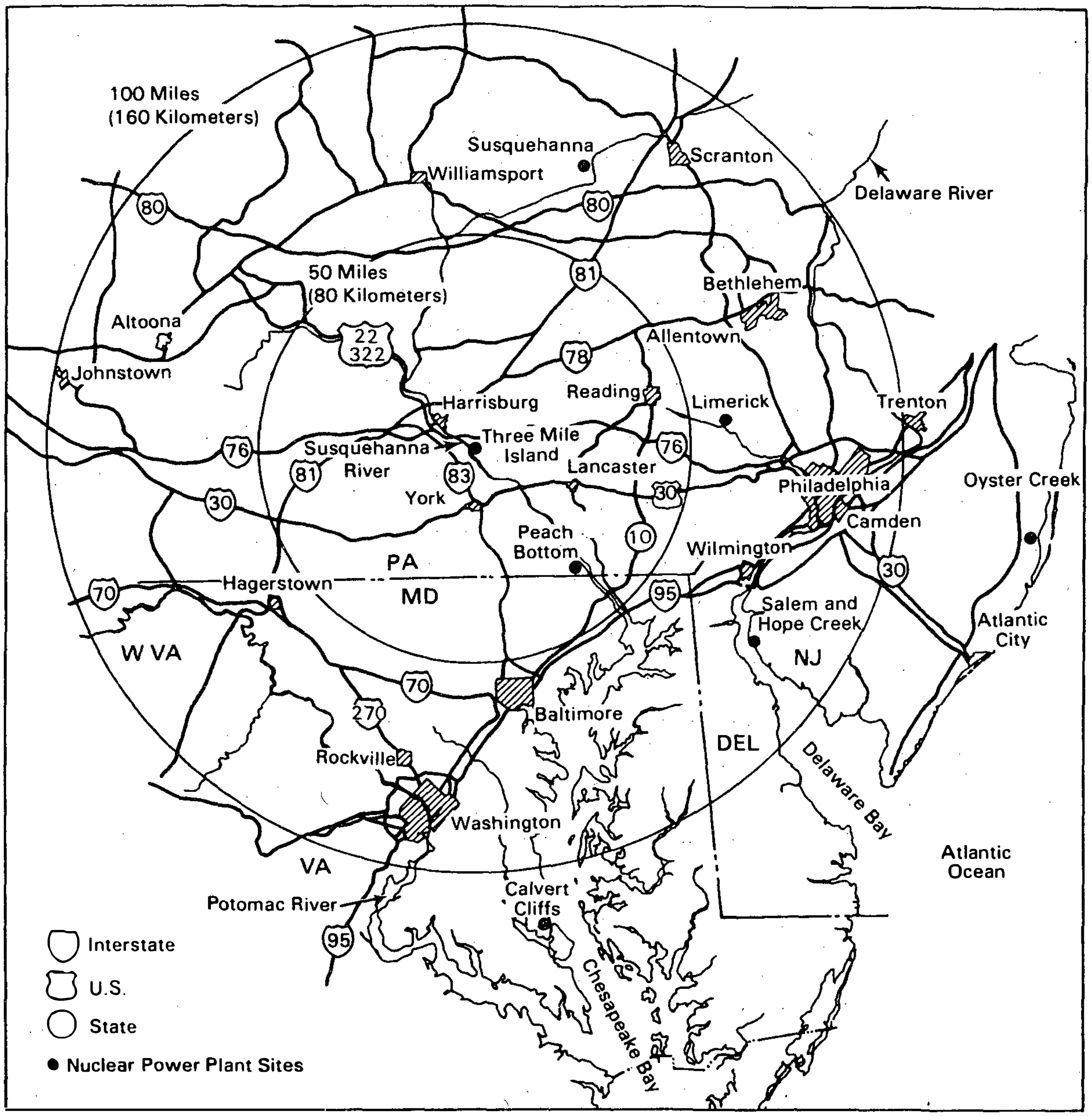

FIGURE 4.2. Map of the Area Within a 50-Mile (80-Kilometer) and a 100-Mile (160-Kilometer) Radius of the Three Mile Island Site

The total population in the 50-mile (80-kilometer) radius was estimated to be 2.2 million[a] in 1981, with approximately 350,000 persons living within a 12-mile (20-kilometer) radius of TMI. Figures 4.3 and 4.4 show the 1981 population distribution within a 12-mile (20-kilometer) and a 50-mile (80-kilometer) radius of TMI. The projected population for the year 2010[b] is 3.2 million persons within a 50-mile (80-kilometer) radius of TMI. Figures 4.5 and 4.6 show the projected population distribution within a 10-mile (16-kilometer) and a 50-mile (80-kilometer) radius of TMI for the year 2010. The population estimates used in Section 3 for estimation of the offsite dose impacts were either interpolated or extrapolated as appropriate from the population estimates for the years 1981 and 2010.

4.1.2 Meteorology

The climate of southeastern Pennsylvania varies seasonally. In winter, the predominant air mass over the region is continental polar air moderated by the influences of the Appalachian Mountains and the Chesapeake and Delaware Bays. Winters are relatively mild for the latitude (40°9'N). In summer, maritime tropical air masses originating over the Gulf of Mexico or the Caribbean Sea predominate. Summers are warm and humid. While the extreme temperatures recorded for the area were 107°F (42°C) in July 1966 and -14°F (-26°C) in January 1912, temperatures of 90°F (32°C) or higher may be reached on only 20 to 25 days annually, and temperatures of 0°F (-18°C) or lower may be expected 1 to 2 days annually. The annual average relative humidity is about 70 percent.

The predominant wind flow is from the northwest. Figure 4.7 shows the onsite wind data at the 100-foot (30-meter) level. The meteorology of the TMI site has been compared with the meteorology of other reactor sites and was found to be fairly typical of valley sites in the frequency of inversions and other stable air phenomena.

Total annual precipitation in the area is expected to exceed 40 inches (102 centimeters), including a normal average snowfall of 37 inches (94 centimeters). The average annual evaporation is within the range of 33 inches (84 centimeters) (lake evaporation) to 45 inches (114 centimeters) (evaporation pan measure).

(a) Based on data from an internal NRC document prepared by the Site Analysis Branch of the Office of Nuclear Reactor Regulation, "1981 Residential Population Estimates 0-80 Kilometers for Nuclear Power Plants."

(b) Letter from F. R. Standerfer to the NRC, February 3, 1988. Subject: Post-Defueling Monitored Storage Environmental Evaluation.

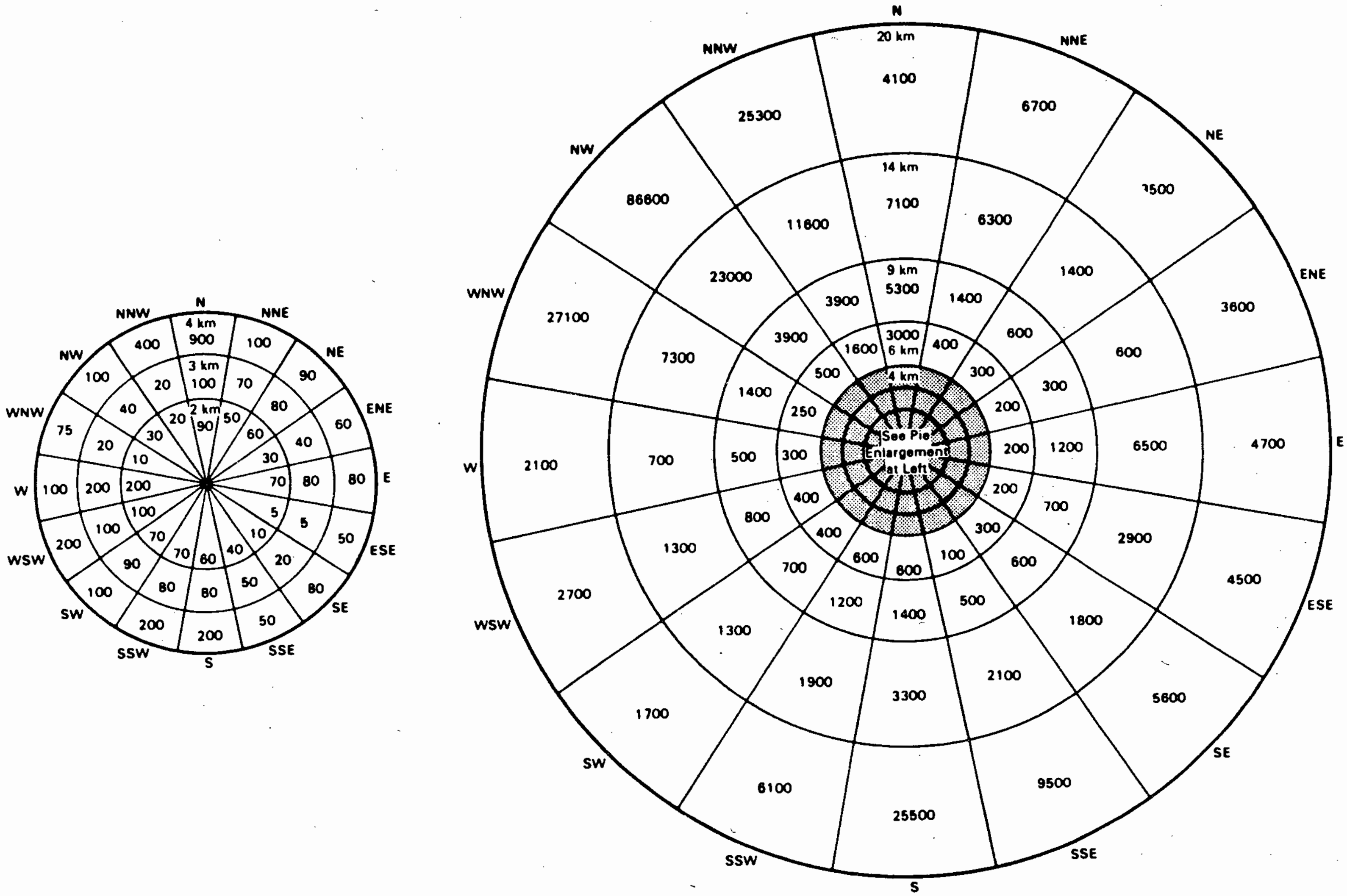

FIGURE 4.3. Population Distribution Within a 12-Mile (20-kilometer) Radius of Three Mile Island (based on data from an internal NRC document prepared by the Site Analysis Branch of the Office of Nuclear Reactor Regulation, "1981 Residential Population Estimates 0-80 Kilometers for Nuclear Power Plants")

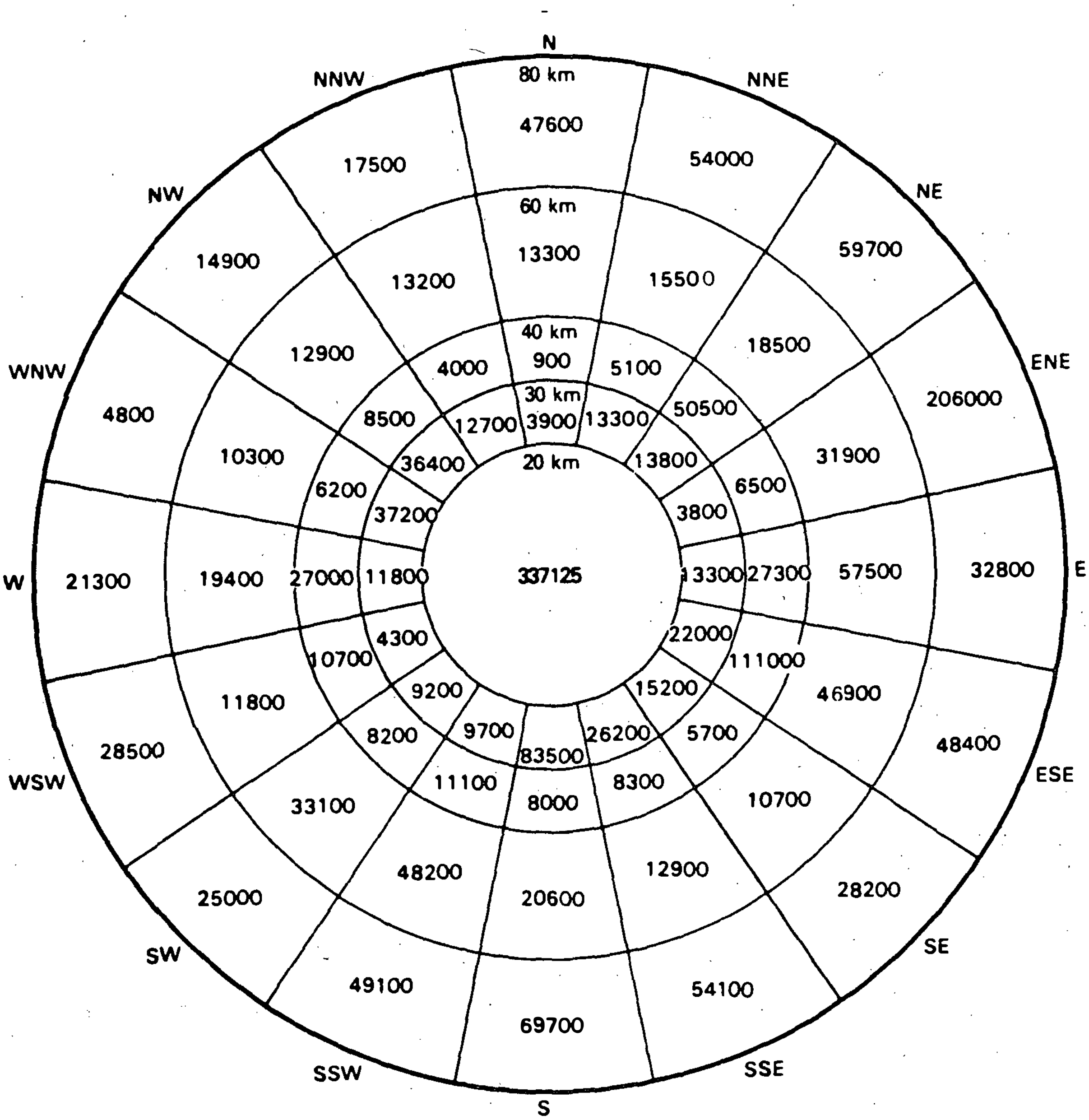

FIGURE 4.4. Population Distribution Within a 50-Mile (80-Kilometer) Radius of Three Mile Island (based on data from an internal NRC document prepared by the Site Analysis Branch of the Office of Nuclear Reactor Regulation, "1981 Residential Population Estimates 0-80 Kilometers for Nuclear Power Plants")

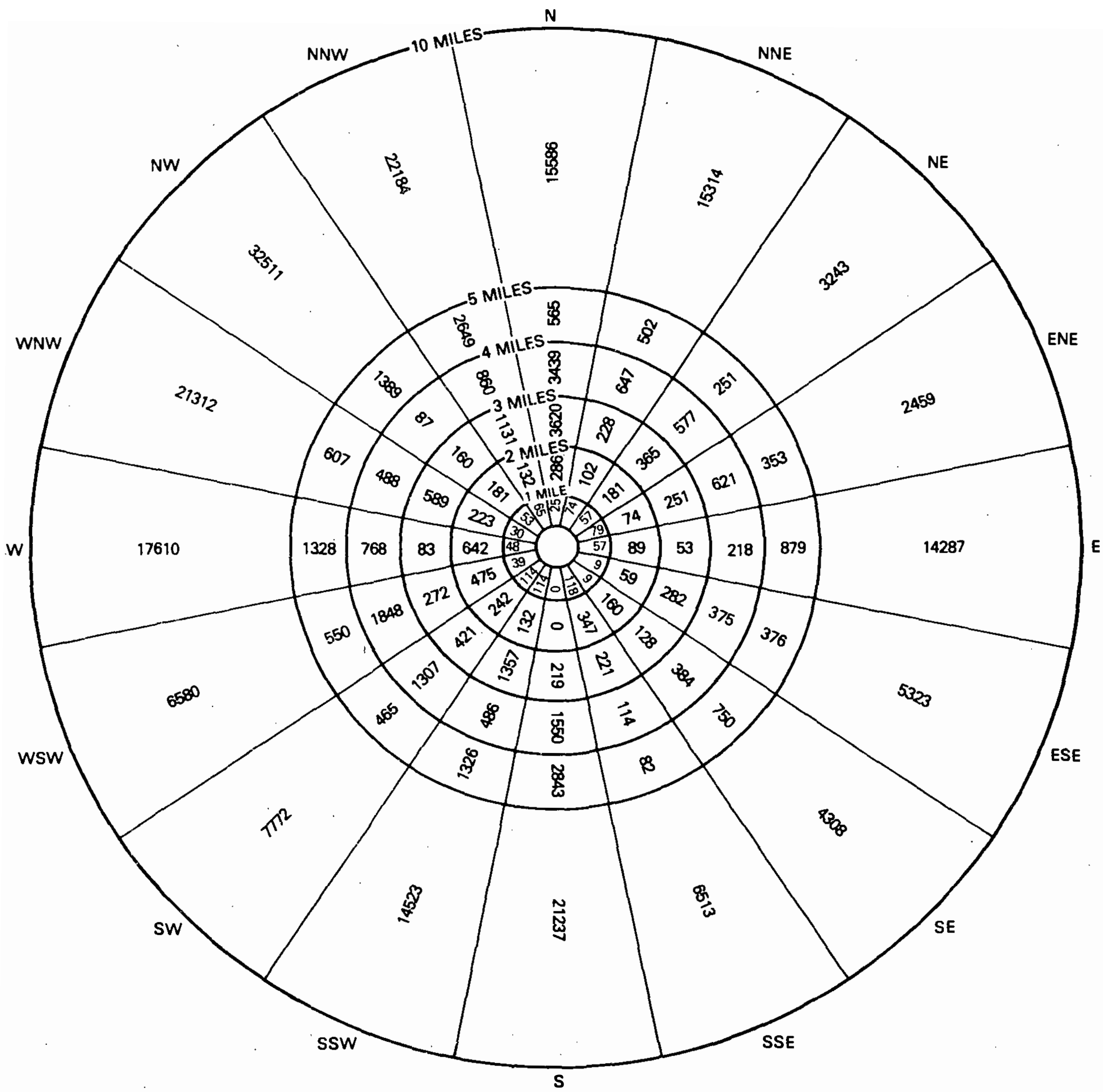

FIGURE 4.5. Projected Population Distribution for 2010 Within a 10-Mile (16-Kilometer) Radius of Three Mile Island (data from a letter from F. R. Standerfer to NRC, February 3, 1988. Subject: Post-Defueling Monitored Storage Environmental Evaluation)

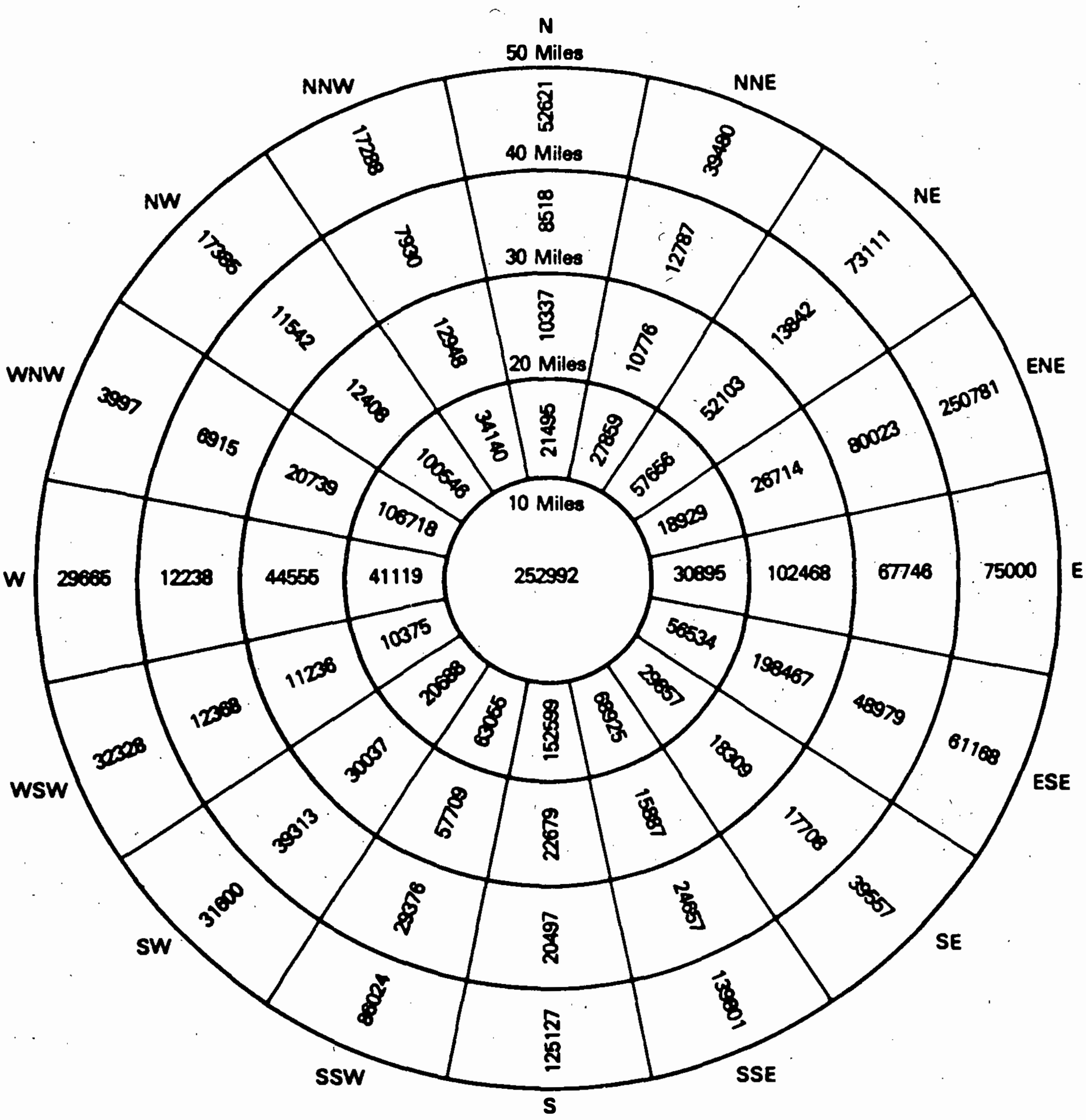

FIGURE 4.6. Projected Population Distribution for 2010 Within a 50-Mile (80-Kilometer) Radius of Three Mile Island (data from a letter from F. R. Standerfer to the NRC, February 3, 1988. Subject: Post-Defueling Monitored Storage Environmental Evaluation)

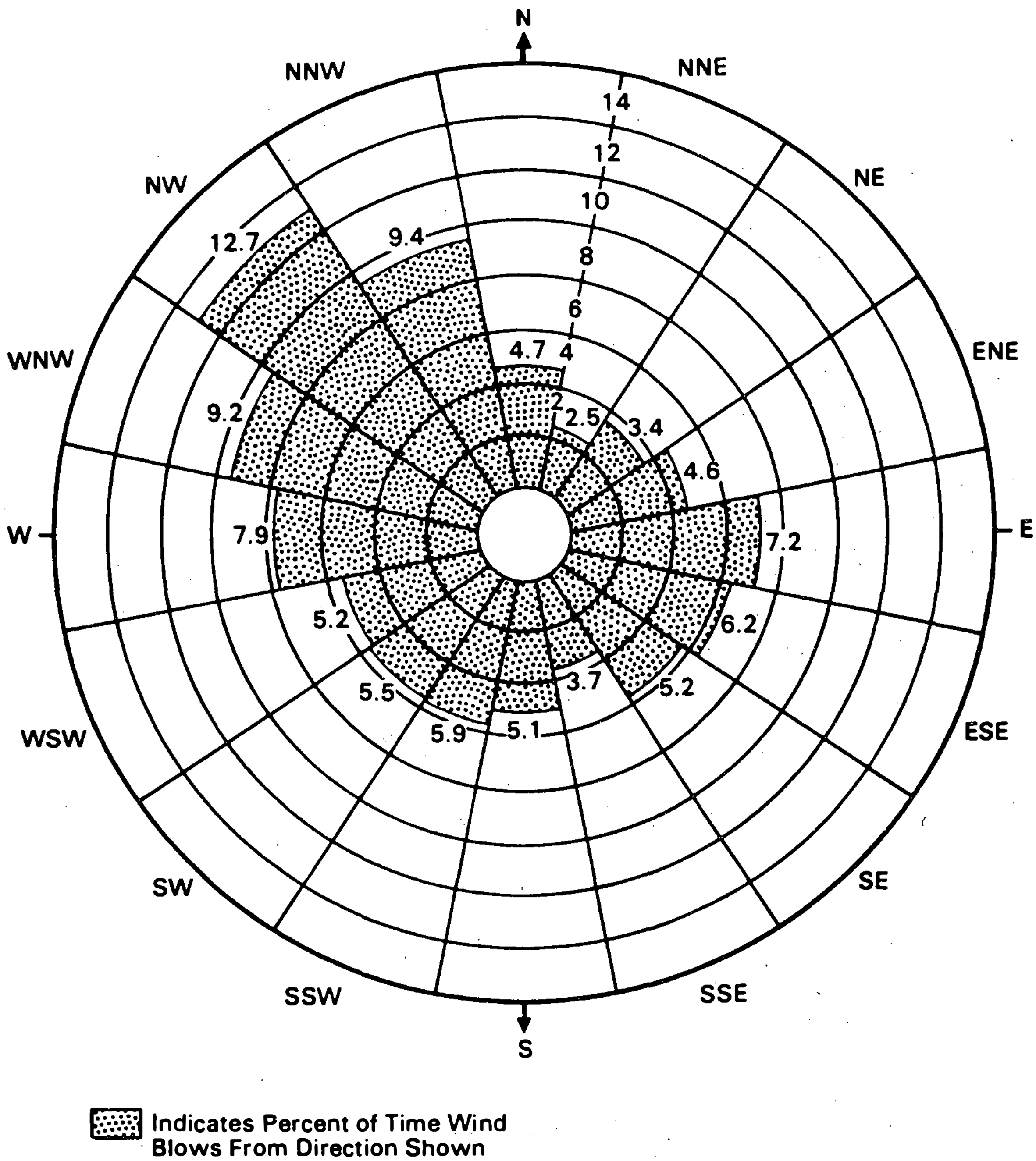

FIGURE 4.7. Three Mile Island Annual Average Wind Direction at 100 Feet (30 meters) (1972 to 1975 data)

4.1.3 Surface Water

The TMI site is located in the Susquehanna River drainage basin, which has a total drainage area of 27,510 square miles (71,810 square kilometers) where it enters the Chesapeake Bay. Recorded data beginning in 1890 indicate that the flow rate of the Susquehanna River is highly variable, ranging from a minimum flow of 1700 ft^3/sec (48 m^3/sec) in 1964 to the maximum flood on record of 1,020,000 ft^3/sec (29,000 m^3/sec) during spring flooding in 1972 (NRC 1976). Mean monthly flows for the period 1891 to 1979 ranged from 11,700 to 82,600 ft^3/sec (330 to 2300 m^3/sec) with the low flow occurring in late summer and the high flow occurring in early spring. The average annual flow rate is 34,000 ft^3/sec (963 m^3/sec). Several dams and reservoirs are located on the Susquehanna River above and below TMI for flood control, low-flow augmentation, and power generation.

The island on which both the TMI-1 and TMI-2 reactors are located is within the 500-year flood plain (0.2-percent chance of flooding in any given year), but not within the 100-year flood plain, as determined by the U.S. Army Corps of Engineers (NRC 1987). The island is diked for flood protection, and the dikes are inspected and maintained by the licensee. In addition, TMI-2 flood procedures require that flood door panels be installed when the river elevation reaches 302 feet (92 meters). Installation of flood door panels effectively precludes the entry of river water.

The surface water of the Susquehanna River downstream from Harrisburg is acceptable for all general uses, including aquatic life and recreation. However, the river is not an attractive source of public water supply because of occasional high sulfate levels and high amounts of wastewater-derived coliform bacteria. Below Harrisburg, late summer blooms of algae occur, which indicate high nutrient levels in the water, primarily phosphates and nitrates. This is attributable both to wastewater treatment and runoff from agricultural areas.

Currently, the river and streams in the TMI vicinity are used for both public and industrial water supplies, power generation, boating, sport fishing, and recreation. Sport fishing, but not commercial fishing, takes place in all streams in the general area of the site. The nearest potable water user is 5 miles (8 kilometers) downstream at the Brunner Island steam-electric generating station. Figure 4.8 shows the principal water users downstream of the TMI plant. Although Chester County, Pennsylvania, and the city of Baltimore, Maryland, also have water intakes downstream, they are seldom used.

Specific water quality data can be found in the PEIS (NRC 1981). In general, the water is moderately high in total hardness, with high and variable sulfate and iron concentrations (often in excess of the State limit), a relatively low alkalinity, and a high fecal coliform

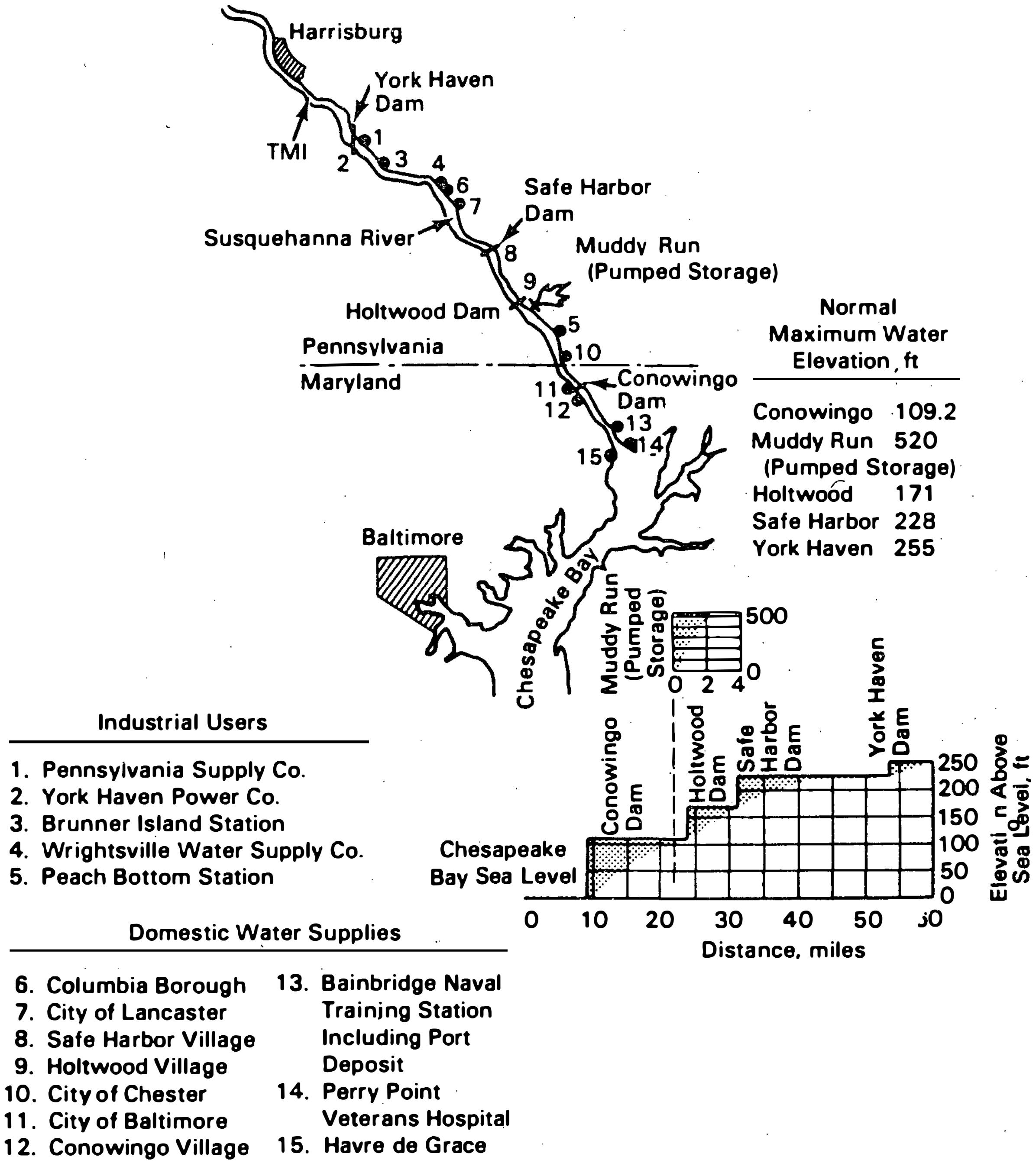

FIGURE 4.8. Principal Water Users Along the Susquehanna River in the Vicinity of Three Mile Island

count (also, often in excess of the State limit). These characteristics are largely attributable to drainage from old coal mines in the watershed and from domestic and agricultural wastes.

Radioactivity measurements of Susquehanna River water were made by the U.S. Geological Survey before the TMI-2 accident. The tritium concentration was measured during the 1977 water year and found to be fairly constant at 178 pCi/L. Gross beta activity was measured on November 8, 1976, and reported as follows:

Dissolved gross beta:	2.4 pCi/L as cesium-137
	1.9 pCi/L as strontium-90/yttrium-90
Suspended gross beta:	0.4 pCi/L as cesium-137
	<0.4 pCi/L as strontium-90/yttrium-90

Radium-226 was measured on the same date by the radon method as 0.08 pCi/L (alpha). Gross alpha activity on the same date was reported as follows:

Dissolved gross alpha:	<1.6 μg/L as natural uranium (<1.08 pCi/L)
Suspended gross alpha:	0.7 μg/L as natural uranium (0.5 pCi/L)

A measurement of uranium concentration, presumably by the chemical (fluorimetric) method, made on the same date gave a value of 0.06 μg/L. The contribution from the commercial nuclear fuel cycle is negligible compared to natural background. The radioactivity observed in the Susquehanna River at Harrisburg during 1977 was below the level regarded as normal for this latitude (40°9'N). For example, the average radioactivity levels in surface water in the Chicago area have been reported as alpha, 0.1 to 3 pCi/L, and beta, 5 to 10 pCi/L.

The tritium concentration of the Susquehanna River has been measured and found to be fairly constant. Samples of Susquehanna River water taken at Danville (upstream from TMI-2), collected and analyzed by the Environmental Protection Agency (EPA) between July 1985 and March 1987, have shown no detectable gamma activity and an average tritium concentration (±2 standard deviations) of 230 ± 200 pCi/L (EPA 1985, 1986a, 1986b, 1987a, 1987b, and 1987c). The Commonwealth of Pennsylvania has also collected a total of 2308 samples from the Susquehanna River and from water intakes which draw from the Susquehanna River both upstream and downstream of the plant (Commonwealth of Pennsylvania 1981, 1982a, 1982b, 1983, 1984, 1985, and 1986). Of these samples, 2307 contained less tritium than the lower limit of detection, which ranged from 230 to 440 pCi/L. A single sample taken at the Lancaster water intake showed 422 ± 192 pCi/L.

4.1.4 Groundwater

The site is underlain by sandy silts, gravels, weathered bedrock, and hard siltstone (the Gettysburg Formation). In general there are two distinctly different water-bearing zones in the naturally deposited materials on Three Mile Island. They are the overburden material deposited during the process of river transport and the underlying Gettysburg shale.

The water-bearing characteristics of the Gettysburg shale can be described as a tabular aquifer, with some beds having the ability to transmit water while other beds have virtually no water-bearing capabilities. The permeability of these beds vary from one bed to another. The tabular aquifer beds can be described as overlapping, lens-shaped and discontinuous in every direction, but may extend laterally (generally east to west) up to several thousand feet and may extend downward from a few hundred feet to as much as 3000 feet (914 meters). Groundwater flow in the Gettysburg shale is highly anisotropic. Aquifer pumping tests were conducted and indicate specific capacities ranging from 0.33 to 15.0 gal/min/ft (1.2 to 5.7 L/min/m) of drawdown.

The licensee measures groundwater elevations at 19 onsite monitoring stations. The mean groundwater elevation for these stations in 1986 was 283.1 feet (86.3 meters) mean sea level (MSL), as based on 218 readings. The Susquehanna River is normally at 277 feet (84.4 meters) MSL. With the exception of two stations, the readings ranged from 277.6 feet (84.6 meters) to 286.7 feet (87.4 meters). The station with the lowest reading recorded 275.5 feet (84.0 meters) MSL. The station with the highest reading recorded 293.2 feet (89.4 meters) MSL.[a] These wells were sited to detect leakage of contaminated water from the Unit-2 reactor, auxiliary buildings, and outside storage tanks. Some of the wells proceed 15 feet (4.6 meters) into the bedrock. Available information suggests that sampling is of the unconfined water table aquifer in the overburden.

The potable water supplies nearest to TMI are three wells located on the east bank of the Susquehanna River, directly across from the site. All these wells have groundwater elevations above the river and above the groundwater level at TMI. The groundwater flow direction in both the overburden material and the Gettysburg shale is from Unit 2 toward either the east or middle channels of the Susquehanna River. This groundwater is discharged into the Susquehanna River system. It is prevented from migrating under the river by opposing flow of groundwater from higher land across the river.

4.1.5 Aquatic Ecology

The biota of the Susquehanna River includes organisms usually associated both with flowing waters and, because of the impoundments, with standing waters.

(a) Letter from F. R. Standerfer to the NRC, June 23, 1987. Subject: Post-Defueling Monitored Storage Environmental Evaluation. 4410-87-6093 Document ID 0194P.

Large aquatic plants are rare in the river because of fluctuating flows and water levels and the type of river bottom substrates, which in most of the free-flowing areas are sand or rock. A dominant source of primary production is algae. The cycle of algae production is representative of algal succession in a lake (a spring bloom of diatoms, a summer abundance of green algae, and a late summer/early fall increase in blue-green algae and flagellates) and indicates the importance of the impoundments in the trophic structure of the river.

Zooplankton composition and abundance are variable; the dominant groups are rotifers (Branchionus sp.), cladocerans (Bosmina sp.), and copepods (Cyclops sp.). Periodic large populations of rotifers also suggest excessive domestic waste loadings of the river. The most abundant benthic (living on or near the bottom of the river) invertebrates are tubificid worms and insect larvae. The fish community can be characterized as a warm-water assemblage and is dominated by members of the minnow, perch, and sunfish families.

4.1.6 Terrestrial Ecology

Land use in the TMI vicinity is primarily agricultural, although a significant amount of land is also devoted to residential and urban development. Agriculture is diverse and includes corn and wheat farming, as well as dairy, poultry, and livestock operations. The forested areas surrounding TMI contain both hardwood and softwood trees. The plant community in these areas is less than 80 years old and consists of species that are common to this area.

In the vicinity of the TMI site, 212 species of terrestrial vertebrates were found, including 179 birds, 19 mammals, 8 reptiles, and 6 amphibians. Small-game animals include the eastern cottontail rabbit and the gray squirrel. Mammalian predators include the longtail weasel and the red fox. The largest mammal found on the site was the white-tailed deer. Four species of upland game bird were found onsite: ring-necked pheasant, American woodcock, mourning dove, and rock dove. Whistling swan, Canada goose, nine species of dabbling duck, seven species of diving duck, and three species of mergansers also were reported. This sampling of species is also typical of the fauna found downriver of the site. Because the Susquehanna River is a major flyway, large numbers and many species of migratory and resident waterfowl nest and feed on the ponds and reservoirs along the river.

None of the species of birds, mammals, reptiles, or amphibians known to reside on or in the immediate vicinity of the TMI site have been designated as federally protected species in Pennsylvania. However, three of the federally listed species (the bald eagle, peregrine falcon, and Indiana bat) may migrate through the area. No known nesting sites of the three have been found in the TMI site vicinity, and no known sites are on record.

The Commonwealth of Pennsylvania's list of endangered and threatened species includes three species of bird that have the potential to pass through the TMI area. They include the king rail, osprey, and black tern. Only the osprey has been sighted in the immediate area of the TMI site, although the nearest recorded nesting site is 33 river-miles (53 kilometers) south.

The golden seal (Hydrastis canadensis), a federally protected plant species, has been confirmed to occur in the TMI vicinity. Wild ginseng (Panax quinquefolius), which is also on the Federal list, is on the historical record of species in the TMI vicinity, although no recent sightings have been recorded.

4.1.7 Background Radiation

Recent reports by the National Council of Radiation Protection and Measurements (NCRP) indicate that the total estimated effective dose equivalent rate from natural background for an individual member of the public in the United States is 300 mrem/yr (NCRP 1987a, NCRP 1987b). The increased background dose rate results from new estimates of the dose rates from radon decay products.

The background concentrations of various radionuclides in air and precipitation in the vicinity of TMI-2 are representative of background concentrations elsewhere in the United States. The EPA measured beta radioactivity in air in the Harrisburg and TMI areas between July 1985 and March 1987 (EPA 1985, 1986a, 1986b, 1987a, 1987b, 1987c). A total of 264 samples analyzed in the field for beta activity (not including samples taken in May and June of 1986) averaged 0.2 pCi/m^3.[a] The activity in the May and June samples is attributable to the Chernobyl accident, which occurred on April 26, 1986. The average gross beta activity in 30 samples collected at Harrisburg during May 1986 was 0.6 pCi/m^3; the 42 samples collected at TMI averaged 0.8 pCi/m^3. The average concentration in nine samples taken during June 1986 at Harrisburg was 0.3 pCi/m^3; the average of the seven samples taken at TMI in June 1986 was 0.7 pCi/m^3. In addition, there were two samples taken at Middletown during June 1986 that averaged 0.3 pCi/m^3. The detection limit for these analyses was 0.1 pCi/m^3.

Air-sample filters from Harrisburg and TMI were combined for 6-month periods and analyzed for plutonium and uranium. The average isotopic concentrations (±2 standard deviations) are as follows: plutonium-238, 0.50 ± 0.70 aCi/m^3;[b] plutonium-239/240, 0.33 ± 0.46 aCi/m^3; uranium-234, 15.7 ± 3.2 aCi/m^3; uranium-235, 0.44 ± 0.46 aCi/m^3; and uranium-238, 13.6 ± 2.8 aCi/m^3.

(a) There are one trillion (1,000,000,000,000) picocuries in a curie.
(b) There are one quintillion (1,000,000,000,000,000,000) attocuries in a curie.

Precipitation samples were also collected and analyzed by the EPA between June 1985 and March 1987 at Harrisburg and Middletown. The samples were analyzed for gross beta activity, tritium, and in some cases gamma activity. Except for samples collected during May 1986, all samples were combined for a month. Results are reported as nCi/m^2.[a] Minimum detectable levels are determined by the amount of rainfall as well as other factors. The average beta activity (±2 standard deviations) in 17 monthly samples (excluding May 1986) at Harrisburg was 0.21 ± 0.06 nCi/m^2. The average of 19 monthly samples at Middletown was 0.15 ± 0.05 nCi/m^2. (The total beta activity for the May 1986 samples affected by Chernobyl at Harrisburg was 1.22 ± 0.77 nCi/m^2; at Middletown it was 2.87 ± 0.55 nCi/m^2.) Tritium results from 38 samples in Harrisburg and Middletown averaged 0.19 ± 0.2 nCi/L. In addition, many of these same precipitation samples were analyzed for gamma-emitting radionuclides. The only samples exceeding the lower limit of detection were those taken during or shortly after the Chernobyl accident.

4.2 SUSQUEHANNA RIVER/CHESAPEAKE BAY AREA

The predominant features of the area under evaluation include the Susquehanna River and the Chesapeake Bay. The 450-mile (724-kilometer) Susquehanna is a major river in the eastern United States and supplies about 50 percent of the fresh water in the bay. The Chesapeake Bay is one of the largest estuaries in the world, having a surface of about 4400 square miles (11,400 square kilometers), a length of nearly 200 miles (320 kilometers), and more than 7000 miles (11,000 kilometers) of shoreline. The Susquehanna River/Chesapeake Bay system supports commercial and recreational fishing and boating and supplies water for public and industrial use.

Sport fishing is a popular activity in the Susquehanna River from the vicinity of TMI to Havre de Grace (see Figure 4.8). The portion of the river below the Conowingo Dam (shown in Figure 4.8) receives spawning migrations of some anadromous species, primarily members of the herring family and striped bass. Sport fishing for crappie, bass, walleye, channel catfish, and sunfish is popular on the entire river. Although the river primarily serves local residents, sizable numbers of fishermen from Maryland and Pennsylvania are attracted to the river.

Sport fishing on the Chesapeake Bay is also a popular activity involving both private and charter boats. The majority of the fishing is done by residents of Maryland, the District of Columbia, Delaware, Pennsylvania, and Virginia. There is also a large and growing use of the Chesapeake Bay for other water-oriented recreation such as boating.

(a) There are one billion (1,000,000,000) nanocuries in a curie.

Shellfish and finfish that are commercially harvested from the Chesapeake Bay include blue crabs, oysters, soft-shelled crabs, surf clams, sea scallops, menhadden, croaker, bluefish, and flounder. The shellfish and finfish harvest is marketed fresh and processed. Regular markets are spread across the United States and parts of Canada.

In addition to the Chesapeake Bay's importance to commercial and sport fishing, the surrounding marshes and woodlands provide thousands of acres of natural habitat for a diversity of wildlife. In the shallow waters of the upper Chesapeake Bay, large aquatic plants and terrestrial plants, such as cord grass (_Spartina_ sp.) and wild celery (_Vallisneria_ sp.), are quite productive, making the area an attractive food source for waterfowl. This area is in the path of the Atlantic flyway and provides wintering and feeding grounds for migrating waterfowl. The waterfowl species that are attracted to the region in large numbers include Canada geese, ducks, whistling swans, other species of birds that use the wetlands for food and other habitat requirements, plus a variety of game birds. The wildlife resources of the area provide opportunities for hunting and trapping and for activities such as bird watching, nature walking, and nature photography.

4.3 TRANSPORTATION ROUTES

The vicinity of TMI is served by the transportation routes shown in Figure 4.2. Interstate 81 is oriented northeast to southwest. Interstate 80 runs east-west, north of the site. Interstate 70, south of the site, also runs east-west. State Route 10, although a much lower-volume road, is important locally. It is oriented north-south, less than 50 miles (80 kilometers) east of the site. Interstate 76, the Pennsylvania Turnpike, north of the site and south of Harrisburg, connects with urban centers to the east and west. U.S. Route 30 is a high-capacity road between Lancaster and York, oriented east-west and passing south of the site. Interstate 83, originating at Harrisburg, extends south to York and Baltimore. U.S. Route 22/322 passes by the site to the northwest.

Shipments of radioactive waste from the TMI site routinely pass over State Route 283 and Interstate Routes 83, 81, and 80 before they leave the Commonwealth of Pennsylvania to the west. Interstate 76 is not normally used for westbound shipments because of tunnel restrictions. Interstate 81 is normally used for southbound shipments. The highway route to the low-level waste (LLW) disposal site near Richland, Washington, is shown in Figure 4.9.

FIGURE 4.9. Route to the Low-Level Waste Disposal Facility from Three Mile Island

4.4 OFFSITE DISPOSAL LOCATIONS

The licensee's proposal and the NRC staff-identified alternatives involve disposal of radioactive wastes at licensed LLW burial sites at offsite locations. Shipments of low-level wastes for disposal have been transported by truck to the commercial LLW burial site near Richland, Washington.

The shipment of low-level wastes to the commercial LLW burial site near Richland is assumed for waste disposal before 2001. Although other sites may be available at this time, because of the distance involved (2680 miles [4313 kilometers]), this LLW site is judged to be the bounding case from a transportation accident standpoint.

The LLW burial site near Richland is operated by U.S. Ecology, Inc., as a commercial radioactive waste disposal site. The site is located in a semi-arid area of relatively low population density, 25 miles (40 kilometers) northwest of Richland on 100 acres (40 hectares) of leased land near the center of the Department of Energy (DOE) Hanford Nuclear Reservation. The facility is licensed by the NRC for the disposal of commercial radioactive waste. The impact of LLW disposal at this site is the subject of separate environmental evaluations and is considered beyond the scope of this document.

The Low-Level Waste Policy Amendments Act mandates State and/or regional disposal sites (or State possession of LLW) by December 31, 1992, (as discussed in Section 2.3.5). Accordingly, the Commonwealth of Pennsylvania has entered into a regional compact, which has been ratified by Congress. No site for the disposal facility has been selected although it has been indicated that the facility will be located in Pennsylvania. It is assumed for the purpose of this document that waste generated after 2001 would be shipped to this disposal facility. A generic site 250 miles (400 kilometers) from TMI was assumed because this distance approximates that between TMI-2 and the most extreme border of Pennsylvania. The characteristics of this site are unknown at the present time; its operation will be the subject of a separate environmental review. The impact of the disposal of TMI waste at this site is beyond the scope of this document.

5.0 COMPARISON OF THE ENVIRONMENTAL IMPACTS OF THE LICENSEE'S PROPOSAL OF DELAYED DECOMMISSIONING AND NRC STAFF-IDENTIFIED ALTERNATIVES

This section compares the environmental impacts of the licensee's proposal of delayed decommissioning and the five quantitatively evaluated U.S. Nuclear Regulatory Commission (NRC) staff-identified alternatives described in Section 3.0. The impacts are summarized in Section 5.1. The discussion of the radiological impacts in Section 5.2 includes an estimate of the possible health effects resulting from radiation doses to the hypothetical maximally exposed offsite individual, to the population within the 50-mile (80-kilometer) radius, and to the TMI-2 cleanup workers. The discussion of nonradiological impacts in Section 5.3 includes consideration of the cost, land commitment, and socioeconomic effects. In Section 5.4 the discussion of potential accidents includes consideration of radiological impacts resulting from accidents at the TMI-2 site and during waste transportation, and nonradiological impacts including traffic accidents, injuries, and fatalities.

5.1 SUMMARY OF THE IMPACTS FOR THE ALTERNATIVES CONSIDERED

Table 5.1 summarizes the expected radiological environmental impacts of routine releases that would result from delayed decommissioning, delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, immediate decommissioning, and incomplete defueling, as evaluated in Sections 3.1 through 3.6 (the impact of accidents is discussed in Section 5.4). For each alternative, the table lists the dose received by the TMI-2 cleanup workers, the dose received during waste transportation, the dose for the maximally exposed offsite individual, the dose to the offsite population within the 50-mile (80-kilometer) radius, and the dose to the population outside the 50-mile (80-kilometer) radius that receives radiation dose that is attributable to the TMI-2 cleanup. The offsite doses are reported for transportation, atmospheric, and river pathways.

A direct comparison of the alternatives is not appropriate because the extent or degree of decontamination achieved in the facility by the completion of the alternative varies among the alternatives. Delayed decommissioning (the licensee's proposal), immediate decommissioning, and incomplete defueling result in only limited additional area and equipment decontamination at the start of decommissioning. Delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort will result in (1) building and equipment decontamination to the point where general area dose rates approximate those in an undamaged reactor at the end of its operating life, (2) fuel removal and decontamination of the reactor coolant system, (3) treatment of radioactive liquid wastes, and (4) packaging, shipping, and offsite disposal of radioactive wastes before the start of decommissioning or refurbishment.

TABLE 5.1. Estimated Radiological Environmental Impacts[a]

Section Number and Alternative	Occupational Dose, person-rem	Offsite Dose Pathway	50-year Dose Commitment[b]: Waste Transportation, person-rem	50-year Dose Commitment[b]: Maximally Exposed Offsite Individual, mrem	50-year Dose Commitment[b]: Offsite Population Within 50-mile Radius of TMI-2,[c] person-rem	50-year Dose Commitment[b]: Offsite Population Outside 50-mile Radius of TMI-2, person-rem
3.1 Delayed Decommissioning[d]	86 to 230 (31 to 280)	Transportation	0.5 to 2.4 (0.3 to 2.6)			
		Atmosphere				
		(bone)		23 (6.0 to 30)	13 (2.4 to 19)	1.2 (0.5 to 1.3)
		(total body)		1.9 (0.5 to 2.6)	7.8 (1.3 to 11)	0.3 (0.2 to 0.4)
		River				
		(bone)		0.03 (0.01 to 0.04)	0.09 (0.04 to 0.1)	0.3 (0.09 to 0.4)
		(total body)		0.02 (0.007 to 0.03)	0.008 (0.002 to 0.01)	0.03 (0.008 to 0.05)
3.2 Delayed Cleanup[e]	1500 to 4000 (1300 to 8400)	Transportation	9.7 to 19 (9.7 to 170)			
		Atmosphere				
		(bone)		24 (8.1 to 31)	14 (3.3 to 20)	1.2 (0.6 to 1.3)
		(total body)		1.9 (0.6 to 2.6)	7.9 (1.4 to 11)	0.3 (0.2 to 0.4)
		River				
		(bone)		0.2[f]	1.4 (1.2 to 1.6)	3.9 (3.0 to 5.5)
		(total body)		0.1[f]	0.08 (0.06 to 0.09)	0.2 (0.2 to 0.3)
3.3 Immediate Cleanup[g]	3700 to 9400[h]	Transportation	91 to 170			
		Atmosphere				
		(bone)		6.7	4.3	0.2
		(total body)		0.6	2.4	0.1
		River				
		(bone)		0.2	1.1	2.9
		(total body)		0.1	0.06	0.2
3.4 Immediate Cleanup/ Reduced Effort[i]	3700 to 9300[j]	Transportation	91 to 170			
		Atmosphere				
		(bone)		5.6	3.1	0.3
		(total body)		0.4	1.7	0.06
		River				
		(bone)		0.2	1.0	2.8
		(total body)		0.1	0.06	0.2

TABLE 5.1. (contd)

Section Number and Alternative	Occupational Dose, person-rem	Offsite Dose Pathway	50-year Dose Commitment[b]: Waste Transportation, person-rem	Maximally Exposed Offsite Individual, mrem	Offsite Population Within 50-mile Radius of TMI-2,[c] person-rem	Offsite Population Outside 50-mile Radius of TMI-2, person-rem
3.5 Immediate Decommissioning[k]	17 to 41	Transportation	0.3 to 0.5			
		Atmosphere				
		(bone)		0.05	0.01	0.002
		(total body)		0.001	0.0009	0.0001
		River				
		(bone)		0.007	0.02	0.05
		(total body)		0.006	0.002	0.006
3.6 Incomplete Defueling[l]	86 to 230	Transportation	0.5 to 2.4			
		Atmosphere				
		(bone)		23	13	1.2
		(total body)		1.9	7.8	0.3
		River				
		(bone)		0.03	0.09	0.3
		(total body)		0.02	0.008	0.03

(a) Impacts associated with decommissioning are not included.
(b) Doses from offsite burial of low-level wastes are not included.
(c) Includes the dose (for river pathway) from consumption of Chesapeake Bay shellfish.
(d) Cumulative 50-year dose commitment received over a 1-year period of preparation, a 23-year period of storage, and a 1-year period of decommissioning preparations. Numbers in parentheses are the cumulative 50-year dose commitment received over a 1-year period of preparation, a 5- to 33-year period of storage, and a 1-year period of decommissioning preparations.
(e) Cumulative 50-year dose commitment received over a 1-year period of preparation, a 23-year period of storage, and a 4-year period of cleanup. Numbers in parentheses are the cumulative 50-year dose commitment received over a 1-year period of preparation, a 5- to 33-year period of storage, and a 4-year period of cleanup.
(f) Rounding off to one significant figure, the dose to the maximally exposed individual would be the same for 23 years, 5 years, or 33 years of PDMS.
(g) Cumulative 50-year dose commitment received over a 2-year period for engineering study, a 3- to 4-year period of cleanup and an 18-year post-cleanup storage period.
(h) Includes 26 to 42 person-rem of occupational dose estimated for an 18-year storage period following the completion of cleanup.
(i) Cumulative 50-year dose commitment received over a 7- to 10-year period of cleanup and a 14-year post-cleanup storage period.
(j) Includes 21 to 34 person-rem of occupational dose estimated for a 14-year storage period following the completion of cleanup.
(k) Cumulative 50-year dose commitment received over a 2-year period of decommissioning preparations.
(l) Cumulative 50-year dose commitment received over a 1-year period of preparation, a 23-year period of storage, and a 1-year period of decommissioning preparations.

The occupational dose estimated for the licensee's proposal is 86 to 230 person-rem. Occupational dose estimates for the alternative actions range from 17 to 41 person-rem for the immediate decommissioning alternative to 3700 to 9400 person-rem for the immediate cleanup alternative. The occupational dose estimates for the remaining alternatives fall within these estimated ranges. As mentioned previously, the degree of decontamination varies among the alternatives. Many of the activities that would occur during the period encompassed by the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives will occur during the decommissioning period of delayed decommissioning (licensee's proposal), immediate decommissioning, and incomplete defueling alternatives. Because the impacts of the decommissioning period are not evaluated in this supplement, the impacts of many of the activities during the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives are not reflected in the occupational dose estimates for delayed and immediate decommissioning or incomplete defueling.

The population dose due to waste transportation is distributed to truck crews and those persons along the transportation route. The estimated dose from the licensee's proposal is 0.5 to 2.4 person-rem (total body). The dose ranges from 0.3 to 170 person-rem (total body) for the alternative actions. The dose to the persons along the transportation route is a small fraction of the total annual dose from background sources that is received by this population.

For routine offsite releases resulting from delayed decommissioning, the total 50-year dose commitment estimated for the maximally exposed individual is 23 mrem to the bone and 1.9 mrem to the total body from releases to the atmosphere, and 0.03 mrem to the bone and 0.02 mrem to the total body from releases to the Susquehanna River. In comparison, for the five NRC staff-identified alternatives, the total 50-year dose commitment estimated for the maximally exposed offsite individual ranges from 0.05 to 31 mrem to the bone and 0.001 to 2.6 mrem to the total body from releases to the atmosphere, and 0.007 to 0.2 mrem to the bone and 0.006 to 0.1 mrem to the total body from releases to the Susquehanna River. These doses are based on exposures occurring over periods of 2 to 38 years and on a series of conservative assumptions, as discussed in Section 3.0 and Appendix E. The doses resulting from the licensee's proposal and alternatives are in addition to the approximately 300 mrem/yr to the total body received by the average Harrisburg resident from natural background (NCRP 1987a and 1987b). Thus, the total body dose to the maximally exposed individual is 0.03 percent of the background dose received by this individual during the period of impact for delayed decommissioning and ranges from 0.001 to 0.03 percent of the background dose for the NRC staff-identified alternatives.

The total 50-year dose commitment to the population living within 50 miles (80 kilometers) of TMI-2 from the licensee's proposal is 13 person-rem to the bone and 7.8 person-rem to the total body from releases to the atmosphere, and 0.09 person-rem to the bone and 0.008 person-rem to the total body from releases to the Susquehanna River. In comparison, for the five NRC staff-identified alternatives the total 50-year dose commitment to the population within 50 miles (80 kilometers) of TMI-2, is estimated to range from 0.01 to 20 person-rem to the bone and 0.0009 to 11 person-rem to the total body from releases to the atmosphere, and 0.02 to 1.6 person-rem to the bone and 0.002 to 0.09 person-rem to the total body from releases to the Susquehanna River. The population doses are potentially distributed to a population ranging from 2.5 million persons to 3.7 million persons within 50 miles (80 kilometers) of TMI-2. In addition to the doses incurred during storage and/or cleanup, these populations are expected to receive annual background radiation doses to the total body of approximately 750,000 person-rem per year and 1,100,000 person-rem per year for 2.5 million and 3.7 million persons, respectively (assuming an average background dose rate of 300 mrem/yr). Thus, the total body dose received by the population within the 50-mile (80-kilometer) radius of TMI-2 during the period of impact is 0.00004 percent of the background dose for the licensee's proposal and ranges from 0.0000002 to 0.00004 percent of the background dose for the five NRC staff-identified alternatives.

An additional population living throughout the whole United States, but outside the 50-mile (80-kilometer) radius receives radiation dose attributable to the TMI-2 cleanup from external exposure, inhalation, the consumption of food exported from within the 50-mile (80-kilometer) radius, and consumption of Chesapeake Bay shellfish. Because of the potentially large size of this population, the dose during any of the alternatives is an even smaller fraction of the background radiation dose than that given above for the population within the 50-mile (80-kilometer) radius.

Table 5.2 summarizes the nonradiological impacts that could result from the licensee's proposal for delayed decommissioning and the alternatives as discussed in Section 3.0. These include the estimated cost of implementation (in 1988 dollars), the long-term commitment of space for radioactive waste burial, and the estimated number of transportation accidents expected during waste shipments.

The estimated cost of implementing the licensee's proposal ranges from $92 million to $100 million. For the NRC staff-identified alternatives the cost of implementation ranges from $17 million to $20 million for the immediate decommissioning alternative, to $260 million to $510 million for the immediate cleanup/reduced effort alternative. These costs are in 1988 dollars and include the estimated waste-disposal costs.

None of the alternatives or the licensee's proposal would require any new long-term commitment of land onsite, but all would require storage space in a low-level waste (LLW) commercial burial site.

TABLE 5.2. Estimated Nonradiological Environmental Impacts of Cleanup Alternatives[a]

Section Number and Alternative	Cost, $ millions[b]	LLW Burial Ground Space, ft^3[c]	Estimated Number of Traffic Accidents
3.1 Delayed Decommissioning	92 to 100 (29 to 140)[d]	950 to 4600 (310 to 6400)	0.02 to 0.1 (0.01 to 0.1)
3.2 Delayed Cleanup	210 to 340 (150 to 370)	121,000 to 187,000 (120,000 to 189,000)	0.6 to 1.1 (0.6 to 7.2)
3.3 Immediate Cleanup	310 to 400[e]	120,000 to 182,000	4.5 to 7.2
3.4 Immediate Cleanup/ Reduced Effort	260 to 510[f]	120,000 to 182,000	4.5 to 7.2
3.5 Immediate Decommissioning	17 to 20	70 to 370	0.007 to 0.02
3.6 Incomplete Defueling	92 to 100	950 to 4600	0.02 to 0.1

(a) Impacts associated with decommissioning or refurbishment are not included.
(b) Constant 1988 dollars.
(c) LLW burial ground space is in cubic feet. For metric equivalents, see Section 3.0.
(d) Numbers in parentheses are the impacts from the alternative, based on a 5- to 33-year period of storage.
(e) Includes $68 million to $74 million in labor cost for an 18-year storage period following cleanup.
(f) Includes $54 million to $59 million in labor cost for a 14-year storage period following cleanup.

The amount of storage space required for the licensee's proposal is 950 to 4600 cubic feet (27 to 130 cubic meters). The amount of storage space necessary for the remaining alternatives ranges from 70 to 370 cubic feet (2 to 11 cubic meters) for the immediate decommissioning alternative to 120,000 to 189,000 cubic feet (3400 to 5400 cubic meters) for the delayed cleanup alternative.

The number of transportation accidents estimated to occur during the licensee's proposal for delayed decommissioning ranges from 0.02 to 0.1. For the NRC staff-identified alternatives the number of transportation accidents ranges from 0.007 to 0.02 for the immediate decommissioning alternative to 4.5 to 7.2 for the immediate cleanup and immediate cleanup/reduced effort alternatives. An accident is defined as any form of traffic accident and does not necessarily imply personnel injuries, fatalities, or any disturbance to the cargo. The number of injuries, fatalities, and radiological events resulting from traffic accidents is described in Section 5.4. The number of accidents estimated to result during delayed cleanup is smaller than for immediate cleanup or immediate cleanup/reduced effort because of the significant reduction in shipping distance assumed to occur if cleanup is delayed until a regional LLW disposal facility is available.

5.2 RANGE OF RADIOLOGICAL IMPACTS AND POSSIBLE HEALTH EFFECTS

In estimating potential health effects from both offsite and occupational radiation exposures as a result of TMI-2 cleanup, the staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences (NAS) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR 1972; BEIR 1980). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rem and 220 potential cases of all forms of genetic disorders per million person-rem.

The cancer-mortality risk estimates are based on the "absolute risk" model described in BEIR I (BEIR 1972). Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range could be zero because there may be biological mechanisms that can repair damage caused by radiation at low doses and/or dose rates. The potential number of total cancers would be approximately 1.5 to 2 times the number of potential fatal cancers, according to BEIR III (BEIR 1980).

Values for genetic risk estimators range from 60 to 1100 potential cases of all forms of genetic disorders per million person-rem (BEIR 1980). The value of 220 potential cases for all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology.

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP 1977), the National Council on Radiation Protection and Measurements (NCRP 1975), the NAS (BEIR 1980), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1982).

The risk of potentially fatal cancers in the exposed work-force population is estimated as follows: multiplying the plant-worker-population dose (as shown in Table 5.3 for the licensee's proposal and the quantitatively evaluated alternatives) by the somatic risk estimator (135 potential deaths from cancer per million person-rem) produces the estimated number of cancer deaths that may occur in the total population of exposed workers involved in each alternative (also

TABLE 5.3. Potential Fatal Cancer Death Estimates for the Total Exposed Work-force Population[a]

Section Number and Alternative	Occupational Dose Commitment, person-rem[b]	Estimated Number of Potential Cancer Deaths
3.1 Delayed Decommissioning[c]	86 to 230	0.01 to 0.03
3.2 Delayed Cleanup[c]	1500 to 4000	0.2 to 0.5
3.3 Immediate Cleanup	3700 to 9400	0.5 to 1.3
3.4 Immediate Cleanup/ Reduced Effort	3700 to 9300	0.5 to 1.3
3.5 Immediate Decommissioning	17 to 41	0.002 to 0.006
3.6 Incomplete Defueling[c]	86 to 230	0.01 to 0.03

(a) Impacts associated with decommissioning are not included.
(b) 50-year dose commitment.
(c) Estimates assume a 23-year PDMS period.

shown in Table 5.3). The higher value of 1.3 cancer deaths for the immediate cleanup and immediate cleanup/reduced effort alternatives means that there is the potential for one radiation induced cancer death attributable to the exposure of the work force over the lifetime of the entire work force. The risk of potential genetic disorders attributable to exposure of the work force is a risk borne by the progeny of the workers but may be added to the risk to the entire population and is thus properly considered as part of the risk to the general public.

Conservative estimates of the radiological doses and dose commitments resulting from the alternatives are given in Section 3.0. Accurate measurements of radiation and radioactive contaminants can be made with a very high sensitivity so that much smaller amounts of radionuclides can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees that have occasionally been constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear power plant effluents, upper-bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus, the risks to the maximally exposed member of the public outside the site boundaries or to the total population outside the boundaries can be estimated. These risk estimates for the alternatives evaluated are presented below.

The risk to the maximally exposed individual is estimated by multiplying the preceding risk estimator (135 potential deaths from cancer per million person-rem) by the estimated dose to the total body (as shown in Table 5.4). This calculation results in a risk of potential premature death from cancer to the maximally exposed individual from exposure to radioactive effluents (gaseous or liquid) ranging from approximately 9 chances in 10 billion for the immediate decommissioning alternative to approximately 3 chances in 10 million for the delayed decommissioning, delayed cleanup, and incomplete defueling alternatives. These risks are very small in comparison to cancer incidence from causes unrelated to the cleanup of the TMI-2 facility.

TABLE 5.4. Potential Premature Cancer Death Estimates for the Maximally Exposed Individual[a]

Section Number and Alternative	Maximally Exposed Off-site Individual Dose Commitment, mrem[b]	Estimated Risk of Cancer Death
3.1 Delayed Decommissioning[c]	1.9	0.0000003
3.2 Delayed Cleanup[c]	2.0	0.0000003
3.3 Immediate Cleanup	0.7	0.00000009
3.4 Immediate Cleanup/ Reduced Effort	0.5	0.00000007
3.5 Immediate Decommissioning	0.007	0.0000000009
3.6 Incomplete Defueling[c]	1.9	0.0000003

(a) Impacts associated with decommissioning are not included.
(b) 50-year dose commitment from atmosphere and river pathways.
(c) Estimates assume a 23-year PDMS period.

The risk of death from cancer to the average individual within 50 miles (80 kilometers) of the facility from exposure to radioactive effluents from TMI-2 is much less than the risk to the maximally exposed individual. Multiplying the dose to the general population within 50 miles (80 kilometers) of TMI-2 from exposure to radioactive effluents by the preceding somatic risk estimator (as shown in Table 5.5), the staff calculates less than 0.001 cancer deaths (i.e., the probability of a single cancer death occurring in the entire offsite population is approximately 1 chance in 1000) from the delayed decommissioning, delayed cleanup, and incomplete defueling alternatives to less than 0.0000004 cancer deaths (i.e., the probability of a single cancer death occurring in the entire offsite population is approximately 4 chances in 10 million) from the immediate decommissioning alternative. The statistically expected value is zero deaths in each case.

The significance of this risk can be illustrated by comparing it to the total projected incidence of cancer deaths in the population within 50 miles (80 kilometers) of TMI-2. Multiplying the estimated population within 50 miles (80 kilometers) of TMI-2 assumed for the

TABLE 5.5. Potential Premature Cancer Death Estimates for the General Population Within 50 Miles (80 Kilometers) of TMI-2[a]

Section Number and Alternative		Offsite Population Dose Commitment, person-rem[b]	Estimated Risk of Cancer Death
3.1	Delayed Decommissioning[c]	7.8	0.001
3.2	Delayed Cleanup[c]	8.0	0.001
3.3	Immediate Cleanup	2.5	0.0003
3.4	Immediate Cleanup/ Reduced Effort	1.8	0.0002
3.5	Immediate Decommissioning	0.003	0.0000004
3.6	Incomplete Defueling[c]	7.8	0.001

(a) Impacts associated with decommissioning are not included.
(b) 50-year dose commitment.
(c) Estimates assume a 23-year PDMS period.

year 1991 (2.5 million people) by the incidence of eventual actual cancer fatalities of about 20 percent (American Cancer Society 1985), the staff estimates that about 550,000 cancer deaths are expected.

For purposes of evaluating the potential genetic risks, the progeny of workers are considered members of the general public. However, it is assumed that only about one-third of the occupational radiation dose is received by workers who have offspring after the workers have been exposed to radiation (see Paragraph 80 of ICRP 1977). For example, multiplying the sum of the dose to the population within 50 miles (80 kilometers) of TMI-2 from exposure to radioactivity attributable to effluent from the delayed decommissioning alternative (i.e., 7.8 person-rem total body, including gonads) and the estimated dose from occupational exposure (i.e., one-third of between 86 and 230 person-rem) by the preceding genetic risk estimator (220 potential cases of all forms of genetic disorders per million person-rem), the staff estimates that between 0.008 and 0.02 potential genetic disorders may occur in all future generations of the exposed population from delayed decommissioning activities. Estimates of the potential genetic disorders for delayed decommissioning and the five quantitatively evaluated alternatives for all future generations of the exposed population are shown in Table 5.6. The statistically expected number of genetic disorders attributable to alternatives is between zero and one.

TABLE 5.6. Potential Incidence of Genetic Disorders in Future Generations of the Exposed Population Within 50 Miles (80 Kilometers) of TMI-2[a]

Section Number and Alternative	Estimated Number Of Potential Genetic Disorders
3.1 Delayed Decommissioning[b]	0.008 to 0.02
3.2 Delayed Cleanup[b]	0.1 to 0.3
3.3 Immediate Cleanup	0.3 to 0.7
3.4 Immediate Cleanup/Reduced Effort	0.3 to 0.7
3.5 Immediate Decommissioning	0.001 to 0.003
3.6 Incomplete Defueling[b]	0.008 to 0.02

(a) Impacts associated with decommissioning are not included.
(b) Estimates assume a 23-year PDMS period.

BEIR III (BEIR 1980) indicates that the mean persistence of the two major types of genetic disorders is about 5 generations and 10 generations, respectively. Thus, in the following analysis the risk of potential genetic disorders from the cleanup operations is conservatively compared with the risk of actual genetic ill health in the first 5 generations. Multiplying the estimated population within 50 miles (80 kilometers) of the plant (about 2.5 million persons in the year 1990) by the current incidence of actual genetic ill health in each generation (about 11 percent), it is estimated that about 1.4 million genetic abnormalities are expected in the first five generations of the population (BEIR 1980) from causes unrelated to TMI-2 cleanup.

No significant radiological impact is expected on aquatic or terrestrial biota, including endangered species, as a result of any of the alternatives.

5.3 RANGE OF NONRADIOLOGICAL IMPACTS

The major nonradiological impacts identified include the cost of implementation, long-term commitment of land and burial ground space, and the socioeconomic effects. No significant chemical releases are expected for any of the alternatives.

Cost estimates were based on staff consideration of the cost of major activities expected for each alternative. The estimates are not based on an extremely detailed level of information, but they are believed to provide an adequate basis for comparing the cost impact of the alternatives. The estimated costs (in constant 1988 dollars), as shown in Table 5.2, for the licensee's proposal of delayed decommissioning range from $92 million to $100 million. For the NRC staff-identified alternatives, the estimated costs range from $17 million to $20 million for the immediate decommissioning alternative to $260 million to $510 million for the immediate cleanup/reduced effort alternative.

None of the alternatives require a new long-term commitment of land at the TMI-2 site. The licensee's proposal (delayed decommissioning) would require 950 to 4600 cubic feet (27 to 130 cubic meters). The delayed cleanup alternative would require the largest disposal space (120,000 to 189,000 cubic feet [3400 to 5400 cubic meters]) and the immediate decommissioning alternative would require the smallest disposal space (70 to 370 cubic feet [2 to 11 cubic meters]), as shown in Table 5.2.

The 1987-1988 work force would be reduced from approximately 1150 persons to 100 to 125 persons in the first year of delayed decommissioning, delayed cleanup, and incomplete defueling, and to 70 to 75 persons in subsequent years; however, the employment reduction in the surrounding area amounts to only about 0.2 percent of the local baseline employment in the surrounding area. Thus, the socioeconomic impact on the local economy should be minor. The staffing level for immediate decommissioning was assumed to be twice as large as the staffing level for the first 2 years of PDMS during delayed decommissioning: 200 to 250 persons in the first year and 140 to 150 persons the following year. The staffing level for completing cleanup after PDMS for the delayed cleanup alternative would probably be somewhat smaller than the current staffing level, although larger than that used during PDMS. The socioeconomic impacts for the immediate cleanup and immediate cleanup/reduced effort alternatives are expected to be minor; essentially the present economic impact of TMI-2 cleanup or slightly less would be maintained for a period of 5 to 6 years for immediate cleanup, or 7 to 10 years for immediate cleanup/reduced effort.

The estimated time commitment varies from 7 to 35 years for delayed decommissioning. This includes a 1-year period of preparations for PDMS, an assumed storage period of 5 to 33 years, and a 1-year period of preparations for decommissioning. The time commitment for delayed cleanup varies from 10 to 38 years. This includes a 1-year period of preparations for PDMS, a storage period of 5 to 33 years, and a cleanup period of 4 years following the end of PDMS. The immediate cleanup alternative could be completed in about 5 to 6 years, including a 2-year period for engineering studies and a 3- to 4-year cleanup. The immediate cleanup/reduced effort could be completed in 7 to 10 years. The immediate decommissioning alternative could be completed in 2 years following completion of defueling. In the evaluation of the incomplete defueling alternative, a 25-year period was considered (a 1-year period of preparations for PDMS, 23 years of storage, and 1 year of preparations for decommissioning); however, the time commitment could range from 7 to 35 years depending on the length of the storage period. In all cases, additional activities, either decommissioning or refurbishment, would be required following the time span considered for each alternative.

No significant nonradiological impact is expected to aquatic or terrestrial biota, including endangered species, as a result of any of the alternatives.

5.4 RANGE OF ACCIDENT IMPACTS AND THEIR PROBABILITY

The accident impacts include both radiological impacts resulting from potential accidents at the TMI-2 facility and radiological and nonradiological impacts of accidents during transportation of the waste to a low-level waste site. Table 5.7 lists the possible radiological accidents and resulting dose estimates to the maximally exposed individual for the licensee's proposal (delayed decommissioning) and the five quantitatively evaluated alternatives. For delayed decommissioning, the largest accident impact resulting from a fire during PDMS, gave an estimated 13 mrem to the bone and 1.6 mrem to the

TABLE 5.7. Estimated Environmental Impacts of Nontransportation Radiological Accidents[a]

Section Number and Alternative	Stage of Accident and Accident Description	Dose: Maximally Exposed Offsite Individual, mrem: Bone	Total Body	Offsite Population, person-rem: Within 50-Mile Radius of TMI-2: Bone	Total Body	Outside 50-Mile Radius of TMI-2: Bone	Total Body
3.1 Delayed Decommissioning[b]	PDMS						
	Fire in stairwell	13	1.6	0.8	0.4	0.1	0.04
	Decommissioning Preparations						
	Fire in stairwell	0.07	0.008	0.009	0.006	0.0001	0.0001
	HEPA filter failure	0.08	0.003	0.009	0.0008	0.0002	0.00001
3.2 Delayed Cleanup[b]	PDMS						
	Fire in stairwell	13	1.6	0.8	0.4	0.1	0.04
	Cleanup						
	Fire in stairwell	0.07	0.008	0.009	0.006	0.0001	0.0001
	HEPA filter failure	89	9.7	9.7	6.9	0.3	0.1
	Decontamination liquid spill	0.2	0.006	0.08	0.004	0.001	<0.00001
	Storage tank rupture	0.002	0.0003	0.03	0.0007	0.1	0.007
3.3 Immediate Cleanup	Engineering Study Period						
	Fire in stairwell	0.2	0.02	0.01	0.007	0.001	0.0003
	Cleanup						
	Fire in stairwell	0.2	0.02	0.01	0.007	0.001	0.0003
	HEPA filter failure	150	16	12	8.4	1.4	0.5
	Decontamination liquid spill	0.4	0.008	0.07	0.004	0.001	0.0001
	Storage tank rupture	0.002	0.0003	0.02	0.0005	0.07	0.004
	Post-cleanup Storage						
	Fire in stairwell	2.4	0.3	0.2	0.2	0.02	<0.001
3.4 Immediate Cleanup/ Reduced Effort	Cleanup						
	Fire in stairwell	0.2	0.02	0.01	0.007	0.001	0.0004
	HEPA filter failure	150	17	13	8.8	1.0	0.5
	Decontamination liquid spill	0.4	0.008	0.07	0.004	0.002	0.0001
	Storage tank rupture	0.002	0.0003	0.02	0.0005	0.07	0.004
	Post-cleanup Storage						
	Fire in stairwell	2.4	0.2	0.2	0.2	0.02	0.01

TABLE 5.7. (contd)

Section Number and Alternative	Stage of Accident and Accident Description	Dose: Maximally Exposed Offsite Individual, mrem		Dose: Offsite Population, person-rem: Within 50-Mile Radius of TMI-2		Dose: Offsite Population, person-rem: Outside 50-Mile Radius of TMI-2	
		Bone	Total Body	Bone	Total Body	Bone	Total Body
3.5 Immediate Decommissioning	Decommissioning Preparations						
	Fire in stairwell	0.2	0.02	0.008	0.005	0.001	0.0004
	HEPA filter failure	0.2	0.006	0.008	0.0007	0.001	0.00007
3.6 Incomplete Defueling[b]	PDMS						
	Fire in stairwell	13	1.6	0.8	0.4	0.1	0.04
	Decommissioning Preparations						
	Fire in stairwell	0.07	0.008	0.009	0.006	0.0001	0.0001
	HEPA filter failure	0.08	0.003	0.009	0.0008	0.0002	0.00001

(a) Impacts associated with accidents during decommissioning are not included.

(b) Estimates assume a 23-year PDMS period.

total body of the maximally exposed individual and 0.8 person-rem to the bone and 0.4 person-rem to the total body of the offsite population within a 50-mile (80-kilometer) radius of the site. For the NRC staff-identified alternatives, the largest 50-year dose commitments would result from a high-efficiency particulate air (HEPA) filter failure accident during the immediate cleanup/reduced effort alternative, giving an estimated 150 mrem to the bone and 17 mrem to the total body of the maximally exposed individual and 13 person-rem to the bone and 8.8 person-rem to the total body of the offsite population within a 50-mile (80-kilometer) radius of the site. It is important to note that these accidents are based on a series of conservative assumptions as discussed in Section 3.0, and and can be compared with a background dose of 300 mrem/yr to the average individual and 750,000 to 1,100,000 person-rem to the population of 2.5 to 3.7 million persons assumed for the analysis to live within a 50-mile (80-kilometer) radius of TMI-2 at the time of the accidents. Accident impacts associated with any alternative are a fraction of the background exposure.

Table 5.8 lists the major radiological and nonradiological consequences of transportation accidents. For delayed decommissioning (the licensee's proposal) an estimated 0.02 to 0.1 accidents would occur (the probability of an accident during the entire duration of the alternative is approximately 2 to 10 chances in 100) with 0.02 to 0.08 injuries (the probability of an injury during the entire duration of the alternatives is approximately 2 to 8 chances in 100), 0.001 to 0.006 fatalities (the probability of a fatality during the entire duration of the alternative is 1 to 6 chances in 1000) and a population dose of 0.00003 to 0.0002 person-rem. For the NRC staff-identified alternatives, the maximum estimate of 4.5 to 7.2 accidents would occur for the immediate cleanup and immediate cleanup/reduced effort alternatives, with 3.9 to 6.3 injuries, 0.3 to 0.5 fatalities (the probability of a fatality during the entire shipping is 3 to 5 chances out of 10), and a population dose of about 0.005 to 0.01 person-rem. The number of accidents, injuries, and fatalities estimated during the delayed cleanup alternative is smaller than for the immediate cleanup alternative because of the significant reduction in shipping distance assumed to occur if cleanup is delayed until a regional LLW disposal facility is available.

TABLE 5.8. Estimated Radiological and Nonradiological Impacts from Truck Accidents[a]

Section Number and Alternative	Radiological Impacts Population Dose, person-rem	Nonradiological Impacts, Estimated Number[b]		
		Accidents	Injuries	Fatalities
3.1 Delayed Decommissioning[c]	0.00003 to 0.0002	0.02 to 0.1	0.02 to 0.08	0.001 to 0.006
3.2 Delayed Cleanup[c]	0.0009 to 0.002	0.6 to 1.1	0.3 to 0.6	0.03 to 0.05
3.3 Immediate Cleanup	0.005 to 0.01	4.5 to 7.2	3.9 to 6.3	0.3 to 0.5
3.4 Immediate Cleanup/ Reduced Effort	0.005 to 0.01	4.5 to 7.2	3.9 to 6.3	0.3 to 0.5
3.5 Immediate Decommissioning	0.00002 to 0.00003	0.007 to 0.02	0.007 to 0.01	0.0006 to 0.001
3.6 Incomplete Defueling[b]	0.00003 to 0.0002	0.02 to 0.1	0.02 to 0.08	0.001 to 0.006

(a) Impacts associated with decommissioning are not included.
(b) Truck crew and public.
(c) Estimates assume a 23-year PDMS period.

6.0 CONCLUSIONS

The NRC staff's conclusions are based on the evaluation of the environmental impacts associated with the licensee's proposal and the staff-identified alternatives. The licensee's proposal is to place the TMI-2 facility in post-defueling monitored storage at the conclusion of defueling for an unspecified period of time after which the licensee would likely decommission the facility. The NRC staff has termed this proposal delayed decommissioning. The NRC staff-identified alternatives are (1) facility storage followed by completion of cleanup (i.e., delayed cleanup), (2) a 2-year period for an engineering study followed by completion of cleanup (i.e., immediate cleanup), (3) completion of cleanup at a reduced level of effort (i.e., immediate cleanup/reduced effort), (4) an immediate 2-year period of preparations for decommissioning (i.e., immediate decommissioning), (5) initiation of delayed decommissioning following removal of only 85 percent of the fuel (i.e., incomplete defueling), (6) additional cleanup followed by a storage period and subsequent completion of cleanup (i.e., additional cleanup before storage), and (7) no further cleanup following defueling (i.e., the "no-action" alternative).

The staff concludes:

- The licensee's proposal and the NRC staff-identified alternatives (with the exception of the no-action alternative) are within applicable regulatory limits and could each be implemented without significant environmental impact. The potential health impact on both workers and the offsite public from any of the alternatives is very small.
- None of the alternatives is obviously superior to the licensee's proposal from the perspective of environmental impacts. Although the quantitative estimates of potential impacts vary among alternatives, these differences are not judged sufficiently large to allow for identification of an obviously superior alternative. Much of the variation results from the variations in the endpoints of the alternatives: delayed decommissioning, immediate decommissioning, and incomplete defueling would result in limited additional area and equipment decontamination before the facility is decommissioned; delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, and additional cleanup before storage would result in building and equipment decontamination to the point where general area dose rates approximate those in an undamaged reactor facility (that has not undergone a significant accident) nearing the end of its operating life.

- The alternative of no further cleanup following defueling (or "no-action" alternative), required by the National Environmental Policy Act of 1969 as part of environmental impact statements, is not acceptable because it would indefinitely postpone decommissioning of the facility without specific approved exemptions from NRC regulations, and would not result in the completion of cleanup or in the elimination of the small but continuing public health and safety risk associated with the damaged TMI-2 facility.

- The licensee's proposal and the NRC staff-identified alternatives result in calculated doses to the public that are fractions of the dose received from background radiation.

- Although the endpoints of the licensee's proposal and the staff-identified alternatives vary, the environmental impacts estimated for the alternatives evaluated in this supplement fall within the range of impacts estimated in the NRC staff's original Programmatic Environmental Impact Statement (NRC 1981) on the cleanup.

- Implemention of the licensee's proposal (delayed decommissioning) would result in substantial occupational dose savings and reduced transportation impacts over several of the alternatives considered.

- The licensee's proposal for completing the cleanup by post-defueling monitored storage of the TMI-2 facility followed by decommissioning is environmentally acceptable and will not significantly affect the quality of the human environment.

7.0 DISCUSSION OF COMMENTS ON THE DRAFT SUPPLEMENT

Pursuant to 10 CFR 51 (CFR 1988a), the Programmatic Environmental Impact Statement Related to the Decontamination and Disposal of Radioactive Wastes as a Result of the March 28, 1979 Accident at Three Mile Island Nuclear Station, Unit 2 (PEIS), Draft Supplement 3, was transmitted in April 1988, with a request for comments to the Federal and State government agencies noted in the Foreword. In addition, a notice requesting comments from interested members of the public was published on April 27, 1988 (53 FR 15160). The comment letters received by the staff, portions of the transcripts of public meetings held on May 26, 1988, July 14, 1988, and September 7, 1988, by the Commission's Advisory Panel for the Decontamination of TMI-2, and the transcript of a U.S. Nuclear Regulatory Commission (NRC) periodic briefing by the TMI-2 Advisory Panel on October 25, 1988, are reproduced in Appendix A of this final supplement.

The NRC staff's response to these comments and consideration of the issues involved are shown in this supplement in two forms: by revisions in the text as found in the draft supplement (all revisions, whether or not they were in response to comments, are designated by vertical lines beside the text) and by responses to comments as given in Sections 7.1 through 7.11. Comments and questions that were clearly outside the scope of the supplement (such as those concerning the origin of certain regulations or the ability of the licensee to maintain the facility in storage or to complete cleanup) were noted by the staff but are not addressed in the final supplement. Comments that were addressed in the text of the draft or final version of the supplement are not otherwise addressed in this section.

The ordering of Sections 7.1 through 7.11 corresponds generally to the ordering of the subject material in the text of the supplement (purpose and scope, facility status, description of alternatives, occupational dose, waste management, commitment of resources, regulatory requirements, existing environment, environmental impacts, and decommissioning). In this section, similar comments and questions concerning these issues are grouped together for ease of reference.

In parentheses to the right of each topic heading in this section is a series of numbers that correlate the topic with public comments received in letters or at public meetings. (The text of the letters and the transcripts of the public meetings are found in Appendix A.) The parentheses contain, first, the number keyed to the relevant letters or public meeting transcripts, followed by a dash, and then the page number within the letter or transcript. As explained in Appendix A, the pages of each letter and transcript have been numbered by the staff for ease of reference. In some cases the numbers do not correspond to the numbering system used by the author of the letter.

7.1 PURPOSE AND SCOPE OF THE SUPPLEMENT AND THE REGULATORY PROCESS

7.1.1 Public Intervention (2-4, 3-17)

One commenter asked whether the public will be entitled to intervene if GPU implements "long-term monitored storage of the facility."

Response:

> Members of the public are entitled to request a hearing on any amendment to the operating license of any nuclear power plant. An amendment to the TMI-2 license must be issued before the licensee can implement post-defueling monitored storage (PDMS). The Commission (usually through an Atomic Safety and Licensing Board) may grant a hearing at the request of any person or group whose interest may be affected by Commission action on the licensee's proposal provided they meet other requirements of the Commission's regulations regarding intervention.

7.1.2 Completion of the Cleanup Program (10-3, 10-14, 10-16, 10-17)

The licensee stated that they consider the "cleanup program" to include those actions necessary to recover from the accident and place the plant in a safe and stable condition that poses no risk to the public health and safety. They also have indicated that this program will be completed before PDMS. Such additional activities as the decontamination of the reactor coolant system and cleanup of the reactor building, especially the basement and inside the D-rings, are not necessary to ensure the public health and safety and will be performed during decommissioning of the plant. Thus, the scope of the GPU Nuclear proposal was limited to placing the TMI-2 facility in PDMS. According to the licensee, additional cleanup prior to storage and the final disposition of the plant has not been studied or proposed.

Response:

> The final supplement has been revised to more accurately reflect the licensee's proposal, as understood by the NRC staff. However, the NRC staff does not consider that the cleanup as defined in the PEIS will be complete before PDMS. As defined in the PEIS (and discussed in Section 1.0 and Section 2.1 of Draft and Final Supplement 3), the completion of cleanup will be achieved when four fundamental activities have been completed: (1) building and equipment decontamination to a point where general area dose rates approximate those in an undamaged reactor facility nearing the end of its operating life, (2) fuel removal and decontamination of the reactor coolant system, (3) treatment of radioactive liquid wastes, and (4) packaging of radioactive wastes and

shipment of the wastes to an offsite disposal facility. Although considerable progress has been made on the cleanup, the licensee did not propose that these tasks be completed by the time the TMI-2 facility is placed in PDMS.

However, extensive cleanup has been accomplished, as discussed in Section 2.1 of Draft and Final Supplement 3. The activities that the licensee will accomplish before PDMS would be adequate to ensure public health and safety. Furthermore, there are no regulatory requirements that would prevent the licensee from beginning the decommissioning process following the current defueling effort, as discussed in Section 3.5.7 of this final supplement.

7.1.3 Criteria for the Completion of Cleanup (24-4, 3-1)

Two commenters asked what the specific criteria are for the termination of cleanup. One of the commenters felt that since core inventories can only be estimated, it is necessary to define the action set points as a process derivative.

Response:

As indicated in Sections 1.0 and 2.1 of both Draft and Final Supplement 3, the cleanup plan evaluated in the PEIS called for four fundamental activities: building and equipment decontamination; fuel removal and decontamination of the reactor coolant system; treatment of radioactive liquids; and packaging, handling, shipment, and disposal of radioactive wastes. The PEIS indicated that the general area radiation dose rates at the completion of the cleanup would approach 10 mrem/h in most areas of the reactor building and auxiliary and fuel-handling building (AFHB). This is typical of normally occupied areas in a undamaged reactor facility at the end of its operating life. However, there are no criteria regarding the amount of contamination that may be left in a facility at the time the licensee begins the decommissioning process. However, the criteria given in 10 CFR 20 (CFR 1988a) are applicable to the offsite dose and occupational exposure associated with decommissioning processes.

7.1.4 Cleanup Endpoint - Auxiliary and Fuel-Handling Building (2-3)

One commenter asked what dose levels would be expected for the AFHB at the end of its life.

Response:

The general area dose levels in the AFHB are less than 2.5 mR/h in many areas, although they are 15 mR/h or more in some of the cubicles that contain contaminated equipment (GPU 1988). This is similar to dose levels that would be found in AFHBs at a facility that has not experienced a significant accident after 40 years of plant operation.

7.1.5 Reliance on Data Supplied by GPU (2-1, 3-13, 9-1, 12-1, 18-40, 19-1)

Several commenters indicated that there appeared to be a great reliance on data supplied by GPU. These commenters felt that this casts some doubt on the results given in the supplement, because of the lack of independence as well as the "sloppiness" of the licensee's data.

Response:

The NRC staff maintains an ongoing presence at the TMI site and routinely reviews and audits the data obtained from the licensee's measurements of conditions in the TMI-2 facility. In cases where it is deemed important, the NRC or one of its contractors will make confirmatory measurements of the licensee's results.

Information used in this supplement was not obtained solely from data supplied by GPU. Other sources of information are given in Section 8.0. The licensee, however, does operate and manage the TMI-2 facility and as such does obtain the bulk of the measurements characterizing the facility.

7.1.6 Inadequacy of Data (2-3, 14-1, 18-40, 18-42, 19-1, 19-2)

One commenter felt that the data used in Draft Supplement 3 were inadequate and that further scrutiny of the quantity and location of all radionuclides is of vital importance. A second commenter also expressed this concern and specifically addressed the fuel debris to be left within the reactor vessel, the area under the reactor vessel including the water in the sump below the reactor vessel, and the reactor coolant system. A third commenter inquired why new calculations concerning the number and quantity of remaining radionuclides were not made.

Response:

The data used in Draft and Final Supplement 3 are continually being updated as more current measurements are made. Refining the measurement techniques used in the TMI-2 facility and making new measurements to determine the quantity and location of the radionuclides in the facility are important tasks that are being performed regularly. However, because of the complications involved in measuring the large amount of radioactive material in the facility and because of the facility's complicated structure, it is not possible to know the exact quantity and location of every curie of radioactive material. Thus, for the calculations that were made for this supplement, the NRC staff used data that it felt would bound the impact of the alternatives evaluated. That is, the NRC staff is confident that the impact resulting from implementation of any of the alternatives evaluated would be smaller than the impact calculated in this supplement. Further characterization of the TMI-2 facility, especially the reactor vessel and reactor coolant system, will occur before the facility is placed in storage. If the results are not within the range assumed in this supplement, the staff will reevaluate the consequences of the revised levels of contamination and determine whether or not these consequences are acceptable. If the staff finds that the consequences are environmentally unacceptable, then additional decontamination, shielding or isolation will be required.

7.1.7 Engineering Design and Operation Details (13-1, 24-4, 24-6)

Several commenters stated that engineering details of the PDMS design and operation are missing and that many assumptions are made in Draft Supplement 3. One commenter gave as examples details regarding containment entries (the basis for the assumption of once-a-month entries), design and operations of ventilation systems, filters and their efficiencies, other containment penetration systems, water accumulation/condensation inside containment, and the basis for out-leakage. One commenter indicated that although they understood that the calculated numbers are to serve as targets and the actual design will have to be fitted into the information in the supplement, more detailed information on operations, plans, and design would improve confidence by minimizing future surprises.

Response:

The purpose of the PEIS and its supplements is to determine the environmental impact of a given action. This is frequently done before much of the design information is available. According to Section 1502.5 of the Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (NEPA) in 40 CFR 1500 (CFR 1988b), "An agency shall commence preparation of an environmental impact statement as close as possible to the time the agency is developing or is presented with a proposal so that the preparation can be completed in time for the final statement to be included in any recommendation or report on the proposal. The statement shall be prepared early enough so that it can serve practically as an important contribution to the decision making process. . . .For applications to the agency, appropriate environmental assessments or statements shall be commenced no later than immediately after the application is received." If design or operation information is not available, worst-case assumptions are made based on the information that is available. This allows the environmental impact statement to bound the environmental impacts (that is, the actual environmental impacts from implementation of any alternative would be less than those assumed in the impact statement). The information in the supplement can be updated if necessary when new information is available. The new information obtained from the licensee's safety analysis review has been incorporated in this final supplement.

7.2 FACILITY STATUS

7.2.1 Radionuclide Inventory (1-2, 2-3, 3-10, 3-16, 18-41, 19-1)

Two commenters requested a complete accounting of where all the radionuclides have gone since the accident. One of the commenters wished to know the basis for the information in Table 2.4, which gives an estimate of the maximum amount of radionuclides and their location, and requested that references be provided so that the public might evaluate the amount of radionuclides removed during cleanup and defueling.

Response:

Because of the nature of the accident and the method by which the material has been removed from the reactor and shipped offsite, the staff cannot provide a complete accounting of every radionuclide since the time of the accident.

Section 2.2 of Draft and Final Supplement 3 explains the methods used to obtain the estimates given in Table 2.4.

7.2.2 Uncertainties in Radionuclide Dispersion and Distribution (1-2, 1-5, 3-9)

One commenter inquired on what information Table 2.4 was based, in light of the uncertainties of radionuclide dispersion and deposition following the accident, and indicated that one of their major concerns with PDMS was based on the uncertainties about the amount of radioactivity in buildings, pipes, and other components.

Response:

Because verified models are not available for accurately analyzing the transport and deposition of the fragmentation debris or the leaching of soluble materials from the damaged core, a set of assumptions was made regarding the dispersion and deposition of radionuclides in the TMI-2 facility. These assumptions were based on information available from fuel measurements and contamination measurements throughout the reactor building, as well as on the chemical and physical state of the radionuclides. All assumptions were chosen to ensure that the amount of activity estimated to be in any location either meets or exceeds the amount actually measured in that location. The assumptions are stated in Section 2.2 of Draft and Final Supplement 3.

7.2.3 Manganese-54 Source Term (18-41, 19-2)

One commenter inquired whether more than 12 curies of manganese-54 (with a half-life of 312 days) would be present at the end of 10 years.

Response:

As Table 2.3 of Draft Supplement 3 indicates, approximately 26,000 curies of manganese-54 were calculated to be present in the TMI-2 facility immediately following the March 28, 1979, accident. With a half-life of 312 days, fewer than 12 curies would remain by January 1, 1989, just less than 10 years after the accident. Table 2.3 of Final Supplement 3 indicates that fewer than 5 curies would be present on January 1, 1990.

7.2.4 Containment Building (2-3, 3-16)

One commenter responded to the following statement in Section 2.1.1 of Draft Supplement 3: "The reactor containment building is uniquely designed and constructed to maintain its structural integrity (with almost no leakage) during a wide variety of accidents." This commenter asked how long after an accident the reactor containment building was designed to maintain its structural integrity, whether it was specifically designed to house radioactive waste materials for an indefinite period of time, and if not, whether such storage of wastes would necessitate a license amendment.

Response:

The reactor containment building was designed to maintain its integrity during a peak accident pressure of 60 pounds per square inch gauge (psig) allowing only 0.2 percent leakage during the first 24 hours following the accident and

0.1 percent leakage per day thereafter. However, the accident that occurred at TMI-2 was not an accident of this proportion, since a peak accident pressure of only 28 psig was reached. The reactor containment building was designed to maintain its overpressure protection for a period of at least 40 years, whether or not a design-basis accident occurs. The present purpose of the TMI-2 containment is not to maintain its integrity during a peak accident overpressurization event but rather to simply provide isolation and an environmental barrier at ambient pressure levels.

The reactor building was not designed specifically to house radioactive waste for an indefinite period of time. The current NRC regulations do not allow for an indefinite storage of waste in the facility.

7.2.5 Containment Damage (1-5)

One commenter asked if the condition of the containment and the damage caused to it by the accident would be known by the time of PDMS.

Response:

There has been no evidence of any damage to the containment building that would result in any compromise of its ability to contain radiation during PDMS. Worker access is available above the 305-foot elevation, and no signs of containment degradation there have been observed. Video examination below the 305-foot elevation (the reactor building basement) has not disclosed any damage to the containment building.

7.2.6 Contamination Movement (2-3)

One commenter asked if it is possible for radiation levels to shift or relocate from one section of the plant to another; thus, sections of the facility that are currently designated to have certain radiation levels may actually be inconsistent with GPU's endpoint criteria.

Response:

The following methods will result in the shifting or relocation of radioactive contamination and, therefore, radiation exposure levels, from one section of the plant to another:

(1) movement of radioactive material by personnel, either advertently or inadvertently,

(2) movement of radioactive material by animals including insects, or

(3) movement of radioactive materials by water or air transport.

The licensee makes measurements at least monthly of the radiation levels present in the TMI-2 facility. These measurements are used to determine the decontamination progress that has been made to date and can be used to identify any relocation of radiation levels from one section of the plant to another. These measurements are also used to ascertain whether the endpoint criteria have been met.

7.2.7 Resuspension of Activity from Concrete-Block Walls (1-5)

One commenter inquired on what findings and/or studies NRC bases its assumption that the activity in the top 1/2 inch of the wall becomes available for resuspension. The commenter also asked what allowances are made for the fact that the walls might crumble due to stress from age and cleanup activities already undertaken.

Response:

Section 3.2.2.1 of Draft Supplement 3 and Section 3.1.2.1 of Final Supplement 3 contain the assumption that the activity in the first 1/2 inch (1.3 centimeters) of the concrete block becomes available for resuspension after the structure has dried for a period of time. This assumption is based on a study by Arora and Dayal (1986), as referenced in Section 2. Their study indicated that for cesium in cement, the cesium leach rates were greater when the wet periods were interspersed with dry periods than when the cement form was continuously saturated. The observed enhancement in cesium release with increasing length of dry periods is believed to be a result of the replenishment of the surface with cesium migrating from the subsurface zones during dry periods. This phenomenon was bounded in this supplement by assuming that up to one-eighth of the radioactive material in the concrete-block wall would migrate to the surface and be available for suspension into the atmosphere. This number (one-eighth of the total amount) is at least several times greater than the amount of radioactive material that is expected to be available for resuspension from the concrete-block wall.

The cleanup activities that have occurred or are being proposed for the period before PDMS are relatively nondestructive. The environment to which the walls of the containment have been exposed since the accident would not cause significant degradation of the concrete. Therefore, the NRC staff did not consider the crumbling of walls due to stress from age or cleanup activities a credible occurrence for the periods of time considered in this supplement.

7.2.8 Leaching of the Concrete-Block Wall (2-4)

One commenter inquired about the following statement in Section 2.2.2.3 of Draft Supplement 3: "The efforts that are being made to leach radioactivity from the concrete-block wall may reduce this inventory somewhat." The commenter asked how much "somewhat" was, what levels of leaching would be acceptable and/or desired by the NRC, and if the staff was aware that GPU had made incorrect projections in this area. The commenter quoted a report (Task Force Report: Reactor Building Basement Decontamination, p. 9) that stated, "They predict about 6 to 8 years of leaching will be required to reduce the block wall activity to 10% of the present value. This may be compared to an earlier prediction made by Dr. Godbee of about two years."

Response:

The magnitude of the reduction in radioactivity in the concrete-block wall as a result of future leaching operations was unknown at the time that Draft Supplement 3 was written. The NRC staff is aware that a wide range of projections has been made regarding the degree to which leaching operations will remove the activity. For this reason, in analyzing the offsite dose resulting from immediate or delayed cleanup of the concrete-block wall for Draft Supplement 3, the staff conservatively assumed that no reduction in the amount of radioactivity would occur during leaching activities. The statement quoted from Section 2.2.2.3 of Draft Supplement 3, was written to indicate that for the purposes of analyzing the dose to the population, the amount of activity that was assumed to be present in the concrete-block wall was greater than the amount that would be expected to be present following leaching operations.

Section 2.1.1 of Final Supplement 3 indicates that during 1988 an attempt was made to leach activity from the concrete-block wall of the enclosed stairway and elevator structure, resulting in the removal of an estimated 33 percent of the cesium-137 inventory in the area treated, an amount that represents a removal of 7 percent of the total inventory of the structure. The offsite dose analysis presented in Section 3.0 of the final supplement accounted for the reduction in the amount of radioactivity in the enclosed stairway/elevator structure as a result of the leaching operations.

7.2.9 Basement Cleanup Process (1-5)

One commenter asked when radiation doses in the basement are expected to be low enough to permit entry for complete cleanup. The commenter further asked if radiation dose levels, which are currently too high to permit entry, did not rule out the possibility of immediate cleanup as an alternative.

Response:

> Without further removal of contamination by remotely operated equipment, entrance into the basement on a routine basis is not likely for some time. Entry into the basement would most likely not be considered in areas where the dose rate remained much above 1 R/h, although even at levels higher than 1 R/h radiation levels, a worker could be allowed to work for a short time. High dose rates, however, do not preclude the possibility of cleaning the basement, or the possibility of the immediate cleanup alternative. Dose reduction efforts have already been made in the reactor building basement, including scabbling the walls using robots and leaching radioactivity from the concrete-block wall, as described in Section 2.1.1 of Draft and Final Supplement 3.
>
> A more complete study and description of possible options for reducing occupational dose in the basement and possible approaches and work sequences for basement cleanup are given in Munson and Harty (1985).

7.2.10 Reactor Coolant System Decontamination (10-13)

The licensee indicated that the extent of reactor coolant system decontamination activity is limited to fuel removal and draining the reactor coolant system to the extent practical.

Response:

> Reactor coolant system decontamination activity expected to be completed by the end of defueling will be limited to fuel removal (to the extent possible) and the draining of the reactor coolant system. However, before the cleanup is complete (as defined in the PEIS and discussed in Sections 1.0 and 2.1 of Final Supplement 3), additional decontamination of the reactor coolant system will be necessary. The additional decontamination of the reactor coolant system will occur during immediate cleanup following the completion of the current defueling process, during cleanup following PDMS, or during the decommissioning period.

7.2.11 Sectioning and Disposal of Reactor Internals (2-3, 3-16)

One commenter asked about the meaning of the following sentence in Section 2.1.1 of Draft Supplement 3, "Sectioning and disposal of the reactor internals and reactor vessel are not considered part of the cleanup because radiation levels expected from these components would be no higher than in a normal reactor nearing the end of its life." The commenter asked what "sectioning and positioning of the reactor internals" were a part of and wondered what would happen if radiation levels were incorrect. The commenter further asked what constituted a normal reactor and what radiation levels would be expected in a "normal reactor at the end of its life."

Response:

Sectioning and disposal (not positioning) of the reactor internals and reactor vessel are considered part of the decommissioning (or recommissioning) process because this activity would also occur during decommissioning of a reactor facility that has not undergone a significant accident. In other words, this is not an action that is necessary in order to clean up the TMI-2 facility as a result of the accident.

Even if radiation levels in the reactor internals and reactor vessel are found to be higher than expected during sectioning and disposal operations, little or no impact is anticipated because additional shielding or distance could be used to reduce occupational dose. However, because of the short length of time the TMI-2 reactor operated (less than 14 months), the quantity of the activation products in the reactor internals and in the reactor vessel is less than the quantity in a reactor that has operated more than 14 months and much less than the quantity that would be present in a reactor that had operated for 40 years. It is not likely that this assumption is incorrect. Measurements taken on the lower grid rib section and plenum confirm that radiation levels are no greater than expected on reactor internal components.

The term "normal reactor" as used in the draft supplement referred to a reactor that had not undergone a significant accident. This term has been rewritten in this final supplement to better reflect this definition.

The levels of radiation emitted from the reactor internals and reactor vessel will vary among facilities, depending on the material used to construct the vessel and internals, the operating history, and the operating power. The statement in question was used as a qualitative statement to explain why some activities were considered to be part of the decommissioning or recommissioning process rather than part of the cleanup. The staff would not expect to compare the absolute radiation levels in the reactor internals and reactor vessel of the TMI-2 reactor with the levels in operating reactor facilities at the end of their operational life.

7.2.12 Interim PDMS Isolation Criteria (26-15)

One commenter cited a plant status report for the period of July 9 to August 6, 1988, that stated, "One plant area has been isolated and placed in interim post-defueling monitored storage status. Seven other plant areas are in the process of being verified to meet the interim PDMS isolation criteria." The commenter asked what the interim PDMS criteria are and which seven areas were referred to. In addition, the commenter requested a definition of interim and isolation.

Response:

The "interim PDMS criteria" are criteria or goals set by the licensee for the radiological conditions that will exist in a given area at the time the facility will be put in PDMS. These goals are listed in Table 3.1 of Draft Supplement 3 and Table 3.2 of Final Supplement 3.

The seven areas referred to in the plant status report are:

(1) seal return cooler/filter room,
(2) 2-1E 4160 switchgear room,
(3) 2-2E 4160 switchgear room,
(4) motor control center 2-11EA,
(5) motor control center 2-21EA,
(6) elevator equipment room, and
(7) north stairwell.

These areas of the AFHB have been decontaminated to levels that are near the licensee's goals. At the time of the plant status report, the licensee was in the process of verifying that these areas did meet the interim PDMS criteria, at which point the areas would be isolated (separated by denying access or by posting signs indicating no access) from areas that have not been decontaminated fully to prevent recontamination of the cleaned area.

7.2.13 Accidents Relating to the Auxiliary and Fuel-Handling Building (2-3)

One commenter asked what unique problems will be posed by the AFHB since it "was not designed to be leak free. . ." during a ". . . variety of accidents," how much and just exactly what leaks from the AFHB.

Response:

Because the dose levels expected to be present in most sections of the AFHB at the end of the current defueling period are expected to be in the range of those found in AFHBs of operating reactors, and areas with higher levels of contamination are expected to be sealed, no unique problems would be posed by the TMI-2 AFHB.

It is possible that small amounts of contamination may become suspended in the AFHB atmosphere. During the periods between active ventilation of the AFHB, the air in the AFHB will passively equalize with outside air through the station vent. In addition, the air in the Unit-2 fuel-handling building is in direct communication with the air in the Unit-1 fuel-handling building. Thus, any airborne contamination in the Unit-2 fuel-handling building would move into Unit 1 and out the Unit-1 station vent.

7.2.14 <u>Continued Use of Accident-Generated Water</u> (1-5)

One commenter inquired what would preclude the use of the accident-generated water to clean the reactor coolant system.

Response:

No action other than disposal of the accident-generated water would preclude its use during the decontamination of the reactor coolant system. For the evaluation in Draft and Final Supplement 3, it was assumed that the accident-generated water would be processed and removed from the reactor building before and from the AFHB before or shortly after the initiation of PDMS.

7.2.15 <u>Precautions Taken to Ensure a Criticality Event Does Not Occur</u> (1-6, 24-4)

One commenter referred to page 3.19, footnote (a) of Draft Supplement 3 and asked what precautions would be taken to ensure that criticality would not occur. A second commenter stated that assurances should be given that there is no chance that the small amount of fuel left could form a critical mass.

Response:

Various methods are available to ensure that a criticality event will not occur during either PDMS or further cleanup. These include ensuring that the small quantity of fuel debris remaining after the current defueling efforts will not be available in large enough quantities to create any possibility of a criticality event. The licensee is using state-of-the-art equipment to survey and quantify the fuel remaining in the various locations throughout the facility. The licensee will provide a criticality analysis that will address each separate quantity of residual fuel in each defined location. The criticality analysis will estimate the quantity of fuel remaining, its location, its dispersion within the location, its physical form (i.e., as film, fine fragments, or intact fuel pellets), its mobility, the presence of any moderating or reflecting material, and its potential for a criticality event. In this submittal, the licensee must demonstrate that the cleanup has progressed far enough that an inadvertent criticality event is precluded. The criticality analysis will be submitted to and reviewed by the NRC staff.

7.2.16 Permanent Dose Reduction Techniques (2-3)

In response to a statement made in Section 2.1.1 (page 2.4) of Draft Supplement 3, the commenter asked how permanent are "permanent dose reduction techniques."

Response:

The phrase "permanent dose reduction techniques" refers to methods that permanently remove the source of radiation from an area. Once the contamination has been removed, only recontamination of the same area would result in the area being contaminated. The phrase "permanent dose reduction techniques" is used to distinguish the removal of the source of radiation from another temporary dose reduction technique, that is, of shielding the radiation source by placing structures on or around it to attenuate the dose rate.

7.3 ALTERNATIVES

7.3.1 Post-Defueling Monitored Storage

7.3.1.1 Rationale for PDMS Proposal (1-5, 3-21, 3-22)

Several commenters asked for an explanation of the rationale for delaying cleanup and why there was a change in the timetable.

Response:

In its role as a regulatory agency, the NRC is evaluating the licensee's (GPU Nuclear's) proposal to place the TMI-2 facility in PDMS. The licensee's Technical Plan (GPU 1987b) states:

> A monitored storage period following completion of the current cleanup program is beneficial for several reasons.
>
> Occupational dose in the plant will be reduced during monitored storage due to the natural decay of radioactive contamination. Over an extended period, levels for the dominant isotopes (Strontium-90, Cesium-137) could be reduced by as much as a factor of 2 (a factor of two-thirds for a 20-year storage period). The occupational dose in radiation zones would be reduced proportionately.
>
> The monitored storage period allows time for continued development of decontamination technology so that the most effective and efficient techniques may be applied. Further reduction in occupational exposures would be achieved through use of advanced robotic technology, automatic cleaning and chemical cleaning techniques, and advanced waste treatment methods.
>
> This monitored storage period also allows for resolution of the current limitation on national waste disposal capabilities so that selection of processes may be less dependent on waste volume production. The result may be further reductions in occupational dose required to accomplish specific tasks.

In addition, in comment letter number 10, the licensee states:

> . . .PDMS assures a continued safe and stable TMI-2 plant condition until the time of decommissioning of TMI-1, at which time both units could be decommissioned simultaneously. Two clear advantages result:
>
> 1. The possibility of decommissioning activities at TMI-2 affecting operations at TMI-1 is eliminated.
>
> 2. By performing a common function for both facilities, the work force can be utilized more efficiently.

7.3.1.2 <u>Comparison of Rationale for PDMS Proposal with Rationale for Disposal of Accident-Generated Water</u> (3-14, 3-18, 13-1, 13-2)

Several commenters inquired about the benefits of storage for a period of only 20 years, especially in relation to the discrepancy between the position of the NRC staff on disposing of wastes, including the accident-generated water, and their position on the licensee's proposal for PDMS. One commenter asked why anticipated advances in decontamination technology were expected to occur in 20 years, while advances in the removal of tritium from water were not expected.

Response:

The NRC staff does conclude in Final Supplement 2 that storage of the water on the TMI-2 site for an indefinite period of time is inappropriate, while in Draft Supplement 3, it concludes that the storage of the TMI-2 facility is environmentally acceptable. In the case of the accident-generated water, the water contains such low levels of radioactive contamination that whether it is evaporated, put in the river, or stored on the island, the environmental impact is not significant. In addition, there does not appear to be any reasonable promise of advanced technology within the next 20 years that would allow for the removal of the tritium from the accident-generated water. On the other hand, although the environmental impacts of storage or immediate cleanup are also insignificant, the occupational dose savings would be considerable even over a 23-year storage period (see Section 5.2). In addition, the possibility of advanced robotic technology, decommissioning technology, and waste technology appears very promising on the basis of advances that have been made in these areas during the last decade.

7.3.1.3 Beginning of PDMS (24-4)

One commenter requested further information about where and when Mode 3 ends and PDMS begins. The commenter was specifically interested in the administrative and technical interfaces and boundaries, along with the appropriate rationale.

Response:

An amendment to the TMI-2 license is required to implement PDMS. The licensee has requested the amendment to their license in their August 16, 1988 submittal to the NRC. This supplement to the PEIS is part of the staff's review of the licensee's proposal. The staff is also reviewing the licensee's safety analysis report (GPU 1988), which was submitted in support of the license amendment. Assuming that PDMS is found acceptable by the NRC staff, a license amendment would be issued. This amendment would have terms and conditions that would define the beginning of PDMS.

7.3.1.4 Duration of Storage (1-1, 3-9, 3-17, 13-1, 19-4, 24-4)

Several commenters indicated that the licensee did not designate a time period for PDMS. The commenters inquired why the NRC chose a

20-year storage period for evaluation in Draft Supplement 3. Other commenters indicated that it was important that a specific date be chosen and regulatory guidelines put in place to ensure that this date is met. One commenter stated that in January 1986, GPU had committed to the NRC Commissioners that under no circumstances would the PDMS period run beyond the time when TMI-1 decommissioning begins. This commenter requested that there be a license condition to ensure that this would be the case.

Response:

Because no information was provided by the licensee as to the length of the storage period, a storage period of 20 years was assumed in Draft Supplement 3 because this period of time approximately coincides with the end of TMI-2's operating license in the year 2009. However, since the writing of the draft supplement, the licensee has indicated to the NRC and to the TMI-2 Advisory Panel (July 14, 1988) that the storage period would likely continue to the end of the Unit-1 operating license. The NRC staff has assumed for this evaluation that the likely expiration date for the Unit-1 license is 2014. Thus, assuming PDMS starts in 1991, and the Unit-1 license expires in 2014, the storage period would have a 23-year duration from the start of PDMS.

The decommissioning rule requires that a licensee take certain steps to begin the decommissioning process before the expiration date of the license (see Section 2.3.4). The TMI-2 license expires in 2009. Therefore, the licensee would be required to amend their current license to defer the beginning of decommissioning if PDMS extends past 2009. The existing rules preclude the need for a license condition for TMI-2.

7.3.1.5 Comparison with Conclusions of NUREG-0683, Draft Supplement 1 (18-42, 19-3)

In NUREG-0683, Draft Supplement 1 (NRC 1983), the staff considered methods to reduce worker dose at TMI-2. One of the alternatives considered was that of defueling the reactor, placing the containment building in an interim monitored storage, and then performing final building cleanup using robotics when appropriate technology and devices became available. One commenter noted that in Draft Supplement 1, the NRC indicated certain obstacles to this procedure, which included (1) uncertainties about the development of robotic technology, (2) lack of information about the feasibility and safety of interim storage, and (3) lack of assurance that funds will be available for ultimate cleanup. The commenter felt it appropriate that the NRC notify the public as to how these three obstacles have been overcome.

Response:

(1) In NUREG-0683, Draft Supplement 1 and Final Supplement 1, (NRC 1984), the staff stated:

> Robotics is a rapidly emerging technology with the potential for eliminating considerable occupational radiation exposure. . . .How much time would elapse before reliable and economical robotic devices could perform a majority of the in-containment cleanup work is unknown. The most optimistic projections for robotic technology indicate that adequate robots will be available before they would be required for building cleanup under the current work sequence. More realistic projections indicate that a storage period of 10 to 20 years may be required before robotic cleanup would be possible.

These projections do not seem unreasonable, although they now appear to be somewhat conservative. Robots have been used extensively in the basement cleanup for obtaining radiation monitoring data as well as for video inspections, collecting concrete cores, flushing and pumping of the elevator shaft, high- and low-pressure flushing of walls, and scabbling of walls. Although adaptations of the currently used robots would do much to further cleanup at this time, advances projected during the next 23 years will further improve robotics and thus further simplify the cleanup task. During the 5 to 6 years since Draft Supplement 1 was written, enough assurances have been provided, based on the current use of robots in the cleanup, to indicate that robotic technology will be available and adequate to accomplish cleanup goals.

(2) In Draft Supplement 1, the staff indicated that "the safety of the interim-care phase would require additional study and assessment." The safety analysis report for PDMS (GPU 1988) as well as this document provides the results of additional study and assessment.

(3) In Draft Supplement 1, the staff also indicated that "provisions for financing future cleanup would need to be made." The staff still finds that this is the case. Future additional cleanup under the licensee's proposal would not occur until the licensee begins the decommissioning process. The decommissioning rule requires that each licensee submit by July 1990 a decommissioning funding plan that describes the licensee's plans for assuring that sufficient funds are available to decommission the facility. In a letter dated August 5, 1988, from E. Kintner, Vice President GPU Nuclear, to the NRC it was stated that, "GPU Nuclear understands that

the [Decommissioning] Rule applies to TMI-2 and would cover all activities involved in the decommissioning the plant starting from Post-Defueling Monitored Storage (PDMS) conditions. GPU Nuclear will, of course, abide by that Rule and provide the required plan and certification for TMI-2 by July 1990." A copy of the letter is found in Appendix A (comment letter 28) of this report.

7.3.1.6 License Amendment (1-6, 24-5)

One commenter asked if GPU Nuclear would need an amendment to its license before PDMS was entered. A second commenter asked if GPU Nuclear would have a possession-only license or an operating license with an amended possession-only-type technical specification.

Response:

Before the licensee can place the facility in long-term storage, an amendment to TMI's operating license would be required to ensure that the technical specifications reflect the plant conditions expected during the storage period. This information is given in Section 2.3.3 of this final supplement. At the present time, the staff has not made a determination as to the applicability of a possession-only license for TMI-2 similar to other possession-only licenses that have been issued in the past.

7.3.1.7 Comparison of Licensee's Proposal with Undamaged Reactors (2-3, 3-16)

One commenter noted that in Section 2.1 of Draft Supplement 3 the staff stated, "The primary difference between an undamaged reactor at the end of its useful life and the licensee's PDMS proposal is that during PDMS relatively high levels of contamination would remain in the reactor building basement and a small amount of residual fuel would remain in the reactor coolant system [during] storage." The commenter asked from what factual data these conclusions were derived, and how many undamaged reactors at the end of their "useful" lives the NRC has dealt with. In addition, the commenter wished to know if technical experts from these plants were consulted and if their input was a matter of public record, whether other differences existed between these plants and GPU's PDMS plan, whether embrittlement was a factor at these plants, and what the staffing levels were.

Response:

The statement cited in the above question was meant as a comparative statement rather than a quantitative statement. The comparison between an undamaged reactor at the end of its useful life and the licensee's PDMS proposal for the TMI-2 reactor was made to show that, unlike TMI-2, undamaged reactors have not had large quantities of radioactive water dumped into their basements and have not had fuel debris dispersed through their reactor coolant system. No comparison of the potential for embrittlement or of staffing levels was implied.

The NRC staff has had considerable experience with reactors that have not had a significant accident before the end of their useful lives. Examples include Humboldt Bay, Dresden Unit 1, Indian Point Unit 1, Peach Bottom Unit 1, Pathfinder, Vallecitos boiling water reactor, Fermi Unit 1, LaCrosse, Shippingport, Elk River, and the Carolina-Virginia tube reactor. These reactors have involved a variety of designs, operating histories, and power levels.

7.3.1.8 Containment Heat Loading (24-6)

One commenter inquired about the validity of the assumptions in the draft supplement based on the potential heat loading and lack of ventilation inside the containment building: for instance, assumptions regarding concentrations, desorption, resuspension, and releases, including correlations made with current data.

Response:

Ventilation in the reactor building is currently required because of the presence of workers in the reactor building. During decontamination and defueling tasks, workers tend to stir up contamination. In the absence of workers, the amount of airborne contamination would be reduced.

The potential heat loading of the building was not considered as a factor in determining source-term information. The large size of the containment building and the fact that much of it is underground reduces the amount of heat buildup incurred during the summer months. The temperature in a similar sealed, unused containment building in the eastern half of the State of Washington, Washington Nuclear Plant Unit 1 (WNP-1), reached a maximum of 92°F and 90°F during the summers of 1987 and 1988, respectively. The maximum outdoor temperatures during the summers of 1987 and 1988 were 107°F and 105°F, respectively.

7.3.1.9 Ability to Detect a Criticality Event (1-6)

A commenter asked how the licensee will know between entries whether a criticality event has occurred and how workers would know during entries whether a criticality event was occurring.

Response:

Before PDMS begins, workers will take steps to ensure that a criticality event is not credible (see Section 7.2.15). Most of the fuel debris remaining in the TMI-2 facility following the current defueling effort would be sealed in piping or enclosed in components. Measurements will be made by the licensee and verified by the NRC staff to ensure that the amount of fuel debris in a given area will not be large enough to cause a criticality event. The licensee does not plan to maintain monitoring activities during PDMS that would specifically identify a criticality event in the containment building. Workers, however, would be able to detect a criticality event using the radiation survey meters that they would normally carry when in the reactor building.

7.3.1.10 Dry Storage of the Plenum (2-4)

One commenter asked what advantages there were to storing the plenum dry.

Response:

The main advantage to storing the plenum dry in the fuel transfer canal and using shielding to reduce the radiation dose to the surrounding areas is that the absence of water will reduce the potential for accidents involving the movement of water from the fuel transfer canal, which could possibly result in movement of contamination. Section 3.1.1.1 of the final supplement contains a discussion of preparations for PDMS and the location of the reactor vessel internals.

7.3.1.11 Ventilation of the Reactor Building (2-4, 3-16)

One commenter asked whether "ventilating" the reactor building before each entry was the same as purging it.

Response:

Yes.

7.3.1.12 Determination of the Number of Entries During PDMS (1-5)

One commenter asked how the number of entries would be determined during PDMS.

Response:

The schedule of entries during PDMS is discussed in Section 3.2.1.3 of Draft Supplement 3 and Section 3.1.1.3 of Final Supplement 3. The licensee indicated in "Technical Plan, TMI-2 Cleanup Program Post-Defueling Monitored Storage" (GPU 1987b) that entries to the reactor building and AFHB would be made for purposes of visual inspection, radiation survey, and recording of plant conditions. Table 2.3 of that document (printed as Table 3.3 in Final Supplement 3) lists the anticipated schedule for initial PDMS monitoring and inspections. The number of entries will be greatest early in PDMS. The licensee's plan calls for monthly entries initially (12 times per year) and indicates "that the initial frequency will decrease (e.g., quarterly) based on an evaluation of data accumulated during the initial period" (GPU 1987b).

7.3.1.13 Monitoring Equipment (14-3)

One commenter asked about whether monitoring equipment to detect criticality and fire would be present in the facility after defueling. In addition, the commenter recommended that air monitors be in place to check the air during passive ventilation.

Response:

Monitoring equipment to detect a criticality event will not be present in the TMI-2 facility after defueling. Instead, before PDMS begins, steps will be taken to ensure that a criticality event is not credible (see response in Section 7.2.15). Most of the fuel debris remaining in the TMI-2 facility following the current defueling effort would be sealed in piping or enclosed in components. Measurements will be made by the licensee and verified by the NRC and its contractors to ensure that the amount of fuel debris in a given area will not be large enough to cause a criticality event.

Monitoring equipment to detect a fire would be present, as indicated in Section 3.1.1.1 of the final supplement. The high-efficiency particulate air (HEPA) filter in the passive breather ventilation system would periodically be assayed as discussed in Section 3.1.1.3 of the final supplement.

7.3.1.14 Monitoring Airborne Effluents (1-6)

One commenter asked what means would be used to determine the amount of radioactivity in the reactor before this radioactivity would be purged to the environment.

Response:

The radiation monitors located in the purge exhaust and vent stack would be used to ensure that the amount of radioactivity in the effluent was within the acceptable limits given in the technical specifications. If the amount of radioactivity in the effluent was above the technical specification limits, the purge exhaust could be terminated or returned to the reactor building.

7.3.1.15 Inleakage During PDMS (1-5)

One commenter asked why the amount of water expected to leak into the facility during PDMS (5000 gallons) was so much less than the inleakage during the past 9 years.

Response:

The expected annual inleakage of 5000 gallons is much less than the amount of water that flowed into the reactor building basement over the last 9 years, including the approximately 264,000 gallons (10,000 liters) that flowed in during the 2 years following the accident. The sources for the water in the reactor building basement included the primary coolant, water from the reactor building spray system, water used for decontamination, and river water inleakage from the building air coolers.

According to the environmental evaluation conducted by the licensee (Letter from F. R. Standerfer to the NRC, March 11, 1987. Subject: Environmental Evaluation for TMI-2 Post-Defueling Monitored Storage, 4410-87-L-0025), inleakage of groundwater and precipitation are anticipated to be the major sources of liquids during PDMS. The licensee estimated, on the basis of experience to date and the anticipated lower frequency of maintenance during PDMS, an annual inleakage of 5000 gallons (1900 liters). Water inleakage currently occurs in the following areas of the plant and is collected as indicated (Letter from F. R. Standerfer to the NRC, June 23, 1987. Subject: Post-Defueling Monitored Storage Environmental Evaluation, 4410-87-L-0093):

(1) fire service penetration, east wall of the turbine building at the 300-foot elevation - Drainage is to the turbine building sump, water treatment sump, or the condensate regeneration polisher sump.

(2) building joint, between the service building and air intake tunnel - This area does not have sump drainage. It is pumped periodically, as necessary, to remove inleakage.

(3) construction joint, basement of the auxiliary building - Drainage is to the auxiliary building sump.

(4) electrical penetration, southwest corner of the control building area at the 281-foot elevation - Drainage is to the control building area sump.

No inleakage is expected into the reactor building.

7.3.1.16 Classification of Cleanup Water (3-12)

One commenter asked whether the water that was used for the cleanup process would be considered accident-generated water if cleanup was delayed.

Response:

The definition of accident-generated water is presented in the nomenclature list as follows:

On February 27, 1980, an agreement executed among the City of Lancaster, Pennsylvania, the Metropolitan Edison Company and the NRC defined "accident-generated water" as follows:

- Water that existed in the TMI-2 auxiliary, fuel handling, and containment buildings including the primary system as of October 16, 1979, with the exception of water which, as a result of decontamination operations, becomes commingled with nonaccident-generated water such that the commingled water has a tritium content of 0.025 μCi/mL or less before processing.

- Water that has a total activity of greater than 1 μCi/mL prior to processing except where such water is originally nonaccident water and becomes contaminated by use in cleanup.

- Water that contains greater than 0.025 μCi/mL of tritium before processing.

The water generated during final cleanup would not meet the first two definitions of accident-generated water. It could meet the third definition only if the quantity of tritium in the water was greater than 0.025 μCi/mL. This translates to

95 curies of tritium in the entire 1 million gallons (3.8 million liters) used during the 4 years of cleanup. A conservative estimate that 1.9 curies of tritium will be left in the facility at the start of storage is given in Section 2.2.2.2 of the final supplement. Assuming a 23-year storage period, slightly over 0.5 curie of tritium will be present, given no reduction in the source term other than radioactive decay. However, some of the tritium is expected to exchange with water in the air during the storage period, and thus would be released to the atmosphere. The remaining tritium would have been absorbed into the concrete walls and floors. Therefore, it is highly unlikely that the water used during final cleanup following a storage period would meet the definition of accident-generated water.

7.3.1.17 Liquid Releases Following PDMS (2-4, 3-17)

One commenter asked, "How will the liquid releases to the Susquehanna River following PDMS differ in composition to the 2.3 million gallons of radioactive water currently stored at TMI?"

Response:

The liquid releases to the Susquehanna River following PDMS would be recycled through ion-exchange columns as necessary to ensure that the release rates to the Susquehanna River are below technical specification limits. The liquid releases would be similar in composition to the accident-generated water after processing through ion-exchange systems, except that the liquid releases following PDMS would contain only trace amounts of tritium. Furthermore, some of the isotopes with shorter half-lives would have decayed to negligible levels.

7.3.1.18 Emergency Workers (1-6)

One commenter asked, in the event of an incident at Unit 2, how many workers would be available to deal with an emergency, and whether it would be possible or likely that workers from Unit 1 would be drawn to Unit 2 to help deal with an emergency.

Response:

As reported in Section 3.2.5 of Draft Supplement 3 and Section 3.1.5 of Final Supplement 3, the level of direct employment for the PDMS program would be about 100 to 125 workers during the transition year following the completion of current defueling activities and about 70 to 75 persons thereafter until the end of the storage period. These workers would be available to deal with an emergency, although the number onsite at any one time might vary. Currently, fire, security, and medical emergency personnel are shared with Unit 1.

7.3.2 Immediate Cleanup

7.3.2.1 Reactor Coolant System Measurements (1-5)

Referring to a statement made in Section 3.3.1.1 of Draft Supplement 3 that "the selection of methods and processes for additional reactor coolant system decontamination is expected to depend on the technology available, the results of measurements being made at the present time, and the future disposition of the facility," a commenter asked for a further explanation of the measurements being undertaken, what is being measured, and in what manner the results would affect decisions about reactor coolant system decontamination and the future of the facility.

Response:

The statement quoted above refers to the measurement of radioactive material located in the reactor coolant system. The amount of radioactive material, including the amount of fuel debris, is being measured in all accessible locations of the reactor coolant system. The methods that will be used during the decontamination of the reactor coolant system will depend, in part, on the amount of radioactive material present in the reactor coolant system and its precise location in the system. For instance, those areas with little or no contamination will require very minor amounts of decontamination, while decontamination efforts in areas that contain large amounts of radioactive material will be more extensive.

The draft supplement indicated that the selection of methods and processes for additional reactor coolant system decontamination is expected to depend on the future disposition of the facility and on measurements being made at the present and in the future. The NRC staff did not intend to imply that the results of the measurements would affect decisions on the future of the facility.

7.3.2.2 Radiation Levels Resulting from Aggressive Decontamination (2-4)

One commenter asked if the NRC could quantify the radiation levels produced by "aggressive decontamination efforts" (Section 3.2.2.1, page 3.16, of Draft Supplement 3).

Response:

The purpose of decontamination operations (including potential aggressive decontamination operations such as those that would probably occur in the basement during the decontamination or removal of the concrete-block stairwell/elevator structure) is to reduce the radiation dose rate in the TMI-2 facility. The magnitude of this reduction depends on the procedures and methods used for decontamination and, therefore, cannot be quantified at this time.

The statement as used in Draft Supplement 3 refers to the increased release of radioactive material that may occur during certain cleanup activities as a result of aggressive decontamination efforts. Although the total amount of radioactive material in the facility will be reduced by decontamination operations, there is a possibility that aggressive decontamination operations would result in a temporary increase in the airborne concentration of radioactive material in the building atmosphere and, thus, an increase in the amount released from the facility. It is difficult to quantify the airborne concentration that will result following these operations. The NRC staff conservatively assumed that the airborne effluents released from the facility during an entire 1-year period following PDMS would be based on a release rate two orders of magnitude (100 times) larger than the average annual release rates for particulates during the period of January 1, 1987 to September 30, 1988 (adjusted for radioactive decay).

7.3.2.3 Length of Cleanup Period (26-22)

One commenter asked if it would be possible to continue with cleanup for periods longer or shorter than 4 years.

Response:

The possibility of performing cleanup in a period of 3 to 4 years is addressed in Section 3.3 of both Draft and Final Supplement 3. The impacts of a longer cleanup period are discussed in Section 3.1.1 of the draft supplement and evaluated as a 7 to 10 year cleanup period in Section 3.4 of the final supplement. A cleanup period of less than 3 years was not evaluated; the staff did not consider this to be a viable option because of the amount of work necessary to complete cleanup to the endpoint assumed in the PEIS (see Section 2.1 of the final supplement).

7.3.2.4 Accident Analysis (24-6)

The commenter stated that the accident analysis presented in Section 3.3.2.2 of the draft supplement is cursory and abbreviated. The commenter pointed out that fire is the single source of energy for the TMI-2 plant and that to assess the associated hazards, information such as the combustible loading, ignition sources, design of fire suppression systems, the standards and specifications to which they are designed, system operations, and monitoring and surveillance systems should be used to define a "design basis fire," and then the analysis should be completed.

Response:

The fire protection program evaluation[a] provides information on combustible loadings, ignition sources, and fire suppression systems. Environmental releases from a postulated fire are also presented. In addition, the licensee's safety analysis report on PDMS (GPU 1988) evaluates offsite dose resulting from a fire in the reactor building during PDMS.

The accident analysis presented in Section 3.3.2.2 of Draft Supplement 3 and in Section 3.0 of Final Supplement 3 was performed to bound the potential environmental impacts. During activities such as immediate cleanup (or cleanup following PDMS or preparations for immediate decommissioning or preparations for decommissioning after PDMS), many factors such as the combustible loading and the ignition sources will vary as the activity progresses. Thus, in order to determine the impact of a fire during this period of time, a set of conservative assumptions was made. These assumptions are explained in Sections 3.1.2.3, 3.2.2.3, 3.3.2.3, 3.4.2.3, and 3.5.2.3 of this final supplement.

7.3.3 Comparisons and Comments Pertaining to Both Alternatives

7.3.3.1 Comparison of Alternatives - Endpoint (3-2, 10-6, 10-7, 10-18, 18-4, 24-5)

Several commenters questioned the validity of comparing the impacts of PDMS and immediate cleanup for the time span from the end of the current defueling effort to the completion of cleanup. Some of the commenters felt that the comparison should be made using a common time frame and recommended that the comparison include a 20-year

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(a) Letter from F. R. Standerfer to the NRC, November 17, 1987. Subject: TMI-2 Fire Protection Program Evaluation (4410-87-L-0146/0224P).

storage period following the 4-year immediate cleanup period, so that both alternatives would be evaluated for a 24-year period.

Response:

Section 3.0 of Final Supplement 3 indicates that the alternatives were evaluated from completion of the current defueling effort to an endpoint, which would be either decommissioning the facility or initiating refurbishment. Although it is assumed that following completion of immediate cleanup or immediate cleanup/reduced effort, the facility would either be decommissioned or refurbished, the staff also realizes that the licensee may hold the facility in storage until Unit 1 is decommissioned. In response to this comment, the staff additionally evaluated a period of storage from the completion of immediate cleanup or immediate cleanup/reduced effort until the time that Unit 1 is decommissioned (assumed to be 2014, that is, 40 years from the issuance of the Unit-1 operating license). The impacts associated with this storage period are found in Sections 3.3 and 3.4 of this final supplement. The NRC staff does not consider an analysis of a longer storage period to be beneficial. However, the impact of a longer storage period can be extrapolated from the information presented in Sections 3.3 and 3.4 of the final supplement.

7.3.3.2 <u>Estimate of Dose from Fuel Remaining After Defueling</u> (24-5)

One commenter indicated that leaving less than 1 percent of the fuel in the plant will not affect offsite doses appreciably. The commenter indicated the basis for this statement was actual release data compiled by GPU for the years 1983 to 1986, indicating that the offsite dose rates from liquid and gaseous releases as well as airborne particulates and iodines have remained fairly steady, independent of the amount of fuel in the plant. According to the commenter, the mechanism of release appears to be adsorption and resuspension from the basement walls where the contaminants have been absorbed.

Response:

The NRC staff concurs that dose rates estimated for the time period following defueling would be quite small and the amount of fuel debris in the plant does not correlate with offsite doses. Activities related to the cleanup inside the reactor building may contribute significantly to the resuspension of contamination resulting in release rates independent of the amount of fuel.

The quarterly reports on gaseous effluents from the TMI-2 facility, however, do indicate that a small amount of alpha radioactivity is being released (see Table 3.5 of Final Supplement 3). The major isotopes present in the concrete walls in the basement are cesium-137 and strontium-90, however, neither of these isotopes have an alpha contribution. Therefore, it is quite likely that the small quantity of alpha radioactivity is originating from fuel-related sources and probably from the fuel removal activities.

7.3.3.3 Fraction of Activation Products Available for Release (10-17)

The licensee felt that the assumption made in Draft Supplement 3 for the cleanup period following PDMS (Section 3.2.2.1, page 3.16) that 10 percent of the activation products become airborne appears overly conservative, since this activity is interstitially bound to the material it is contaminating.

Response:

The NRC staff acknowledges that the major portion of the activation products in the facility is interstitially bound to the material they are contaminating. However, the assumption in question maintains that 10 percent of the activation products could potentially be suspended. The fraction assumed to be suspended was much smaller and was based on the assumed release rates for particulates, as explained in Section 3.2.2.1 of Draft and Final Supplement 3. In addition, it should be noted that during the cleanup period following PDMS, the reactor coolant system would be decontaminated and this process would result in removing a fraction of the activation products located in the reactor coolant system.

7.3.3.4 Breach-of-Containment Accident (24-7)

A commenter stated that a second accident that requires examination is the possibility of a crack in the concrete wall and leakage of condensates through it.

Response:

An accident involving a breach of the containment was not considered likely. The reactor containment building was designed to maintain its integrity during a wide variety of external accidents, including tornado-generated missiles such as a 1200-pound (540-kilograms) utility pole impacting at 200 mph (270 kilometers/h) or an aircraft impact of 300,000 pounds (136,000 kilograms) traveling at 200 knots. With the removal of more than 99 percent of the fuel, there would no longer be a source of energy inside the reactor building that could result in a large enough pressure to breach the containment or release a significant amount of radioactive material through a crack in containment. Furthermore, the basement of the reactor building where the majority of the remaining contamination is located is enclosed in a welded steel liner between 0.25 inch (0.6 centimeters) and 0.5 inch (1.3 centimeters) thick, which would further act to contain the radioactivity in the reactor building.

7.3.3.5 Potential for Releases Resulting from Accidents (2-4)

One commenter asked if there was any discernible difference in the potential for accidental releases during immediate cleanup as opposed to PDMS.

Response:

The risk of a fire would likely be less during PDMS because little or no activity would occur in the facility during storage and a large number of power circuits would have been deactivated. However, the smaller likelihood of fire during PDMS may be somewhat offset by the greater number of years that the reactor would be expected to be in PDMS in comparison to the immediate cleanup alternatives.

The risk of a ruptured HEPA filter during decontamination activities and the risk of a spill of decontamination solution in the reactor building were only considered for the immediate cleanup period and the period of cleanup following PDMS. These accidents were not considered for the PDMS period, since decontamination activities will be minimal.

7.3.4 No-Action Alternative

7.3.4.1 Evaluation of the No-Action Alternative (10-16)

The licensee stated that the no-action alternative should be evaluated on the basis that all preparations for PDMS have been completed and TMI-2 has been placed in a safe, stable, and secure condition that represents no risk to public health and safety.

Response:

The no-action alternative has been evaluated according to the current interpretation of the National Environmental Policy Act (NEPA) Regulations. In the Federal Register (46 FR 18026), March 23, 1981, the Council on Environmental Quality (CEQ) published the "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations." Question number 3 dealt with the no-action alternative. The response provided by CEQ was:

> There are two distinct interpretations of "no action" that must be considered, depending on the nature of the proposal being evaluated. The first situation might involve an action . . .where ongoing programs initiated under existing legislation and regulations will continue, even as new plans are developed. In these cases, "no action" is "no change" from current management direction or level of management intensity. . . . The second interpretation of "no action". . .would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward.

Using the first definition, the no-action alternative could be seen to be similar to the immediate cleanup alternative, where the "no action" is "no change" from the prior cleanup plan. In this case, "no change" would involve a continuation of the original plan detailed in the PEIS. For purposes of completeness the staff decided to evaluate the alternative using the second definition where the no-action alternative would be the one in which the activity would not take place. Since part of the activity associated with PDMS is the preparation for PDMS, the no-action alternative would appropriately not evaluate the preparation activities.

7.3.4.2 Difference Between the No-Action Alternative and PDMS (1-6, 2-4)

One commenter requested that the "subtle" differences between the no-action alternative and the licensee's proposal be explained. The commenter further asked what guarantees or laws would preclude the licensee's PDMS proposal from becoming the no-action alternative. A second commenter concluded that the only difference between PDMS and the no-action alternative was the preparation phase before PDMS. This commenter asked when the PDMS plan becomes the no-action alternative option.

Response:

Section 3.1.5 of Draft Supplement 3 indicated that the no-action alternative would be essentially the same as that described by the licensee's proposal except that neither preparations for PDMS nor subsequent actions to finish the cleanup would occur. Final Supplement 3 indicates in Section 3.7.2 that for the no-action alternative, following the current defueling effort, no further efforts would be made to complete the decontamination of the facility or to prepare the facility for storage or decommissioning. In addition, no attempts would be made following defueling to monitor releases from the facility or to maintain the facility.

The NRC will not allow the licensee to place the facility into monitored storage until the necessary requirements for long-term storage are met. The NRC regulations require that the license holders at nuclear power facilities take certain steps to ensure that the facility will ultimately be decommissioned and equipment, structures, and portions of the facility and site containing radioactive contaminants are removed or decontaminated to levels acceptable for unrestricted use of the property.

The licensee's proposal would not become the no-action alternative because preparations would be made for PDMS (including deactivating systems and sealing fuel transfer tubes and systems containing residual fuel).

7.4 OCCUPATIONAL DOSE

7.4.1 Occupational Dose Estimation Method (10-4, 18-3, 24-6)

Two commenters (including the licensee) indicated that the occupational dose estimates given in the draft supplement for both immediate and delayed cleanup are two to five times too small. Thus, according to the commenters the dose savings from implementation of PDMS is greater than indicated in Draft Supplement 3. The commenters cited an analysis (according to one commenter the analysis consisted of a time-motion study) performed by GPU Nuclear that indicates that the dose savings from PDMS are much greater than originally estimated.

Response:

The study cited by the commenters, which is contained in Appendix 1.A of the safety analysis report on PDMS (GPU 1988), was reviewed by the NRC staff. Although a time-motion study would provide the best estimates of occupational dose, the GPU study is not a time-motion study but rather an extrapolation of job-hours based on a cost-estimate study performed for the period extending to the end of Phase III. However, on reviewing GPU's study, the NRC staff determined that the occupational dose estimates given in the draft supplement did not include some tasks that would be necessary and estimated occupational dose on the basis of the most expeditious methods of decontamination. The staff feels that this approach is conservative and has therefore revised the occupational dose estimates as given in Section 3.0 and Appendix H of the final supplement.

7.4.2 Occupational Dose Levels (2-4)

One commenter asked what the occupational dose levels were for ". . .an undamaged reactor nearing the end of its life," as mentioned in Section 3.3.3 of the draft supplement.

Response:

Section 3.3.3 of Draft Supplement 3 indicates that the *occupational radiation dose* expected during the cleanup process described for the immediate cleanup alternative was estimated to be between 300 and 3100 person-rem, as shown in Table 3.23. (This value has been revised for the final supplement to 3700 to 9400 person-rem [Section 3.3.3].) This is the *occupational dose* that is estimated to be required to achieve radiation levels in the TMI-2 facility that are similar to the radiation levels in an undamaged reactor nearing the end of its life. The general area *radiation levels* in an undamaged reactor nearing the end of its life vary from location to location, as they do in the TMI-2 facility; however, they would approach 10 mrem/h. The major difference between TMI-2 and an undamaged reactor is that radiation dose levels in the undamaged reactor would not be attributable to large amounts of fuel debris in the reactor vessel or large quantities of radioactivity in the concrete walls of the basement.

7.4.3 Occupational Dose Estimates for Immediate Cleanup (1-6)

One commenter asked why the estimated occupational doses are so much higher for immediate cleanup.

Response:

The occupational dose range that was estimated for the alternative of immediate cleanup is higher than the occupational dose range that was estimated for delayed cleanup for the following reasons:

(1) The 23-year period of PDMS would result in the decay of the principal radionuclides to levels approximately two-thirds the level that would be present during immediate cleanup.

(2) It was assumed that robotics, decontamination, and waste treatment technologies would allow further reduction in occupational dose levels during cleanup following PDMS.

7.4.4 Mitigation of Occupational Dose (18-38)

One commenter indicated that it is possible to mitigate the amount of worker exposure by using more workers and exposing them to less radiation.

Response:

The use of a greater number of workers will distribute the dose, so that each worker receives a somewhat smaller dose. However, the total person-rem required to complete a job is usually greater for a larger group of workers than it is for a smaller group. This is because there would be an extra dose obtained by each additional worker as they walked to and from the area where the work was to begin and during the initial part of each task, as the worker became familiar with the equipment and the task. In addition, dose would be incurred by the additional support personnel, such as radiation protection technicians who are responsible for monitoring the greater number of workers.

7.5 WASTE MANAGEMENT CONSIDERATIONS

7.5.1 Class A Waste Shipments (10-17)

The licensee indicated that most Class A waste does not require shipment in a licensed shipping cask in order to comply with NRC and U.S. Department of Transportation (DOT) regulations. Most of this Class A waste is shipped in unshielded 98.5-cubic-foot or 1014-cubic-foot containers.

Response:

The staff recognizes that the licensee currently ships Class A waste in unshielded containers. However, for cleanup periods following PDMS, the staff's calculations show that the waste loadings (when averaged over all the waste to be shipped) would require shielded Type A waste casks.

7.5.2 Cask Leases (10-20)

The licensee stated that in their experience shipping container leases for Type B casks typically average $2000 per day.

Response:

The specialized Type B cask that is used to transfer irradiated fuel from the damaged reactor core has lease rates of approximately $1500 per day to $2000 per day.

Costs would be expected to be higher for a short-term lease of 1 or 2 weeks. However, according to communications with companies that lease waste shipping containers, lease rates for Type B shipping containers used to transport nonfuel waste range from approximately $150 per day to $200 per day for a shipping campaign of moderate length (3 to 4 months).

7.5.3 Emergency Allocations for Waste Disposal (1-1, 3-9)

One commenter stated, "The NRC tells us that immediate cleanup would require additional emergency allocations."

Response:

Page 2.33 of the draft supplement (Section 2.3.5 of the final supplement) states, "Immediate cleanup without PDMS *could* require additional emergency allocations." It has not yet been determined whether or not additional emergency allocations would be required for disposal of waste.

7.5.4 Waste Disposal Impact (1-3, 1-6, 3-10)

One commenter asked how the impact of the waste disposal at either a regional or other site could be considered outside the scope of the EIS. The commenter stated that delaying cleanup has a major impact on the final resting place for the waste from TMI, since the Commonwealth of Pennsylvania is in the process of developing a site.

Response:

The environmental impact of waste disposal at a commercial low-level waste disposal site is the subject of an environmental evaluation specific to the chosen site, which must be completed before the site can be licensed. Waste forms other than those evaluated during the environmental evaluation for the site will not be allowed for burial. The environmental evaluation for a regional burial site must be specific in regard to the environmental characteristics of the site and must also address all types of wastes that will be accepted into it, including wastes from hospitals and university research laboratories. Wastes from TMI-2 will not be accepted at a regional site until the site is licensed.

7.5.5 Approved Method for Waste Disposal (2-4)

One commenter asked if the NRC has an approved method for waste disposal, that is, shallow burial versus above-ground monitored storage.

Response:

Currently, the only licensed low-level waste disposal sites are shallow land burial sites. However, the Low-Level Radioactive Waste Policy Amendments Act of 1985 mandates that the U.S. Nuclear Regulatory Commission, in consultation with States, identify waste disposal methods other than shallow land burial. New disposal sites will not be restricted to the use of shallow land burial, but all disposal methods will be required to meet 10 CFR 61 (CFR 1988a) requirements before the sites are licensed ("Licensing Requirements for Land Disposal of Radioactive Waste"). There are no commercial high-level waste burial sites at this time.

7.5.6 Waste Regulation Concerns (14-3)

One commenter expressed opposition to the licensee's proposal because waste disposal requirements might change in such a way that would prevent the removal of accident wastes from TMI-2.

Response:

The NRC staff does not foresee any changes in the waste disposal requirements that would prevent the removal of accident wastes from TMI-2.

7.5.7 NRC Staff Policy on Waste Removal (18-43, 19-3)

One commenter indicated that the NRC staff policy throughout the cleanup has been to remove all radioactive waste from the site when possible. However, this conflicts with the licensee's proposal.

Response:

The NRC staff policy is to allow the licensee to remove the radioactive waste from the site when possible while ensuring the protection of the health and safety of the public and the workers. As explained in Final Supplement 3, the health and safety of the public would not be significantly affected by the licensee's proposal. The health and safety of the workers, however, would benefit from the storage period because of the reduced amounts of radioactivity following decay of the radionuclides during the storage period.

7.5.8 Removal of Waste Generated Before PDMS (1-6)

One commenter asked whether all the waste generated between the beginning of cleanup and the beginning of PDMS would be removed from the island before Unit 2 is placed in PDMS.

Response:

Much of the waste generated since the beginning of the cleanup process has already been removed from the site. At the start of PDMS, the remaining waste either would have been shipped offsite or would be in the process of being shipped.

7.5.9 Generation of Additional Water for Decontamination and Subsequent Disposal (1-1, 3-9)

One commenter asked why more water would be generated during the cleanup options when the licensee has already accumulated a large quantity of water that could be used for decontamination.

Response:

If the accident-generated water is available for use at the time of the final stage of cleanup, no action would preclude its use during decontamination. If it is not available, however, an additional source of water would be required. The purpose of Supplement 3 is to address the impact of post-defueling cleanup activities without re-addressing the impact of disposal of the accident-generated water. Because the impact of disposal of the accident-generated water was addressed in Supplement 2, it was assumed for Supplement 3 that an additional source of water would be used.

7.6 COMMITMENT OF RESOURCES

7.6.1 Financial Ability to Complete an Immediate Cleanup (3-4, 3-7)

Two commenters asked if funds were available for immediate cleanup and if there has been any attempt to analyze the ability of the licensee to afford immediate cleanup.

Response:

Attempts to analyze the ability of the licensee to afford immediate cleanup are not considered as part of this supplement; however, the NRC staff is continuing to monitor the licensee's financial health and ability to continue the cleanup effort and believes the funds are available to afford an immediate cleanup.

7.6.2 Cost Estimates - Validity of Basing Estimate on 1988 Dollars (2-4, 3-17)

One commenter asked whether the cost of cleanup was determined in 1988 dollars and indicated that basing the cost of cleanup on 1988 dollars gives imprecise and inaccurate estimates.

Response:

All costs are figured in 1988 dollars as indicated and discussed in Sections 3.2.6, 3.3.6, and 5.1 of Draft Supplement 3 and Sections 3.1.6, 3.2.6, 3.3.6, 3.4.6, 3.5.6, and 5.1 of Final Supplement 3. The cost estimates in the PEIS are given as ranges for the purpose of comparison only. These numbers represent the best estimate of cost at the time the supplement was prepared.

7.6.3 Cost of Rehiring and Retraining Workers (2-4, 3-17)

One commenter asked if the economic cost estimates for PDMS included the cost of retraining and rehiring workers who had been gone for 20 years. The commenter also wished to know if the NRC cost estimates included costs resulting from corporate insolvency and bankruptcy.

Response:

The additional cost for retraining workers is addressed in Section 3.2.6 of Draft Supplement 3, and Sections 3.1.6 and 3.2.6 of Final Supplement 3. This cost was indirectly factored into the cost estimates for delayed cleanup by assuming that immediate cleanup would require 3 to 4 years and cleanup following PDMS would require 4 years for completion.

In estimating the costs, the NRC did not consider insolvency or bankruptcy of the licensee.

7.6.4 Financial Plan (3-5, 3-28, 18-19, 18-21, 18-42, 19-3, 24-5)

Many commenters indicated that the NRC should hold the utility to some sort of financial responsibility to ensure that funds are available for cleanup following PDMS as well as the decommissioning tasks. Commenters requested specific details of the financing plans, including an estimate of the expenses of the total task (including additional decontamination) and a reliable scheme for setting this funding aside. One commenter suggested a licensing amendment that would require a sinking fund. Another commenter suggested that a mechanism should be available to enable the Commonwealth of Pennsylvania to take ownership of these funds.

Response:

Although financial resources in excess of those designated by the decommissioning rule (53 FR 24018) and discussed in Section 2.3.5 of the final supplement would not be required by the decommissioning rule, the licensee has submitted a letter to the NRC (see Appendix A, comment letter number 28) that states, "GPU Nuclear understands that the [Decommissioning] Rule applies to TMI-2 and would cover all activities involved in the decommissioning the plant starting from Post-Defueling Monitored Storage (PDMS) conditions." The NRC staff understands this as a commitment by the licensee to provide a plan that outlines the activities involved in decommissioning the plant starting from the PDMS conditions, as well as to provide a funding plan for these activities during decommissioning. The funding plan as described in Section 2.3.5 of the final supplement, includes requirements (prepayment, external sinking fund or surety method, insurance, or other guarantee method) for ensuring that the funds will be available when the facility is decommissioned. The surety or insurance must be payable to a trust established for decommissioning costs (see Section 2.3.4). Acceptable trustees include an appropriate Federal or State Government agency or an entity that has the authority to act as a trustee and whose trust operations are regulated and examined by a Federal or State agency.

7.6.5 Economic Concerns (2-1, 3-14, 3-21, 3-22, 9-1, 13-2, 14-4, 18-33, 18-38, 18-42, 18-44, 19-3, 20-2, 20-6)

Many comments were made expressing concern about the economic health of the utility and the availability of adequate funding to handle the cleanup and decommissioning of the plant 20 or 30 years from now. The comments included concern regarding rate payer equity (Would future rate payers be willing to pay for the cleanup?) to concerns about the utility's ability to afford the cost, expertise, and technology for decommissioning both Unit 1 and Unit 2 at the same time.

Response:

The assurance of funding for the decommissioning of the TMI-2 facility is required by the decommissioning rule issued by the NRC on June 27, 1988 (53 FR 24018), and described in Section 2.3.4 of the final supplement. As discussed in Section 7.6.4, the licensee has submitted a letter to the NRC (see Appendix A, comment letter number 28) that states that "GPU Nuclear understands that the [decommissioning] Rule applies to TMI-2 and would cover all activities involved in the decommissioning the plant starting from Post-Defueling Monitored Storage (PDMS) conditions."

7.7 REGULATORY REQUIREMENTS - REGULATORY ROLE OF THE NRC (3-17, 13-1, 24-4)

Several commenters indicated that there do not seem to be any firm regulatory requirements associated with the licensee's proposal. The major concern was that the storage period would exceed the specified time period. In addition, concern was expressed that there were no regulatory guidelines and that the licensee would make their own rules.

Response:

The regulatory aspects associated with the licensee's proposal are more appropriately a part of the license amendment that is requested by the licensee. This final supplement, along with the safety evaluation review of the licensee's safety analysis report on PDMS (GPU 1988), forms the basis for the license amendment affecting PDMS.

In addition, the NRC will have a continuing onsite presence and will require the licensee to maintain the facility in accordance with all NRC regulations.

7.8 EXISTING ENVIRONMENT

7.8.1 Flood Plain Concerns (1-3, 1-6, 3-11)

One commenter asked how the NRC would deal with the fact that Unit 2 is in the 100-year flood plain, and if the regulations would be "maneuvered" in some way so that TMI would be exempt from requirements. The commenter also asked how this would affect the Unit-2 license before the licensee seeks approval for PDMS.

Response:

Section 4.1.3 of Draft and Final Supplement 3 states that the island on which both the TMI-1 and TMI-2 reactors are located is not within the 100-year flood plain. However, it is within the 500-year flood plain (0.2-percent chance of flooding in any given year), as determined by the U.S. Army Corps of Engineers (see Final Supplement 2, pages A.8 and A.9).

The regulations will not be altered to exempt TMI from requirements.

The location of TMI-2 within the 500-year flood plain will not affect the licensee's ability to seek approval for PDMS for two reasons. First, the island has dikes for flood protection, and the dikes are periodically inspected and maintained by the licensee. Second, TMI-2 flood procedures require that flood door panels be installed when the river elevation reaches 302 feet (92 meters). Flood door panels are placed on the reactor building, auxiliary building, control building, diesel generator building, and turbine building. Installation of flood door panels effectively prevents the entry of river water.

7.8.2 Groundwater Concerns (1-3, 3-11)

One commenter asked if TMI-2 would be able to satisfy the groundwater intrusion criteria.

Response:

As indicated in Section 3.1.1.3 of the draft and final supplements, quarterly groundwater monitoring would be continued during PDMS to detect any outleakage from plant buildings.

7.8.3 Supply Well Water Levels (6-1)

One commenter indicated that it was unclear if the reported higher water levels in the three water-supply wells on the east bank of the river are static levels or pumping levels. The commenter stated that the final supplement should indicate how heavily the wells are pumped.

Response:

The NRC staff does not know if the reported water levels in the supply wells on the east bank of the river are static levels or pumping levels or how heavily the wells are pumped. The staff understands the concern of the commenter to be the possible intrusion of contamination into the water-supply wells on the east bank of the river as a result of activities discussed in Draft and Final Supplement 3. However, no activities were identified that would release contamination to the groundwater. Accidental releases of liquids directly to the Susquehanna River, as discussed in Section 3 and summarized in Section 5 of the final supplement, would result in a maximum dose of 0.003 mrem (total body) to the maximally exposed individual who drank water from the river. The dose to an individual obtaining drinking water from an offsite well would be less, on the basis of the discussion in Section 4.1.4 of the final supplement regarding the most probable path for potential releases to the groundwater.

7.8.4 Removal of Chemicals from Water Released to Drinking Water Supply (1-5)

One commenter asked if the water used for further cleanup would contain chemicals, and how these would be removed from the water used for cleanup before the water was released to the area drinking water supply.

Response:

Any water released to the Susquehanna River or to any other drinking water supply would have to meet the licensee's technical specifications as well as the conditions of the National Pollutant Discharge Elimination System (NPDES) permit issued by the Commonwealth of Pennsylvania, Department of Environmental Resources (PaDER). When necessary, water that is used during decontamination and cleanup processes is run through an ion-exchange system (for instance, the EPICOR II system) to filter any radioactive material and chemicals that may be present.

7.9 ENVIRONMENTAL IMPACT

7.9.1 Cancer Fatality Estimates (21-1)

One commenter recommended including cancer fatality estimates for the maximally exposed individual in Table 5.1 or in the text in Section 5.0.

Response:

Table 5.1 in both Draft and Final Supplement 3 provides the radiological environmental impacts (the 50-year dose commitments) for the cleanup alternatives. Cancer fatality estimates are not given in this table. The cancer fatality estimates for the maximally exposed individual are given in Section 5.2 of the draft supplement (page 5.6, second paragraph) and also in Section 5.2 of the final supplement.

7.9.2 Revised Risk Estimates (1-3, 3-11)

One commenter stated that revisions were being made to the dosimetry for the survivors of the Japanese atomic bombings and that these revisions, along with increased followup time for epidemiological studies, are being taken into account by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) in producing risk estimates for ionizing radiation exposure. Further, this report will be used by the International Commission on Radiological Protection (ICRP) in reviewing its recommendations on the system of dose limitations. The commenter pointed out that a preliminary reassessment of the Hiroshima and Nagasaki survivors has raised the fatal cancer risk factor for the exposed population by a factor on the order of 2, and that risk estimates could be substantially greater depending on the form of the risk model used and the shape of the dose response curve when extrapolating to low doses from observations at high doses.

Response:

This comment addresses two separate but interrelated issues: (1) the effect that the new assessment of the radiation dose received by the atomic bomb survivors will have on the health effects estimates, and (2) the shape of the dose response curve.

With regard to the first issue, the NRC staff is aware of the reassessment of the data on the survivors of the Japanese atomic bombings. The staff understands that this information may as much as double (a factor of approximately 2) the estimate of health effects from low linear-energy-transfer radiation. However, the effect on organ-specific doses is expected to be considerably less. Although the staff is aware of these developments, recommendations have not been finalized by the international committees. Because the magnitude of the dose impacts calculated in this final supplement is so small, the staff's conclusions would not be altered even if the calculated impacts were doubled.

Regarding the second issue, the dose response model, the 1980 BEIR III Committee found that the linear-quadratic relationship was the preferred model for estimating response on the basis of the existing experimental evidence and microdosimetric theory. Both the National Council on Radiation Protection and Measurements (NCRP) and ICRP hold the same view.

7.10 DECOMMISSIONING

7.10.1 Applicability of Decommissioning Rule to TMI-2 (26-8)

One commenter inquired if the decommissioning rule was applicable to TMI-2.

Response:

Yes.

7.10.2 Cost of Decommissioning (3-7, 18-32, 20-1)

Several commenters requested estimates of the cost of decommissioning. One commenter stated that, although the Public Utility Commission factors decommissioning into the rate base, there are no criteria to determine dollar amounts and no provision for early decommissioning of reactors.

Response:

> Cost estimates for decommissioning a nuclear reactor vary among reactors and decommissioning alternatives. However, the decommissioning rule published June 27, 1988 (53 FR 24018) specifies the minimum amounts (January 1986 dollars) required to demonstrate reasonable assurance of funds for the decommissioning of reactor facilities that have not undergone a serious accident.

7.10.3 Impact of Additional Contamination in the TMI-2 Facility on the Implementation of the Decommissioning Rule (24-5)

One commenter questioned whether the decommissioning funding plan that must be submitted by July 1990 will incorporate the fact that because of its extra contamination the plant would be in worse shape than a "normal" plant in a SAFSTOR condition and whether additional technical methods and allowances for extra financial resources would be required for this additional task in the plan. The commenter also asked what type of license GPU would hold in the meantime and whether the licensee contemplated a period of further decontamination followed by SAFSTOR during the decommissioning period. The commenter requested a clear description of the highlights and options involved in the TMI-2 decommissioning process.

Response:

> The decommissioning rule published on June 27, 1988 (53 FR 24018) specifies the minimum amount of money that must be available for decommissioning a nuclear power plant that has not experienced an accident of the magnitude of TMI-2. The licensee has submitted a letter to the NRC (see Appendix A, comment letter number 28) that states that "GPU Nuclear understands that the [Decommissioning] Rule applies to TMI-2 and would cover all activities involved in the decommissioning the plant starting from Post-Defueling Monitored Storage (PDMS) conditions." The NRC staff understands this as a commitment by the licensee to provide a plan that outlines the activities involved in decommissioning the plant starting from the PDMS conditions, as well as to provide a funding plan that accounts for the funding of these activities during decommissioning.

The TMI-2 licensee currently holds an operating license. They have, however, proposed that the facility license be changed to a "possession-only" license. If this license is granted, it would be in effect during the PDMS period and through the decommissioning period until the completion of decommissioning and the granting of the termination of the license by the Commission. The termination of the license will be based on: (1) the performance of the decommissioning in accordance with the approved decommissioning plan and the order authorizing decommissioning and (2) the final radiation survey and associated documentation demonstrating that the facility and site are suitable for release for unrestricted use.

The licensee's specific plans for decommissioning are not yet known. According to the decommissioning rule, these plans are due within 2 years following the permanent cessation of operations and in no case later than 1 year before the expiration of the operating license. The licensee has not yet formally announced permanent cessation of operations. Unless an early decision to decommission is made, a preliminary decommissioning plan would be required 5 years before the license expires on November 4, 2009.

7.10.4 Decommissioning Alternatives - Entombment (18-46)

One commenter asked about the possibility of entombing the Unit-2 facility. The commenter indicated that this would likely solve a number of problems including worker exposure, expense of future cleanup, and the necessity of having to depend on new technology that may not be forthcoming.

Response:

Entombing the Unit-2 facility is one of the decommissioning alternatives (ENTOMB) that would be allowed under certain circumstances by the decommissioning rule (53 FR 24018). However, the licensee's decision as to which decommissioning alternative is appropriate to propose to the NRC for TMI-2 would be more appropriately made by the licensee at the time they submit their decommissioning plan.

7.10.5 Decommissioning - Unrestricted Use (2-4, 26-31)

One commenter asked about NRC's decommissioning plans and specifically wished to know at what levels "unrestricted" use of TMI would be acceptable. A second commenter asked if unrestricted use was the goal for cleanup of any facility and if unrestricted use meant that public use of the area would be allowed. In addition, the commenter asked if any nuclear plants had been decommissioned to the point of unrestricted use.

Response:

The NRC does not have any decommissioning plans; decommissioning plans are submitted by the licensee. On June 27, 1988, the NRC issued a final rule on decommissioning that became effective on July 27, 1988 (53 FR 24018). The final rule discusses the issue of unrestricted use. Unrestricted use is a term used to describe a site that has no radiological hazards so that the license can be terminated and the site can be considered an unrestricted area. An unrestricted area would be accessible for public use. Unrestricted use is the goal of the decommissioning process for all nuclear plants. Regulatory Guide 1.86 (NRC 1974) contains specific values for acceptable radiation limits for areas of unrestricted use. The Elk River demonstration reactor in Elk River, Minnesota, has been completely dismantled and the ground leased for unrestricted use.

7.10.6 Inclusion of TMI-2 Under SAFSTOR Guidelines (18-31)

One commenter asked whether the TMI-2 facility would fall under the guidelines of the SAFSTOR decommissioning alternative.

Response:

Because TMI-2 has an operating license, it would fall under the regulations applicable to facilities with operating licenses and, thus, would be a candidate for the SAFSTOR decommissioning alternative.

7.10.7 Decommissioning and Decontamination Ability (2-2, 3-15, 9-3)

One commenter recommended that GPU, the NRC, the U.S. Department of Energy (DOE), and the industry admit that they do not know how to decommission and decontaminate a nuclear power plant.

Response:

Since 1960, 5 licensed power reactors, 4 demonstration reactors, 1 licensed ship reactor, and 52 licensed research reactors have been or are being decommissioned by the methods discussed in the Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NRC 1988). Forty-two research reactors and critical facilities have been dismantled. Only one power reactor, the Elk River demonstration reactor, has been completely dismantled.

7.10.8 Defaulting on Decommissioning (26-9)

One commenter asked what would happen if at some future point, the licensee could not continue incurring the costs of decommissioning and thus could not ensure the public health and safety at one of their plants.

Response:

> The Commission has recognized that this possibility may occur. The Atomic Energy Act contains provisions for the Federal Government to assume responsibility for decommissioning if public health and safety are jeopardized because of inactivity on the part of the licensee.

7.11 OTHER COMMENTS AND QUESTIONS

7.11.1 Credibility of the March 1979 Accident (2-4)

One commenter referred to Section 3.2.2.2 of Draft Supplement 3 and asked if the March 1979 accident at TMI-2 could be considered "credible" by NRC standards.

Response:

> Yes. Although considered unlikely, the March 1979 accident that resulted in the melting of the uranium fuel was considered credible and was within the assumptions made for design-basis accidents. The point the staff is making in Section 3.2.2.2 of the draft supplement (Section 3.1.2.2 of the final supplement) is that after removal of more than 99 percent of the fuel, the licensee must demonstrate that recriticality is not credible. Criticality would be precluded by the small amount of fuel debris remaining, its dispersed distribution, and the lack of a moderator.

7.11.2 Research Development (1-5, 1-6, 18-38, 18-43, 19-3, 20-6)

Several commenters asked if the licensee or the NRC plans to continue research related to the development of technology for the cleanup following PDMS. Other commenters indicated that the NRC and the licensee should develop and help finance advanced technology for the cleanup. One commenter asked if the NRC would obtain a commitment from the licensee to finance such development.

Response:

> The NRC has no plans for additional research directly related to TMI-2 during the proposed PDMS. The NRC in its oversight role in regard to the cleanup has not contributed

funds and likely will not contribute funds in the future to develop technology for cleanup following PDMS. This task would be left to the licensee. No commitment will be obtained by the NRC from the licensee to finance further development of technology.

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9.0 INDEX

APPENDIX A

COMMENTS ON THE DRAFT SUPPLEMENT TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX A

COMMENTS ON THE DRAFT SUPPLEMENT TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

The comment letters received in response to the draft supplement are listed below according to the sources of the letters as follows: Federal Government agencies, State Government agencies, local government agencies, citizen groups and businesses, the licensee, and individual citizens. The letters are followed by a listing of the transcripts of public meetings and an NRC briefing by the TMI-2 Advisory Panel. The numbers in the second column are used in Section 7.0 to identify the sources of the comments addressed in both the letters and the transcripts. The page number where the letter or transcript first appears in this appendix is shown in the third column.

Source	Letter or Transcript No.	Page
Federal Energy Regulatory Commission J. Steven Herod, Director, Office of Electric Power Regulation	5	A.14
U.S. Department of Agriculture Rodney J. Mays, Assistant State Conservationist for Natural Resources	7	A.15
U.S. Department of Agriculture Rodney J. Mays, Assistant State Conservationist for Natural Resources	15	A.35
U.S. Department of Defense Department of the Army James F. Johnson, Chief, Planning Division, Baltimore District, Corps of Engineers	23	A.44
U.S. Department of Energy Ernest C. Baynard, III, Assistant Secretary, Environment, Safety, and Health	25	A.48
U.S. Department of the Interior Bruce Blanchard, Director, Environmental Project Review	6	A.15
U.S. Department of Labor Frank S. Chalmers, Director, Directorate of Policy	4	A.14
U.S. Environmental Protection Agency Richard E. Sanderson, Director, Office of Federal Activities	21	A.43

Source	Letter or Transcript No.	Page
Commonwealth of Pennsylvania, Department of Health George K. Tokuhata, Director, Division of Epidemiology Research	8	A.16
Maryland Department of Natural Resources Richard I. McLean, Administrator, Radioecology Power Plant Research Program	11	A.30
Pennsylvania Intergovernmental Council Sandra L. Kline, Special Assistant Intergovernmental Review Process	24	A.45
The City of York, Pennsylvania William J. Althaus, Mayor	17	A.37
Concerned Mothers and Women Deborah Davenport, Member	14	A.33
Susquehanna Valley Alliance	1[a]	A.9
Susquehanna Valley Alliance Frances Skolnick	19[a]	A.38
Three Mile Island Alert (TMIA), Inc. Eric Epstein, Spokesperson	2[a]	A.12
Three Mile Island Alert (TMIA), Inc. Eric Epstein, Spokesperson	9	A.18
Three Mile Island Alert (TMIA), Inc. Vera Stuchinski, Chairperson	13	A.31
Three Mile Island Alert (TMIA), Inc.	20[a]	A.40
Three Mile Island Alert (TMIA), Inc.	27[a]	A.49
GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4410-88-L-0097 Document ID 0400P	10	A.19
GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4410-88-L-0114 Document ID 0400P	16	A.35
GPU Nuclear Corporation E. E. Kintner, Executive Vice President 4410-88-L-0117 Document ID 0402P	28	A.51
Judy B. Hamaker	12	A.31
June E. Wood	22[b]	A.43

Source	Letter or Transcript No.	Page
Comments received at the May 26, 1988, TMI-2 Advisory Panel Meeting	3[c]	A.55
Comments received at the July 14, 1988, TMI-2 Advisory Panel Meeting	18[c]	A.84
Comments received at the September 7, 1988, TMI-2 Advisory Panel Meeting	26[c]	A.135
U.S. NRC Periodic Briefing by TMI-2 Advisory Panel, October 25, 1988	29[c]	A.180

(a) Submitted as supplement to transcript of public meeting.
(b) Newspaper clipping was inserted with letter, but is not shown.
(c) Excerpt from transcript of meeting.

The comment letters and the transcripts of public meetings and an NRC briefing by the TMI-2 Advisory Panel are listed a second time below. In this list, they are ordered chronologically, according to the dates on which the letters were received or on which the meetings were held.

Source	Letter or Transcript No.	Page
Susquehanna Valley Alliance (SVA)	1[a]	A.9
Three Mile Island Alert (TMIA), Inc. Eric Epstein, Spokesperson	2[a]	A.12
Comments received at the May 26, 1988, TMI-2 Advisory Panel Meeting	3[b]	A.55
U. S. Department of Labor Frank S. Chalmers, Director Directorate of Policy	4	A.14
Federal Energy Regulatory Commission J. Steven Herod, Director, Office of Electric Power Regulation	5	A.14
U.S. Department of the Interior Bruce Blanchard, Director, Environmental Project Review	6	A.15
U.S. Department of Agriculture Rodney J. Mays, Assistant State Conservationist for Natural Resources	7	A.15
Commonwealth of Pennsylvania, Department of Health George K. Tokuhata, Director, Division of Epidemiology Research	8	A.16
Three Mile Island Alert (TMIA), Inc. Eric Epstein, Spokesperson	9	A.18
GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4410-88-L-0097 Document ID 0400P	10	A.19
Maryland Department of Natural Resources Richard I. McLean, Administrator Radioecology, Power Plant Research Program	11	A.30
Judy B. Hamaker	12	A.31
Three Mile Island Alert (TMIA), Inc. Vera L. Stuchinski, Chairperson	13	A.31
Concerned Mothers and Women Deborah Davenport, Member	14	A.33
U.S. Department of Agriculture Rodney J. Mays, Assistant State Conservationist for Natural Resources	15	A.35

Source	Letter or Transcript No.	Page
GPU Nuclear Corporation F. R. Standerfer, Director, TMI-2 4410-88-L-0114 Document ID 0400P	16	A.35
The City of York, Pennsylvania William J. Althaus, Mayor	17	A.37
Comments received at the July 14, 1988, TMI-2 Advisory Panel Meeting	18[b]	A.84
Susquehanna Valley Alliance Frances Skolnick	19[a]	A.38
Three Mile Island Alert (TMIA), Inc.	20[a]	A.40
U.S. Environmental Protection Agency Richard E. Sanderson, Director, Office of Federal Activities	21	A.43
June E. Wood	22[c]	A.43
U.S. Department of Defense Department of the Army James F. Johnson, Chief, Planning Division, Baltimore District Corps of Engineers	23	A.44
Pennsylvania Intergovernmental Council Sandra L. Kline, Special Assistant Intergovernmental Review Process	24	A.45
U.S. Department of Energy Ernest C. Baynard III, Assistant Secretary, Environment, Safety, and Health	25	A.48
Comments received at the September 7, 1988, TMI-2 Advisory Panel Meeting	26[b]	A.135
Three Mile Island Alert (TMIA), Inc.	27[a]	A.49
GPU Nuclear Corporation E. E. Kintner, Executive Vice President 4410-88-L-0117 Document ID 0402P	28	A.51
U.S. NRC Periodic Briefing by TMI-2 Advisory Panel, October 25, 1988	29[b]	A.180

Copies of letters received are arranged in this appendix in the order received. The transcripts of the public meetings and the NRC briefing by the TMI-2 Advisory Panel, also arranged chronologically, follow the copies of the letters.

Numbers written in the margins of the comment letters refer to the section of the supplement where the comment is addressed or question is answered. The margin note "CN" means that the comment was noted, although it was not specifically addressed in the text of the supplement.

(a) Submitted as supplement to transcript of public meetings.
(b) Excerpt from transcript of meeting.
(c) Newspaper clipping was inserted with letter, but is not shown.

The numbers at the bottom of each page of a letter or transcript are used in Section 7.0 for ease of reference.

COMMENT LETTERS RECEIVED

No. 1

5-26-88

<u>SVA'S STATEMENT TO THE CITIZENS' ADVISORY PANEL CONCERNING NRC'S REVIEW OF GPU NUCLEAR'S PROPOSAL TO PLACE UNIT 2 IN PDMS PRIOR TO COMPLETION OF CLEAN-UP.</u>

I speak for the Susquehanna Valley Alliance whose membership resides mostly in Lancaster County and whose mental and physical health stands to be impacted upon by any decisions made about Three Mile Island. Following is a summary of our comments on the EIS, Supplement #3. I am submitting a list of questions which I would ask to have answered in a timely manner so that I can review the answers prior to submitting comments to the NRC.

Hot on the heels of the NRC's refusal to permit the storage of the Accident Generated Water at Unit 2 until a more suitable method of disposal was found whereby the radioactivity would be retained instead of dispersed into the environment, comes their consent to permit the placing of Unit 2 into a storage mode prior to the completion of clean-up so that more suitable methods can be found to finish the clean-up. PDMS is only a fancy name to conceal the fact that TMI will after all become a site for the storage of radioactive waste.

A.9

Indeed PDMS closely resembles the no-action alternative since there are no
7.3.1.4 assurances that Unit 2 will ever be cleaned up. The NRC speaks of a 20 year storage period, but provides no rationale for choosing this number. The Licensee refuses to commit itself! Obviously delayed clean-up solves 2 problems for the licensee

1) they do not have to proceed with an area of clean-up which would preclude the restart of Unit 2 and

2) they won't have to worry about that messy and inconvenient problem of what
7.5.3 to do with the waste. NRC tells us that immediate clean-up would require additional emergency allocations. (EIS Page 2.33)

Not so long ago, we heard of NRC's commitment to prevent TMI from becoming a site for the storage of waste. This EIS clears the way for just that. This waste mind you will be in out of the way places, not immediately available for monitoring.

We are shocked to learn that it will take at least 4 more years, and who knows, it could be more, to clean up Unit 2. It seems like only yesterday that we were being accused of holding up clean-up because we had asked for hearings concerning the disposal of the radioactive accident generated water.

Why generate more water when we have already accumulated the major medium
7.5.9 for decontamination?

1-1

One of our major concerns with leaving Unit 2 so contaminated for so 7.2.2
many years is based on uncertainties about the amount of radioactivity in buildings, pipes and other components. We are informed in the EIS that the number and quantity of the majority of radionuclides are estimated from the amount present at the time of the accident. The amount present at the time of the accident is based on a computer code, Origen 2. A computer code is only as accurate as the data that a person puts in, so there must be allowance for errors. Studies have been undertaken to follow the paths of the radionuclides as they were released from the damaged core. This is an ongoing project and as one reads through any research reports on the accident one soon is very aware of the uncertainties which exist as to how and to where the radionuclides were dispersed. The NRC recognises this developmental aspect of the clean-up. They state in the EIS,

> "Although predictions have been made regarding the transport and deposition of materials released as vapors and/or aerosols during core heat-up, refined modeling methods are not available for accurately analysing the transport and deposition of the fragmentation debris, or the leaching of soluble materials from the damaged core. " (page 2.22)

They also state that plans to decontaminate the reactor building following PDMS are tentative because the Licensee has

> "incomplete information (although currently being obtained) on the amount and location of contamination" (page 3.10)"

Table 2.4 which shows an estimate of the maximum amount of radionuclides 7.2.1
left and their location, comes as a complete surprise in light of these two statements. We want to know upon what information this table might be based. Furthermore, we want to have a complete accounting of the radionuclides present in the core at the time of the accident. Looking at just two of the radionuclides, tritium (which the NRC failed to mention was an important activation product) and Krypton 85, it is impossible to account for both of these radionuclides. There were over 8000 curies of tritium and over 97,000 curies of Krypton in the reactor at accident time. How does the NRC end up with less than one curie of both tritium and Krypton-85?

1-2

The approval of TMI to become a site for the storage of radioactive waste
raises questions about Regulatory procedures and furthermore the acceptability
of this plan to the State of Pennsylvania. If clean-up were to continue
presently then the waste would go to out of state sites. If it is delayed,
it will largely remain within the State. How does the State react to this?
Would the State site be able to accommodate this amount of waste? Would it
also be expected to accommodate the waste if Unit 2 were to be decommissioned.
7.5.4 How can the NRC dismiss the question of the impact of the waste disposal
by saying that it would be the subject of an analysis elsewhere. The
disposal of the waste at TMI is a major issue to be dealt with at this time
in keeping with the requirements of the National Environmental Policy
Act. Obviously,the people of Pennsylvania will be impacted upon not only by
the possible transportation accidents when taking the waste to a site,but also
by the possibility that the site will be located in somebody's backyard in Pa.
7.8.1 How will the NRC deal with the fact that Unit 2 is in the 100 year flood
plain? Will it have to manoeuver the regulations in some way that TMI will
7.8.2 be exempt from their requirements?Will TMI be able to satisfy the ground
water intrusion criteria?

The health impacts section so nearly resembles all other such sections in
Supplements to the EIS. I wish to call the attention of the NRC to some
7.9.2 revisions of the dosimetry of the survivors of the Japanese atomic bombings
which together with the now increased follow-up time for epidemiological
studies,are being taken into account by the United Nations Scientific Committee
on the Effects of Atomic Radiation (UNSCEAR) in producing risk estimates for
ionizing radiation exposure. This report will be used by ICRP in reviewing
its recommendations on the system of dose limitations. A preliminary reassessment
of the Hiroshima and Nagaski survivors has raised the fatal cancer risk
for the exposed population by a total factor of the order of 2. The risk
estimates could be substantially greater depending on the form of risk model
used and the shape of the dose reponse curve when extrapolating to low doses
from observations at high doses. The most important aspect of this information
to us is that standards must continue to be changed so that the public is
protected against unnecessary exposure to radiation.

One final point,which I must address to you Mayor Morris concerns the payment of the $10,000 by the Licensee to the City of Lancaster for the retrieval and analysis of samples of water from the Susquehanna river. This was directed

by the court. We want to make sure that this payment will continue as long as TMI continues to be radioactive. Water will continue to be poured into the Susquehanna River. Furthermore,there is a likelihood that other solutions will be added to the water for chemical decontamination. We want to know what steps the city will take to monitor this,so that our drinking water will be provided some sort of protection.

This concludes my comments on the EIS.
I wish to submit a typewritten copy of DR K.Z.Morgan's statement on EIS Supplement #2,which is related to the disposal of the AGW. He is opposed to the disposal of the water by evaporation and dispersal of the radioactivity into our air. He views it as an unnecessary exposure to ionizing radiation for the people in this area. He also shows it capable of inflicting much grater damage than the NRC/GPU would admit.

Thank you.

SV45 <u>QUESTIONS RELATING TO THE EIS ON GPU NUCLEAR'S PROPOSAL FOR PDMS</u>

7.2.2 1. Due to the uncertainties of radionuclide dispersion and deposition following the accident, upon what information is Table 2.4 based?

7.2.5 2. By the time of PDMS, will we know the condition of the containment and the damage to it caused by the accident? How will this information be made available to the Public?

7.11.2 3. While Unit 2 is in PDMS, what research will continue which relates to the reactor?

7.3.1.1 4. Explain the rationale for delaying clean-up. Delay will have no effect on the long-lived radionuclides. Is the delay then for reasons of technological advances?

7.3.1.12 5. How will the number of entries be determined during PDMS?

7.2.7 6. Upon what findings and/or studies does the NRC base its assumption that the activity in the top ¼" of the wall becomes available for resuspension? What allowances are made for the fact that the walls might crumble due to stress from age and clean-up activities already undertaken?

2.2.1 7. What is 10% of each activation product? Upon what information or studies do you make the assumption that 10% of the activation products will remain in the reactor building at the end of defueling? (EIS page 2.27,2.2.1)

7.3.1.15 8. The water which will leak into the system has been determined to be 5000 gallons per year. Explain why this amount is so much less than the in-leakage for this past 9 years.

7.3.2.1 9. Page 3.31, Section 3.3.1.1 Explain those measurements which are being presently undertaken? What is being measured? In what manner will the results affect decisions about RCS decontamination and the future of the facility?

7.2.14 10. What would preclude the use of the AGW to clean the RCS?

7.8.4 11. Will the water used for further clean-up contain chemicals? How will these be removed from the water before the water is released to our drinking water supply?

7.2.9 12. Page 3.32, Section 3.3.1.2 When do you expect the radiation doses to be low enough to permit entry into the basement for complete clean-up? If they are presently too high to permit entry, does this not rule out the possibility of immediate clean-up as an alternative to be considered?

13. How can the impact of the waste after disposal at either a regional or other site be considered outside the scope of this EIS? Delaying clean-up has a major impact on the final resting place for the waste from TMI, since the State of Pa is presently in the process of developing a site. 7.5.4

14. Page 3.19, footnote a. What are the precautions to be taken to ensure that criticality would not occur? 7.2.15

15. Between entries, how will the Licensee know that criticality has not occured? 7.3.1.9

16. During entries, how will the workers know that criticality is not occuring? 7.3.1.9

17. By what means will the Licensee determine the amount of radioactivity in the reactor prior to purging this radioactivity to the environment? 7.3.1.14

18. In the event of an incident at Unit 2, how many workers would be available at any one time to deal with the emergency-at a time when the workers have been reduced in the first year and then in the second year and thereafter. Is it possible or likely that workers from Unit 1 would be drawn to Unit 2 to help deal with an emergency? 7.3.1.18

19. Does GPU Nuclear need an amendment to its license before PDMS is enacted. 7.3.1.6

20. Since Unit 2 is in the 100 year flood plain, how will this affect its License prior to seeking approval for PDMS. 7.8.1

21. Explain why the estimated occupational doses are so much higher for immediate clean-up. 7.4.3

22. Explain the subtle difference between the no-action alternative and the Licensee's proposal. What guarantees or laws will preclude the Licensee's PDMS proposal from becoming the no-action alternative? 7.3.4.2

23. Into what areas and how much money will the Licensee or the NRC put into research to develop technology for clean-up following PDMS? Will the NRC obtain a commitment from the Licensee to finance such development? 7.11.2

24. Will all of the waste generated since the on-set of clean-up and up to theplacement of the plant in PDMS be removed from the island before the Unit is placed in PDMS? 7.5.8

No. 2

A.12

TMIA: THREE MILE ISLAND ALERT, INC.

315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

TMI-ALERT's COMMENTS TO THE ADVISORY PANEL ON PDMS

My name is Eric Epstein and I am the spokesperson for TMI-Alert. I would like to comment on the staff's Programmatic Environmental Impact Statement on Post-Defueling Monitored Storage at TMI.

In reviewing the staff's comments I was struck by several familiar and disturbing themes.

7.1.5 First, there is a heavy reliance on data supplied by GPU. This lack of independence, coupled with the staff's propensity to rely on outdated data, cast a shadow on the veracity of this document.

Secondly, the PEIS relies heavily on assumptions and conjecture relating to such items as the state of robotics and cleanup technology, radiation locations, radiation levels, and GPU's commitment and ability (economic health) to clean the plant
7.6.5 up. Thus the PEIS is too abstract and theoretical, and allows GPU the flexibility of finishing the cleanup when and how it sees fit. This is clearly a textbook lesson on how not to regulate.

Let me remind you that GPU has a knack for making rosy projections that have failed to materialize. For instance, we were originally told that, "Decontamination of the containment building will take until late 1982. Then we'll need the balance of 1982 and 1983 for fuel removal" (Robert Arnold, The Evening News, July 14, 1980). It is now 1988 and fuel is still being "recovered" and "removed." The original projected cost of $400 million, is approaching $1 billion, roughly what it cost to build Unit-1 and Unit-2. Yet the same people who are so proud of their pioneering accomplishments are content to mothball the plant indefinitely.

Actually, if you look at some recent events at Unit-2 it would seem as though the plant is already mothballed: January 19, 1988, GPU notified the NRC "that the training qualifications of a senior health physics technician (HPT) had lapsed several months in the past;" February 22 and 27, 1988, fires occurred in the Decontamination Facility of the reactor building, and in both instances assigned fire extinguishers failed to operate; and, April 1, 1988, NRC inspectors toured the reactor building and determined that "housekeeping on all elevations had deteriorated in that paper towels, cardboard tags, plastic bags, and other transient combustible materials were scattered in work areas and low usage areas". (Source: NRC Inspection Reports 50-320/87-15, 50-320/88-03, 50-320/88-01, 50-320/88-05).

Throughout the PEIS the NRC clearly accepted GPU's proposition that Post-Defueling Monitored Storage is somehow separate and distinct from the cleanup. This is absurd. The cleanup of Three Mile Island should not come to a screeching halt because GPU and the NRC have established an arbitrary end point.

Ironically, some of the same arguments the staff used against radioactive water storage were employed to endorse a postponement of the cleanup. For instance, the staff argued that postponement will significantly reduce radiation levels and allow time for the development of innovative technologies to deal with some of the problems created by the accident.

In contrast, TMI-Alert and other concerned citizens have consistently called for an expedited and safe cleanup, which will hopefully include a resolution to the water problem that will not result in direct, radioactive releases to the public and the environment (TMIA supports transporting the the sludge off-site to a low-level waste site, the Nevada Test Site or the Hanford Reservation).

GPU has the means, both economical and technological, as well as an experienced work force at its disposal, to continue the cleanup. Moreover, the staff did not have a clear preference in resolving this issue, and stated that the "TMI-2 site should not be allowed to become a waste disposal site" (NUREG-0683, PEIS, 3.1.5). The public has a clear preference, and we want to give the Panel a message to convey to the Commissioners: clean the plant up now! Cleanup means finishing the job you started, regardless if takes four or four hundred years. Radiation doesn't take vacations, and neither should GPU or the NRC. We can not allow these people to walk away from their commitment.

Let me conclude by saying that there are several problems intricately intertwined with the timing of the cleanup. To postpone the cleanup is to postpone the inevitable decontamination and decommissioning of Unit-2. It is high time for GPU, the NRC, the DOE, and the industry to admit that they do not know how to decommission and decontaminate a nuclear power 7.10.7 plant. Due to their collective ineptitude and overzealousness, there is a crippled, but dangerous plant, in the middle of the Susquehanna River that needs to be retired. But there's a catch: GPU doesn't want to clean it up just yet, the NRC is content to leave the plant in limbo-land, and nobody knows just how to decontaminate and decommission it.

A.13

Questions on PDMS

7.3.1.7 1. 2.1 The staff noted that, "The primary difference between an undamaged reactor at the end of its useful life and the licensee's PDMS proposal is that during PDMS relatively high levels of contamination would remain in the reactor building basement and a small amount of residual fuel would remain in the reactor coolant system storage."

What factual data are these conclusions derived from? How many "undamaged reactors at the end" of their "useful" lives have the NRC dealt with? Were technical experts from these plants consulted? If so, is their input a matter of public record? What other differences exist between these plants and GPU's PDMS plan? Was embrittlement a factor at these plants? What was the staffing levels at these plants?

7.2.4 2. 2.1.1 The staff argued that, "The reactor containment building is uniquely designed and constructed to maintain its structural integrity (with almost no leakage) during a wide variety of accidents."

How long after an accident was the RCB designed to maintain its integrity? Was it specifically designed to house radioactive waste materials for an indefinite period of time? If not, would not storage of such wastes necessitate a license amendment?

7.2.16 3. 2.4 How permanent are "permanent dose reduction techniques?"

7.2.11 4. 2.1.2 "Sectioning and disposal of the reactor internals and reactor vessel are not considered part of the cleanup because radiation levels expected from these components would be no higher than in a normal reactor nearing the end of its life."

What are "sectioning and positioning of the reactor internals" part of? What if radiation levels are incorrect? What exactly are the radiation levels of a "normal reactor at the end of its life?" What constitutes a normal reactor?

7.2.13 5. 2.1.4 What unique problems will the AFHB pose since it "was not designed to be leak free..." during a"...variety of accidents?" How much, and just exactly what, leaks from the AFHB?
7.1.4 What are the dose levels found in AFHB at the end of its life?

7.1.6 6. 2.2.1 Why weren't new calculations taken concerning the number and quantity of remaining radionuclides? Does the NRC or GPU have
7.2.1 a comprehensive inventory of the radionuclides released since the accident? Is it possible for radiation levels to shift or relocate from one section of the plant to another? If so, isn't possible
7.2.6 that sections designated to have certain radiation levels may now be inconsistent with GPU's endpoint criteria?

7. 2.2.2.3 "The efforts that are being made to leach radioactivity from the concrete-block wall may reduce this inventory somewhat." 7.2.8

How much is "somewhat?" What levels are acceptable and/or desired by the NRC? Is the staff aware that GPU has already made incorrect projections in this area: "They predict about 6 to 8 years of leaching will be required to reduce the block wall activity to 10% of the present value. This may be compared to an earlier prediction made by Dr. Godbee of about two years" (Task Force Report: Reactor Building Basement Decontamination, p.9).

8. 2.3.3 Re: U.S. NRC's proposed decommissioning plans. At what levels would "unrestricted" use of TMI be acceptable? 7.10.5

9. 3.1.5 Physically there is no difference between PDMS and the No-Action Alternative. (Theoretically preparation for PDMS appears to be the qualifier). When does the PDMS plan become the No-Action Alternative option? 7.3.4.2

10. 3.2.1.2 What are the advantages of storing the plenum dry? 7.3.1.10

11. 3.2.1.3 Is "ventilating" the reactor building before each entry the same as purging it? 7.3.1.11

12. 3.2.2.1 Can the NRC quantify radiation levels produced by "...aggressive decontamination efforts...?" (p. 3.16). 7.3.2.2

13. 3.2.2.1 How will the liquid releases to the Susquehanna River following PDMS differ in composition to the 2.3 million gallons of radioactive water currently stored at TMI? (p. 3.17). 7.3.1.17

14. 3.2.2.2 By NRC standards, was the March 1979 accident at TMI-2 considered "credible?" 7.11.1

15. 3.2.6 Does the NRC have an approved method for waste disposal, i.e. shallow burial vs. above ground monitored storage? 7.5.5

16. 3.2.7 Is the public entitled to intervene if GPU implemented "long-term monitored storage of the facility?" 7.1.1

17. 3.3.2. Is there any discernible difference for the potential of accidental releases during immediate cleanup as opposed PDMS? 7.3.3.5

18. 3.3.3 What are the occupational dose levels of "...an undamaged reactor, nearing the end of its life...?" 7.4.2

19. 5.1 If the cost of the cleanup is figured in 1988 dollars, then estimates for delayed cleanup are imprecise and inaccurate. 7.6.2
Did the NRC factors such costs as retraining and rehiring workers or corporate insolvency and/or bankruptcy? 7.6.3

No. 4

U.S. Department of Labor

Occupational Safety and Health Administration
Washington, D.C. 20210

Reply to the Attention of:

MAY 13 1988

Mr. John F. Stolz
Director
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation
13D16
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Stolz:

This is in response to your letter of April 27 addressed to Assistant Secretary John A. Pendergrass, concerning the issuance of a draft supplement to the programmatic environmental impact statement - Three Mile Island, Unit 2.

The Occupational Safety and Health Administration (OSHA) would like to thank you for the opportunity to review the supplement. OSHA has no comments on the draft report.

If we can be of further service to you, please do not hesitate to contact me.

Sincerely,

Frank S. Chalmers
Director
Directorate of Policy

4-1

No. 5

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

May 17, 1988

Dr. Michael T. Masnik
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Masnik:

The Office of Electric Power Regulation of the Federal Energy Regulatory Commission has received the April 1988 draft statement dealing with the possible environmental impact of alternate approaches to the completion of the cleanup of General Public Utilities' TMI-2 facility. We have no comment at this time.

Sincerely,

J. Steven Herod
Director, Office of
Electric Power Regulation

5-1

No. 6

United States Department of the Interior

OFFICE OF ENVIRONMENTAL PROJECT REVIEW
WASHINGTON, D.C. 20240

ER 88/292

JUN 2 1 1988

Dr. Michael T. Masnik
Project Directorate I-4
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Masnik:

The Department of the Interior has reviewed draft supplement 3 to the programmatic environmental statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident, Three Mile Island Nuclear Station, Unit 2, Dauphin County, Pennsylvania, and have the following comments.

The draft supplement states that the Gettysburg Formation aquifer is artesian in the site area. Water levels in the monitoring wells at the site are reported as being lower than those of three water supply wells on the east bank of the Susquehanna River, directly opposite the site. Previous documents have stated that ground water at the Three Mile Island Nuclear Station site is under water-table conditions (e.g., NUREG 0066, the July 1976 draft supplement to the Final Environmental Impact Statement related to operation of Three Mile Island Nuclear Station, Unit 2). The present supplement should clarify the
4.1.4 ground-water situation at the site, explaining whether the onsite observation and monitoring wells are only in the water-table aquifer or whether some wells also monitor the underlying artesian aquifer. The final supplement should indicate whether there is any significant hydraulic continuity between the Gettysburg Formation aquifer and the water-table aquifer. If hydraulic continuity has become evident, it should be explained.
7.8.3 It is unclear if the reported higher water levels in the three water-supply wells on the east bank of the river are static levels or pumping levels. The final supplement should indicate how heavily the wells are pumped.

We hope these comments will be helpful to you in the preparation of a final supplement.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

6-1

No. 7

United States Department of Agriculture

Soil Conservation Service

228 Walnut Street, Room 850
Box 985 Federal Square Station
Harrisburg, PA 17108-0985

June 22, 1988

Dr. Michael T. Masnik, Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Masnik:

We appreciate the opportunity to review the DEIS related to decontamination and disposal of radioactive wastes from Three Mile Island Nuclear Station, Unit 2 (Docket No. 50-320). At this time, we have no comments.

RODNEY J. MAYS
Assistant State Conservationist
for Natural Resources

cc:
James B. Newman, Director, Ecological Sciences Division, SCS, Washington, D. C.

7-1

No. 8

Commonwealth of Pennsylvania

Department of Health

HARRISBURG

717-787-5264

June 23, 1988

Dr. Michael T. Masnik
Office of Nuclear Reactor REgulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Masnik:

At your request, I have reviewed the Draft Supplement 3 To The Programmatic Environmental Impact Statement - Three Mile Island, Unit 2. As in the past, I have concentrated on the epidemiologic aspects of the document. Please note that my comments are based on your staff's analysis, as given.

A copy of my comments is enclosed.

Enclosure

Sincerely,

George K. Tokuahta, Dr.P.H., Ph.D.
Director
Division of Epidemiology Research

P.O. BOX 90, HARRISBURG, PA 17108

DRAFT SUPPLEMENT 3 TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT - THREE MILE ISLAND, UNIT 2

The purpose of Draft Supplement Dealing with Post-Defueling Monitored Storage and Subsequent Cleanup (Supplement No. 3) is to evaluate the potential environmental impacts of alternative approaches to completing the TMI - 2 cleanup. The licensee has submitted a proposal to maintain the TMI-2 facility in a monitored storage mode (referred to as "post-defueling monitored storage") for an unspecified period of time following current efforts to remove the damaged fuel. Following the storage period (approximately 20 years), the decontamination process would be resumed and completed. This alternative is referred to as "delayed cleanup".

Six alternatives to the licensee's proposal were identified by the NRC staff: 1) immediate cleanup without storage period; 2) immediate cleanup with a reduced level of effort without storage period; 3) more extensive cleaning than that proposed by the licensee; 4) delayed cleanup with storage less than 20 years; 5) delayed cleanup with storage longer than 20 years; and (6) no further cleanup following defueling.

Delayed cleanup and immediate cleanup were quantitatively evaluated relative to their environmental impacts, including radiation exposure to the offsite population from routine and accidental releases, occupational radiation dose, waste management impacts, socioeconomic impacts, commitment of resources, and regulatory considerations.

The potential environmental impacts associated with delayed cleanup and immediate cleanup are summarized in Table S.1., which appears to be the most informative source of data epidemiologically.

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DRAFT SUPPLEMENT 3 TO THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT - THREE MILE ISLAND, UNIT 2

Estimates of the cancer mortality risks to workers and the general public were based on conservative assumptions. The following comparative risk estimates between Delayed Cleanup and Immediate Cleanup are of particular interest:

a) Occupational radiation doses, thus estimated risk of radiation-induced cancer deaths among workers, along with estimated numbers of traffic accidents/injuries/deaths are higher for the Immediate Cleanup mode than the Delayed Cleanup mode.

b) On the other hand, bone doses and total body doses to the offsite population, thus estimated risk of radiation-induced cancer deaths offsite are higher for the Delayed Cleanup mode than the Immediate Cleanup mode.

c) Estimated risk of radiation-induced genetic disorders in the offsite population is greater for the Immediate Cleanup mode than the Delayed Cleanup mode.

d) Delayed Cleanup mode would be more costly than Immediate Cleanup mode.

As can be seen from the above comparison, differences in health risks associated with radiation exposure are not consistent between the two modes, i.e., one mode would provide a higher risk to on-site workers, but a lower risk to offsite population and vice versa. However, it is important to recognize that projected cancer fatalities in the offsite population residing within 50 miles of the site are 0.002 (2 chances in 1000) among 2.2 million- 3.2 million people for Delayed Cleanup as compared with the estimate of 0.0003 (3 chances in 10,000) for Immediate Cleanup.

The estimated number of traffic fatalities during waste shipments is, regardless of cleanup modes, generally higher than that of cancer fatalities associated with radiation exposure.

Based on the overall assessment, the NRC staff has concluded that the licensee's proposed plan and the NRC staff-identified alternatives for completion of cleanup are within the applicable regulatory limits and could each be implemented without significant environmental impact. No alternative (except "no action" alternative or "no further cleanup following defueling") was found to be clearly preferable from an environmental impact perspective. Analyses conducted and views expressed by the NRC staff are consistent with our epidemilogic review of the data provided in the Supplement No. 3 dated April 1988.

May 31, 1988

George K. Tokuhata

George K. Tokuhata, Dr.P.H., Ph.D
Director
Division of Epidemiology Research
Pennsylvania Department of Health

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717)233-7897

June 22, 1988

TMI-ALERT'S COMMENTS ON NUREG 0683, SUPPLEMENT #2, DRAFT REPORT

Three Mile Island Alert (TMIA) is a non-profit, safe-energy organization formed in 1977 after the construction of Three Mile Island Unit-1 and Unit-2, and the licensing of Unit-1. We have been an active intervenor in hearings before the Nuclear Regulatory Commission (NRC) on safety, managerial and technical issues.

We have taken the time to evaluate the NRC staff's Programmatic Environmental Impact Statement (PEIS) on Post-Defueling Monitored Storage at TMI-2. Unfortunately, we were struck by several familiar and disturbing themes.

7.1.5 First, there is a heavy reliance on data supplied by GPU. This lack of independence, coupled with the staff's propensity to rely on outdated data, cast a shadow on the veracity of the PEIS.

Secondly, the PEIS relies heavily on assumptions and conjecture relating to such items as the state of robotics and cleanup technology, radiation locations, radiation levels, and
7.6.5 GPU's commitment and ability (economic health) to clean the plant up. Thus the PEIS is too abstract and theoretical, and allows GPU the flexibility of finishing the cleanup when and how it sees fit. This is clearly a textbook lesson on how not to regulate.

Let me remind you that GPU has a knack for making rosy projections that have failed to materialize. For instance, we were originally told that, "Decontamination of the containment building will take until late 1982. Then we'll need the balance of 1982 and 1983 for fuel removal" (Robert Arnold, The Evening News, July 14, 1980). It is now 1988 and fuel is still being "recovered" and "removed." The original projected cost of $400 million, is approaching $1 billion, roughly what it cost to build Unit-1 and Unit-2. Yet the same people who are so proud of their pioneering accomplishments are content to mothball the plant indefinitely.

Actually, if you look at some recent events at Unit-2 it would seem as though the plant is already mothballed: January 19, 1988, GPU notified the NRC "that the training qualifications of a senior health physics technician (HPT) had lapsed several months in the past;" February 22 and 27, 1988, fires occurred in the Decontamination Facility of the reactor building, and in both instances assigned fire extinguishers failed to operate; and, April 1, 1988, NRC inspectors toured the reactor building and determined that "housekeeping on all elevations had deteriorated in that paper towels, cardboard tags, plastic bags, and other transient combustible materials were scattered in work areas and low usage areas". (Source: NRC Inspection Reports 50-320/87-15, 50-320/88-03, 50-320/88-01, 50-320/88-05).

Throughout the PEIS the NRC clearly accepted GPU's proposition that Post-Defueling Monitored Storage is somehow separate and distinct from the cleanup. This is absurd. The cleanup of Three Mile Island should not come to screeching halt because GPU and the NRC have established an arbitrary end point.

Ironically, some of the same arguments the staff used against radioactive water storage were employed to endorse a postponement of the cleanup. For instance, the staff argued that postponement will significantly reduce radiation levels and allow time for the development of innovative technologies to deal with some of the problems created by the accident.

In contrast, TMI-Alert and other concerned citizens have consistently called for an expedited and safe cleanup, which will hopefully include a resolution to the water problem that will not result in direct, radioactive releases to the public and the environment (TMIA supports transporting the the sludge off-site to a low-level waste site, the Nevada Test Site or the Hanford Reservation).

GPU has the means, both economical and technological, as well as an experienced work force at its disposal, to continue the cleanup. Moreover, the staff did not have a clear preference in resolving this issue, and stated that the "TMI-2 site should not be allowed to become a waste disposal site" (NUREG-0683, PEIS, 3.1.5). The public has a clear preference, and we want to give the Panel a message to convey to the Commissioners: clean the plant up now! Cleanup means finishing the job you started, regardless if takes four or four hundred years. Radiation doesn't take vacations, and neither should GPU or the NRC. We can not allow these people to walk away from their commitment.

There are several problems intricately intertwined with the timing of the cleanup. To postpone the cleanup is to postpone the inevitable decontamination and decommissioning of Unit-2. It is high time for GPU, the NRC, the DOE, and the industry to admit
7.10.7 that they do not know how to decommission and decontaminate a nuclear power plant. Due to their collective ineptitude and overzealousness, there is a crippled, but dangerous plant, in the middle of the Susquehanna River that needs to be retired. But there's a catch: GPU doesn't want to clean it up just yet, the NRC is content to leave the plant in limbo-land, and nobody knows just how to decontaminate and decommission it.

Submitted by,

Eric Epstein, Spokesperson, TMI-Alert

No. 10

GPU Nuclear

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July 12, 1988
4410-88-L-0097/0403P

Dr. Michael T. Masnik
Senior Project Manager
OWFN 13D16
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Masnik:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Draft Programmatic Environmental Impact Statement, Supplement No. 3

This letter transmits comments concerning the draft Programmatic Environmental Impact Statement (PEIS), Supplement No. 3, which evaluates GPU Nuclear's proposed Post-Defueling Monitored Storage (PDMS) of Three Mile Island Unit 2 (TMI-2).

GPU Nuclear is pleased that the Staff has confirmed that the PDMS configuration is environmentally safe and that the benefits of long-term storage of TMI-2 outweigh any potential effects. Further, we want to stress that the dominant issue inherent in a decision to pursue PDMS is reduced occupational radiation exposure to the TMI-2 workforce. Included in the attached comments are results of a recently completed GPU Nuclear study which estimated worker radiation exposure for the PDMS proposal and for the NRC identified alternative of additional decontamination activity. These estimates, which were not available when the Supplement No. 3 Draft was prepared, indicate a significantly larger benefit in reduced occupational radiation exposure than presented in the PEIS Draft.

Based on the PEIS Draft Supplement No. 3 and our attached comments, GPU Nuclear concludes that there is every reason to identify the PDMS proposal as the preferred alternative. All of the identified alternatives are safe and present no significant effect to the off-site public or the environment. The PDMS proposal, consistent with the basic NRC principle for radiation exposure of "as-low-as-is-reasonably-achievable" (ALARA), additionally offers a significant reduction in the radiation exposure to the TMI-2 workforce. GPU Nuclear believes this makes it clearly preferrable to the other alternatives.

If you have any further questions on these comments, we will be pleased to answer them.

Sincerely,

/s/ F. R. Standerfer

F. R. Standerfer
Director, TMI-2

EDS/emf

Attachment

cc: Senior Resident Inspector, TMI - R. J. Conte
Regional Administrator, Region 1 - W. T. Russell
Director, Plant Directorate IV - J. F. Stolz
Systems Engineer, TMI Site - L. H. Thonus

A.20

GENERAL COMMENTS

General Comment No. 1 - Preparation for PDMS

The discussion of "Preparations for PDMS," Page 3.6, Section 3.2.1.2, should be revised to include the prerequisites that GPU Nuclear has established for PDMS. These prerequisites are described in the December 1986 plan. Further, it should be stated that after TMI-2 is initially placed in PDMS, some activities may continue until completed. 3.0 3.1.1.2

Activities which may be carried on subsequent to the implementation of PDMS include:

1. Water Processing - Due to the anticipated duration of the ongoing adjudicatory process on the disposal of Accident Generated Water (AGW), it is expected that AGW disposal will be ongoing into PDMS. Because certain systems and facilities (e.g., the Processed Water Storage Tanks) are needed to support this activity, they will not be placed in a final storage configuration until after initial implementation of PDMS.

2. Decontamination - During the initial stages of PDMS, removal or isolation of small sources of radioactivity or radioactive material may continue (e.g., actions needed to place AGW disposal support systems in a final PDMS condition).

3. Radioactive Waste - Completion of shipment of remaining wastes generated during the Cleanup Program will be accomplished. Thus, radioactive waste shipments will continue during PDMS until all packaged waste from TMI-2 cleanup activities has been shipped off-site.

4. SNM Accountability - Activities to complete the transfer records for the fuel debris which was shipped to the Department of Energy will continue.

In summary, TMI-2 will be prepared to enter PDMS upon completion of the ongoing Cleanup Program (see General Comment No. 2 below). While some activities may continue for a period following implementation of PDMS, these activities will not alter the NRC assessment of environmental impact.

General Comment No. 2 - Completion of the Cleanup Program

GPU Nuclear's TMI-2 "Cleanup Program" includes those actions necessary to recover from the accident and to place the plant in a safe and stable condition that poses no risk to the public health and safety. The key elements of this program will be accomplished as a prerequisite to implementing PDMS. The use by the NRC of the terms "immediate cleanup" and "delayed cleanup" do not make clear that extensive cleanup has been accomplished and that the planned "Cleanup Program," as defined in the various PDMS documents, will be completed prior to PDMS. More accurate terminology for NRC's two alternative cases would be "immediate additional decontamination" and "final decontamination as part of decommissioning." 7.1.2

Additional near-term activities, while further reducing remaining radioactive contamination at TMI-2, are not necessary to ensure the public health and safety and are not consistent with the ALARA principle. These activities are not part of the "Cleanup Program" but rather will be accomplished as an integral element of decommissioning. This distinction should be addressed in the PEIS since these additional activities, whenever accomplished, will require considerable occupational exposure with no measurable increase in the margin of safety afforded by PDMS.

General Comment No. 3 - Worker Radiation Exposure

7.4.1 The NRC has included estimates of the occupational radiation exposure for the PDMS proposal and the primary alternative action. GPU Nuclear has recently completed a task by task study of the occupational radiation exposure for these alternatives and these estimates are summarized in Table 1. These GPU Nuclear estimates indicate a significantly larger person-rem savings than is indicated in the Draft PEIS. Thus, there is a greater ALARA incentive to adopt the PDMS proposal over the primary alternative. Moreover, if, as GPU Nuclear has proposed, final disposition of TMI-2 occurs at the time of TMI-2 decommissioning, the person-rem savings could be even larger.

Consistent with the original PEIS TMI-2, NUREG-0683, 1981, GPU Nuclear views the occupational dose savings as the dominant consideration in evaluating the PDMS alternative. The PEIS should emphasize that the PDMS condition poses no risk to public health and safety; in fact, the potential releases from TMI-2 during this period are expected to be much less than those analyzed in NUREG-0112, "The Final Environmental Impact Statement Related to the Operation of Three Mile Island Nuclear Station, Unit 2." On balance, the significant reduction in occupational exposure as a result of PDMS more than offsets even the maximum hypothetical environmental effect. Thus, a clear advantage for PDMS is demonstrated.

TABLE 1

SUMMARY OF GPU NUCLEAR PERSON-REM ESTIMATES

ADDITIONAL DECONTAMINATION ACTIVITIES	IMMEDIATE (Person-Rem)	POST-PDMS (Person-Rem)
REACTOR BUILDING		
Preparations/Support Activities		
Characterization	30 - 60	10 - 30
Ventilation Control and Area Isol.	0 - 0	0 - 0
Health Physics Support	1110 - 2450	370 - 820
Engineering Support	60 - 130	30 - 60
Basement General Cleanup	1340 - 2940	530 - 1160
Basement Cubicle Cleanup	1290 - 2840	430 - 950
Basement Block Wall Removal	180 - 400	100 - 210
D-Ring Dose Reduction	710 - 1550	180 - 390
D-Ring Final Decon	740 - 1630	280 - 610
Dome and Polar Crane Decon	20 - 40	0 - 10
El. 347'-0" Decon/Dose Reduction	70 - 160	20 - 40
El. 347'-0" Final Cleanup	370 - 820	90 - 210
El. 305'-0" Decon/Dose Reduction	120 - 260	30 - 60
El. 305'-0" Final Cleanup	570 - 1260	140 - 310
System Decontamination		
Reactor Coolant System	10 - 20	0 - 10
Non-RCS Systems	60 - 130	30 - 70
Subtotal (Reactor Building)	6680 - 14690	2240 - 4940
AUXILIARY AND FUEL HANDLING BUILDINGS		
Preparations/Support Activities		
Characterization	10 - 10	0 - 0
Health Physics Support	20 - 50	0 - 10
Engineering Support	0 - 0	0 - 0
AFHB Decon/Dose Reduction	100 - 220	20 - 40
Subtotal (AFHB)	130 - 280	20 - 50
RADWASTE MANAGEMENT	360 - 550	180 - 280
PDMS TASKS	0 - 0	230 - 490
APPROXIMATE RANGE OF PERSON-REM EXPOSURE	7200 - 15500	2700 - 5800
APPROXIMATE SAVINGS INCURRED BY IMPLEMENTATION OF PDMS		4500 - 9800

A.22

General Comment No. 4 - Practicality of Continued Near-Term Work

As a practical matter, "immediate cleanup," while useful as a hypothetically bounding case for assessing the environmental impact of the PDMS proposal, is not a viable alternative. To continue cleanup activities in the special case of TMI-2, beyond those currently planned, would require a substantial planning and engineering effort as well as the development of new technology and tooling. It is likely that additional work would require the use of destructive decontamination techniques. Therefore, such an undertaking would constitute, in effect, a new program comparable to decommissioning and would result in generation of significant quantities of abnormal waste which would require disposal. The current low-level waste disposal capacity and system of allocations are not adequate to accept an influx of the large volume of normal and abnormal wastes which would require disposal. The GPU Nuclear proposal is to enter PDMS and subsequently undertake further decontamination as part of plant decommissioning. In the interim, it is likely that the total volume of future radwaste could be reduced because of efficiencies gained in packaging and volume reduction as a result of developing technologies. Thus, from a radwaste disposal perspective, there is a clear advantage to placing the plant in PDMS.

1.0 As stated, in our December 1986 plan, PDMS assures a continued safe and stable TMI-2 plant condition until the time of decommissioning of TMI-1, at which time both units could be decommissioned simultaneously. Two clear advantages result:

1. The possibility of decommissioning activities at TMI-2 affecting operations at TMI-1 is eliminated.

2. By performing a common function for both facilities, the workforce can be utilized more efficiently.

The NRC's new decommissiong rule, 10 CFR 50.82(b)(iii), specifically recognizes the presence of other nuclear facilities at the site to be a factor in determining the appropriate timeframe for completing a decommissioning safely.

Recognition of these issues and consideration of the associated advantages to be realized by placing TMI-2 in PDMS should be included in this PEIS.

General Comment No. 5 - PEIS Summary Table S-1

7.3.3.1 Table S.1, which summarizes and compares the impacts from NRC's "delayed cleanup" and "immediate cleanup" alternatives does not compare the two alternative cases on a common timeframe. As a result, GPU Nuclear believes it does not present an accurate comparison of these alternative cases.

CN GPU Nuclear has developed a suggested revision to Table S.1 which portrays a comparison of like activities. We use a common timeframe and the NRC data, except for the occupational exposure estimates where we use the GPU Nuclear estimates from Table 1.

The three major changes to Table S-1 are proposed by GPU Nuclear:

1. Compare the two alternatives over the seme time period (24 years) ,so that time dependent factors (e.g., cost, off-site radiation exposure) can be compared on the same basis;

2. Compare radiological exposures due to these activities to natural background radiation exposure to highlight their relative insignificance; and

3. Divide Table S.1 into three separate parts so that similar impacts are more readily compared.

In addition, it is suggested that an appendix (or reference) addressing collective occupational person-rem estimates be provided to facilitate an understanding of the bases of the PEIS estimates. This appendix should be based on the GPU Nuclear study summarized in Table 1. The GPU Nuclear person-rem estimates are significantly higher than those presented in the PEIS. The principal contributors (i.e., 60%) are Reactor Building basement and D-Ring activities where personnel access currently is limited. Although PDMS envisions maximum use of advanced robotics, such application will be limited in some areas (e.g., D-Rings) and management of personnel exposure will be key. Therefore, the natural decay process during PDMS, which will result in a significant decrease in work area dose rates, will significantly decrease personnel exposure and, in some cases, the scope of work required. A detailed analysis of occupational person-rem costs, the results of which are summarized above, is in the process of publication and will be forwarded as Appendix 1A of the Post-Defueling Monitored Storage Safety Analysis Report.

The resultant suggested revisions to the Draft PEIS Table S-1 are attached as:

1. Revised Table S-1 - Radiation Dose Impacts

2. Revised Table S-2 - Potential Health Impacat

3. Revised Table S-3 - Other Impacts

REVISED TABLE S-1

Impacts	RADIATION DOSE IMPACTS[a]: NRC Post-PDMS Cleanup Alternative (24 yr)	RADIATION DOSE IMPACTS[a]: NRC Immediate Cleanup Alternative Plus 20-yr Storage (24 yr)	Natural[b] Background Radiation (24 yr)
Occupational Dose	2670-5760 person-rem	7170-15520 person-rem	N/A
Bone Dose to the Off-site Population			
Maximally Exposed Individual	0.001[d] to 0.03[c] rem	0.001[d] to 0.009[c] rem	4.08 rem
Total Population	9[d] to 20[c] person-rem	7[c] to 9[d] person-rem	9 million person-rem
Total Body Dose to the Off-site Population Within a 50-Mile Radius of TMI-2			
Maximally Exposed Individual	0.0005[d] to 0.004[c] rem	0.0005[d] to 0.001[c] rem	7.20 rem
Total Population	2[d] to 11[c] person-rem	2[d] to 3[c] person-rem	16 million person-rem

FOOTNOTES:

a Off-site doses include the contribution from the NRC's 4-year additional decontamination effort and the contribution from airborne releases only during a 20-year storage period.

b Natural background radiation doses are based on NCRP-93 and are calculated based on individual doses of 0.17 rem/yr bone dose and 0.30 rem/yr total body dose. A population of 2.2 million was used to calculate the person-rem.

c These doses were calculated by the NRC and represent bounding conditions. There is no significant difference in the alternatives based on environmental impact. All doses are well below 1% of natural background radiation.

d. These doses were calculated for the GPU Nuclear PDMS storage proposal as presented in the Environmental Evaluation for PDMS. They are adjusted for a 24-year time period to coincide with the NRC dose calculations. Doses were calculated using actual source terms. Based on actual experience and technical data for the period 1983-87, these data assume equivalent releases for periods of active decontamination and PDMS.

REVISED TABLE S-2

	POTENTIAL HEALTH IMPACT		
	NRC Post-PDMS Cleanup Alternative	NRC Immediate Cleanup Alternative Plus 20-yr Storage	Natural Incidence
Projected Total No. of Cancer Deaths for:			
Off-site Population	0.001[a]	0.0004	352,000[a]
Worker Population	0.4 to 0.8	1 to 2	160[b]
Projected No. of Genetic Disorders[c] (off-site population)	0.2 to 0.4	0.5 to 1	1,100,000
Individual Risks to Off-site Population			
Cancer	Less than 1/2,000,000,000[d]	Less than 1/5,000,000,000	1/6[c]
Genetic Disorder	Less than 1/27,000,000	Less than 1/11,000,000	1/10

Explanation of Health Risk:

a This value implies that there is approximately 1 chance in 1000 that a single fatal cancer may occur among the 2.2 million person off-site population. Moreover, the natural cancer mortality rate among 2.2 million persons is about 352,000 cases.

b The natural incidence of cancer deaths for the worker population is 16% of the estimated workforce of 1000 required for the cleanup phase of either NRC alternative.

c Genetic disorders are calculated for the equilibrium condition which includes 5 generations for the 2.2 million persons for a total of 11 million individuals. Worker exposure dose almost exclusively accounts for genetic disorder values and is incorporated into the off-site population since future generations of radiation workers are the members of the public.

d The average individual cancer risk due to PDMS and additional NRC-defined decontamination activities would be 1 chance in 2 billion. For the average individual, the natural risk of dying from cancer is approximately 1 chance in 6.

REVISED TABLE S-3

OTHER IMPACTS

	NRC Post-PDMS Cleanup Alternative (24 yr)	NRC Immediate Cleanup Alternative Plus 20-yr Storage (24 yr)
Cost ($ Million)	200-320	240-320[a]
Radioactive Waste Burial Ground Volume	33,000 to 74,000 ft^3 [b]	32,000 to 70,000 ft^3
Estimate Number of Traffic Accidents	0.5 to 1[c]	1 to 3
Estimated Number of Traffic Injuries	0.3 to 0.6[c]	1 to 3
Estimated Number of Traffic Fatalities	0.02 to 0.05[c]	0.1 to 0.2

a. The cost is based on the NRC estimate of $170 to $240 million to perform "immediate cleanup" plus the NRC estimate of $3.8 million per year for 20 years to maintain the plant in a stored condition. The cost estimates are used for purposes of comparing alternatives and do not reflect actual GPU Nuclear cost estimates. The initial GPU Nuclear estimate of the relative cost indicates the NRC's "immediate cleanup" alternative would be more costly.

b. Advances in waste reduction and packaging technology should result in a reduction in the overall waste volume for this alternative.

c. An assumed reduction in the distance travelled to the off-site burial site, coupled with anticipated waste volume reductions, should cause the degree to which the environmental assessment favors the NRC's "delayed cleanup" to increase.

General Comment No. 6 - Residual Fuel

The goal of the current defueling program is to remove greater than 99% of the
fuel. The Reactor Vessel (RV) will be defueled to the extent that 2.2.1
subcriticality can be ensured. We call to the Staff's attention the
information contained in Technical Specification Change Request No. 53. 2.1.3
submitted via GPU Nuclear letter 4410-87-L-0042 dated April 23, 1987, and
approved by License Amendment No. 30 dated May 27, 1988, which noted that the 2.2.2.3
quantity of residual fuel in the RV may exceed 70 kg. The final quantity of
fuel remaining in the RV will be reported as part of the Defueling Completion 2.2.2.4
Report in accordance with Technical Specification 1.3. 2.2.3

The source term available for environmental releases is relatively insensitive to the quantity of residual fuel in the Reactor Vessel as the fuel is contained and subcritical. Thus, the overall conclusions of the PEIS do not change because this fuel will be contained within the Reactor Vessel and cannot contribute to the Reactor Building atmospheric release source term. Bounding calculations for purposes of total environmental assessment need not await the Defueling Completion Report. They can be performed now based on an assumed residual fuel inventory of 1% of the original core inventory as indicated in the discussion of the comparison of NRC's cleanup alternatives in Section 3.0, page 3.1, of the PEIS.

SPECIFIC COMMENTS

Summary and Nomenclature

Summary v/Footnote - See General Comment No. 6 concerning residual fuel in RV.

Nomenclature xxi/ALARA - Should use definition from 10 CFR 20.1

Nomenclature xxvi - Millroentgen and mrem are not units of radioactivity. They are units for measuring radiation exposure either in air (roentgens) or in humans (rem).

Nomenclature xxviii/SDS - In addition to radioactive cesium, the Submerged Demineralizer System was designed to remove radioactive strontium and many other radioactive isotopes present in the radioactively contaminated water it processes.

Section 1

Introduction

Pages 1.1, 2.30, 2.31, 3.1 - GPU Nuclear currently estimates that at least 99% of the original fuel inventory will be removed prior to entry into PDMS. Thus, for purposes of this document, it should be assumed that 1% of the original fuel inventory remains at TMI-2. (See General Comment No. 6.) GPU Nuclear is unable to duplicate the estimated 0.16 percent value quoted on Pages 2.30 and 2.31 based on the estimated residual fuel values provided by GPU Nuclear on Page 11 of the December 1986 report. 1.0 2.2.2.4 2.2.3

Pages 1.1, 2.16 - The extent of Reactor Coolant System decontamination activity is limited to fuel removal and draining of the Reactor Coolant System to the extent practical. 1.0 7.2.10

Page 1.1 - Treatment of radioactive liquids may not be completed prior to entry into PDMS as it is likely that Accident-Generated Water processing and disposal will be underway. Treatment of Accident-Generated Water is analyzed separately in PEIS Supplement No. 2. 1.0

A.27

Section 2

Background Information Affecting Cleanup Alternatives

2.1.1 Page 2.4/Section 2.1.1 - (Second Paragraph) - At the end of 1987, the general area exposure rates at the 347' elevation were approximately 25 to 35 mR/hr, with less than 35 mR/hr for most well-travelled areas.

2.1.1 Page 2.9/Section 2.1.1 - (Second Paragraph) - The last sentence should read, "In addition, a layer of sludge was deposited on the basement floor."

7.1.2 Page 2.11/Section 2.1.1 - As stated in our General Comment No. 2, GPU Nuclear considers the "Cleanup Program" to be completed prior to entry into PDMS.

2.1.1 Page 2.11/Section 2.1.1 - Depending on the radioactivity levels of the Reactor Building basement water, processing may be through SDS and EPICOR II or only through EPICOR II. This distinction should be acknowledged.

2.1.1 Page 2.11/Section 2.1.1 - Work being performed in the Reactor Building basement prior to entry into PDMS is primarily being performed in Quadrants 1 and 2.

2.1.1 Page 2.12/Figure 2.7 - The data presented in this figure should be clarified. The radiation exposure rates are not general area exposure rates but rather are exposure rates obtained by use of a shielded directional probe. Most of the data is derived from contact readings. Even the general area readings are highly directional and do not give an accurate representation of actual general area exposure rates. Thus, the actual general area exposure rates, taken with a non-directional probe, would be lower than the contact exposures rates but higher than the general area exposure rates identified on this figure.

2.1.2 Page 2.13/Section 2.1.2 - The latter stages of defueling will require cutting through the lower grid plates and flow distributor forging in the lower core support assembly.

2.1.2 Page 2.13/Section 2.1.2 - The final storage location of the Reactor Vessel components has not been selected; however, they will be stored in suitable locations to minimize the potential for migration of fuel or activity to uncontained areas of the Reactor Building. Suggested rewording of this sentence would be: "After defueling, reactor internals may be returned to the vessel or stored in other suitable locations in the Reactor Building such as under shielding in the refueling canal."

2.1.2 Page 2.13/Section 2.1.2 - The statement that "Defueling will continue until all the fuel accessible, throughout the reactor vessel, has been removed," may not be accurate. GPU Nuclear will remove as much fuel from the reactor vessel as can be achieved, based on technology, criticality concerns, and ALARA considerations. Some fuel which is accessible (e.g., thin films on Reactor Vessel components) may not be practicable to remove.

Page 2.16/Table 2.1 - This table should be annotated to reflect that the estimated core material distribution in the Reactor Vessel is as of December 31, 1987, as stated in the text on Page 2.13. 2.1.2

Page 2.28/Section 2.2.2.3 - The estimate for "somewhat soluble fission products" was calculated based on the ratio of an estimated 21,000 curies of total cesium remaining to the original estimate of 660,000 curies; i.e., 3.2% of the original activity remaining in the Reactor Building. However, in deriving this estimate, approximately 15,000 curies of cesium remaining in the "D"-Rings were not considered; thus, the estimate of the remaining "somewhat soluble fission products" increases to 5.5% of the original value. 2.2.2.3

Page 2.29/Section 2.2.2.3 - The Cs-137:Sr-90 ratio for the 3000 psi concrete slab wall is approximately 2:1 vice 24:1. 2.2.2.3

Section 3

Proposed And Alternative Plans for Completion of TMI-2 Cleanup

3.0 Page 3.1/Section 3.0 - Based on current status of the adjudicatory process for
3.1.12 Accident-Generated Water (AGW) disposal, there may be AGW in the Auxiliary and Fuel Handling Buildings when TMI-2 enters PDMS. Specifically, the Fuel Pools may not yet be drained.

7.1.2 Page 3.1/Section 3.0 - The scope of the GPU Nuclear proposal is limited to placing TMI-2 in a PDMS condition. Additional activity and the final disposition of the plant subsequent to PDMS has not been studied nor is it now proposed.

3.0 Page 3.2/Table 3.1 - The radiological goal of <35,000 mR/hr for the Reactor Building Basement general area exposure rate is based on the expected dose rates in the basement following the planned scope of work. The actual conditions in the Reactor Building Basement, following the completion of the current scope of the cleanup activities, are expected to range from 1 R/hr to greater than 100 R/hr based on the success of those activities in the various areas of the Reactor Building Basement. The limiting factors will be accessibility and ALARA conditions.

7.3.4.1 Page 3.4/Section 3.1.5 - The no action alternative should be evaluated on the basis that all preparation for PDMS has been completed and TMI-2 has been placed in a safe, stable, and secure condition that represents no risk to public health and safety.

3.1.1.1 Page 3.6/ Section 3.2.1.1 - Presently the only items identified to be preserved for future use following PDMS are the mechanical components of the Polar Crane.

3.1.1.1 Page 3.6/Section 3.2.1.1 - These sections imply that the current environmental
Page 3.9/Section 3.2.1.3 monitoring program at TMI will be maintained
3.1.1.3 Page 4.12/Section 4.1.4 unchanged throughout PDMS. However, both GPU Nuclear's December 1986 Report on PDMS and our March 1987 Environmental Evaluation state that the environmental monitoring program at TMI undergoes continuous review and modification in response to changing site and plant conditions. This process is expected to continue during PDMS. However, an adequate and appropriate site environmental monitoring program will be maintained throughout PDMS to provide coverage for TMI-1 and TMI-2.

3.1.1.3 Page 3.7/Section 3.2.1.3 - The current plan for monitoring effluents during
Page 3.13/Section 3.2.2.1 passive airflow conditions is to periodically (semi-annually) perform an assay of the HEPA filter. Based on a known filter efficiency, the total particulate release to the environment can be determined. Since filter deposition is cumulative, this method provides determinative monitoring of breather effluents on a continuous basis.

Page 3.8/Table 3.2 - Although not specifically defined in previous GPU Nuclear submittals, the continuous sump level monitoring referred to in Table 3.2 is 3.1.1.3
via an alarm function. Remote level measuring devices are not planned.

Page 3.10/Section 3.2.1.4 - Principal post-PDMS activities required to restore the plant to a condition similar to a normal plant at end of life include decontamination of Reactor Coolant System and connecting systems and cleanup 7.1.2
of the Reactor Building, especially the basement and inside the O-Rings. PDMS is a logical "hold point" prior to decommissioning. The next step (i.e., accomplishment of these post-PDMS activities) logically is a part of decommissioning of the plant.

Page 3.14/Section 3.2.2.1 - Radionuclides specifically associated with the 3.1.2.2
fuel debris are located in the Reactor Coolant System and connected piping systems.

Page 3.16/Section 3.2.2.1 - An assumption that 10% of activation products 7.3.3.3
become airborne appears to be overly conservative since this activity is interstitially bound to the material it is contaminating.

Page 3.21/Section 3.2.2.2 - These accident analyses assume failure of both 3.1.2.3
Page 3.36/Section 3.3.2.2 stages of a double-stage HEPA-filter at the "most 3.2.2.3
critical time". This double failure event should be characterized as a very low probability event. 3.3.2.3

Page 3.23/Section 3.2.2.2 - GPU Nuclear plans to deactivate the SDS system 3.1.2.2
upon completion of AGW disposal; thus, SDS would not be available for 3.1.2.4
post-PDMS activities. A more appropriate assumption is that contaminated liquids would be processed by EPICOR II prior to storage in an outside storage 3.2.2.2
tank pending subsequent disposal. 3.2.2.4

Page 3.26/Section 3.2.4 - Preparation for PDMS could generate some Class B 3.1.4
waste due to the relatively high Sr-90 concentration in contamination at TMI-2. Based on present experience, the estimated ratio of Class A to Class B 3.2.4
waste would be approximately 20:1.

Page 3.26/Section 3.2.4 - Radioactive waste would not necessarily be shipped 3.1.4
off-site as it is generated. Normal procedures call for waste to be staged on-site until a sufficient volume is generated to make up a full shipment. 3.2.4

Page 3.26/Table 3.14 - The amount of waste listed under "Preparations for PDMS" appear low. GPU Nuclear currently estimates that 38,000 cubic feet of CN
waste will be generated in 1988 with another 9000-18,000 cubic feet estimated for 1989. Of this volume, approximately 4000-5000 cubic feet would be Class A waste directly related to preparation for PDMS.

Page 3.27/Section 3.2.4 - Most Class A waste does not require shipment in a
Page F.1/F.1 licensed shipping cask in order to comply with the 7.5.1
NRC and DOT regulations. Most of this Class A waste is shipped in unshielded containers of 98.5 ft^3 or 1014 ft^3.

3.1.4 Page 3.27/Section 3.2.4 - The 142 ft^3 casks licensed for shipment of Class C waste are also licensed for shipment of Class B wastes.

2.35 Page 3.27/Section 3.2.4 - The assumption that the regional disposal facility will be 500 miles from the TMI site appears to be overly conservative since the low-level radioactive waste disposal site will be located in Pennsylvania.

CN Page 3.27/Section 3.2.4 - In discussing the unique arrangement between GPU Page 3.40/Section 3.3.4 Nuclear and the U.S. Department of Energy (DOE) to dispose of waste classified as greater than Class C, it should be noted that the current GPU Nuclear contract with the DOE for this service expires December 31, 1989. Disposal of such waste after that time will require negotiation of a new contract.

3.3.22 Page 3.34/Section 3.3.2.1 - The Submerged Demineralizer System (SDS) should not be assumed to be operable for purposes of analysis of the "immediate decontamination" alternative. GPU Nuclear plans to deactivate the SDS system upon completion of AGW disposal.

7.33.1 Page 3.40/Table 3.23 - Table 3.23 should include the dose estimate for the 20-year storage period after the so-called "immediate cleanup" alternative to provide a more valid comparison to "delayed cleanup." Based on Table 3.13, values of 3-20 person rem for this period would be appropriate.

A.29

Section 5

Comparison of Environmental Impact of Delayed and Immediate Cleanup

Page 5.3/Section 5.1 - This discussion refers to an assumed average background dose rate of 87 mrem/yr. The recently revised value of 300 mrem/yr, as defined in NCRP Report No. 93, should be incorporated. 4.1.7

ATTACHMENT
4410-88-L-0097

Appendix F

Waste Volume Estimates and Waste Transportation Impacts

F.1 Page F.3/Table F.3 - The radionuclides Tc-99 (0.3 Ci/m^3) and H-3 (700 Ci/m^3) should be added to the list of isotopes present at TMI-2 in order to ensure the accuracy of Footnote (a).

7.5.2 Page F.16/Section F.2.4 - GPU Nuclear experience indicates that shipping container leases for type B casks typically average $2000/day.

-18-

0400P

10-20

A.30

Maryland Department of Natural Resources
Energy Administration — Power Plant Research Program
Tawes State Office Building
Annapolis, Maryland 21401
(301) 974-2261

William Donald Schaefer, *Governor*
Torrey C. Brown, M.D., *Secretary*

July 20, 1988

Dr. Michael T. Masnik
TMI Project Directorate
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Draft Supplement No. 3 to the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2 (NUREG-0683)

Dear Dr. Masnik:

The above referenced document has been reviewed by Maryland's Departments of Natural Resources and the Environment and the Governor's Commission on Three Mile Island. We find the document to be a comprehensive presentation and evaluation of the licensee's proposal to delay final decontamination and place the facility in a monitored storage configuration following defueling, and alternatives to this plan. We concur with NRC staff that the licensee's proposal would not have any significant environmental impact, and, further, that alternatives to this proposal do not appear to have any significant environmental or human health-related advantages over it.

The State of Maryland has no objection to approval of the licensee's proposal by the Commission.

Sincerely,

Richard I. McLean
Administrator, Radioecology
Power Plant Research Program
Department of Natural Resources

RIM/rva

DNR TTY for Deaf: 301-974-3683

No. 12

JULY 17, 1988

DEAR SIR.

PLEASE CONSIDER SERIOUSLY THE COMMENTS
MADE BY ERIC EPSTEIN, VERA STUCHINSKY AND
FRANCES SKOLNICK REGARDING THE CLEAN UP OF
THREE MILE ISLAND. I HAVE REVIEWED EXTENSIVELY
THE EIS SUPPLEMENT #3 AND FIND IT TO BE
A SLOPPY, AMATEUR EVALUATION OF THE SITUATION.
WHEN WILL YOU GUYS LISTEN TO US. WE CARE!
WE ARE FIGHTING FOR OUR LIVES NOT BEING PAID
TO CONSIDER THIS SITUATION. WHEN WILL YOU LEARN
7.1.5 NOT TO DEPEND ON GPU'S DATA. THEY ARE
SLOPPY, SLOPPY, SLOPPY!!! WE DO NOT WANT A
DISPOSAL SITE, MAKE THEM CLEAN UP THE WHOLE
MESS. THEY ARE JUST TRYING TO GET OUT OF IT!!!
I COULD NOT MAKE THE ADVISORY MEETING SO
HEAR ME. NOW!!!

Judy B Hemaker

12-1

No. 13

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

July 14, 1988

Dr. Michael T. Masnik
Senior Project Manager
TMI Cleanup
OWFN 13D16
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Masnik:

As chairperson of Three Mile Island Alert (TMIA), I would like to comment on NUREG-0683, Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident, Three Mile Island Nuclear Station, Unit 2. The NRC staff has endorsed an insufficient plan for delayed cleanup of Unit 2.

This plan lacks firm regulatory requirements. The summary 7.7
states that the duration of the storage period during delayed
cleanup was not specified by the licensee, so the NRC staff
assumed a storage period of twenty years. If the staff feels 7.3.1.4
that twenty years is appropriate, why is it not specified that
the duration of the storage period will not exceed twenty years?
Where are the regulatory guidelines? What is to stop GPU from
writing their own rules?

The PEIS is filled with references to the staff's approval 7.1.7
of procedures based on assumptions. For example, on page 3.10, "By the end of PDMS it is expected that the licensee will have made a decision on the future disposition of the plant and the final cleanup will be performed," and on page 3.23, "Although the licensee has not made any detailed plans for the cleanup following PDMS, it is assumed that during the cleanup, the contaminated liquids would be processed through the SDS and could be stored...before being processed through the EPICOR II system." Such assumptions are made repeatedly throughout the PEIS.

In addition, a glaring inconsistency with the staff's
previous position on monitored storage of wastes was apparent in 7.3.1.2
their support of the licensee's PDMS proposal. The staff justified this proposal by stating that there would be less occupational dose contamination due to radioactive decay during

13-1

the storage period (PEIS 1.0). Four pages later, the staff stated that after the completion of cleanup, the radiation levels in the TMI-2 reactor would be primarily due to cesium-137 (PEIS 2.1). Now, cesium-137 has a half-life of 30 years, so it would take 30 years for just half the total quantity of the cesium to decay. It would take approximately 300 years for this radioactive material to decay to insignificant levels. Twenty years is obviously not long enough to make a significant difference.

7.3.1.2 When members of the public asked the NRC to maintain the 2.3 million gallons of radioactive waste water in monitored storage on the island, rather than evaporate it, the staff unequivocally vetoed this plan. On page 7.4 (7.1.8) of the final PEIS dealing with disposal of the accident-generated water, the staff explained that "in the absense of overriding benefits associated with storing waste onsite, the staff believes that waste should be disposed of as expeditiously as possible. In this case, the staff concluded that there is no significant benefit from continued onsite storage (of the water)." It was noted that the tritiated water would remain radioactive for such a long time, that indefinite storage would have a negligible effect on the amount of radioactivity. However, the contamined water contains tritium, which has a half life of only 12.3 years, less that half that of cesium-137.

It was also noted (PEIS 1.0) that anticipated advances in decontamination technology are expected to occur within the next twenty years, while the still-contaminated Unit-2 reactor is in monitored storage. (This very argument was rejected by the staff when citizens asked that the tritiated water be held on site, until a better method of disposition is available, instead of dispersing it into the atmosphere.) The NRC has made no commitment to the public to pursue research on decontamination technology.

7.6.5 And finally, the NRC has neglected to make even a marginal show of good intent to the public by requiring GPU to demonstrate financial ability to pay for the final cleanup of Unit 2, some 20 years hence. The NRC is making a mockery of the regulatory process because it refuses to direct the utility to establish the means by which it can guarantee future funds for the cleanup. Responsibility to the public is completely overlooked.

It is a fact that utilities constantly underestimate the costs to build and maintain nuclear power plants (including TMI), and routinely run into huge cost overruns. It is just as likely that this will occur following PDMS. The NRC is simply choosing to ignore the likelihood that funds will not be available, and that ratepayers will be forced into rateshock, when GPU must find the money to decommission Unit 1 as well as complete the cleanup.

The PEIS is a shockingly inadequate document. Clearly the NRC staff has chosen to take no responsibility to recommend stringent regulatory guidelines for a safe cleanup of Unit 2.

Sincerely,

Vera L. Stuchinski

Vera L. Stuchinski
Chairperson, TMIA

A.33

No. 14

TO: July 10, 1988

Dr. Michael T. Masnik,

Office of Nuclear Reactor Regulation,

U.S. Nuclear Regulatory Commission,

Washington, D.C. 20555

FROM:

Deborah Davenport,

Member, Concerned Mothers and Women,

1802 Market Street,

Camp Hill, Penna. 17011

Dear Dr. Masnik:

I'm writing with some brief comments on Nureg-0683, Supplement 3, dealing GPU Nuclear's projected plans for the decontamination and disposal of wastes from Three Mile Island Nuclear Station, Unit 2. Plans which I feel are inadequate to protect the health and safety of people in this area. And they are plans which are also premature,
7.1.6 since the results of testing on various areas, and components of the plant have not been completed. Without adequate testing, and full release to the public of their results, whether from the past ten years or a future date, it would be very difficult for anyone to state that GPU's plans impose a Delayed Cleanup on the TMI area was the best possible alternative to follow re. the completion of the TMI Cleanup.

Assessments of the potential for criticality of fuel debris left within the reactor vessel itself, is of particular concern, and should be so. Already, GPU Nuclear has applied to remove criticality monitoring from the reactor vessel, via the Federal Register, without knowing

the state of the bottom of the reactor vessel itself, and the nature and amount of the materials, (core debris), within it. In addition, the area under the reactor vessel, has barely been tested at all, or so we have been told by The GPU Nuclear Corporation; however, statements made to that effect, during [redacted] Advisory Panel Meeting of May 26, 1988, by Frank Standerfor of GPU indicate that some unusual assumptions about the sump in question were already being made. Mr. Standerfer stated that the high levels of radiation [redacted] were preventing the testing in full, of the area directly below the reactor vessel, and indicated that said radiationwas comming from shine emanating from the bottom of the reactor vessel, which could not be shielded as it was in other areas around the reactor vessel. Fuel Debris in the reactor vessel sump was essentially assumed by GPU, not to be the cause [redacted] of high readings below the reactor vessel.

There is water in the sump below the reactor vessel. How much water is there, and how contaminated is the water? It would seem incredible, that the sump water, would not been contaminated to a measurable degree, as per other accident generated water. Concerns for that area of TMI2 do not appear to be adequately answered to date, particularly re. possible criticality concerns, present, future [redacted] monitoring concerns, and cleanup. A fuller assessment of materials in the reactor coolant system would also be welcome before the NRC approves any plan to let GPU Nuclear apply their own rendition of SAFESTOR to TMI 2. Again, assessment of fuel debris in all areas will prove more difficult because GPU was already granted exemptions in accounting for, and testing core debris characteristics before shipment to DOE, this was some time ago.

Still a fuller testing , and accounting program now might answer more fully questions which must be raised by GPU's premature Delayed Cleanup proposal, ans the NRC's PEIS assessment of that plan as safe.

7.3.1.13 Regarding future monitoring of TMI2, I'm again raising deep concern that any monitoring that might detect incidents or events of criticality be removed from any area, particularly the reactor vessel. Ditto fire equipment. If more radioactive materials are to be left throughout the plant, full monitoring capabilities should be maintained. In addition, the projected plans for monitoring should include checks of the air in what I assume is the stack past the HEPA Filters when buiding entries are not in progress, via "passive ventilation".

A.34

Finally, I am deeply epposed to a delayed cleanup, because of the changes that could occur in laws over a period of time. We
7.5.6 have no solid guarentee, that over time, waste disposal requirements might be changed in some ways that would prevent the removal of accident wastes from TMI2. Through the reclassification of waste categories, changes in state or federal regulations, this area might be left with an excess of TMI2 Radioactive wastes on the island itself. While the D.O.E. Memorandum of Understanding is still upheld, and sites such as Barnwell remain open , it would seem the course of wisdom to continue the cleanup. I am aware of the dangers that populations outside the area face in the transportation of waste; however, I feel an event of any significance here, at TMI2, would have even graver consequences. For some forseeable future, it sits next to Unit 1, an operating nuclear plant; an accident in Unit 2 of any "significant

magnitude, could affect Unit 1, causing an unsafe situation re. that plant as well. In addition TMI is located too near population centers, and is situated on an island on a river which affects many morepeople. Again removal from the area would then seem the greater course of wisdom, than running the risk of storing such wastes, forever, at Three Mile Island. The current backup of fuelrods at Peachbottom somewhat illustrates , at present, what I think might happen here in the future.

There is not a doubt that doses to workers might be somewhat reduced by a delayed Cleanup, however, accepting the statements made that almost all the noble gases were released during the accident, and the possibility that , for that reason, and others, doses to surrounding populations would be equal, with or without a delayed cleanup, accepting the current
risk and continuing to clean the plant. We have absolutely no guarentee 7.6.5
of future future funding being available to complete the cleanup,certainly not from the GPU Nuclear Corporation. If the excuse arises to get out of appropriating funds to clean up TMI at some future time, I'm certain GPU will take advantage of it. Whether in 1990, or past the year 2000, GPU will probably remain the same, if they still exist.

Area residents should be spared further burdens, and [redacted] extension of the tyranny of fear imposed upon them for over ten years by the GPU Corporation; at least in regard to Unit 2, shoud be ended with an immediate, and full cleanup. If there are areas of the plant too hot to clean now, perhaps the public is due a fuller explanationas to why that might be so; if not, impossible, the cleanup should proceed.

Sincerely,

[illegible]
1802 Market St
Camp Hill, PA 17011

No. 15

United States Department of Agriculture

Soil Conservation Service

228 Walnut Street, Room 853
Box 985 Federal Square Station
Harrisburg, PA 17108-0985

July 18, 1988

Dr. Michael T. Masnik, Project Manager
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Masnik:

We appreciate the opportunity to review the DEIS for the Three Mile Island Station, Unit 2 (Docket No. 50-320). At this time, we have no comments.

Sincerely,

Garland H Lipscomb, acting

RODNEY J. MAYS
Assistant State Conservationist
for Natural Resources

cc:
James B. Newman, Director, Ecological Sciences Division, SCS, Washington, D. C.

The Soil Conservation Service is an agency of the Department of Agriculture

15-1

No. 16

Nuclear

GPU Nuclear Corporation
Post Office Box 480
Route 441 South
Middletown, Pennsylvania 17057-0191
717 944-7621
TELEX 84-2386
Writer's Direct Dial Number:

(717) 948-8461

July 14, 1988
4410-88-L-0114/0400P

Dr. Michael T. Masnik
Senior Project Manager
OWFN 13D16
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Masnik:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Draft Programmatic Environmental Impact Statement, Supplement No. 3

GPU Nuclear letter 4410-88-L-0097 dated July 12, 1988, which transmitted GPU Nuclear's comments on the draft Programmatic Environmental Impact Statement, Supplement No. 3, contained several minor errors which should be corrected. The attached pages correct those errors and replace the pages provided in our original transmittal.

If you have any questions on these comments, we will be pleased to answer them.

Sincerely,

F. R. Standerfer
Director, TMI-2

JJB/emf

Attachment

cc: Senior Resident Inspector, TMI - R. J. Conte
Regional Administrator, Region 1 - W. T. Russell
Director, Plant Directorate IV - J. F. Stolz
Systems Engineer, TMI Site - L. H. Thonus

GPU Nuclear Corporation is a subsidiary of the General Public Utilities Corporation

16-1

A.36

ATTACHMENT
4410-88-L-0097

Additional near-term activities, while further reducing remaining radioactive contamination at TMI-2, are not necessary to ensure the public health and safety and are not consistent with the ALARA principle. These activities are not part of the "Cleanup Program" but rather will be accomplished as an integral element of decommissioning. This distinction should be addressed in the PEIS since these additional activities, whenever accomplished, will require considerable occupational exposure with no measurable increase in the margin of safety afforded by PDMS.

General Comment No. 3 - Worker Radiation Exposure

The NRC has included estimates of the occupational radiation exposure for the PDMS proposal and the primary alternative action. GPU Nuclear has recently completed a task by task study of the occupational radiation exposure for these alternatives and these estimates are summarized in Table 1. These GPU Nuclear estimates indicate a significantly larger person-rem savings than is indicated in the Draft PEIS. Thus, there is a greater ALARA incentive to adopt the PDMS proposal over the primary alternative. Moreover, if, as GPU Nuclear has proposed, final disposition of TMI-2 occurs at the time of TMI-1 decommissioning, the person-rem savings could be even larger.

Consistent with the original PEIS TMI-2, NUREG-0683, 1981, GPU Nuclear views the occupational dose savings as the dominant consideration in evaluating the PDMS alternative. The PEIS should emphasize that the PDMS condition poses no risk to public health and safety; in fact, the potential releases from TMI-2 during this period are expected to be much less than those analyzed in NUREG-0112, "The Final Environmental Impact Statement Related to the Operation of Three Mile Island Nuclear Station, Unit 2." On balance, the significant reduction in occupational exposure as a result of PDMS more than offsets even the maximum hypothetical environmental effect. Thus, a clear advantage for PDMS is demonstrated.

ATTACHMENT
4410-88-L-0097

TABLE 1

SUMMARY OF GPU NUCLEAR PERSON-REM ESTIMATES

ADDITIONAL DECONTAMINATION ACTIVITIES	IMMEDIATE (Person-Rem)	POST-PDMS (Person-Rem)
REACTOR BUILDING		
Preparations/Support Activities		
Characterization	30 - 60	10 - 30
Ventilation Control and Area Isol.	0 - 0	0 - 0
Health Physics Support	1110 - 2450	370 - 820
Engineering Support	60 - 130	30 - 60
Basement General Cleanup	1340 - 2940	530 - 1160
Basement Cubicle Cleanup	1290 - 2840	430 - 950
Basement Block Wall Removal	180 - 400	100 - 210
D-Ring Dose Reduction	710 - 1550	180 - 390
D-Ring Final Decon	740 - 1630	280 - 610
Dome and Polar Crane Decon	20 - 40	0 - 10
El. 347'-0" Decon/Dose Reduction	70 - 160	20 - 40
El. 347'-0" Final Cleanup	370 - 820	90 - 210
El. 305'-0" Decon/Dose Reduction	120 - 260	30 - 60
El. 305'-0" Final Cleanup	570 - 1260	140 - 310
System Decontamination		
Reactor Coolant System	10 - 20	0 - 10
Non-RCS Systems	60 - 130	30 - 70
Subtotal (Reactor Building)	6680 - 14690	2240 - 4940
AUXILIARY AND FUEL HANDLING BUILDINGS		
Preparations/Support Activities		
Characterization	10 - 10	0 - 0
Health Physics Support	20 - 50	0 - 10
Engineering Support	0 - 0	0 - 0
AFHB Decon/Dose Reduction	100 - 220	20 - 40
Subtotal (AFHB)	130 - 280	20 - 50
RADWASTE MANAGEMENT	360 - 550	180 - 280
PDMS TASKS	0 - 0	230 - 490
APPROXIMATE RANGE OF PERSON-REM EXPOSURE	7200 - 15500	2700 - 5800
APPROXIMATE SAVINGS INCURRED BY IMPLEMENTATION OF PDMS		4500 - 9700

No. 17

THE CITY OF YORK, PENNSYLVANIA

50 W. KING ST. POST OFFICE BOX 509 YORK, PA 17405 (717) 849-2221

WILLIAM J. ALTHAUS
Mayor

July 29, 1988

Dr. Michael T. Masnik
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C.

Re: TMI-2 Post Defueling Monitored Storage

Dear Doctor Masnik:

I write to provide my comments, as Mayor of the City of York, concerning the planned Post Defueling Monitored Storage (PDMS) of Three Mile Island Unit Two. Since assuming office in January 1982, I have followed closely the clean-up of TMI-2, as well as the restart and operation of TMI-1. I have toured the facilities and met with officials of GPU Nuclear on these subjects.

I have now had the opportunity to review the company's plan for monitored storage of Unit 2. It is my opinion that PDMS is the proper and responsible method to maintain Unit 2 until the decommissioning of Unit 1. Safety of the community and the workers is obviously of paramount importance. PDMS is clearly more consistent with this goal than attempts to remove the remaining vestiges of fuel and contamination.

As a public official closely in touch with opinion in my community, I do not believe that TMI-2 represents a source of serious safety concern to the people of the City of York. I believe PDMS will meet not just environmental safety needs, but will also be satisfactory to the people of central Pennsylvania.

Furthermore, in my dealings with officials of GPU Nuclear, and my observation of their management of both the clean-up and restart issues, I find that the company has responded in a responsible and capable fashion to a major environmental and community challenge.

I recommend strongly that the Nuclear Regulatory Commission approve Post Defueling Monitored Storage of TMI Unit 2.

17-1

Thank you for the opportunity to provide comments.

Very Truly Yours,

William J. Althaus

William J. Althaus
Mayor

WJA/mkj

xc: Ms. Lisa G. Robinson, Public Affairs Rep., GPU Nuclear Corp.
Mr. Fred D. Hafer, President, Metropolitan Edison Co.
file

17-2

No. 19

Susquehanna Valley Alliance
P.O. Box 1012 · Lancaster, PA 17604
(717) ~~394-3782~~

July 14th.1988

SUSQUEHANNA VALLEY ALLIANCE'S COMMENTS ON THE NRC'S ENVIRONMENTAL IMPACT STATEMENT, SUPPLEMENT #3, APRIL 1988, CONCERNING POST DEFUELING MONITORED STORAGE AND SUBSEQUENT CLEAN UP OF TMI UNIT 2.

7.1.6 We understand that the NRC staff must act upon any proposals submitted by the Licensee. However, it is unacceptable to us that the NRC print a draft of its evaluation of this proposal in light of the inadequacy of the data presently available. Unit 2 is clearly not close to being prepared for PDMS. Much work needs to be done, including the completion of defueling. Data, particularly that needed to determine the quantity and configuration of remaining radionuclides has not yet been submitted and will not be available for evaluation until defueling is completed. The purpose of an EIS is to provide enough information to both the public and all interested parties so that they can carefully evaluate a proposal and determine its consequences. Furthermore, the information is supposedly to permit public input into the decision making process. Clearly, if inadequate information is provided, the EIS does not meet its requirements as defined in the National Environmental Policy Act.

7.1.5 There are major weaknesses in the NRC's evaluation of radionuclides and their impact during PDMS. The most serious weakness is the lack of independence and and objectivity in evaluating this proposal. The NRC uses the Licensee's data rather than any of its own. In doing so, rather than evaluate the Licensee's proposal with an open mind, they serve only to confirm and grant the Licensee's desires. Hardly an appropriate act for an agency supposedly regulating an industry.

7.2.1 Using the Licensee's data, the NRC has calculated the inventory of radionuclides which will remain in the reactor and throughout Unit 2. This inventory is presented in Table 2.4. No references are provided so that the public might evaluate the amount of radionuclides which was removed during clean-up and defueling. Other references provided are from research undertaken by GPU Nuclear. This lack of information makes it more difficult to evaluate the impact of delaying clean-up.

Page 1

Concerning the discussion about Activation products, Page 2.27 - if 90% of the activation products is assumed to have been removed during defueling, the research and basis upon which this assumption is made should be referenced. This is most important in light of the NRC's admission that refined methods for determining the transportation of debris and radionuclides during an accident are not available. Measurements of fuel and surfaces may be fraught with errors, both mechanical and human, and therefore public scrutiny of the radionuclide content of Unit 2 during PDMS is essential. Only with full disclosure of information may this evaluation be made.
Furthermore, if 90% of the activation products is assumed to have left with the fuel or to have been incorporated into stainless steel of the components and is inaccessible, then would not part of this 90% also be a part of the inventory at the end of defueling, and hence be in addition to the 10% estimated to remain? Considering Manganese-54, with a half life of 312 days, surely there would be more than 12 curies left at the end of 10 years as indicated in Table 2.3 7.2.3

The claim that less than one curie of Krypton-85 will remain during PDMS needs further scrutiny. A review of environmental releases of K-85 during the accident and subsequent clean-up does not account for the total inventory of K-85 present at the onset of the accident. As late as October 1987, the Licensee was unable to account for as much as 335 curies of K-85.

The claim that less than one curie of Tritium will remain during PDMS also needs further scrutiny. An estimated 8800 curies of tritium was present at the time of the accident. The NRC claims that the AGW contains 1020 curies.
A review of environmental releases and additional reports shows that all of the tritium has not yet been accounted for and therefore there is no basis upon which to conclude that only one curie will remain in Unit 2. This issue is of particular importance to the disposal of the accident generated water and the determination of whether or not the water to be used in the subsequent clean-up is "accident generated water" as defined by the Lancaster City Agreement.

These comments address only Manganese-54, Krypton-85, and tritium. However, we feel that further scrutiny of the quantity and location of all radionuclides is 7.1.6
of vital importance.
The need for independent evaluation of the radionuclide inventory is heightened by the facts that the Licensee has on occasions miscalibrated waste which has left the island, and moreover by the discovery that instrumentation used for measuring strontium was miscalibrated for some period of years during clean-up.

Page 2

The public's trust in the Licensee's ability to collect accurate data has suffered irreversible damage when in 1984, the Licensee was found to have maintained a policy to systematically falsify critical safety data and destroy documents for months leading to the 1979 accident. In light of this it is incomprehensible that the NRC should rely so heavily on the Licensee's data.

7.3.15 In December 1983, in Nureg 0683, Supplement #1, the NRC considered methods to reduce worker dose at TMI Unit 2. One of the methods considered was that following defueling, the plant would be placed in storage. The NRC indicated certain obstacles to this procedure which included:

1) uncertainties about the development of robotic technology
2) Lack of information about the feasibility and safety of interim storage
3) lack of assurance that funds will be available for ultimate clean-up

There is no evidence in the draft supplement that these obstacles have been eliminated. It is therefore appropriate that the NRC notify the public prior to any decision on PDMS how these 3 obstacles have been overcome to enable the NRC to conclude that the Licensee's proposal will have no significant environmental impact.

7.11.2 7.6.4 7.6.5 The public requires assurance that not only are efforts being undertaken by the NRC and the Licensee to develop and help finance advanced technology for the clean-up, but also that funding is put in place for PDMS, subsequent clean-up and decommissioning. Furthermore, a mechanism which enables the State of Pa. to take ownership of these funds should be made available. The Licensee stands to save $57million dollars by a reduction in its work force during PDMS. These funds should be laid aside for the people in this area who stand to loose, and who must shoulder the burden of a decaying radioactive site in their back yard.

7.5.7 It is ironic that in evaluating the regulatory considerations of delayed clean-up, the NRC fails to mention its policy of encouraging Licensees to remove all radioactive waste from the site when possible. This is the policy to which the NRC so fervently clung when the public asked them to consider and accept the storage of accident generated water on the island until the tritium had decayed. It is exactly this kind of behavior which continues to erode the public confidence in the regulatory abilities of the NRC.

It is not surprising to us that the NRC concludes that any of the alternatives considered in this draft will not significantly affect our environment. Even the lack of a firm factual basis could never preclude the NRC from a finding in the Licensee's favor.

Whether clean-up is immediate or delayed, the public must suffer the consequences of millions of gallons of radioactive water going into their drinking water supply and the venting of radioactivity into their air from Unit 2 for an unspecified period of time (The Licensee was careful not to designate a time period for PDMS, 7.3.1.4
whereas the NRC suggested 20 years, which is meaningless since there is no means of enforcement). Only those who must carry the burden of radioactive exposure (with no provision of electricity to off-set the cost) have the right to decide whether GPUN's proposal will not have a significant environmental impact. The NRC must provide the Public with the tools to make such an evaluation. This draft does not provide those tools.

In conclusion, the NRC must provide more information as it arises. They must provide the basis and research for their assumptions. Only when the public has been given this information and sufficient time to evaluate it and provide input to the NRC, only then should the NRC render a decision on this issue which will affect those of us living here for the rest of our lives.
Furthermore, along with any decision on this proposal the NRC has an obligation to us, the public to:

1) Establish administrative procedures which will ensure that the Licensee will complete clean-up
2) Obtain a commitment that should clean-up be delayed, the Licensee will not refurbish Unit 2
3) Ensure that adequate funding is set aside for use by those who clean-up TMI
4) Ensure that both the NRC and the Licensee commit money to the research and development of technology to be used in clean-up

Frances Skolnick

Frances Skolnick

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St. Harrisburg, Penna. 17102 (717) 233-7897

July 14, 1988

Tonight I intend to focus on the research and economic parameters of postponing the cleanup of TMI 2 , referred to as the Post-Defueling Monitored Storage (PDMS) option. This discussion must necessarily encompass several generic issues associated with decontamination and decommissioning of nuclear power plants. However, before I begin, I would like to clarify several outstanding issues from the last meeting, and comment on some recent developments.

I would like to draw the Panel's attention to an incident on May 13, 1988, in which GPU "mis-classified" a piece of reactor core debris (NRC Region I Inspection Report No. 50-320/88-08, p.5). Similar incidents occurred in August, 1985 and December 1987, and in both instances GPU's license to ship radioactive waste was temporarily suspended. Waste management is a programmatic problem at Unit 2. Moreover, the NRC noted, "we are concerned that your root cause analysis of all events may not be effective in addressing human performance problems in distinction to related technical problems" (IR No. 50-320/88-08, p.1). With these events in mind, how can the public be assured that GPU is competent to manage Unit 2 during PDMS with a substantially scaled down staff?

Perhaps GPU has sensed the public's apprehension. Recently, they have bombarded local newspapers with ads portraying the merit of PDMS. This is not a low-budget venture. A full-page ad during the week in the Patriot News cost $3,553.95, and on Sunday the same ad sells for $3,760.35. Is the public subsidizing this slick PR campaign? How much has this campaign cost GPU? The cost and source of the funding should be disclosed so that the public can make an intelligent decision in this matter.

I want to clarify several issues from the last meeting relating to decommissioning. TMIA is well aware that the Public
7.10.2 Utility Commission (PUC) factors decommissioning into the ratebase, but a) there is no criteria to determine dollar amounts, and b) there is no provision for early retirement. In addition, there is no mechanism in place to put money aside for an immediate or delayed cleanup. To date, GPU has failed to detail funding plans for the final phase of cleanup. I'll address this issue in more detail later.

Also, I challenged Dr. Travers' estimates on the generic costs of decommissioning nuclear power plants. To begin with, there is no clear definition for the term decommissioning. Therefore, there is a wide variation (discrepancy) in published estimates. Of course estimates vary depending on costs, operational life, activity, design, etc. Dr. Travers stated it was approximately $200 million in 1988 dollars to decommission a nuclear power plant. What is decommissioning to Dr. Travers? What were his projections based on? The Atomic Industrial Forum has estimated the cost for decommissioning from $30.1 to $129.3 million; Analysis and Inference, Inc. estimated $173.3 to $694.9 for a large Pressurized Water Reactor (PWR); and Duane Chapman, an economist at Cornell University, has projected the cost to be $3 billion for a reference PWR (Public Citizen, Dismantling the Myths About Nuclear Dismantling, April 15, 1985 p.19) As you can see, estimating decommissioning costs is an inexact science. For this reason, Dr. Travers' estimate is objectionable, and points to the need to closely scrutinize all of the NRC's and GPU's estimates and projections related to decontamination and decommissioning.

Many people who work with public utility issues that I've 7.6.5
spoken to, expressed concern over the economic aspects of a delayed cleanup. Indeed, some of you on the Panel have expressed doubt that money will somehow be available for decontamination activities, and the eventual decommissioning of TMI 2. This skepticism is commendable and warranted. The reality of the matter is that the financing of an immediate or delayed cleanup is sketchy at best.

Already, GPU customers have shouldered a huge economic burden. TMI 2 was briefly in the rate base, no clean up funds accumulated, and the decommissioning account is broke. While the general consensus by experts in the field is that ratepayer equity should be maintained, GPU ratepayers have already assumed an inequitable status. The ratepayer equity theory stipulates that the ratepayer is responsible for decommissioning costs since that person enjoyed the benefits of electrical generation. However, the TMI ratepayer was deprived of this benefit since Unit 2 was shut down prematurely. While ratepayer equity is a valid principle, in the TMI case it doesn't work. The TMI ratepayer has been burdened enough, e.g. construction costs, cleanup costs, and energy replacement costs.

Should the principle of ratepayer equity hold when imprudent management decisions incur huge unknown costs? When management failure was responsible for the destruction of a $700 million investment? When an investment was rendered unusable after 1/120 of its projected life? Should the next generation of ratepayers be liable because GPU does not want to engage in timely decontamination and decommissioning activities? With such obvious inequity it is improbable that adequate funds will be forthcoming in the future.

If not the ratepayers, then who? General Public Utilities doesn't know where the funds will come from. Gordon Tomb indicated to TMIA in a phone conversation on Thursday June 30, 1988, further decontamination funding goes beyond the Thornburgh Plan. According to Tomb, further cleanup funding "is a little fuzzy." Doug Bedell told TMIA on July 8, 1988, that the "funding question should be addressed at the Advisory Panel."

Post Defueling Monitored Storage further complicates the funding picture. At the time delayed cleanup is projected to take place, almost every license for a commercial nuclear power plant will have expired! The nuclear industry will be undergoing simultaneous decommissioning. Therefore, funding sources utilized for the TMI cleanup will either be unavailable or under pressure to bail out other nuclear utilities. TMI-1 and Oyster Creek will also be undergoing decontamination and decommissioning and those projects are likely to be under-funded.

In actuality, we are dealing with generic economic questions relating to the "back end" of nuclear power production. These are the hidden costs of decontamination and decommissioning, which GPU and the NRC would like to hide for another 20 years. This is not a site-specific problem.

To date, there has been no decommissioning of a large, commercial nuclear power plant. Costs are unknown and typically underestimated. Battelle Pacific Northwest Laboratory conducted several studies examining decommissioning costs between 1979 and 1982. Battelle Studies provided the basis for utility estimates, but these studies were based on the decommissioning of the 22.5 MW Elk River plant which operated for only four years. This reactor was 1/40 of TMI's size."Many modern reactors can produce 50 times more power and will have operated some seven times as long as Elk River" (Cynthia Pollock, Decommissioning: Nuclear Power's Missing Link, Worldwatch Paper 69, April, 1986, p.11). Moreover, there was no peer review, and the objectivity of Battelle is called into question due to their heavy reliance on contracts from the Department of Energy (DOE), the NRC and the Electrical Power Research Institute (EPRI). When the study was updated in 1984 "costs had indeed risen much faster than inflation over the preceding six years" (Pollock, p.26).

Other reports from DOE and RAND Corporation suggest that we can expect cost overruns. For example, "A January, 1984, report by DOE showed that of the 47 reactors surveyed, 36 reactors cost at least twice as much to complete as originally projected and 13 cost at least four times as much" (Energy Information Administration, 1983). This demonstrates how unrealistic economic projections at the "front end" or "back end" of nuclear power production are when based on unknown variables.

Although the NRC stated that they have "had considerable experience with reactors that have not have had a significant accident before the end of their useful lives" (NRC's Response to Questions Raised at the May 26, 1988, Advisory Panel Meeting, Harrisburg, PA, p.11), that experience is limited to small reactors. In fact, many commercial reactors are not anywhere close to being decontaminated or decommissioned, primarily due to a lack of available technology.

The NRC stated that one of the advantages of delaying the cleanup is:

> The monitored storage period allows time for continued development of decontamination technology so that the most effective and efficient techniques may be applied. Further reduction in occupational doses would be achieved through use of advanced robotic technology, automatic cleaning and chemical cleaning techniques, and advanced waste treatment methods.(NRC's response, p.2).

NRC anticipates emerging technology, yet on page 10 of the same document the staff noted that: "The NRC has no plans to develop technology for cleanup following PDMS. This task would be left to the licensee. No commitment will be obtained by the NRC from the licensee to finance further development of technology."

Where is this new technology going to come from? In 1984 Dr. Paul Woolam, a member of the Commission of the European Communities team that studied decommissioning capabilities stated, "The design of equipment for dismantling, especially remote equipment, is in its infancy"(Smith, Konzek, and Kennedy, Decommissioning a Reference Pressurized Water Reactor.) In this field, GPU has portrayed itself as a pioneer, but is now content to sit idly by and wait for new technologies to be developed. If not the NRC, GPU or other international agencies, then who?

What about DOE and the decommissioning of Shippingport? Shippingport is a 72 MW PWR owned by DOE. In order to cut costs, the 800 ton, 5 million curie, pressurized vessel reactor and neutron shield will be put on a barge which will sail down the Ohio and Mississippi Rivers, across the Gulf of Mexico, through the Panama Canal, up the West Coast, up the Columbia River to the Hanford Reservation. The federal government is avoiding a valuable decommissioning experience by barging the entire reactor as a unit. The radioactive debris has a a guaranteed burial site, unlike the dilemma faced by commercial reactors which have no place to go after retirement. Therefore, the waste will be disposed of under unrealistically lax DOE waste site regulations.

(Note: DOE's funds have come under increasing pressure to clean up hazardous sites at defense plants. The total costs range from $40 to $70 billion [Hazardous Waste News, June 1988]. Therefore, increased research and development funding for decommissioning nuclear power plants from this agency is unlikely.)

Not much in the way of research is being conducted by utilities who have had to close plants prematurely. The entire industry is deferring instead of developing.

Humboldt Bay: shut-down 12 years ago, because the cost of refurbishing it to withstand a major earthquake was more than the original construction and licensing costs. Despite appeals from local citizens groups to dismantle the plant, it was put into temporary storage with no decommissioning funds set aside.

Dreseden 1: shut-down 10 years ago due to radioactive corrosive products inside the piping. Partially decontaminated with chemicals in the early 80s. The plant is in temporary storage until Units 2 and 3 are ready for retirement.

Indian Point 1: shut-down in compliance with the Atomic Energy Commission's regulations in 1974, because it lacked an emergency core cooling system. Waiting for Indian Point 2 decommissioning in 20006.

Fermi 1: put into temporary storage in 1975 due to an accident.

Peach Bottom 1 - put into temporary storage 13 years ago. (If Units 2 and 3 are not restarted, the current decommissioning fund does not have enough money to decommission any of the units.)

Saxton Nuclear Experimental Facility - owned and operated by GPU, this 7 MW reactor operated from 1962 to 1972. Saxton was placed in "temporary storage" in 1972 and is scheduled to be dismantled in 1997. Dismantling costs are estimated to be $12 million-200 % of the original capital costs (Burns and Roe, 1981:I-3, Ernest Fuller, personal communications, August 15, 1983).

Several trends are readily apparent by examining these reactors: in each case deferring was prompted by inadequate funding; there is a reluctance to undertake unknown tasks; very little is being done in the way of research and development to decommission and decontaminate reactors; all the above reactors were shut down prematurely placing a strain on the licensee's cash flow, making research and development impractical; and the NRC clearly accepts "temporary storage" as a means of getting around decontamination and decommissioning.

It is clear the cost of postponing cleanup is immense, and likely to be unfairly distributed. The NRC and GPU's claim that future technologies and robotics will be developed appear to be wishful thinking. As was noted, every utility is playing a waiting game, gambling that someone else will pioneer decontamination and decommissioning technologies. Cynthia Pollock aptly described the problems with waiting 30 to 100 years: 7.6.5

> Assumptions must be made about the evolution of technologies and the likely increase in decommissioning costs, inflation, and real interest rates. Estimates must also include provisions for stricter government regulations and other unforeseeable events. The staff most familiar with the plant will have left the company and excellent record keeping will be required to inform the future crew of the reactor's intricacies and its operating history. The longer dismantlement is deferred, the greater the margin of error and the higher the total costs are likely to be (Pollock, p.33).

The Advisory Panel should oppose Post Defueling Monitored Storage for the following reasons: 1) more costly, 2) the cost is inequitable and will be borne by the next generation of ratepayers, 3) there is an underlying assumption that technology will suddenly come forward, despite a lack of research and development. 7.11.2

The Panel should recommend to the NRC that the cleanup of TMI 2 proceed immediately. GPU should be liable for costs, and develop appropriate technologies. In addition, GPU should develop a funding plan based on equitability and realism to be reviewed by the Public Utility Commission, the Consumer Advocate, the Commonwealth of Pennsylvania and citizens.

Finally, regarding the NRC's responses to TMIA's questions. Question 1: concerning the NRC's experience with decommissioning. The staff's answer failed to alleviate our concern regarding the federal government's lack of in experience decommissioning a nuclear reactor.

Question 6: we still remain unconvinced that adequate safeguards are in place for the movement and location of radioactive materials.

And to the best of our knowledge questions 7, 8, 9, 10, 12, 14, 15, 17 and 18 were not answered.

No. 21

United States Environmental Protection Agency

External Affairs (A-104E) Washington DC 20460

EPA

Federal Activities

Dr. Michael T. Masnik
Project Directorate 1-4
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Masnik:

In accordance with Section 309 of the Clean Air Act, the U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Nuclear Regulatory Commission's Draft Supplement 3 to the Programmatic Environmental Impact Statement related to the cleanup at Three Mile Island Unit 2. Our review of the EIS concludes that the dose and risk analysis of the two cleanup alternatives are reasonable and sound, and that the calculated risk associated with either alternative is very low and constitutes no significant hazard. Accordingly, EPA has rated this draft supplement "LO" (Lack of Objections).

7.9.1 We have one minor technical comment to offer. Table 5.1 (page 5-2) would be improved if it included cancer death estimates for the maximally exposed individual. The table presents risk information associated with the two cleanup alternatives, but the text only addresses cancer fatalities for the population. Cancer death estimates to the maximum exposed individual would show that the individual risks are insignificant.

If you have any questions, please call Dr. W. Alexander Williams (382-5909) of my staff.

Sincerely,

Richard E. Sanderson
Director
Office of Federal Activities

No. 22

June E. Wood
526 Franklin
Alburtis, Pennsylvania 18011

Dear Sir — 5/5/87

Many of us objected from the start, to produce electricity by nuclear effort,

But, we were put down by the educated, the know-hows, the mucky mucks, if you will, those who feel "they know" what is best for us and for everyone ——

Now, we have the sad results with TMI and no solution (yes, some more theory and ideas)

No. 23

What can we the people do in similar effort when we know, we have gut feelings about something so important to our lives and more to the lives of our children —

Do the people "at the top" in these egghead organizations know the terrible responsibilities they have, the power they have to make decisions affecting us for years —

Thank you
June E Wood

22-2

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203-1715

REPLY TO ATTENTION OF:
Planning Division

July 22, 1988

John F. Stolz, Director
Project Directorate I-4
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Stolz:

Reference your letter dated April 27, 1988, regarding the Draft Supplement 3 to the Programmatic Environmental Impact Statement for Three Mile Island, Unit 2 (DSEIS-TMI). The comments provided below address the Corps of Engineers (Corps) areas of concern, including direct and indirect impacts to existing and/or proposed Corps projects, flood control hazard potential, and permit requirements under Section 404 of the Clean Water Act.

There are no existing or proposed Corps projects that would be affected by the work described in the DSEIS-TMI. The flood plain concerns were adequately discussed in the report.

Certain activities in the waters of the United States, including most wetlands, require Department of the Army Permits from the Corps of Engineers. Corps regulations (33 CFR 320 through 330 and 33 CFR 230 and 325 (Appendix B)) require full compliance with the National Environmental Policy Act of 1969 (NEPA) during the review and evaluation of permit applications. To the maximum extent possible the Corps will accept the information presented in NEPA documents for evaluating permit applications. If you have any questions or need additional information on permits, the point of contact is Mr. Tom Filip, Assistant Chief, Regulatory Branch, Operations Division, at (301) 962-3671.

If you have any other questions on this matter, please call me or my action officer, Mr. Larry Lower, at (301) 962-4905.

Sincerely,

Harold L. Nelson
for James F. Johnson
Chief, Planning Division

23-1

No. 24

Pennsylvania Intergovernmental Council

P.O. BOX 11560 • HARRISBURG, PA 17108-1660 • (717) 783-3700

August 4, 1988

Michael T. Masnik
Senior Project Manager
OWFN 13D16
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Masnik:

Pennsylvania's Single Point of Contact under Executive Order 12372 has received the enclosed comments from the Pennsylvania Department of Environmental Resources regarding your Draft Supplement 3 to the Programmatic Environmental Impact Statement for Three Mile Island Unit 2 (EI-00093). Although the period for comments has passed, we are forwarding them to you for informational purposes.

Should you have any questions, please feel free to contact us.

Sincerely,

Sandra L. Kline

Sandra L. Kline
Special Assistant
Intergovernmental Review Process

Enclosure

Strengthening Intergovernmental Relations and Public Decision-making in Pennsylvania

24-1

DEPARTMENT OF ENVIRONMENTAL RESOURCES

July 29, 1988

SUBJECT: Issuance of Draft Supplement 3 to the Programmatic Environmental Impact Statement - Three Mile Island, Unit 2

TO: Laine A. Heltebridle
Pennsylvania Intergovernmental Council

FROM: Frederick G. Carlson, Director
Office of Policy
Department of Environmental Resources

Attached are comments from the DER Bureau of Radiation Protection concerning the Programmatic Environmental Impact Statement - Three Mile Island, Unit 2.

Attachment

RECEIVED
AUG - 3 1988
PA. INTERGOVERNMENTAL COU.

24-2

REVIEW OF NUREG 0683, SUPPLEMENT NO. 3

The NUREG 0683, Programmatic Environmental Impact Statement (PEIS), Draft Supplement No. 3 dated April, 1988, deals with Post-Defuelling Monitored Storage (PDMS) and the subsequent clean up concept for the damaged reactor plant at the Three Mile Island Nuclear Station, Unit 2 (TMI-2). A review of this supplement needs to keep in focus the special and unique circumstances of the TMI-2 plant over the past nine years. After the accident on March 28, 1979, the original PEIS was issued by NRC in March, 1981, with the expressed intent to provide an overall evaluation of the environmental impacts of the clean up activities at TMI-2.

Subsequently, on April 28, 1981, the Commission issued a policy statement indicating that the NRC staff would evaluate and act on major cleanup proposals as long as the impacts associated with the proposal activities fell within the scope of the impacts already assessed in the PEIS. The PEIS, however, was to be supplemented as new information became available. The first supplement (No 1, issued in 1984) reevaluated the occupational dose estimates in the original PEIS because new information led NRC staff to conclude that the cleanup could result in greater occupational radiation exposure than was originally estimated. A second supplement (No 2, issued 1987) updated the information presented in the original PEIS regarding options for the disposal of the accident generated water and the environmental impacts that could result from it.

It should be noted that a number of features are unique in this process.

1. The NRC has shown initiative and provided aggressive leadership and guidance in this process well beyond what a PEIS for a normally operating reactor would furnish. This guidance has been generated variously, either on NRC's own initiative, or in consultation with the licensee, or in response to licensee's proposed actions.

2. Whereas a 'normal' Environmental Report is written basically with the purpose of generating viable options and selecting from them and not directly guiding licensing (e.g. Technical Specifications), for TMI-2 the PEIS has been an instrument for detailed licensing guidance not only as new decisions became pending but also on a continuing basis.

The Commonwealth views TMI-2, although still holding an operating license, as a special and unique plant whose cleanup is of primary importance and a source of extreme concern to the general public. As a result, the Commonwealth considers the exceptional process above entirely proper and supports it.

In December, 1986, General Public Utilities Nuclear (GPUN) proposed to the NRC a scheme for terminating the cleanup activities at TMI-2, go into Post-Defueling Monitored Storage for a time period, and later complete decommissioning the units. This was followed by an Environmental Report on March 11, 1987, which examined the environmental impacts associated with the proposal. The PEIS supplement no 3, subject of this review, has been generated by the NRC in response to this proposal. In accordance with the requirements of the National Environmental Policy Act (NEPA), a number of alternative courses of actions, in particular an option which continues with the current cleanup activities to completion, were considered. The conclusion was that whereas both major options were acceptable, a choice could not be made between the two in view of the inherent uncertainties of the analysis. However, in keeping with the special PEIS process in this case, a strong implication exists that the calculated results will serve as a bounding envelope into which the contours of a specific design and its impact have to fit.

The Commonwealth has several comments related directly or indirectly to the <u>assurance</u> that (1) the entire cleanup including decommissioning will be completed in the near future, (2) the environmental impacts can in fact be kept as low as calculated by adopting appropriate design and operating procedure measures, (3) there will be adequate surveillance and monitoring by GPUN during the dormant (and later decommissioning) phases and (4) over the protracted period, the NRC's licensing guidance and oversight will be as keen and effective in its regulatory surveillance. In our view, the decision regarding PDMS rests heavily in generating this assurance. The basis for this concern is described in the detailed comments below:

<u>Comment No 1</u> **<u>Program Plan (Front End)</u>**

The PDMS program plan is described in a very broad outline and the details are missing. For example: what are the specific criteria for current cleanup termination? GPU has committed to 99% or more core material removal before PDMS. As core inventories can only be estimated, it is necessary to define the action set points as a process derivative. An ancillary aspect to this issue is the question of where and when mode 3 ends and PDMS begins. The administrative and technical interfaces/boundaries need be discussed along with the appropriate rationale. 7.1.7 7.1.3 7.3.1.3

A second concern in the front end is the issue of criticality. Pennsylvania must be assured that there is no chance that the small amount of fuel left behind can form a critical mass, either locally, or in bulk. 7.2.15

<u>Comment No 2</u> **<u>Program Plan (Back End-Decommissioning)</u>**

The Commonwealth must be assured that the PDMS will end and decommissioning begin in the near and determined future. Specifically we need to know what that date will be. In January, 1986, GPUN committed to the NRC Commissioners that under no circumstances would the PDMS run beyond the time when TMI-1 Decommissioning begins. Through a license condition and otherwise, assurance needs be generated that such is the case. 7.3.1.4 7.7

The impact of the new proposed Decommissioning Rule (published by the NRC as a Federal Register Notice on June 27, 1988), on decommissioning of TMI-2 has to be carefully examined. It is understood that TMI-2 must 7.10.3 submit its decommissioning plans by 1990. How does the plan incorporate the fact that due to its extra contamination, the plant would be in worse shape than a 'normal' plant in a safe store condition? Does GPUN have to detail the special technical methods and extra financial resources required for this additional task in the plan? Does GPUN, in 7.3.1.6 the meantime, have a possession only license, or operating license with amended possession-only-type Tech Spec's or some other variant? During decommissioning does GPUN contemplate further decontamination to put the plant in safe store first, or proceed with the full scope dismantling and decommission? A clear description of the highlights of this process and options will assure the general public regarding the certainty of the process.

Comment No 3, Financial Assurance

7.6.4 Closely allied to the comment above is the issue of financial assurance. Adequate funds must be available to accomplish the decommissioning tasks. Our concern derives from the following facts: (1) The financing for the original cleanup was not easily put together. It took an active initiative on the part of the Commonwealth to move it along. (2) The activity extends well into the future and is of somewhat undermined scope. (3) The plant does not generate revenue and cannot set aside a portion of its income in an escrow fund, for example. (4) In the current scheme, TMI-1 and TMI-2 may begin decommissioning together, thus stretching GPUN resources. (5) An outcome of the accident has been that the general public needs more rather than less guarantees from GPUN. At this point, specifics of the financing plans, rather than overall general guarantees are needed to establish the viability of PDMS. Such plans must include, at a minimum, an estimate of the expenses of the total task including additional decontamination, and a reliable scheme for setting this funding aside.

A.47

Comment No 4 Basis for Comparison: Offsite Releases

7.3.3.1 The PDMS and immediate cleanup have been compared by terminating the time span at the end of cleanup. The fact is that for both options, final decommissioning activities will have to follow, proceeded by (possibly) a safe store period. In order to move the comparison towards equitability, the immediate cleanup option should have been followed by a 20 year safe store period in the PEIS. Based on actual release data compiled by GPU for the years 1983 to 1986, the offsite dose rates (from liquid and gaseous releases, and airborne particulates and iodines), have remained fairly steady independent of the amount of fuel in the plant. The mechanism of release appears to be desorption from the basement walls where the contaminants have been absorbed, their resuspension and subsequent release. As such, contamination absorbed in the walls appears to be the predominant determinant for the offsite releases. This observation, if true, has three implications:

7.3.3.2
1. Leaving less than 1% fuel in the plant will not affect offsite doses appreciably;

2. A 20-year offsite dose component should have been included in the immediate cleanup option. For example, summary Table S.1 (items 6-9) will be changed and read considerably different;

3. A cost component, corresponding to 20 year monitoring, should be added to the immediate cleanup cost (item 10 in S.1);

Comment No 5 Basis for Comparison: Worker doses

The PEIS worker doses have been computed in the PEIS based on current 7.4.1
data and a simple extrapolation for future activities. Such extrapolations have to be very careful, because it is clear that cleaning up the residual amounts of radioactivity is going to be harder. It is our opinion that the worker dose numbers may be on the low side, and their differences are consequently less pronounced. A more detailed study, based on detailed time motion analysis, is currently in progress at GPUN. The preliminary results indicate that the worker doses might have been underestimated by a factor of 3 to 5. Such increases, although appearing small, are significant on two accounts.

1. Summary Table S.1 (first two items) will be changed and read considerably different.

2. As workers have to keep individual doses within a total lifetime quota, such increases significantly affect their workability.

Comment No 6 Plant details

Engineering details of the PDMS design and operations are missing. For 7.1.7
example, more details are needed regarding design of containment entries (basis for once a month assumption), design and operations of ventilation systems, the filters and their efficiencies, other containment penetration systems, water accumulation/condensation inside containment, basis for outleakage, etc. In obtaining the source terms for the releases, a number of assumptions have been made regarding concentrations, desorption, resuspension and releases. Although some correlations have been made with current data, would the same be valid 7.3.1.8
when the containment is bottled up with potentially additional heatloading and lack of ventilation inside?

In order to get a better handle on the releases, a good assessment for the monitoring and the surveillance systems is necessary. We appreciate the caveat that the calculated numbers are to serve as targets, and the actual design would have to be fitted into it. Nevertheless, more detailed operations and design information upfront improves confidence by minimizing future surprises.

Comment No 7 Accident Analysis

The accident analysis presented in section 3.3.2.2 is cursory and 7.3.2.4
abbreviated. In particular, in the absence of other driving energies as in a 'normal' nuclear plant, fire is the single source of energy for the TMI-2 plant. In order to assess the associated hazards one needs to know the combustible loading, ignition sources, design of fire suppression systems, the standards and specifications they are designed (e.g. Appendix R, possibly), system operations, monitoring and surveillance systems and other similar facts. All this information would be used to define "a design basis fire" and then the analysis completed.

No. 25

7.3.3.4 A second accident that requires examination is the possibility of a crack in the concrete wall, and leakage of condensates through it.

Comment No 8 **Decommissioning**

1.0 In order to continue cleanup at TMI-2 beyond a certain level, one has to tear apart pipes, walls, etc. These activities properly belong during decommissioning. For the immediate cleanup option, this would mean a full-scale dismantling activity with an operating reactor i.e. TMI-1 next door. For the PDMS option, however, it is possible to schedule the two decommissioning activities together and achieve an economy of scale. This has been recognized in the proposed NRC decommissioning rule. The extent of this advantage can potentially be quite broad and go well beyond the narrower worker man-rem considerations. There is inadequate discussion of this issue in the PEIS.

In summary, significant worker dose reduction and potential simultaneous dismantling of the two units are two arguments favoring PDMS. Nevertheless, we feel that for a program which may extend 50 years or more in the future, generating confidence and assurance is absolutely necessary and will contribute substantially in establishing the viability of the option. Details of the PDMS program plan, financing details, system design, operations and maintenance plans, implementation plans, decommission plans, etc., are required before the Commonwealth can accept this proposal.

5

24-7

A.48

Department of Energy
Washington, DC 20585

August 17, 1988

Mr. John F. Stolz, Director
Project Directorate I-4
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Dear Mr. Stolz:

In response to your letter of April 27, 1988, we have reviewed Draft Supplement 3 to the Programmatic Environmental Impact Statement (EIS) regarding cleanup actions necessitated by the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2. The draft supplement is based on a proposal by the licensee to delay cleanup of the reactor following defueling.

Based upon our review, we have no comments to submit to you on the content of the draft supplement.

Please provide us with a copy of the final document when published. We appreciate the opportunity to respond to the Draft Supplement.

Sincerely,

Ernest C. Baynard, III
Assistant Secretary
Environment, Safety and Health

25-1

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

September 7, 1988

TMIA's COMMENTS TO THE ADVISORY PANEL

I would like to begin by taking care of some old business, including a brief review of some events that have taken place this summer at TMI-2. I would also like to take the time to thank the NRC for responding to the rest of TMIA's questions on the staff's EIS on PDMS. However, I did not receive GPU's letter addressing the issue of funding as was indicated in the cover letter.

TMIA is resubmitting a request to GPU to reveal the full cost and source of their advertising campaign to promote PDMS. Let me remind the Panel that several months ago GPU thought $800,000 was a worthwhile gamble for rate payers to underwrite for the purchase of an evaporator. Moreover, it is estimated " ... it will cost $10 million in the first year and $5 million in the subsequent years to keep Unit 2 in monitored storage " (The Patriot News, September 2, 1988, B5.) With funding in doubt for a continued cleanup, the public has a right to know how much it is spending to convince itself that PDMS is the right course of (in)action.

Also, at the last meeting I formally asked Mr. Kitner if GPU would comply with an NRC order to continue an immediate cleanup, rather than place Unit-2 in PDMS. TMIA would appreciate a response.

Drawing from GPU and the NRC's actions and observations one gets the distinct impression that the plant has already been placed into post-defueling monitored storage. According to the Plant Status Report for the period of July 9 to August 6, 1988, the staff noted, "One plant area has been isolated and placed in an interim Post Defueling Monitored Storage (PDMS) status. Seven other plant areas are in the process of being verified to meeting the interim PDMS isolation criteria" (p.2).

This passage facilitates several logistical questions for the NRC and GPU. What are the "interim" PDMS criteria? What are the seven areas that may be placed into "isolation?" Please define "interim" and "isolation." On the surface, this seems like a replay of GPU's decision to purchase, design, fabricate, install and test an evaporator prior to the resolution of the accident-generated, water issue.

As the summer is drawing to a close I thought it would be appropriate to draw the Panel's attention to some highlights of the action (or inaction) at the Island.

June 9, during a routine inspection "six pages of word puzzles were found in the procedures book (operations procedural manual) at the defueling platform in the RB" (Inspection 50-320/88-10.)

July 20, Edwin H. Stier concluded his investigation on TMI-2 sleeping allegations. "Stier's further investigation into management response to the allegations revealed inadequacies in management response to the allegations that the shift supervisor slept or was otherwise inattentive to duties. These inadequacies lead to inaccurate or distorted information reported to higher levels of TMI-2 and other GPU Nuclear management and to the Nuclear Regulatory Commission, Stier said" (News Release, GPU Nuclear, July 20, 1988.)

July 26, 1988 - "A railcar carrying a loaded shipping cask and its unmanned yard engine drifted for approximately 60 yards on the site tracks. The engine and the railcar came to a final rest as a result of an increase in the natural grade of the rails" (August 1988, Status Report.)

August 31, 1988 - A Unit-2 operator was fired after a 11-day investigation, including a medical probe. "showed the licensed operator, who was not identified, had been drinking and taking drugs either before he reported to work or while he was at work" (The Patriot News, August 31, 1988, p.B3). Although the utility prohibits its workers from reporting to work under the influence of drugs and alcohol, " ... those who have tested positive are not always fired" (Patriot, August 31, 1988.) Refer to June 15, 1987, for a related incident.

Unfortunately there is more then a thread of continuity to these problems. On July 1, 1988, the NRC, GPU and the Commonwealth met to discuss "poor human performance ... such as complacency, with respect to the changing plant status leading to post-defueling monitored storage and/or the influence or poor procedures or work schedules..." (Inspection Report 50-320/88-10, p10.) At the meeting GPU "acknowledged the potential for apathy in light of the end of the cleanup project" (p.10) If their apathetic, sleeping, and having trouble following directions now, what can we expect in the next 20 to the 30 years when the plant is idle?

Let me now switch to decommissioning, economics and PDMS. At this point it is clear that PDMS is analogous with decommissioning. GPU recently stated in a press release on August 25, that they are " ... proposing to maintain Unit 2 in safe, monitored storage until it is decommissioned along with TMI-1 sometime in the next century."

Earlier this summer " ... the NRC issued on June 27, 1988, a final rule on decommissioning which became effective on July 27, 1988 (Michael Masnik, August 30, 1988.) This new NRC rule has a direct impact on post-defueling monitored storage, since PDMS is little more than a precursor to decommissioning at best, and a initial phase at worst.

Under the section on Decommissioning Alternatives, the NRC noted, ""Delaying completion of decommissioning to allow short lived nuclides to decay may be justified in some cases, however, any, extended delay would rarely be justifiable" (Federal Register/Vol. 53. No. 126/ Thursday June 30, 1988/ Rules and Regulations, p.24681.)

GPU is asking for at least a 30 year delay to allow worker exposure rates to diminish. At the last meeting we witnessed an appreciable difference between the radioactive levels projected by the NRC and GPU. This is indeed a puzzle since GPU supplied the majority of the data for the staff's Environmental Impact Statement. It seems as if GPU's motto for this project is, "If at first you don't succeed, lower your standards."

Who's to say that GPU or the NRC will not revise their figures after 20 to 30 years, and ask the community to wait another 20, 30 or maybe 60 years before finishing the cleanup! An expedited cleanup will resolve the lingering questions related to radiation levels and locations, and allow GPU to make good on their promise to clean Unit-2 up. We agree with the NRC that " case, 20 to 30 years is not justified!

Under the section on Planning, the NRC noted, "Planning for decommissioning is a critical item for ensuring that the decommissioning activities can be accomplished in a safe and a timely manner" (p.24681.)

Yet for PDMS, the NRC does not stipulate any research or development be employed to ensures that the cleanup can precede at a later date. In fact, the NRC acknowledges "Development of detailed plans at the application stage is not possible because many factors (e.g., technology, regulatory requirements, economics) will change before the license period ends" (p.24681.) Thus PDMS allows GPU the luxury of cutting costs, laying off experienced workers and postponing cleanup, until a time in the distant future when, in their judgement, it will be "safe and timely" to resume the cleanup. To date, GPU and the NRC have failed to provide data the demonstrates that <u>any</u> research and development will take place during the layoff. It is clear that GPU and the NRC have adopted former NRC Chairman Hendrie's infamous policy, "Don't turn over new rocks."

Under the section on Residual Radioactivity Levels, "The cost estimate for decommissioning can be based on current criteria and guidance on regarding residual radioactivity levels for unrestricted use...the cost of decommissioning is relatively insensitive to the radioactivity level and use of cost data based on current criteria should provide a reasonable estimate...it is expected that the decommissioning fund available at the end of facility life will approximate closely the actual cost of decommissioning" (p.24681.)

Already there is a disparity between GPU's estimate for decommissioning and the NRC's generic projections. All one needs to do is consult GPU's latest shareholder report to be updated on the economics of decommissioning. GPU acknowledges that there is no money in the Unit-2 decommissioning fund, and the money put aside for TMI-1 may be inadequate. GPU's estimate for decommissioning costs is millions of dollars <u>above</u> the NRC's generic estimate. Once again, GPU fails to supply data on how they are planning to meet this shortfall. I would suggest that the publisher of that newsletter be invited to the next Advisory Panel meeting. Perhaps then we can get some information on funding packages for the continued cleanup and decommissioning of Three Mile Island.

TMIA believes that the Panel should recommend to the NRC that the cleanup of TMI-2 proceed immediately. GPU should be liable for costs and develop appropriate technologies. In addition, GPU should develop a funding plan based on equitability and realism to be reviewed by the Public Utility Commission, the Consumer Advocate, the Commonwealth of Pennsylvania and citizens.

I really don't know what else I can say that would truly affect you people. The last time I was here I spent a lot of time researching and talking to competent, well-versed people in the fields of economics and decommissioning. One panel member questioned my credentials; which is your privilege. Let me remind you that we're all citizens with rights and responsibilities. The federal, state and local governments provide public document rooms, libraries, research material, and if necessary, one can also utilize the Freedom of Information Act to obtain information. The data our organization presents at these meetings is documented. In addition, we have no financial stake in the matters before you.

Let me close by saying that I think the case against PDMS is clear and overwhelming. However, as I look around, I'm reminded of what George Orwell once said, "People can forsee the future only when it coincides with their own wishes, and the most grossly obvious facts can be ignored when they are unwelcome."

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August 5, 1988
4410-88-L-0117/0402P

US Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Dear Sirs:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Funding For Decommissioning of TMI-2
Following Post-Defueling Monitored Storage

This letter is in response to questions concerning funding for decommissioning TMI-2 raised by NRC Staff following the meeting of the NRC's Advisory Panel for the Decontamination of TMI-2 in Harrisburg, PA on July 14, 1988.

TMI-2 is a licensed reactor plant which must, by law, conform to Nuclear Regulatory regulations and orders. The NRC has published a Rule, "General Requirements for Decommissioning Nuclear Facilities," which requires licensees to submit by July 1990 a report containing plans for decommissioning all licensed reactor plants. This report must contain licensee's plans for funding decommissioning and certify that adequate funds will be available for decommissioning, such funds to be kept separate from other company assets and outside the company's administrative control. GPU Nuclear understands that the Rule applies to TMI-2 and would cover all activities involved in the decommissioning the plant starting from Post-Defueling Monitored Storage (PDMS) conditions. GPU Nuclear will, of course, abide by that Rule and provide the required plan and certification for TMI-2 by July 1990.

We believe that intent is fully responsive to the requirements of the Decommissioning Rule. It would be helpful if the NRC representatives would confirm the applicability of the Rule to TMI-2 during the next meeting of the Advisory Panel.

Sincerely,

/s/ E. E. Kintner

E. E. Kintner
Executive Vice President

emf

GPU Nuclear Corporation is a subsidiary of the General Public Utilities Corporation

TRANSCRIPTS OF PUBLIC MEETINGS OF THE TMI-2 ADVISORY PANEL AND AN NRC PERIODIC BRIEFING BY THE TMI-2 ADVISORY PANEL

NOTE: The transcripts included here are those portions of the meeting records that pertain to the subject of this supplement. Where discussions of other subjects occurred, they are indicated by inserting "[DISCUSSION]."

The original meeting transcripts are court recorder's transcripts and were not certified as correct. For this reason, editorial errors may be found in the portions of the transcripts duplicated in this appendix.

No. 3

Comments Received at the May 26, 1988, TMI-2 Advisory Panel Meeting

[DISCUSSION]

MR. MILLER: I would like to know, can you do a comparison for us between the contamination levels that will exist at the end of the defueling period with the levels you keep referring to that exist at the end of a useful life of an operating reactors? You're talking about a factor of 2, 10, 1000? 7.1.3

MS. HARTY: The activity levels? Is that--

MR. MILLER: Your comment--you kept referring to the fact that you would like to see the plant cleaned up to the point where it matched the levels of contamination present at the end of the useful life of an operating reactor.

DR. TRAVERS: Yeah, but--and, Ken, basically, we were talking in the context of dose rates in general areas.

MR. MILLER: Right, but I--

DR. TRAVERS: And you're asking in the context of--

MR. MILLER: Can you give us some sort of a comparison? Maybe they are already lower and you don't have to do anything--but I doubt that.

MS. HARTY: I think the levels that we're looking at for general areas where people move through would be on the order of 10 to 15 milliroentgen per hour, the exposure levels. In that, any operating facility or operating reactor at the end of its lifetime, there's going to be certain areas where the dose rates or exposure rates are a lot higher than that. So, it's very hard to answer your question unless we talk about exact areas.

DR. TRAVERS: But we can answer it in the context of I think what you're getting at, and that is, in the basement, in general areas, dose rates exist that are much higher than those--several hundred R per hour, for example, which are orders of magnitude higher than those that would exist normally in a general area, such as basement of a reactor building, in a reactor at the end of its useful life.
There are cubicles in certain areas even in reactors that don't have accidents that would have rather high levels of radioactive contamination. We recognize that, and our discussion is qualitative to a certain extent, but for general areas is quantitative

(3-1)

down to about 10 to, say, 20 millirem per hour.
In the auxiliary building, as Linda just pointed out, is about at those levels. The work that's been completed, it's been extensive since the accident, has resulted in a reduction of the dose rates in those areas to about what you would expect in a reactor that hasn't had an accident at about the end of its useful life.

MR. MILLER: So, the required additional clean up will be strictly concentrated on those areas that are still unreasonably high?

DR. TRAVERS: I should point out that when we talk about required additional cleanup, we wanted to try to match apples and apples. So, when we talk about the end of cleanup we wanted to try to take some criteria that would allow us, in the context of different alternatives, to get a handle on the differences in the environmental impacts that might result in achieving those limits. So, strictly speaking, there's no cleanup requirement on the books. What we've done in trying to scope out environmental impact is try to get a handle on the environmental impacts that would result from the additional work. For example, in the reactor building basement. To bring those levels down. Similar to what has already been done in the auxiliary fuel handling building.
For example, worker dose has been accrued in the conduct of those operations. Worker dose would necessarily be accrued in bringing the dose rates down in the reactor building basement. Those are the kinds of things that we attempted to quantify with somewhat of a broad range, admittedly.

CHAIRMAN MORRIS: Tom.

7.3.3.1 MR. GERUSKY: You made a comparison between a 4 year cleanup and a 24-year delayed cleanup with a total exposure comparison for 4 years and 24 years.
Would there be any environmental impact or any exposure to the public following the immediate 4 year cleanup and after the 24-year cleanup that has not been taken into consideration in comparing the two?

DR. TRAVERS: If I understand your question, the answer is yes. And, again, for the purposes of scoping out our document, we cut it off at we've defined the end of the cleanup.
For example, if the plant were cleaned up immediately, I can envision--it's still sitting there. It still exists. There's still some residual contamination and some level of environmental impact that could be projected for some period of time prior to its decommissioning.

(3-2)

So, the answer to your question is yes. And we did it deliberately, again, so that we could, in a relative sense, compare different strategies for completing the cleanup. We cut it off.

MR. GERUSKY: But you don't think that the public and we ought to have a feel for what those doses are, what are those environmental impacts are, for the same periods of time until decommissioning, assume you go to decommissioning?

DR. TRAVERS: If you're addressing cleanup, the completion of the cleanup, and that's what we're addressing, those doses aren't the factor. They would certainly be much lower and well within the kinds of numbers that we're kicking around in this document today.

Again, the purpose of an environmental impact statement, in this case, is to compare different strategies for completing the cleanup, completing those activities--

MR. GERUSKY: You're comparing 24 years versus 4 years, and shouldn't you compare 24 to 24? That's what I'm asking. If you're going to an endpoint, shouldn't the endpoint be the same for the exposures for both options?

MS. HARTY: The endpoint would be completion of cleanup after it's completed, whether it's decommissioned or whatever. There would be a separate action that would be taken then and a separate document would be produced at that time. That's generally what happens, as I understand it, after a reactor finishes its lifetime if they're going to decommission it.

DR. TRAVERS: Yeah, but I think--

MS. HARTY: No--oh. We have--We did look for just basis of comparisons, what type of effect would occur during the 20 years after immediate cleanup.

I can show that to you if you'd like.

MR. GERUSKY: Is that in the document?

MS. HARTY: No, it's not in the document because the document dealt only with the period of time for total completion of--

DR. TRAVERS: We cut it off, but as an aside we attempted to evaluate those kinds of impacts.

MS. HARTY: Here's--the numbers. Here, this is for a 20-year period of releases after immediate cleanup.

[DISCUSSION]

(3-3)

MS. HARTY: You can see we have listed--it's a 50-year dose commitments from this 20-year period of releases after immediate cleanup, and we looked at it for the same three population groups we looked at last time. These numbers are smaller than they were for the 20-year period.

Delayed cleanup, as you would expect, because we expected that a lot of that activity in the basement would be cleaned up, contamination in the stairwell, and also the reactor coolant system, but those are the numbers there.

For the record, it's maximally exposed individual the critical organ would be bone, and that's 2 millirem. For the total body it would be 0.2 millirem.

For the total population within a 50-mile radius, the dose to the entire population would be 1.3 person-rem to the volume and 0.7 person-rem to the total body.

For the total population outside the 50-mile radius, we looked at that dose, too. The critical organ, the bone dose, would be 0.06 person-rem and the total body would be less than 0.02 person-rem.

MR. GERUSKY: And that's for 20 years?

MS. HARTY: That's for a 20-year period, but the problem comes in though, after immediate cleanup we don't know that the reactor would sit there for 20 years. That has not been decided. It hasn't even been decided whether to do immediate cleanup or delayed cleanup.

[DISCUSSION]

MR. GERUSKY: Can you provide that document to us?

DR. TRAVERS: Yes.

[DISCUSSION]

CHAIRMAN MORRIS: I'd like to ask one, and I can almost guess the answer but I'd like to ask anyway.

7.6.1 Was there any attempt done to analyze, or is it part of the study, to analyze the ability of the licensee to finance this cleanup? Whether they could financially afford to do it immediately or whether, in fact, in 20 years from now whether they'll be able to finance or be afford to do it at the time?

DR. TRAVERS: That was not part of this evaluation. In the context of the ongoing cleanup, it's an ongoing evaluation that is being done by the NRC staff. We are continuing to monitor the licensee's financial health and ability to carry out, to continue to carry out, the cleanup effort, but as far as your question

relates to long range, we have not carried out that kind of evaluation.
We specifically haven't done it in this document.

CHAIRMAN MORRIS: Okay, but if it's not in this document, I would assume that the NRC would--it would be a consideration or a concern of NRC, separate from the PEIS, that the licensee would be able to afford in 20 years to do the kind of work that needs to be done. Also, whether or not they would have monies available now to do it, or else these questions are kind of moot if there is a present financial problem that the money isn't available or a future financial problem.
So, it may be separate but I think it's a consideration.

DR. TRAVERS: Absolutely.

CHAIRMAN MORRIS: Whether you can determine those factors, I don't know, but it's something that I at least thought of as I went through this.

DR. TRAVERS: There's a parallel in the pending Commission regulations on decommissioning. You're right. That's clearly an issue, that you'd want to have a warm feeling about, that you were looking at a very long period of time.

CHAIRMAN MORRIS: Yes, because you're talking about an average cost for an immediate 1988 dollar average cost for immediate cleanup of about $205 million and an average cost, if you average them, of $260 million in 1988 dollars.
So, financially, there's a fairly significant difference there, of some $55 million or so, or whatever that relates to percentage-wise--27 to 30 percent difference.

[DISCUSSION]

MR. ROTH: Just a follow up on that. Is there any provision that the NRC can make to guarantee that the funds be available at that time? 7.6.4

DR. TRAVERS: There's no provisions in the regulation that I'm aware of that speak to it. I could be corrected, but I'm not an expert in that area.

[DISCUSSION]

DR. TRAVERS: This evaluation really did focus and what we're most prepared to you tonight is the technical evaluation that was done in looking at different alternatives for completing the cleanup.

MR. ROTH: No, I understand that, but I think this is as good a time as any to put on the record the amount of problems that occurred prior to getting all the funding just to do the cleanup and how that was a major battle on certain stages.

Now, we're saying--not we're saying, you're saying that 20 years hence we're going to--we believe the utility will have the funds necessary to do that, and there's no regulation or any way to make sure that does happen if, indeed, you know, there is not a provision for it.

It seems to be almost to the point--I'm not saying it is the point, almost to the point--that the utility could walk away to a certain extent, through a reduction of work force and all these other things, and 20 years hence the time comes and the utility says: well, because of certain problems, financially we can't really do it.

DR. TRAVERS: And that's not really a very viable scenario in my view. This company holds, will continue to hold, a license for this facility until it decommissions it. That's a requirement.

The Commission continues to monitor the financial health of the utilities that possess Part 50 Nuclear Power Reactor Licenses.

This utility also operates several other plants.

[DISCUSSION]

MR. ROTH: Okay. I think the point is, is that the utility did not have sufficient funds to do the cleanup by themselves.

So, we're talking still many millions of dollars, and I think the Commission in the past has always said, well, we really don't have control or we monitor, we look, but we really don't have--and I think that's a real loophole, particularly in this situation where you're looking 20 years down the road and saying, yeah, they'll be able to do it, but we really don't have any provisions to make sure, other than, you know, licensing.

That's just a point. I think--

DR. TRAVERS: Yeah, and that's a valid concern. One of the things, or one of the areas, where the Commission has addressed this concern, is in its decommission rule which has been proposed and is about to be issued in final.

That rule would require financial assurity to provide for ultimate decommissioning nuclear facilities.

That rule will apply to TMI-2 and all of the nuclear plants operated by GPU, as well as other utilities across the country.

So, it is an issue, and it's one that's been relatively recently addressed more fully than it had in the past.

CHAIRMAN MORRIS: But if you--just to pursue it a little further, and to say that $260 million in 1988 dollars is probably going to be three times more than that 20 years from now, or something like

$700 million. Probably. It's probably going to get close to tripling that number.
We know that a billion dollars for the cleanup was a big amount of money to even to try to assemble, and I'm just following up again on what Joel has indicated here.
I guess I would if the delayed cleanup plan ultimately is accepted, I would think what would go with that, I would hope, would be some kind of a review by the NRC that would require some assurances that money will be set aside over a period, over the next 20 years, to have adequate funds available to do the cleanup, because they're big dollars.
It's a concern that I express, at least at this time.

DR. TRAVERS: Yeah, that may be the kind of thing you may wish to express to the Commission when it considers--or when you report to it on a regular basis.

MR. GERUSKY: Do you have an estimate of cost of decommissioning TMI-1? 7.10.2

DR. TRAVERS: There is a generic environmental impact statement on decommissioning, I think. Is it $200 million--does anybody--I can't recall what it comes to.

MR. GERUSKY: And that's in today's dollar?

DR. TRAVERS: Yeah.

MR. GERUSKY: So, we're talking, say, ballpark--

DR. TRAVERS: I'm throwing that number out, sir.

MR. GERUSKY: Yes, but it's still ballpark figures to decommissioning Unit 1--

DR. TRAVERS: Yes, there was a reference study done. I forget.

MR. MILLER: Are the funds currently available to do an immediate cleanup? 7.6.1

DR. TRAVERS: Yes, we believe they are, in the context of our monitoring of the financial health of the utility.

MR. GERUSKY: Is that out of the cleanup fund or out of additional funds that the utility would have to spend on its own. I mean--

DR. TRAVERS: They can tell you best, but I'm speaking from both the fund, the originally estimated $965-odd million and the financial health overall of the company, as monitored by NRC staff.

[DISCUSSION]

CHAIRMAN MORRIS: I'd just like to make, I guess, a couple of quick observations and they're not so much questions although maybe you can tell if I'm wrong, but when you look at the PDMS and the advantages and disadvantages of either way, it seems a major point for delaying it, as I can see.

If it is a major point, and I'm not sure it is because it doesn't seem to have been emphasized, but there's less exposure to the worker and a chance that technology will permit a greater ability to clean up in the future. They seem to be the two main advantages.

The disadvantage to waiting, therefore the advantage to doing it now, is that it is less costly to do it now than it would be if it was waited. At least that's what the ranges indicate, that it would be less costly by, again on average, by a total of $55 million in today's dollars to do it now.

As I read this and looked at it, I try in my own mind to try to figure out why would you wait or why would you not wait, and it just seems like--I realize your conclusions were there doesn't seem to be a clear reason why one is better than another.

DR. TRAVERS: Yeah. You're right, and we did note quantitatively differences like occupational exposure. When all is said and done, our estimate or the difference between what it really would take--you remember we give a range--it might be larger or might be smaller than what we estimated, but based on our best ability to estimate, with a fair number of uncertainties I might add, what those numbers would be, we couldn't come to a firm conclusion that any of the different, differing, levels of impact really drove the selection of either of those two primary alternatives.

CHAIRMAN MORRIS: And that's the very reason why I stopped looking for a way to break that decision, and that's why money again, realizing you didn't look into the future ability of the company--that's why that starts becoming in my mind, as one person, more of a factor and a concern, without hearing some of the comments that might come up following questions by the public.

That's just an observation that I offer.

[DISCUSSION]

FRANCES SKOLNICK, SUSQUEHANNA VALLEY ALLIANCE:

[DISCUSSION]

Actually, when I was sitting back there and looking over here, I was struck by the, like, dark, trying to hang it over everybody's head. It just seemed as if everybody felt like a deep feeling of

(3-8)

hopelessness and that everything was decided anyway, but anyway we will speak on regardless.

I speak for the Susquehanna Valley Alliance whose membership resides mostly in Lancaster County and whose mental and physical health stands to be impacted upon by any decisions made about Three Mile Island. Following is a list, a summary, of our comments on the EIS Supplement No. 3.

I am submitting a list of questions which I would ask to have answered in a timely manner so that I can review the answers prior to submitting comments to the NRC.

Hot on the heels of the NRC's refusal to permit the storage of the Accident Generated Water at Unit 2 until a more suitable method of disposal was found whereby the radioactivity would be retained inside instead of dispersed into the environment comes their consent to permit the placing of Unit 2 into a storage mode prior to the completion of cleanup, so that more suitable methods can be found to finish the cleanup.

PDMS is only a fancy name to conceal the fact that TMI will, after all, become a site for the storage of radioactive waste. Indeed, PDMS closely resembles the no-action alternative since there are no assurances that Unit 2 will ever be cleaned up.

The NRC speaks of a 20-year storage period but provides no rationale for choosing this number. This licensee refuses to commit itself. 7.3.14

Obviously, delayed cleanup solves two problems for the licensee. One: they do not have to proceed with an area of cleanup which would preclude the re-start of Unit 2, and secondly, they won't have to worry about the messy and inconvenient problem of what to do with the waste.

NRC tells us that immediate cleanup would require additional emergency allocations. That's in EIS, Page 2.33. 7.5.3

Not so long ago, we heard of NRC's commitment to prevent TMI from becoming a site for the storage of waste. This EIS clears the way exactly for that. This waste, mind you, will be in out-of-the-way places, not immediately available for monitoring.

We are shocked that it will take at least 4 more years and, who knows, it could be more to clean up Unit 2. It seems like only yesterday that we were being accused of holding up cleanup because we had asked for hearings concerning the disposal of the radioactive water by evaporation.

I ask why generate more water when we have already accumulated the major medium for decontamination? 7.5.9

One of our major concerns with leaving Unit 2 so contaminated for so many years is based on uncertainties about the amount of radioactivity in buildings, pipes, and other components. 7.2.2

We are informed in the EIS that the number and quantity of the majority of radionuclides are estimated from the amount present at the time of the accident.

The amount present at the time of the accident is based on a computer code ORIGEN 2. A computer code is only as accurate as

(3-9)

the data that a person puts in. So, there must be allowance for errors.
Studies have been undertaken to follow the paths of the radionuclides as they were released from the damaged core. This is an ongoing project and, as one reads through any research reports on the accident, one soon is very aware of the uncertainties which exist as to how and to where the radionuclides were dispersed.
The NRC itself recognizes this developmental aspect of the cleanup. They state in the EIS, and I quote:
"Although predictions have been made regarding the transport and deposition of materials released as vapors and/or aerosols during core heat up, refined modeling methods are not available for accurately analyzing the transport and deposition of the fragmentation debris or the leaching of soluble materials from the damaged core."
That's on Page 2.22.
They also state that plans to decontaminate the reactor building, following PDMS, are tentative because the licensee has, and I quote from the EIS, Page 3.10:
"Incomplete information, although currently being obtained, on the amount and location of contamination."
Table 2.4 in the EIS, which shows an estimate of the maximum amount of radionuclides left and their location comes as a complete surprise in light of these two statements.
7.2.1 We want to know upon what information this table might be based.
Furthermore, we want to have a complete accounting of the radionuclides present in the core at the time of the accident.
Looking at just two of the radionuclides, tritium, which the NRC failed to mention was an important activation product, and krypton-85, it is impossible to account for all of both of these radionuclides.
There were over 8,800 curies of tritium and over 97,000 curies of krypton in the reactor at the time of the accident. How does the NRC end up with less than 1 curie of both tritium and krypton-85?
And we want answers, not only to those radionuclides, but to all the radionuclides that are in that reactor before we can really make the decision as to how radioactive that reactor is.
The approval of TMI to become a site for the storage of radioactive waste raises questions about regulatory procedures and, furthermore, the acceptability of this plan to the State of Pennsylvania.
If cleanup were to continue presently, then the waste would go to out of the state sites. If it is delayed, it will largely remain within the state.
I'd like to know from the state tonight, how does the state react to that? Would the state site be able to accommodate this amount of waste? Would it also be expected to accommodate the waste if Unit 2 were to be decommissioned?
7.5.4 I ask how can the NRC dismiss the question of the impact of the waste disposal by saying that it would be the subject of an
(3-10)

analysis elsewhere? The disposal of waste at TMI is a major issue to be dealt with at this time and it is in keeping with the requirements of the National Environmental Policy Act.
Obviously, the people of Pennsylvania will be impacted upon, not only by the possible transportation accidents when taking the waste to a site, but also by the possibility that the site will be located in somebody's back yard in Pennsylvania.
How will the NRC deal with the fact that Unit 2 is in the 7.8.1
100-year flood plain? Will it have to maneuver the regulations in some way that TMI will be exempt from the requirements? Will 7.8.2
TMI be able to satisfy the groundwater intrusion criteria?
All these questions have to be answered.
The health impact section, so neatly resembles all other such sections of supplements to the Environmental Impact Statements.
I wish to call the attention of the NRC to some revisions of the 7.9.2
dosimetry of the survivors of the Japanese atomic bombs which, together with the now increased follow-up time for epidemiological studies, are being taken into account by the United Nations' Scientific Committee on the Effects of Atomic Radiation in producing risk estimates for ionizing radiation exposure.
This report will be used by ICRP in reviewing its recommendations on the system of dose limitations. A preliminary reassessment of the Hiroshima and Nagasaki survivors has raised the fatal cancer risk for the exposed populations by a total factor of the order of 2.
The risk estimates could be substantially greater, depending on the form of risk model used and the shape of the dose response curve, when extrapolating to low doses from observations at high doses.
The most important aspect of the finding to us, is that the standards must continue to be changed so that the public is protected against unnecessary exposure to low level radiation.
One final point, which I am addressing to you, Mayor Morris.
On reviewing some of the City of Lancaster agreement papers, I just wanted to make sure that $10,000, or $100,000, whatever it was, will be forthcoming from the licensee during the entire period that TMI sits uncleaned and still radioactive.
Because, since we draw our water supply from the Susquehanna River, we want to make sure that the city has the resources to continue to sample the water and to check for the addition of the chemical solutions which will probably be used in decontamination somewhere down the line, and we'd like to know what steps the city will take to monitor this, so that our drinking water will be provided some sort of protection.
That concludes my comments on the EIS.

[DISCUSSION]

CHAIRMAN MORRIS: Regarding the questions that you ask this evening, you asked whether, I guess, Tom Gerusky is in a position to answer certain questions this evening.
You also raised several questions that seem to be directed at the NRC, and my assumption is that on most of these questions that the NRC will review the transcript and try to answer whatever questions they feel they appropriately can. I guess within whatever reasonable time period can be expected.
I offer that as a suggestion. If anybody has a problem with it, please speak to it.
Tom, regarding the question that was asked to you directly, are you in a position to speak to it or do you prefer to wait?

MR. GERUSKY: The answer is yes.

MS. SKOLNICK: Yes, you will answer the questions?

MR. GERUSKY: No. Yes. You asked if Pennsylvania was prepared to handle the waste from TMI, yes. In either case.

MS. SKOLNICK: I guess I want to know, too, how do you feel--

MR. GERUSKY: We don't know where the site's going to be yet. All right?

MS. SKOLNICK: Okay. How do you feel about Three Mile Island staying for an unspecified period of time?

MR. GERUSKY: I haven't made up my mind yet.

MS. SKOLNICK: Have you any idea when--

MR. GERUSKY: No.

MS. SKOLNICK: --you will make up your mind?

MR. GERUSKY: No.

MS. SKOLNICK: Will that be a public statement? Will be aware of that?

MR. GERUSKY: The Commonwealth will comment on the document.

[DISCUSSION]

7.3.1.16 MS. SKOLNICK: I suppose then another question which I would have to ask is if cleanup is delayed and resumed in whatever period of time, whenever, and they need--I think it's over a million gallons for cleanup--would that water be accident generated water?

[DISCUSSION]

LINDA MUNSON, CONSULTANT AND PRESIDENT, EVERGREEN TECHNOLOGIES: Well, there's a legal definition that would have, has to do with the amount of tritium, and I would not expect that water would have enough tritium to be classified as accident generated water unless it has tritium in it when it's used to start with.

MS. SKOLNICK: I'm not sure if it's just tritium, though. Aren't there other criteria?

[DISCUSSION]

CHAIRMAN MORRIS: Let me just go back to the question, because one of the panel members said there be confusion to it, and I just want to make sure that the record indicates it clearly.
As I understood Frances to ask, was that during the additional cleanup there will be about a million gallons of water generated, and the question was will that million gallons of water be considered accident generated water.
You were not trying to say that this is the same water as the 1.-some million gallons now in the tanks. You were saying?

MS. SKOLNICK: No. It's not "the" accident generated water--and after cleanup?

CHAIRMAN MORRIS: Yes. Okay. It's "a" accident generated water. Okay. That's what I understood you meant, and I just wanted to make it clear on the record. Thank you.

ERIC EPSTEIN, TMIA: THREE MILE ISLAND ALERT, INC., HARRISBURG, PENNSYLVANIA: Okay. For the record, my name is Eric Epstein.

[DISCUSSION]

Also, I would disagree with Bill Travers' assessment that decommissioning would generally cost $200 million. I would like to introduce documents at the next meeting that would dispute that.
In addition, William Kuhns at the shareholders' meeting indicated that they plan to decommission and decontaminate it, both Unit 1 and Unit 2 at the same time, somewhere around the years 2010 and 2020. So, for the next meeting, I would like to supply those documents and just let you know that Chairman Kuhns did address that issue.
Now, to the information at hand.
In reviewing the staff's comments, I was struck by several familiar and disturbing themes.
First of all, there is a heavy reliance on data supplied by GPU. 7.1.5
This lack of independence, coupled with the staff's propensity to

rely on outdated data, casts a shadow on the veracity of this document.

7.6.5 Secondly, the PEIS relies heavily on assumptions and conjecture relating to such items as the state of robotics and cleanup technology, radiation locations, radiation levels, and GPU's commitment and ability--economic health, which we discussed already--to clean the plant up.

Thus, the PEIS is too abstract and theoretical and allows GPU the flexibility of finishing the cleanup when and how it sees fit. This is clearly a textbook lesson on how not to regulate.

Let me remind you that GPU has a knack of making rosy projections that have failed to materialize. For instance, we were originally told that, and I quote:

"Decontamination of the containment building will take until late 1982. Then we'll need the balance of '82 and '83 for fuel removal."--end of quote.

Well, it is now 1988 and fuel is still being recovered and removed. The original projected cost of $400 million is approaching $1 billion, roughly what it cost to build both Unit 1 and Unit 2. Yet, the same people who are so proud of their pioneering accomplishments are content to mothball the plant indefinitely.

Actually, if you look at some of the recent events at Unit 2, it would seem as though the plant is already mothballed.

On January 19th, GPU notified the NRC, and I quote:

"that the training qualifications of senior health physics technician had lapsed several months in the past ..."--and they had just discovered it.

As you know, on February 22nd and 27th of this year, fires occurred in the decontamination facility of the reactor building, and in both instances assigned fire extinguishers failed to operate.

Finally, just in April, April 1st of all days, April Fool's Day, 1988, NRC inspectors toured the reactor building and determined that, and I quote again:

"housekeeping on all elevations had deteriorated in that paper towels, cardboard tags, plastic bags, and other transient combustible materials were scattered in work areas and low usage areas."

So, I think there is a problem with attention to detail and in adhering to procedures, already.

Throughout the PEIS, the NRC clearly accepted GPU's proposition that post-defueling monitored storage is somehow separate and distinct from the cleanup. I think this is absurd. The cleanup of Three Mile Island should not come to a screeching halt because GPU and the NRC have established an arbitrary endpoint.

7.3.1.2 Ironically, some of the same arguments the staff used against radioactive water storage were employed to endorse a postponement of the cleanup.

For instance, the staff argued that postponement will significantly reduce radiation levels and allow time for the development of innovative technologies to deal with some of the problems created by the accident.

In contrast, TMI-Alert and other concerned citizens have consistently called for an expedited and safe cleanup which will hopefully include a resolution to the water problem that will not result in direct, radioactive releases to the public and the environment.

GPU has the means, both economical and technological, as well as the experienced work force at its disposal to continue the cleanup. Moreover, the staff did not have a clear preference in resolving this issue and state that, I quote:

"TMI-2 should not be allowed to become a waste disposal site."

Well, if the NRC doesn't have a clear preference, the public does have a clear preference, and that is to clean the plant up now.

I think, and I hope you do convey that message to the Commission the next time you meet with them in June.

In addition to that, I would hope that you--and this is just an aside--convey the message to them that we thought, and I should have mentioned this earlier, that it's inappropriate, we felt, to purchase an evaporator prior to the resolution of the hearing.

We didn't get into a big deal about that resolution, but I hope that someone in some capacity would mention that--that we have a problem with that.

In addition, that I--everyone that will speak tonight, I think, will be opposed to making Three Mile Island Unit-2 a low level waste site.

We think cleanup means finishing the job you started, regardless if it takes 4 or 400 years. Radiation doesn't take vacations, and neither GPU or the NRC. We cannot allow these people to walk away from their commitment.

Let me conclude by saying that there are several problems intricately intertwined with the timing of the cleanup. To postpone the cleanup is to postpone the inevitable decontamination and decommissioning of Unit 2.

It is high time for GPU, the NRC, the DOE, and the industry to 7.10.7
admit that they do not know how to decommission and decontaminate a nuclear power plant.

Due to their collective ineptitude and overzealousness, there is a crippled but dangerous plant in the middle of the Susquehanna River that needs to be retired.

But there's a catch: GPU doesn't want to clean it up just yet.

The NRC is content to leave the plant in limbo-land, and nobody knows just how to decontaminate and decommission it.

So, I think we're in a hell of a quandary, and I would urge you to convey the message to the Commission that the plant should be cleaned up as soon as possible.

I have 19 questions, and I don't know much time I have left, and I don't want to read through all 19 of them, but what I'd like to do, if that's all right, Mayor Morris, is select a few questions and read them into the record, if that's okay with you.

[DISCUSSION]

MR. EPSTEIN: 2.1, the staff noted that, and I quote, "The primary
7.3.1.7 difference between an undamaged reactor at the end of its useful life and the licensee's PDMS proposal is that during PDMS relatively high levels of contamination would remain in the reactor building basement and a small amount of residual fuel would remain in the reactor coolant system storage."

What factual data are these conclusions derived from?

How many undamaged reactors at the "end of their useful lives" have the NRC dealt with? Were technical experts from these plants consulted? If so, is their input a matter of public record? What other differences exist between these plants and GPU's PDMS plan? Was embrittlement a factor at these plants? What was the staffing level at these plants?

7.2.4 The second question, the staff argued that, and I quote: "The reactor containment building is uniquely designed and constructed to maintain its structural integrity with almost no leakage during a wide variety of accidents."

I would like to ask how long after an accident was the reactor containment building designed to maintain its integrity? Was it specifically designed to house radioactive waste materials for an indefinite period of time? If not, would not storage of such waste necessitate a license amendment?

7.2.11 The third question this evening, and I quote: "Sectioning and disposal of the reactor internals and reactor vessel are not considered part of the cleanup because radiation levels expected for these components would be no higher than in a normal reactor nearing the end of its life."

What are sectioning and positioning of the reactor internals part of? What if radiation levels are incorrect? What exactly are the radiation levels of a normal reactor at the end of its life? What constitutes a normal reactor?

I mean, there are constant references to a normal reactor at the end of its life. I don't think these people have dealt with one at the end of its life.

I know Humbolt Bay is in limbo-land. I don't know that they've decommissioned or decontaminated a plant.

I mean, to make reference like this, I think--it's troublesome to me.

Just a few more questions, if you'll indulge me.

7.2.1 One of them deals with one of the requests Frances made, and we would appreciate it GPU or the NRC could furnish a complete inventory of where all the radioactive materials have gone since the accident.

7.3.1.11 Another question is, and I think this is a word-speak problem, I didn't understand. In the document, is ventilating the reactor building before each entry the same as purging it? I was unclear if that was the same.

How will the liquid releases to the Susquehanna River following PDMS differ in composition to the 2.3 million gallons of radioactive waste currently stored at TMI? 7.3.1.17

Also, just as a question, and I think I know the answer, is the public entitled to intervene if the indefinite storage option is implemented? 7.1.1

The final question and I think I know the answer to this, also. If the cost of the cleanup is figured in 1988 dollars, then estimates for delayed cleanup are imprecise and inaccurate--and I think you addressed that. 7.6.2

What I was curious is if the NRC factored into the economic costs the costs for retraining and rehiring workers that have been gone for some 20 years. I mean, it's an intangible and I don't know how you factor that kind of experience. 7.6.3

Also, just in the last year, has shown us, Public Services of New Hampshire has declared bankruptcy--the first public utility to do so since the Depression.

So, it's not unreasonable to expect that other utilities will do so at the end of the century when their plants have to be decommissioned.

I have many other questions. I won't bore you or run away with other people's times. The request I would make, I notice the last time when we had a PEIS and the NRC addressed the questions, they decided to rephrase the questions to their liking and bunch a few questions together and then give a generic response.

I--I mean, you know, give me break. If they can, and I know it's indulging Bill, if they could specifically answer some of these questions, I would be appreciative, and I think Frances made a similar request.

[DISCUSSION]

VERA STUCHINSKI, CHAIRPERSON, TMIA: THREE MILE ISLAND ALERT, INC., HARRISBURG, PENNSYLVANIA: Yes. My name is Vera Stuchinski. As chairperson of TMIA, I'd like to supplement Eric Epstein's presentation with some additional comments.

The thing that really concerned me in reading the EIS was that the plan endorsed by the staff seems to lack any firm regulatory requirements. 7.7

The summary states that the duration of the storage period during delayed cleanup was not specified by the licensee so the staff assumed a storage period of 20 years. 7.3.1.4

If the staff feels that the storage period of 20 years is appropriate, I would be interested in some regulatory language that would specify that the storage period would not exceed 20 years. I'm confused about the regulatory guidelines. Perhaps that's not the intent of the EIS, but it seems to lack any teeth. What's to stop GPU from making their own rules? The EIS is just filled with references to the staff's approval of procedures based on assumptions.

Two quick examples:

On page 3.10. "By the end PDMS it is expected that the licensee will have made a decision on the future disposition of the plant and the final cleanup will be performed."

On page 3.23. "Although the licensee has not made any detailed plans for the cleanup following PDMS, it is assumed that during the cleanup the contaminated liquids would be processed through the SDS and could be stored before being processed through the Epicore 2 system."

The assumptions are just made repeatedly through the EIS. It's very disturbing.

7.3.1.2 In addition, there is a glaring inconsistency, which other individuals have pointed out, with the staff's previous position on monitored storage of wastes.

The staff justified this proposal for PDMS by stating that there would be less occupational dose contamination due to radioactive decay during the storage period. Four pages after this reference, the staff stated that after the completion of cleanup the radiation levels in the TMI-2 reactor would be primarily due to cesium-137.

Now, reading this carefully, cesium-137 has a half-life of 30 years. So, it would take 30 years for just half the total quantity of the cesium-137 to decay. Approximately 300 years for the radioactive material to decay to insignificant levels, according to the formula that's used.

Twenty years is obviously not enough to make a significant difference. It's a ridiculous point to state that the radioactive material would decay away to less harmless levels or more harmless levels.

I also want to remind the panel that when members of the public asked the NRC to maintain the 2.3 million gallons of radioactive waste water in monitored storage on the island, rather than evaporate it, the staff vetoed the plan.

On page 7.4 of the final EIS dealing with disposal of the water, the staff explained that in the absence of overriding benefits associated with storage waste onsite, the staff believes that waste should be disposed of as expeditiously as possible.

Now, in this case, the staff concluded that there is no significant benefit from continued onsite storage of the water.

It was noted that the tritiated water would remain radioactive for such a long time that indefinite storage would have a negligible effect on the amount of radioactivity.

Now, the contaminated water contains tritium which has a half-life of 12.3 years. That's less than half that of cesium-137 which was determined to be the main contaminant.

Let's see. It was also noted in the introduction to the EIS that there are anticipated advances in decontamination technology expected to occur within the next 20 years.

Now, this very argument was rejected by the staff when people asked that tritiated water be held onsite--I'm sure all of you remember. We've gone over this so many times--until a better method of disposition was available rather than dispersing into the atmosphere.

This is so blatant--the language in the--it's such a turnabout.

Finally, the NRC staff insisted throughout the public meetings on GPU's evaporation proposal that interim monitored storage of the water onsite would make TMI a low-level waste site.

I know Mr. Gerusky spoke to that, that the island is not licensed for a low-level waste site. Even though we were not suggesting that it become a waste site, a permanent waste site.

Now, I'd like to ask Dr. Travers why the staff does not consider PDMS in the same manner as storage of the tritiated water. If a low-level waste site license would be required for storage of the water, why isn't it required for PDMS?

I'd also like to ask Mr. Gerusky if he could respond to that.

Just to sum up, I found the EIS to be a shockingly inadequate document, and I think it's clear that the NRC staff has chosen to take no responsibilities to recommend any stringent regulatory guidelines for the cleanup.

If I could ask for a response in regards to the low-level waste site quandary.

MR. GERUSKY: There's no requirement that GPU have a license. A low-level waste disposal site in Pennsylvania is a requirement of Pennsylvania law. The utility is covered by federal law.

It would not be a low-level waste site. It would be a storage facility, in either case: if the water stayed on the island or the radioactive material inside the plant.

MS. STUCHINSKI: Unfortunately, I don't have my EIS on the--the final EIS on the water, but I do know that was debated in some of the public meetings.

The intent seemed to be, you know, or was said to the public was: That's nonsense. It can't be held there because it would create the situation of a low-level waste site.

MR. GERUSKY: It isn't--it wouldn't be a low-level waste site in either case.

[DISCUSSION]

DR. TRAVERS: Vera, if I may, take a shot at it. I think--just to drop back on what we did on the water supplement, and then this supplement--is that we concluded in both that just about all of

(3-19)

the alternatives we looked at would not result in a significant environmental impact.
In the case of storage of TMI-2 for some period of time, 20 years or 10 years, whatever, the operation or the condition of the facility during that period would be covered by a license from the Nuclear Regulatory Commission with very specific stipulations--tech specs--that would act to assure things like the assumptions about the status of the facility and the migration of the radionuclides within it were continuing to be maintained.
So, while you wouldn't need a disposal facility determination or license, it would be covered under our Part 50 Power Reactor license and very specific requirements would have to be met by GPU for some period of time.
Let's see, if I can remember what your other question was.
I do want to reiterate that in the course of our Supplement No. 2 on Accident Generated Water, we found that if you store accident generated water onsite that would not result in significant environmental impact. It just wouldn't. Water is so very--what's the word--the water contains such very low levels of radioactive contamination that whether you evaporate it or put it in the river or keep it on TMI-2 for some period of time, it just isn't a significant environmental impact.
What we tried to say in our water EIS is that because of the fact that there are such very small levels of radioactive material to begin with in that water, that you wouldn't accrue any significant benefit by waiting indefinitely--whether it's 20 years, or 30 years, or 40 years--before you do something with it. Because you are ultimately going to have to do something with it.
So, that's sort of the differentiation that we tried to make, even if we didn't explain it.

MS. STUCHINSKY: What about advanced technology that would allow a better method rather than evaporation?

DR. TRAVERS: We just don't see any reasonable promise of such technology, given the chemical make up of tritium is identical to that water.
Again, the consensus of our review, is that to begin with there's just such a small amount in there--believe it or not--that it just doesn't make a whole heck of a lot of difference just what you do with it.

MS. STUCHINSKI: Do you really feel that there would be significant decay of the radioactive material within 20 years of any long-lived radionuclides in the reactor?

DR. TRAVERS: The significance of decay has inherently built into it the level at which you start at.

(3-20)

For example, in the reactor building based on Three Mile Island, if you start out with a thousand R or a thousand curies of cesium, over 20 years you're going to get a significant reduction in the potential exposure to workers who must remove it.
On the other hand, if you start with accident generated water that has very small levels of radioactive material to begin with and project out 20 or 30 years, or 50 years, the delta, or the savings, environmental impact-wise, that you accrue from waiting that period of time is not significant.
So, you have to look at the starting point and the incremental savings of environmental impact that is accrued and not just the physical or radiological half-life, rather, of the material.

[DISCUSSION]

KAY PICKERING, OFFICE OF COORDINATOR, TMIA: THREE MILE ISLAND ALERT, INC., HARRISBURG, PENNSYLVANIA: Good evening. I come tonight with a few comments.
Based on my experience with the public as a person who's at the Three Mile Island Alert office most of the time, Eric and I get the phone calls. We hear comments from the public.
When the newspaper article came out--there was a short article in the local paper--talking about the draft Environmental Impact Statement and it briefly stated the position of the NRC staff on the cleanup, the next couple of days our phone was ringing with irate people saying what's going on here.
They were under the impression, and most of the public is under the impression, that Unit 2 was going to be cleaned up, and that meant from start to finish, that the project would start and that it would be completed, and it would be continuous. 7.3.1.1
They don't understand, and I don't understand, why the about face and they the turnabout, and how the NRC and the utility and the State of Pennsylvania is going to ensure to the public that there will be proper monitoring, if it's not cleaned up now, and that, in fact, the utility will, at a point in time, have the money, have the wherewithal, have the expertise, have the technology, and, in fact, do the cleanup at the endpoint. 7.6.5
I guess most of us have been conditioned by the bureaucracy. We look at the federal government. We look at the superfund. We look at all the other contaminants that are invading our environment that have been here, not just 5 years, 10 years, 20 years. Look at what the Army and the Navy and all those other groups did to us after World War II and since World War II. We look at Olmstead. We look at all of the things that are happening, just here in central Pennsylvania, to our environment.
How can we believe that at some point, 10, 15 or 20 years, that because somebody says they will do something that, in fact, that

will ever happen, that anybody will make them see that it happen. I think we're all just in disbelief of what's happening now and what could happen in the future.

I understand that there was a sale of one dollar today. That the people of New York understand what's going on. That the Shoreham Plant was sold for a dollar to the State of New York, that that plant will never open.

7.6.5 I think we're concerned not just about Unit 2 and the cleanup, but we're very concerned about Unit 1 and how the company's going to handle Unit 1 and, together, how they can possibly afford the cost and the expertise and the technology for both of those plants.

So, I further reiterate the questions that have come here tonight and implore this panel to consider seriously the questions and the comments. And to give us some idea, if you're going to be around for the next 20 years to monitor the cleanup process. Thank you.

[DISCUSSION]

ED TRUNK, PROFESSOR OF MECHANICAL ENGINEERING, PENNSYLVANIA STATE UNIVERSITY: There was a question in front of the group and it wasn't answered.

[DISCUSSION]

MR. TRUNK: I'm Ed Trunk, and I'd just like to reiterate there was a

7.3.1.1 question posed by the last guest and it wasn't answered.

The question was why are we considering this question when we had a timetable before us and we're going down that timetable. Why are we considering this? Why is there a change in timetable before us right now?

[DISCUSSION]

DR. TRAVERS: Well, I can only answer it from our side and then maybe you can ask them.

We're addressing it, the NRC is addressing the issue, frankly, because we are required to do so. We've been given a proposal, a formal proposal, by our licensee, and one of the things we do as a regulatory agency, required to do, is to evaluate proposals, and that's what we're about, and this is just one aspect of it.

[DISCUSSION]

MR. STANDERFER: The purpose of the cleanup project was to remove the undamaged fuel, or remove the damaged fuel and to bring the plant to a condition which is safe and not dangerous.

As we evaluated the logical stopping point of the current work,

(3-22)

and we made our proposal a year and a half ago. And Bill is right. I believe they must consider our proposal.

We clearly understood that to do further work at the present time, and while significant worker exposure which did not alter the hazard the public, whether it was done now or later, we are currently reviewing the Environmental Impact Statement, and we will be submitting our comments with other reviewers.

[DISCUSSION]

JOYCE CORRADI, DIRECTOR, CONCERNED MOTHERS AND WOMEN: My name is Joyce Corradi, C-O-R-R-A-D-I. I'm representing Concerned Mothers and Women.

My first question is in reference to what was told to me tonight. In the presentation by the NRC, they said that in 20 years there would be 3 million or more people in the area that they were relating to for their dose rate.

I'd like to know where they got their projection and how they got that projection.

MS. HARTY: The projected--oh, this is Becky Harty for the record. The projected population distribution for the year 2009 we received as data in a letter from Frank Standerfer of the NRC. So, that was their estimate. GPU Nuclear's estimate of the population in the year 2009.

MS. CORRADI: I'd like to know from Mr. Standerfer where he got it from and how it was calculated.

[DISCUSSION]

MS. CORRADI: Okay. In all the years that this panel had been functioning and all the information that has been shared and buffed and re-buffed, I think this is the largest amount of garbage that's ever been presented to a group at any one time. If it hasn't insulted your intelligence, I can't understand why. It certainly has insulted mine.

[DISCUSSION]

DEBRA DAVENPORT, MEMBER, CONCERNED MOTHERS AND WOMEN: This is Debra Davenport from Concerned Mothers and Women, Camp Hill. I'm always asking the same question.

I want to know what the licensee plans to do to deal with the materials that are directly under the reactor vessel. Is this included in any of the assessments of removal of materials from the plant?

Repeatedly, you know, I see things now in last month's--or whenever the last meeting was--saying, well, we're going in through the bottom of the reactor vessel. There's a great deal

of material down there. We're going to assess this.
But what is under the reactor vessel? What is passed--I know something in the book with the nozzles going into the vessel, but what about the tubes leading into the nozzles. What fuel is in there?
So, I really question whether we're being told about all the fuel that's in the plant and whether there is a full assessment made on removing those fuels.
Also, I really wonder why, over a long period of time, we repeatedly seem to have a drawback from explaining to the public what might be under the reactor vessel in that basement.
I just don't understand--this is like the evaporator. It's premature.
Would GPU have an answer to that?

[DISCUSSION]

CHAIRMAN MORRIS: Okay. Thank you. Frank, could you come forward? If you could, answer the or try to answer the three questions that were raised initially, if you would. Please try to, and then you said you had other comments you wanted to make.

MR. STANDERFER: Three questions addressed--

CHAIRMAN MORRIS: The three questions that we asked on population by Joyce, and then Ms. Davenport asked two specific--

MR. STANDERFER: Population projections are included in all of our safety analysis reports. On Unit 1s and Unit 2s, and so forth. At the next meeting, I could give you the exact basis for that, but it basically tracks back to projections made by the State of Pennsylvania and by the Federal Census Bureau.
These would be the primary references, I believe, but that is--GPU itself is not in the business of making population projections but we're relying on state and federal bodies to make those projections.
We're required to include those on our safety analyses to produce valid safety projections over the next 50 years.

[DISCUSSION]

MR. STANDERFER: But I can provide at the next meeting a detailed analysis of what those projections are for the 50-mile radius--or 50-mile circle around the plant, and what the primary source for those were.

[DISCUSSION]

MS. CORRADI: If, indeed, this is a criteria by which they were using to get dose rates, I should like to know where they came from, the year point end of them, and how valid and updated they are.

[DISCUSSION]

MR. STANDERFER: Yes. With regard to where fuel is in the plant, we are required at the end of defueling to submit a defueling report to the NRC which includes our measurement of where fuel still remains in the plant at the end of defueling.
That's a required report which is--will be submitted to the NRC at the end of defueling.

MS. DAVENPORT: You haven't really answered my question--

[DISCUSSION]

MS. DAVENPORT: That doesn't really answer all of my question. Now it does answer one, but all the information is not in for the EIS that's been drafted in the forum.
We don't know what all the facts are. They're not in because you don't know where everything is, and how much of it is being left there, and what type--but I want to know, are they going to check that area under the reactor vessel, because this has been an off-again and on-again thing for the past year. Are they going to say what's there?
I think in one meeting it was mentioned they were checking the neutron flux detectors--it was said it was too hot to go into. Then it was too much money, according to the newspaper.
You know, I'd kind of like to know what's going to be done about that material. Is it going to be left there and how much of it is there?
The second one, in the inner core detector tube, is materials from the -- or any materials going under the reactor vessel. When are we going to know about this?

MR. STANDERFER: Let me answer those one by one.
We do not believe there is any fuel in the incore detector tubes. We will know that as we defuel down to that point, but currently there is no evidence that there's fuel there.
Under the reactor vessel, we have sampled the water as part of the defueling process. We find no evidence of fuel in the water under the reactor vessel. It's borated water, and there is no reason to believe, at the present time, that there was any leakage from the rector vessel to that area. Our samples so far indicate no evidence of that.

MS. DAVENPORT: Why is it too radioactive down there and you can't get in?

MR. STANDERFER: Well, because there's fuel in the reactor vessel above and it is shining into that area as--like an x-ray machine would shine.

MS. DAVENPORT: Why wouldn't it be the same--as the rest of the--

MR. STANDERFER: Well, because there's no shielding between that cavity and the bottom of the reactor vessel.

[DISCUSSION]

Getting back to the reason GPU made this proposal, we will reduce the hazard, as the NRC's EIS indicates, to a level which is not significant as far as the public is concerned.

We have done enough analysis and will provide more detailed analysis to the NRC in our comments, which has recently been done, to indicate there is at least a factor of 2 difference in worker exposure from doing it earlier than doing it later.

We have done a step-by-step analysis, and our analysis would indicate that the difference is about three times larger than the numbers that the NRC currently has in this document.

So, clearly the significant issue is worker exposure, and our proposal to limit that worker exposure by doing additional work at a later period.

We believe along the lines I think that Tom Gerusky was pointing out, that if cleanup was done 20 years from now or immediately, to evaluate those two cases you must look at a 24-year period in both cases. That is a monitoring period for 20 years plus four years of cleanup, or a cleanup period plus 20 years of monitoring.

Our assessment based on the cleanliness of the plant at the end of the current work or the cleanliness of the plant at the end of continued cleanup is that the emissions from the plant over the monitoring period would be roughly the same in both cases.

That indicates, then, that the public exposure in both cases are roughly the same. The worker exposure, of course, is much higher if you do the work early. The cost of monitoring, since it's basically based on fire protection and operation of ventilation systems and so forth, is roughly the same in both cases.

When you add 20 years of monitoring costs to the immediate cleanup case, the total costs are slightly higher than the delayed cleanup case.

With regard to costs, GPU under currently issued regulations on decommissioning, will be required to submit decommissioning plans for TMI-1, the Oyster Creek plant in New Jersey, and the TMI-2 plant. Those decommissioning plans must address costs of work left to do to decommission the plant and must include plans for providing that funding.

The NRC in that process, under those decommissioning regulations, must address the company's ability to provide those funds.

(3-26)

So, that will be analyzed in our responses to the recently issued decommissioning regulations.

CHAIRMAN MORRIS: How soon, Frank, will that response be submitted?

MR. STANDERFER: There's a time table in the regulations that were just issued in the last week or so. I believe it's within 5 years but, Bob, do you--?

ROBERT ROGAN, DIRECTOR, LICENSING AND NUCLEAR SAFETY, GPU NUCLEAR CORPORATION: I think the initial one's within 5 years and then an update.

[DISCUSSION]

MR. STANDERFER: I believe the requirement for providing those plans is within 5 years, but there's a number of time tables in there. It's not longer than 5 years, and it may be shorter than that, and we have to study that regulation to understand exactly what the time table is for each plant.

CHAIRMAN MORRIS: Okay. My concern really was in making a determination now of those options without knowing what mechanism is in place for requiring some fundings to be--

MR. STANDERFER: Within the relatively near time, near term, within the next 5 years, we must submit the decommissioning plan for TMI-2. That must address all work that has to be done to get to that point.

If there's additional cleanup required before decommissioning, we must address that. The cost of that work must be addressed, and we must address the company's proposed method of assuring that those funds are available.

CHAIRMAN MORRIS: I understood that. What I was saying was that you're saying it doesn't need to submit until--except within the next 5 years and that's from this determination? That's not--

MR. STANDERFER: The decommissioning plan, as I remember--I'd have to study it before the next thing--if a plant was shut down, I believe you have 2 years to supply that plan. If a plant is in the process of cleanup, as TMI-2 is, the time table would start at some point in time and it may be at the end of the cleanup, I'm not sure.

I believe that the 5-year is the longest period that can be. So, it would be less than 5 years or up to 5 years.

CHAIRMAN MORRIS: I'm not trying to argue with you or ask for additional info. I was just making a comment relative to the determination.

(3-27)

DR. TRAVERS: If you do want additional information, it's contained in our Programmatic Environmental Statement under Regulatory Considerations.

It's based on what the draft rule is, and I assumed the final will have--Let me just read it. It says: "The decommissioning rule requires that decommissioning plans be submitted within 2 years following a decision by a licensee to permanently cease operations or 1 year before the operating license expires."

CHAIRMAN MORRIS: Bill, what are you reading from?

DR. TRAVERS: This is from Supplement No. 3, draft Supplement No. 3 of the Programmatic Environmental Impact Statement.

CHAIRMAN MORRIS: Page?

DR. TRAVERS: Page 2.33. In the section on Regulatory and Administrative Considerations that are applicable to what we're doing here. So, there's--

[DISCUSSION]

MR. EPSTEIN: As you notice, it's 5 years. They don't have to put any money in escrow. And there are places, for instance, in California where it is established that utilities--for instance, you have to put money into escrow every year to take care of the decommissioning and decontaminating costs.

This, the deferred monitor storage, allows them to postpone a decision on decommissioning and decontamination. In essence, postponing using their resources which would--I just point this out that other states, other utilities, have done this. Have taken the initiative.

I mean, that's not answering that I had to address. I just wanted to clarify that.

CHAIRMAN MORRIS: Sure. It's not clear to me just what they're going to be required to do by the NRC, in any event.

7.6.4 What kind of financial responsibility the NRC would hold them to? What I've heard here tonight are certain requirements, but there's nothing that's come with them. So, it's, to me, I don't hear anything definitive other than a number of years that certain submissions have to be taken place by.

MR. STANDERFER: That is correct.

CHAIRMAN MORRIS: If there are guidelines that say that you have to put money in escrow every year and things like that, fine, but I'm not hearing you say anything like that at this point.

MR. STANDERFER: GPU is currently accumulating monies for Oyster Creek and TMI-1, and we must address the TMI-2 situation. The vehicle is these plans that are required by the NRC.

CHAIRMAN MORRIS: I understand you must address, but it's not clear to me in what form they will be addressed.

MR. STANDERFER: In the decommissioning plan that would be submitted to the NRC.
As Bill says, within 2 years of discontinuing operations, at least 1 year before the end of the license, and I believe that the final rule had a 5-year period in it for plants that didn't fall in either category.

CHAIRMAN MORRIS: It seems like we're chasing each other in a circle here. I understand what you're saying with that. All I'm saying, and nobody is saying anything differently, is that I'm not hearing what that means--that you have assure that there's guarantee of a certain amount of money in place by a certain given time period.
I'm not hearing anything like that. I'm just hearing that you say you have to submit a plan.

MR. STANDERFER: That has a funding arrangements in it.

CHAIRMAN MORRIS: It has a funding arrangement in it.

MR. STANDERFER: Yes.

CHAIRMAN MORRIS: But it doesn't say what that funding arrangement shall be. Obviously, it's got to be fairly general, but again it's not as specific as, I guess, certain people are looking for.

[DISCUSSION]

No. 18

Comments Received at the July 14, 1988, TMI-2 Advisory Panel Meeting

[DISCUSSION]

MR. STANDERFER: What I would like to do is summarize the comments that GPU Nuclear has provided to the NRC Tuesday of this week on the EIS.

I believe we've given you a copy of that letter in your package there. I'm summarizing the general comments that we made in this presentation. And we have some copies of this. We have people in the audience who would like to have a copy of the EIS letter.

Before I get into the comments themselves, I'd like to make a little background summary. We transmitted our proposal for PDMS, the PDMS plan to the NRC in December 1986 about a year and a half ago.

We then submitted in March of 1987, about a year and a quarter ago, the environmental report for this PDMS proposal. That environmental report is the basis that the NRC used to prepare the environmental impact statement, which they issued in April of this year--roughly 13 months after we gave them the environmental report.

Our environmental report addressed the environmental issues associated with our proposal PDMS. They have used that in their EIS. But then the EIS procedure requires them to compare that with some alternatives.

They put alternatives together. Those were not submitted by GPU. They're alternatives to assist in determining whether or not our proposal has any environmental issues which should be addressed. They tend to be hypothetical in the sense that they haven't been designed and detailed to the degree that our proposal was.

The environmental impact statement comes from the NEPA legislation, the intent of which is to get these kinds of issues considered as early as possible in a project like this, so that if there are any environmental issues which should be considered, they're considered before the project gets too far along, and there's too much money invested in an option, and that sort of thing.

So that's why the environmental issues get addressed at this stage. The actual license amendment which is the item that the NRC will approve PDMS on, we will be submitting later this month. So that license amendment actually isn't even submitted yet. So again, the EIS is to determine whether there's any first-order environmental issues which must be addressed.

The issuing of the final environmental impact statement is not an approval of the PDMS proposal. It's one of the steps towards the eventual action on our license amendment.

(18-1)

So getting into our overall comment, the NRC has used bounding values in the PDMS, many of which we've provided to them.
That means that they've tended to use numbers larger than we expect to end up with so that they can be sure they've bounded the proposal.
We do concur with their findings in the draft PDMS that the PDMS configuration is environmentally safe. The benefits of long-term storage, the PDMS proposal, outweigh potential adverse effects.
And the dominant issue in the PDMS environmental assessment is the reduced occupational exposure to TMI-2 workers.
The first general comment dealt with preparation for PDMS. As we included in our plan a year and a half ago, there's a number of prerequisites which must be achieved prior to entering PDMS.
And they, in summary, include the reactors defueled, and fuel shipped off the island, the potential for criticality or significant radioactive release have been eliminated; and that the plant is in a safe, stable, monitored condition.
As we look forward to PDMS, there's another activity which may be continuing into the first year of PDMS, or what we call the transition year of PDMS.
We now expect to be processing and disposing of water during that initial year of PDMS. We will be decontaminating some of the fuel storage systems and cubicles at that time.
We will still be shipping low-level waste for about a year. And we will be completing the special nuclear material transfer papers with DOE associated with the shipment of the fuel to Idaho.
So in summary, TMI-2 will be ready for entry in the PDMS upon completion of the on-going cleanup program. Some activities may continue for a year or so in the PDMS. But those final activities don't alter the NRC assessment of the environmental impacts in our judgement.
General comment number 2 relates to completion of the cleanup program. As we have indicated in our plan, the cleanup program's intent was to include all actions necessary to recover from the accident and place the plant in a safe and stable condition that poses no risk to the public health and safety.
GPU has not identified additional future cleanup work to be performed separate from decommissioning. Our plan anticipates possibly storing the plant in the PDMS configuration up until the time that Unit 1 is decommissioned, and then the two plants would be decommissioned at the same time.
Of course, the decommissioning activities in TMI-2 would include some more difficult steps than that of TMI-1 because the plant will not be as clean.
In our judgement, it is not ALARA. That means minimizing radiation exposure to workers. ALARA is the shorthand that NRC uses to perform further cleanup work after the end of the cleanup program as we've defined it, short of starting decommissioning.

(18-2)

To help explain this, in this EIS, the NRC has used two terms for the two cases that they have used to bound all the cases. One was what they call immediate cleanup, and the other is delayed cleanup.

We believe to understand these better, you might think of them as immediate additional decontamination, and final decontamination as part of decommissioning. That's how we would term those two.

The next general comment has to do with residual fuel. The draft PEIS bounding calculations are performed now on the basis of an assumed residual fuel inventory of 1 percent of the original core.

And that's a conservative estimate. Defueling is to continue to the extent that subcriticality is ensured. And we expect to do better than the 99 percent removal which this document is based on. So again, it's a bounding number.

The source term, or amount of radioactivity that could be released during PDMS is insensitive to the residual fuel for the most part because it will be contained within the original reactor system.

So it's contained within a metal system within the concrete containment building, and has no possibility of a criticality.

The overall conclusions of the PEIS do not change because there is some residual fuel in the reactor vessel.

7.4.1 The next comment deals with worker exposure and, in our judgement, is the principal issue with regard to what to do next.

In response to this draft EIS, we have recently completed an analysis of occupational exposure, and we're providing that to the NRC.

It indicates a significant larger person-rem savings from PDMS than indicated in this draft. And that, of course, increases the ALARA incentive to do PDMS.

Consistent with the original PDMS, occupational exposure and savings is a dominant consideration in evaluating PDMS.

The significant reduction in occupational exposure more than offsets the maximum hypothetical environmental impacts from PDMS.

The NRC's numbers were simply extrapolated by saying additional cleanup could be performed in 4 years. And in 4-year's time we would achieve radiation exposure at the same rate that we're doing it now per year.

Our study actually goes in and takes a look at how you would do tasks, where you would do them, what would be removed, how many people would be required.

We've broken that down in reactor building work, aux building work, fuel handling building work, rad waste management, and then the PDMS monitoring task.

And our estimate--and these are ranges--is that for the immediate cleanup case, our calculations indicate that the man-rem exposure for that case would be somewhere between 7,200 and 15,500.

(18-3)

So about 7,000 to 15,000 man-rem. The red number there is the number in the PEIS. We would say that the NRC underestimated that by a factor of four or five.

In the PDMS case, we estimate the man-rem expenditure for the NRC scenario to be 2700 to 5800. They said 45 to 1500. So our estimated savings in man-rem exposure by opting for the PDMS proposal is somewhere between 4500 and 9700 man-rem.

Whereas, they include in this EIS 255 to 1600 man-rem. So while the immediate case, as opposed to the delayed case is about a factor of two higher--and we agree with that factor, too--but we say they understate all the values by a factor of four to five.

It just strengthens the conclusion that the man-rem difference is the principal difference which separates the cases for which the decision should be made.

The next comment had to do with the practicality of continued near-term work. The immediate cleanup case is a satisfactory but hypothetical bounding case for environmental assessment.

In other words, it can be used to see if there is any first-order environmental difference between this and the PDMS case.

But it is not planned to the point that it is an alternative which could be implemented, has not been designed or detailed.

In our judgement, additional decontamination work past the end-point that we've established for PDMS would likely require the use of destructive techniques.

In effect, it would be a new program similar to decommissioning.

Major pieces of equipment would be removed from the erected building.

Presumably, the most efficient way to do some of those is use of explosives. And so it would be very similar to decommissioning kind of activities.

Large quantities of waste would be generated. And, of course, they do have large quantities of waste in the EIS for these alternatives.

The current low-level waste disposal sites and allocations under the Low-Level Waste Policy Act are really not set up yet to accept these kinds of large volumes of normal and abnormal waste from TMI-2, and so there would be an institutional issue that would need to be addressed in connection with near-term additional work.

And in addition to the PDMS storage case resulting in lower exposure to workers, as radioactivity decays, the total volume of future rad waste, which would have to be handled and disposed of, would be similarly reduced by the decay of radioactivity.

In the EIS, there is a table in the summary called S.1. We have a number of comments on that table. The first comment is that the two cases, the delayed case and the immediate case, really should be compared on the same time scale. 7.33.1

(18-4)

In other words, the PDMS cases in the NRC terms would be 20 years of storage followed by 4 years of additional cleanup, 24 years. The immediate case should then be 4 years of additional cleanup now followed by 20 years of storage. In other words, two 24-year cases.

I use these years because that's what they use. Our estimate for PDMS was till the end of Unit 1's life, which we currently would estimate as 30 years from now.

But we believe the two cases--when put on the same time scale--give you a better basis for evaluating them. We think it's worth comparing the radiological consequences in these tables to that which natural background radiation exhibits in this area.

And then we would divide the table into three tables because they are three separate considerations in that one table.

And the next three tables are how we would do it. And I'm saying the NRC should exactly do it because it points out our points.

The first one is radiation dose impacts--the first third of the table. The top line has to do with radiation exposure to workers. That's the man-rem estimates that I mentioned earlier with the immediate case of being about a factor of three higher than the delayed case, and the numbers I've summarized earlier. And there's no natural background to compare that to.

The offsite exposures to the public are essentially the same numbers that the NRC used. And we included the natural background over that same 24-year period.

And similarly, for the maximum exposed populations, again, the two cases with regard to offsite population exposures are essentially the same.

The second--or the next third of the table has to do with potential health impacts. And this is the calculation using standard techniques for converting radiation exposure to potential health effects.

And again, the two cases have a potential cancer consequence to offsite populations of much less than one, .001 and .0004, as compared to the natural instance of cancer in this population over the next 50 years, which is around 352,000.

The worker exposure are little higher numbers. In the PEIS case, .4 to .8, and the immediate cleanup case one to two, again, the ratio roughly the same as the difference in man-rem, the natural instance of cancer in this thousand-member worker population over the next 50 years is 160.

Genetic disorder calculation is calculated roughly the same way. And again, it's basically in the worker population. They're the ones that get the major exposures.

And to understand what these risks are, the immediate case results in a cancer risk to an individual of one in 2 billion.

(18-5)

The immediate case in one is 5 billion. The natural instances is, of course, one in six. The genetic order numbers, there are one in 27 million and one in 11 million, as opposed to one in ten.

Incidentally, the genetic disorders are calculated for the next five generations of this population. So it goes out about a hundred years.

And the last part of the table would be other impacts.

Generally, these impacts are not major consideration in EIS, but are of an informational nature.

The first one is what kind of cost we're talking about. And when you add 20 years of monitored storage to the immediate cleanup case, you end up with the two cases costing roughly the same.

And these are the NRC numbers. We have not made cost estimates. But we believe they're satisfactory for EIS purposes, for comparative purposes.

But we believe that that work would be done cheaper than this.

And it's 200 to 320 million in the delayed case, the PDMS case; and 240 million to 320 million in the immediate case.

And then the radioactive waste volumes are the same as they've used, the traffic accidents, and so forth--the same as they've got in their draft.

General Comment 7 speaks to the simultaneous decommissioning of Unit 1 and Unit 2, which is our basic proposal.

The PDMS assures continued safe and stable TMI-2 plant condition until decommissioning of Unit 1 where the two would be decommissioned together.

The clear advantages are that the possibility of decommissioning activities in TMI-2 would not effect Unit 1. And recognizing that major structures are common, decontamination techniques that are developed today include use of explosives, and that sort of thing, which would not be practical in this case.

So it's not too practical to try to decommission Unit 2 while Unit 1 is still running. And then of course the work force that would do the job could be more effectively used if they simultaneously decommissioned both units.

And the NRC decommissioning rule, which was issued last month specifically recognizes this consideration when there are more than one nuclear reactor at the same site, and allows for the two to be handled together as we would propose here.

And the last point is our overall conclusion, which is that based on the NRC conclusions stated in the draft PEIS and the results of our recently completed analysis of occupational exposure for their two cases, we concluded PDMS is clearly the preferred alternative.

And we've got a number of detailed comments in the letter also. But this is the principal issue that we've tried to frame in our letter.

(18-6)

Be glad to answer any questions. And then we have two more presentations in our segment here.

MR. RICE: Frank?

MR. STANDERFER: Yes.

MR. RICE: Could you tell me what ALARA means again?

MR. STANDERFER: As low as reasonably achievable, which means, with regard to radiation exposure, you plan to remove this pump. And you go in and measure the radiation levels. You analyze step-by-step how you're going to do that, and how many workers are going to do that.

Then radiation engineering people look at that and say, if you put some shielding over here, and if you train these fellows on a mock-up, you can do this job at lower total exposure than you're planning to use.

So then you debate that back and forth. And you attempt to arrive at a method of removing that pump which reduces the radiation exposure to workers.

You may use shielding. You may use long-handle tools. You may use mock-ups to practice on so you can do it very rapidly. There's a number of techniques. And the NRC regulations require that every job we do be done in a manner which uses reasonable techniques to minimize the exposure to workers. That's ALARA. And we're saying here, in the big picture, it is ALARA to store this plant for some period of time, 20, 30 years, and it results in major reduction exposure to people.

CHAIRMAN MORRIS: Thank you.

Ken?

MR. MILLER: Frank, on Page 8 of your report you indicated that the delay alternatives would result in lower volumes of rad waste. But on Page 12 it would look like, from your second row of numbers, the reverse effect.

MR. STANDERFER: We've used the NRC numbers. Those come directly out of the report. We have not made any volume estimates.

If we did make a volume estimate, we would estimate a smaller rad-waste volume in the PDMS case due to a number of volumes of waste--would be de minimis because of the radioactivity decay. We believe the techniques of compaction will be developed over the next 20 to 30 years, which would allow to compact waste more effectively.

We believe that a number of things like that could result in the waste being smaller. That's not a guarantee, but it's a prediction. But in the table we ended up using the NRC's numbers.

[DISCUSSION]

ED KINTER, EXECUTIVE VICE PRESIDENT, GPU NUCLEAR: I'd like to first make a statement with regard to one of the issues that was raised at the last meeting, and which was also discussed on the radio interview with you and others this week on WITF.

And that has to do with funding for any eventual decommissioning of TMI-2.

As you know, this company has the responsibility for health and safety of the public. It has exercised that throughout the 9 years in the aftermath of the accident, including providing the funding through various means, which has kept the project moving at the maximum practical rate.

And as of today there are something more than 1000 people working 7 days a week, 3 shifts a day, and they're being paid.

Now we have very carefully considered this matter, associated with funding for the eventual decommissioning. We understand the issue. We believe it's an appropriate one, and we're prepared to say as follows.

The statutes of the United States require that a licensee be responsible, financially as well as otherwise, for the health and safety of the plant, any licensed reactor, including TMI-2.

Recently, the NRC issued a rule on decommissioning which requires by July 1, 1990, that every licensed plant, every nuclear operator provide a funding plan for the eventual decommissioning of this plant or plant.

And we propose to do that. We'll expect under that rule to set forth by July 1990 a plan to ensure that funds will be available for the eventual decommissioning of TMI-2.

And that plan, whatever it is, will have to be acceptable to the NRC. The rule calls for any such plan providing decommissioning funds to be kept separate from company control, company assets, and outside the administrative control of the company.

I believe that should adequately answer the question of financial responsibility for whatever decommissioning will eventually take place.

CHAIRMAN MORRIS: Let me understand that.

When you're talking about decommissioning under the PDMS format 20 years from now, or whenever, there would be some required additional cleanup and decommissioning.

(18-8)

You're talking about a funding plan that would accomplish that as one of further cleaning as well as decommissioning--

MR. KINTER: I'm talking about all that is required to go from PDMS to eventual decommissioning of the plant--through an eventual decommissioning of the plant.
I'm sure that we would intend it to be on that basis, and we would fully expect the NRC not to accept it, unless it was provided on that basis.

CHAIRMAN MORRIS: So again, to repeat, in my terms, I understand that any plan that would be submitted for July 1990--

MR. KINTER: Yes.

CHAIRMAN MORRIS: --would include a plan that would include, funding-wise, PDMS requirements, as well as what would be understood by the NRC to be decommissioning.

MR. KINTER: That's correct.

CHAIRMAN MORRIS: The only reason I raise that is because we, as a panel, I think have looked at two separate items. And we may be looking at it incorrectly, but I think we're looking at it because of the way that PEIS was--

MR. KINTER: No, that's the way the PEIS was written. I think that is an incorrect way to look at it. It is not practical in our view to move from where we are today to the condition which they've used.
And Frank made the point that our evaluation of what comes from here to decommissioning is different from the one presented in the PEIS.
And so I mean, and I repeat, from PDMS through decommissioning. That's what I'm talking to. And that's what we would intend to include in the plan.

CHAIRMAN MORRIS: Just to be clear, and I just want to put this on the record, when I was talking at the last meeting, and my discussion since then has always looked at two actions that the PDMS.
After the 20-year period is up, there would be some kind of additional cleanup required, and then decommissioning.
And that the NRC's new action that was required would be submitted in July of 1990, would only be in regard to the second part of that, which would be the decommissioning part.
I'm hearing you say that they can't really be separated. That they should be linked; you think NRC would link them. And therefore, any funding plan submitted in July of 1990 would include all of the above.

(18-9)

MR. KINTER: That's correct.
The NRC carrying out its responsibilities, I'm sure, would view it that way. And we would expect them to.

CHAIRMAN MORRIS: I may have some questions of the NRC personally at some point on what a funding point is, and how definitive that is, because it's an area that I really want to understand better.

MR. KINTER: Right.

CHAIRMAN MORRIS: Does anybody else have any questions for the panel on that point?

MR. RICE: Mr. Chairman, I have a question.
What is the definition of decommissioning, and what takes place?

MR. KINTER: Well, that's part of the uncertainties in all this with regard to what really is decommissioning. And when I talked to decommissioning in this case, I talked to whatever is required in decommissioning for any other licensed plant.
For example, TMI-1--any undamaged plant. Whatever would be required in that case we would expect to do for TMI-2.

MR. RICE: Do we know what's required?

MR. MASNIK: Yes.
If you'd look on--each member of the panel has been provided with a copy of the decommissioning rules. Look on Page--if you look on Page 24, 020.
It states there that alternatives for decommissioning provide different ways to accomplish decommissioning as defined in the rule.
Alternative ways of reduced residual radioactivity to levels permitting release of the property for unrestricted use, and termination of the license.
So it's geared with unrestricted, or geared to unrestricted use of the property--ultimate unrestricted use of the property.

MR. RICE: Thank you.

CHAIRMAN MORRIS: Anybody else have a question on that point that Mr. Kinter made?
If not, we--

MR. KINTER: Then I would like to introduce the chairman of the TMI-2 Safety Advisory Board. Before doing so, I'd like very quickly to tell you what that board is.

(18-10)

It was established in 1981, shortly after the accident to provide a high level appraisal of the technical scientific aspects of the probe, and particularly worker and public health and safety made up of eminent scientists of several disciplines.

They work closely with us but they maintain their independence from us. Their conclusions are written after each meeting, and the recommendations provided to me.

And their answers in writing, each such recommendation, each time there is such a meeting.

Once a year they meet with the GPU, the General Public Utility, Board of directors and tell them how they feel the cleanup is being handled from a safety point of view.

And once a year for the last 3 years they've also met with the Nuclear Regulatory Commissioners and told them the same thing.

They also have subpanels, one of which has dealt with PDMS, which has followed much more closely than the Safety Advisory Board as a whole, what has been going on, and Dr. Marston is going to talk to that point.

I'd particularly like to call your attention to qualifications of Dr. Marston. When this board was established, it was chaired by James Fletcher who was recalled to the administration of NASA after the satellite shuttle accident.

And we had a very difficult time finding someone with the technical and managerial capability to fill shoes like that. And we were very fortunate to find Dr. Marston. He was willing to help us.

He is a graduate of Oxford as a Rhodes Scholar. He's a graduate of the Medical College of Virginia. He was, for 5 years, the director of the National Institutes of Health, and was, for a number of years, the President of the University of Florida system.

He is currently President Emeritus and Professor of Medicine at the University of Florida. He's a member of the National Academy of Sciences Institute of Medicine. And as a member of that group he has recently participated in preparation of a report which deals with the medical implications of nuclear war.

He's known worldwide as a physician, and as a man who understands medical effects of radiation. So we're very pleased to have Dr. Marston.

And I'd like to have him now tell you what he and his board have concluded about PDMS. Bob?

DR. MARSTON: Thank you, Ed.

MR. KINTER: You're welcome.

DR. ROBERT Q. MARSTON, CHAIRMAN, TMI-2, SAFETY ADVISORY BOARD:
Mr. Chairman, members of the panel.

I really have three things to present. One, an overview of some of the concerns the Board has had, and then a statement that I made on March 17th of this year to the Nuclear Research Regulatory Commission, and then a summary of my presentation.

As you have noted from what Ed has said, my expertise is not in the nuclear field. I am surrounded in the Safety Advisory Board, though, by people of international renown in nuclear scientific and associated fields.

Just an example of the quality of these people, five of them are elected members of their appropriate component of the National Academy of Science.

One is a member of the National Academy of Science, or members of the National Academy of Engineering, and one is a member of the Institute of Medicine in the National Academy of Science.

Others, of course, don't fit into the category of the National Academy of Science such as those who are experts in risk management and public policy groups.

But it is a stimulating and excellent group that I am pleased to work with.

This board has conducted an extensive review of post-defueling monitored storage. And Connie, if you can show, we've looked at it since it was first conceived in 1985. A panel chaired by Professor Rasmussen of MIT have analyzed and made a report to the full board for discussion.

We've looked at the overall parameters set forth at GPUN for PDMS. We've looked at the implications for potential hazards to the public, or the plant workers.

We've looked at the implications for remaining fuel. We've looked at the implications of residual radiation or radioactivity levels in the plant.

We've looked at the radiological and environmental monitoring plans, as well as operations and maintenance proposed for PDMS.

And we've looked at the technical and safety aspects of PDMS. As a result of these studies, we have produced a segment that was agreed to by every member of the Safety Advisory Board.

And this is what I would really like to address to you tonight. In our November 5th and 6th meeting in 1987 we made the following statements.

Post-defueling monitored storage has been analyzed in-depth by the Safety Advisory Board, TMI-2. I don't need that yet.

The Board has agreed that PDMS is an acceptable TMI-2 plant condition that when achieved would pose no hazards to public health and safety.

Upon further Board review of PDMS at a subsequent SAB meeting in February of 1988, it became apparent that in light of the extensive SAB reviews and deliberations are the technical and safety aspects of PDMS, documentation of the basis of this statement was necessary.

As Ed has said, the SAB's choice was oversight of the actions of GPUN management to ensure that those actions relating specifically to the cleanup of the damaged plant did not jeopardize the health and safety of the public and workers.
These actions sometimes require decisions which involved trade-offs between health and safety, and some limited low-level radiation exposure of the public and the workers.
For example, when extremely small amounts of krypton gas were released to the environment, in order to improve the ambient air quality within TMI-2 containment buildings, and thus reduce the potential radiation exposure of workers who were to gain entry to begin the cleanup operations.
Whatever the cost of such trade-offs and personnel exposure, there has been no adverse effect on public health and safety.
Although protection of the health and safety of the workers is a matter of highest priority, the SAB must continue to exercise a considerably greater responsibility in its concern of the effects of the cleanup on the health and safety of the public.
The 1979 accident at TMI-2 left the interior of the reactor building so contaminated with radioactivity that entry by cleanup crews were not possible without extensive preparations and precautions to minimize exposure.
Although the radioactivity has been confined within the building since the accident, except for the planned release of small amounts of krypton soon after the accident, there was a small but finite possibility during the first post-accident months of much lower levels of radiation exposure to nearby residents.
A truly remarkable job has been accomplished in these past 9 years on the insignificant and negligible exposure of the public that occurred, as well as remarkably limited exposure of workers who have been carrying out the cleanup.
This has been achieved by judicious care, planning, deliberate steps, and appropriate decision-making. GPUNC management has directed the allocation of solvable funds for the protection of workers and the public.
Decisions were always in our view in the direction of being overly safe. Until recently, the quantity of damaged fuel that has been present in the reactor vessel has been sufficient to require precautions against any inadvertent criticality occurrence, though the probability of occurrence was extremely small.
A significant milestone will be achieved in early 1989, when more than 99 percent of the damaged fuel will have been removed from the reactor and shipped to the U.S. Department of Energy, National Engineering Laboratory in Idaho.
The remaining small amounts of fuel debris in the reactor system represent only a small fraction of the original fuel, and will pose no threat to criticality or radiation exposure of the workers and the public.

At this stage there will no longer be a need for special precautions, such as maintain borate water in the reactor vessel.
This does not mean that the plant interior has been fully decontaminated, and that no radioactivity remains. During the PDMS phase, workers will have access to most of the plant without protective clothing and with little exposure to radiation.
The reactor building basement, and a few places in the fuel handling building will remain radioactive to the extent that workers will not be permitted access to these areas.
Now there appears to be no reason for workers to enter these more contaminated areas when the PDMS phase has been reached.
To ensure the health and safety of the public, as well as the TMI-1 workers, TMI-2 plant conditions during PDMS phase will be monitored continuously to preclude the development of any unforeseen circumstances.
Once assurance is present, that there is no potential hazard for the public health, GPUNC management must decide what still must be done concerning further cleanup of a small amount of contamination remains.
Should it continue to proceed vigorously, sending additional tens of millions of dollars to improve the condition of the reactor building basement and other areas beyond the endpoint levels rejected in the licensing documents?
And here, Mr. Chairman, I think sort of the heart of my statement coming up in the next three sentences.
If it were the intention of GPU management to use the containment building or any heat producing facility some time in the future, then there would be valid reason to continue to reduce radiation levels in the remaining more radioactive areas.
Since the radioactivity is in an immobilized state within the basement walls and structures, and since GPU has announced that no plan is under consideration to rebuild and restart TMI-2, there appears to be no rational basis to continue to subject workers to unnecessary radiation exposure beyond that currently needed to remove the damaged fuel.
Therefore, the most responsible plan in the view of the SAB would be to go into PDMS. PDMS would be protective of the health and safety of workers, as well as the public.
The prolonged duration of the time under PDMS would allow for additional natural decay of the remaining radioactivity.
When the time has come to decommissioning the TMI-1 plant well into the future, steps can be taken to remove any remaining radioactivity in the TMI-2 containment and associated buildings.
In the intervening years, the residual activity will have been further reduced by natural decay to principal radioactive products. Cesium-137, strontium-90 will have been decaying at the rate of 2-1/2 percent per year.

The radioactivity remaining after approximately 30 years will have been reduced to the present levels. It's also anticipated that advanced robotic systems will be available to further reduce potential exposure of workers expected in the decontamination of the TMI-2 reactor plant in preparation to decommissioning the facility.

Now this represents a consensus statement of all members of the TMI safety advisory board. And you can see that slide. I'll simply repeat the four main points which we have said to the NRC.

Post-defueling monitored storage has been analyzed in depth by the Safety Advisory Board, TMI-2. The Board has agreed that PDMS is an acceptable condition, that when achieved would pose no hazard to the public health and safety.

The limitations placed on the amount of fuel that can remain in the plant ensure that no conditions exist of criticality.

The residual radiation or radioactivity levels of the plant that are potentially releasable offsite during PDMS are likewise believed by the Board to pose no threats to the public.

During the PDMS phase, workers would have access to most of the plant without protective clothing, and with little exposure to radiation.

But the reactor building, and a few places in auxiliary, and the basement buildings, will remain radioactive to the extent that workers would not be able to enter these areas.

There would be no reason to enter these areas.

As I said at the beginning, this is not my area of expertise.

But at any time in the future, Mr. Chairman, or members of the panel, if you would like to have individual members with such expertise to appear before you, or to make reference statement backing this up, then I would be glad to help provide that.

Thank you very much.

CHAIRMAN MORRIS: Okay. Can I just ask one question?

I do thank you for coming here tonight, and for making the presentation, but I see nothing in your presentation that speaks to the likelihood of funding being in place.

When you make the statement that there appears to be no rational basis to continue to subject workers to unnecessary radiation exposure beyond that currently needed to remove the damaged fuel, have you looked at the likelihood of monies being in place 20 years from now, versus immediately?

DR. MARSTON: Yes, sir. We have one member of the panel whose expertise is in management economics. And he has brought, at the last two meetings of the SAB, this question up.

We've had discussions of that question with Phil Clark, and with Ed Kinter. And we've received the same information that you heard from Ed tonight.

CHAIRMAN MORRIS: And you received that information prior to the statement being prepared?

DR. MARSTON: It was during--actually, the statement--well, I didn't know the statement he was going to make tonight until he made it. But he has said to the SAB that it is the responsibility which the company accepts to make the same financial arrangements for eventual decommissioning that are required in any other plants.

CHAIRMAN MORRIS: I just am particularly interested in if you have minutes of your deliberations that speak to the funding question prior to this action. This statement that you've made, there appears to be no rational basis.
I would be interested in seeing those minutes of those deliberations.
This specific recommendation includes the kind of financial information we have been given tonight. I'm particularly interested in that because it's pretty strong statement--

DR. MARSTON: Right. I would be glad to review the minutes of our February meeting.
It is my memory that we did have discussions of the funding issue as this was being prepared. That was questioned in the Safety Advisory Board about exactly where the responsibilities lay in having the primary responsibility for safety.
We did bring it up either in the February meeting, or in our later meeting with Mr. Kinter. And so, I will find out whether it was in February or whether it was after March.

CHAIRMAN MORRIS: Simply, my question is based on whether this statement includes the kind of consideration of funding that has been outlined by Mr. Kinter, or whether it does not.

DR. MARSTON: The statement does not.

CHAIRMAN MORRIS: It did not include a discussion to that level?

DR. MARSTON: Not in this statement. But we have had--

CHAIRMAN MORRIS: Well, prior to voting on this statement, the consensus decision--

DR. MARSTON: Right.

CHAIRMAN MORRIS: --were the members informed to the level of the funding matter today or not? That's what I particularly mean.

DR. MARSTON: I will be glad to look at our February minute meetings.

CHAIRMAN MORRIS: Because if they were not, and it seems to me their decision is based less on funding and more on other safety evaluations, and not as much on funding.

DR. MARSTON: And I think that the real question is where our responsibility lies in that.

CHAIRMAN MORRIS: That's all I'm trying to clear up, sir.

DR. MARSTON: Right.

CHAIRMAN MORRIS: I just want to be clear on whether the statement includes detailed consideration of future funding, or whether it does not include that.

DR. MARSTON: All right.

CHAIRMAN MORRIS: I'm not trying to give you a difficult time. I just want to be clear.

DR. MARSTON: I understand because it has been a key point of discussion. It has been for the Board.

CHAIRMAN MORRIS: Thank you. Are there any other questions of Dr. Marston? Thank you very much.

DR. MARSTON: Thank you.

CHAIRMAN MORRIS: We appreciate your presence.

At this point in the agenda we do have panel working sessions on PDMS, whatever that means. Now I guess what I'd like to do is get comments from the panel.

And maybe to begin them, I would at this time try to provide some comments that were given by Tom Gerusky, if that is okay with you, regarding his assessment of this point.

Now his comments, obviously, were not based -- were based on information that he had coming prior to this evening. So he didn't have the benefit of anything that was presented tonight. But his comments in no special order--and I'm not going to try to include all of them, but I'll include as many as I can read from my notes that I took during the discussion with him today.

He feels that the panel should wait until the NRC has received GPU's projection on worker exposure. And we heard some of that this evening, but he feels we should wait until the NRC has reviewed them.

And he'd like to see or hear comments from the NRC regarding the new information on worker exposure. He would like to see or hear that prior to our acting on this particular issue.

(18-17)

He says that unless there is more substantial reduction to workers as far as exposure is concerned--and he feels that is the main issue before us, is whether you delay through PDMS the cleanup and decommissioning, or whether you proceed with it now. He thinks the issue really revolves around the worker-exposure question. And he feels that unless it can be substantiated more clearly than it was in the PEIS--and I think this is fairly a statement that he gave--unless it can be substantiated that there would be greater savings to workers than have been in the PEIS, he doesn't really see the purpose in waiting for the cleanup.
He was concerned about the kind of fire protection systems that would be in place that weren't spoken to in the PEIS.
He also expressed a concern about the inventory of radioactive materials. And I believe he's talking about further documentation on that.
He wants to make sure that the criticality question is not a problem. He was concerned also on the funding, that we make sure that there is mechanism for funding in place if we do go to PDMS that assures that money will be in place at the time that it's needed.
And he expressly concerned that the utility has not submitted its safety analysis report prior to the PEIS being completed. And that is -- I guess it's a preliminary safety analysis report. He thought that it was putting the cart before the horse doing the PEIS and not doing the preliminary safety analysis report first.
There are just some points that he made. He indicated to me that he felt from his perspective, while he can't vote this evening, if anything would come before us, he thought that we ought not to proceed with a vote on this issue because he felt more information needed to be made available to us.
And with that input that he asked me to provide, I would be happy at this point to see if any other panel member wanted to offer comment as part of where do we go from this point as a panel.

[DISCUSSION]

MR. RICE: Mr. Chairman, what is the objective of our discussion? Is it to prepare the NRC with an advisory decision?

CHAIRMAN MORRIS: Well, I believe that that is one of the main reasons. Forgetting the NRC as a commission, the meeting we have with them next month, forgetting that for a moment, any document that's been produced as part of the cleanup--and this PEIS is one of them--we have normally been asked to review that document and give comments.
Our comments could be that we take no action on it; we have no comment. Or we could support the findings. Or we could disagree with the findings.

(18-18)

So what's really before us at this point is the document--what do we do with the document. Certainly, we have a meeting with the NRC next month.
It would be helpful in discussing with them a position that we might have on this document if we are preferred to present them at that meeting. But if not, we can tell them what we've decided to that point.
But I think the major thing before us tonight is do we want to at this point take any position on this document? Do we have any questions we would like to ask regarding the document? Is there more information we would like to have? So that at some point prior to the deadlines, we at least have considered making some comment on the document.

[DISCUSSION]

MR. SMITHGALL: I have a question. The fact that I think the workers have been exposed tremendously in this in not favor of prolonging that, I still am concerned about the funding, and if PDMS would be instituted.
7.6.4 Isn't it possible in the licensing amendment that would be required here to put a proviso in for a sinking fund, or funding for that eventual completion of what I would term cleanup.
Is it possible to attach a rider on that amendment to require that? I'm asking the staff.

MR. MASNIK: I guess that question is addressed to me. I really can't answer that at this time. I would have to check on that. That's something that would be extraordinary.
To my recollection something like that has never been done before.

[DISCUSSION]

MR. STOLZ: I'm John Stolz. I'm with the NRC. I'm the director of the group to which TMI-2 review is assigned.

MR. SMITHGALL: I think you may want to use that mike.

MR. STOLZ: As Mike said, we would not normally involve the financial aspects of the SAR review with the review of the SAR material that we're about to receive.
The question of safety is the issue that we're going to be looking at. The financial aspects, although it's important, is a separate action.
We're not saying we're not going to look at it. But we propose that we would be looking at the safety aspects of the PDMS, and simply review the financial aspects.

(18-19)

MR. SMITHGALL: When would that financial review occur, at the outset of the SAR--when the SAR is submitted simultaneously with that analysis or 20 or 30 years hence?

I guess my problem is everyone has stated that there really isn't any problem with the PDMS. Nobody's really said the funding's been talked about.

Then they said that, yes, it has been talking about but nobody's said any numbers. You can hear $200,000 in today's dollars, or you could hear a billion dollars if you look at 20 years from now.

My concern is--when do you make that analysis and how do you make it?

MR. STOLZ: We'll have to get the information separately and review that as a separate matter from the PDMS safety analysis review.

In other words, what I'm saying is that I expected we would be issuing a safety evaluation report on the PDMS safety analysis report.

We would want to separately address the issue of financial responsibility as a separate matter with the licensee.

I don't have that.

CHAIRMAN MORRIS: Under what--

MR. MASNIK: And I think it would, though, under the decommissioning rule. The decommissioning rule requires each licensee 2 years from the issuance of a rule a plan that deals with decommissioning funds.

MR. SMITHGALL: I understand that. That's a plan that--is it enforceable to the extent that you would require I read that, Mike, and I know where you're going to refer.

MR. MASNIK: All the plan says is it provides a plan for the securing of the monies required for decommissioning. And the Commission has presented certain guidelines as to how much money should be set aside.

And that amount presently is approximately $100 million for this facility, although there is an escalation clause in that set aside on a yearly basis.

MR. SMITHGALL: But that is for--

MR. STOLZ: But that's 2 years from now.

CHAIRMAN MORRIS: Excuse me.

MR. STOLZ: That matter is going to be given to us 2 years from now.

(18-20)

CHAIRMAN MORRIS: Could I speak at this point?
That implies a normal decommissioning, as I understand it.

MR. STOLZ: That's right.

CHAIRMAN MORRIS: And it has not taken into consideration the kind of PDMS circumstances that we're talking about here. And so you talk about $100 million. And then you talk about $200 or $300 million. Additionally, I think what we're trying to do is simplify from our perspective, and indicate that if you would add that $100 million in normal decommissioning costs in today's dollars, to the $200 to $300 million additionally needed for the cleanup, you have a number that varies between $300 and $400 hundred million dollars, all of which we know is a guesstimate in today's dollars.

And what I think Tom is asking--what I've been trying to ask--is at what point does that total cost which involves what I just stated now, $300 to $400 million, when is there a plan presented that both speaks to the funding of that, and also guarantees the money is going to be in place, either by a sinking fund that Tom Smithgall has indicated, or by some other means?

7.6.4 How are we going to be assured--just let me finish--how are we going to be assured either as a panel or a public that when that money is needed it is going to be there?

Now we heard Mr. Kinter say that it would be required to keep the money separate from other operating monies at GPU. I don't understand really what that means. In what fashion would it be kept? How would we be assured that the money would be--it's a moving target. That's today's dollars. It's going to move as interest rates change at its cost of doing business changes.

It could be a billion dollars 20 years from now. How can we be assured that that's what the cost is going to be; that there's going to be a billion dollars available to do that total cleanup and decommissioning?

That's really what we're asking. And if there's no answer to it yet, say that, and maybe you can provide one at--

MR. STOLZ: We don't have the answer to the financial story now. But I did want to say that notwithstanding that, that we would still be proceeding separately with the safety analysis of--safety evaluation of the safety analysis we're going to receive at the end of July.

CHAIRMAN MORRIS: We understand that. Tom is really not getting into that. I think he's getting into the money aspect.

MR. MASNIK: One other thing, and that is it was clear from the nice discussion--Mr. Kinter had said that the money for decommissioning would be available.

(18-21)

Now there evidently is a problem in the definition of decommissioning. We seem--the NRC seems to chose to look at the end of cleanup, and then a second stage of decommissioning.
And correct me if I'm wrong, but Mr. Kinter seems to think that at the end of the 20-year period, the facility will be decommissioned. And that will include, to a varying extent, the additional cleanup that we are supposing would occur.
And additionally, whatever is acquired during decommissioning.
And if that's the case, he said that the decommissioning plan, which we submitted in 2 years, would address both of those issues. Then I think we have a commitment that the money will be--or the plan will be evaluated, and the monies--well, the money will reflect the cleanup of the facility and decommissioning.

MR. SMITHGALL: My concern was not the definition of decommissioning, or cleanup, or immediate, or post. My concern was the confidence that the money will be there. That's what I'm talking about.
I mean, I'm--or, are we going to be, 20 years from now, trying to put a funding package together that takes into consideration rate payers again, state monies again. We're going to have to be going through that whole ball of wax as we did a few years ago.

MR. MASNIK: I think the--

MR. SMITHGALL: That's my concern. Not necessarily the definition. Is it going to be there? What kind of--

MR. MASNIK: The assurance that--

MR. SMITHGALL: --confidence do we have that it's going to be there?

MR. MASNIK: The assurance that the money will be there is required by the rule. But the amount, I think, is what's in question.
In other words, the rule says at least $100 million.

CHAIRMAN MORRIS: How did--

MR. MASNIK: And there is some assurance that that money will be there because there are strict guidelines as to how that money is to be kept separate from the operating expenses of the licensee.

CHAIRMAN MORRIS: Where does it say that--that it has to be kept separate, and how it would be paid into that separate account?

MR. MASNIK: I think in the section--

MR. STOLZ: There are several alternatives described in the rule.

(18-22)

MR. MASNIK: Look on page 24050.
(PAUSE)

MR. MASNIK: Under Item B in Column 1 there it says each electric utility--self-submitted decommissioning report. And then it talks further on.
If you look at the next paragraph in the middle--as provided paragraph E(2) and (3) of this section, financial insurance is provided by the following methods: repayment, external sinking fund, security method. There are a number of different ways.

MR. SMITHGALL: Then when I ask you that if there is an ability to put a proviso in their license amendment for a sinking fund, you said it was an extraordinary method.

CHAIRMAN MORRIS: It's two different things.

MR. SMITHGALL: I know that.

MR. MASNIK: We're talking about the license. And when we talk about modifying the license, we're talking about modifying the technical specifications which deal with operation of the facility.
I mean, how often you moderate--things like that. And typically, it doesn't address financial issues at some later date.
In fact, that's one of the bases for this rule, that the Commission was concerned that there would not be adequate financial funds in the end for facilities to clean them up.
And that's why they're required now to set aside certain amounts of money.

CHAIRMAN MORRIS: And--go ahead.

DR. WALD: I take it you're saying, then, the rule is sufficient without it being mentioned in the license.

MR. MASNIK: That's my understanding, yes.

CHAIRMAN MORRIS: Are you in agreement, or can we get some kind of assurances that what was stated tonight on this record is in fact going to be the interpretation of the NRC that in fact cleanup, as we've been told, and decommissioning will be considered as one at the time the financial statement is made in July of 1990? What kind of assurances can we get that that will be the case?

MR. MASNIK: I don't know if I can give you an assurance of that on my own. I would have to check on that. But it would seem to me that that plan would be reviewed.

(18-23)

And if the licensee chose to include in that plan those items that would require additional cleanup or decommissioning then money set aside for that would be considered.

CHAIRMAN MORRIS: Well, I guess the major factor in my thinking is in PDMS, if cleanup after PDMS is not contained in this new order of the Commission that has to be submitted by July of 1990 then we have no assurances that money will be available.

If it is included as part of that then at least we have this new action that seems to indicate that money would be set aside in some form, sinking fund or whatever, to protect us if we wait through PDMS. And it's an important factor.

MR. MASNIK: I agree. I think the only assurance we have right now is Mr. Kinter's assurance that that plan will address those items necessary to get the plant to the point where it can be decommissioned.

CHAIRMAN MORRIS: And we're asking the NRC to look at that question, I guess, and give us some feedback, if possible, on whether you agree with that interpretation.

And one other thing I'd like to get into a little bit is what is decommissioning. And I know that Fred asked that earlier. But as I understand it, decommissioning can take a lot of different forms.

There can be a request after--as far as I understand it, TMI-1 has a 20-year life left they can request--they being GPU can request an additional year extension. So it can end up operating for another 30 years.

And then they can ask for some kind of safety storage, or safe storage requirement for additional numbers of years, up to, I think, maybe even 60 years.

MR. MASNIK: That is correct. There are three options.

CHAIRMAN MORRIS: So that plant could in fact be there for 90 more years without it having to be removed or totally decontaminated. There can be a safe storage requirement for 60 additional years. And in fact if that happens, they could allow TMI-2 to parallel to some degree that kind of action for Unit 1.

MR. MASNIK: That's possible. And it's also possible under the rule that in the interest of public health and safety it could be extended beyond 60 years.

CHAIRMAN MORRIS: So when you look at a decommissioning financial plan with that potential scenario, it's very confusing to me how it would be presented in July of 1990.

(18-24)

I'm not trying to make things more complicated, but it becomes very complicated to me when you talk about it since.

If we knew that decommissioning meant you removed the plant 30 years from now totally from the island, and this is what the cost is going to be for that, and therefore we want to make sure that money's in place, that's easy to understand.

But when you have both the moving target as to inflation and a moving target as to the actual physical removal of the structure, I don't know how they put a financial plan together that really is going to hit a target 90 years from now.

MR. SMITHGALL: It's called mortgaging the future.

CHAIRMAN MORRIS: It's my biggest concern, and that's why I continue to pursue it.

MR. SMITHGALL: In light of that I just want to make a point and then ask a question of Mike again.

It appears that the intent of the cleanup all along has been to ensure that cleanup be accomplished in a timely fashion, as expeditiously as possible, within the bounds of public health and safety.

It appears that PDMS runs counter to all the NRC's stated as far as not making Three Mile Island the long-term storage for radioactive waste.

I'd like to just hear how you rationalize that with PDMS being environmentally acceptable.

MR. MASNIK: I think we have to go back a number of years when the original PEIS was issued, where we talked about what the endpoint of the cleanup would be.

And it was nebulous at that time because we had a poor understanding. We looked at four different factors, one was building and equipment decontamination. One was fuel removal and decontamination of reactor cooling system. One was treatment of radioactive liquids. And one was packaging, handling, and shipment of disposal of radioactive waste.

That was sort of where we were headed. But I think superimposed on all of this is our concern about public health and safety. And I think we've come a long way in satisfying those four requirements. We're certainly not at the point where we've completed them.

But I think what has happened is that the licensee has reevaluated going further in cleanup, based on their calculations of those dosed workers, they felt that it is advantageous to delay any further cleanup for some unspecified period of time, and allow the decay of radioactive material in the plant.

(18-25)

And they've come forward with that request. And the NRC has evaluated it. And at least from an environmental point of view, we find it acceptable.

MR. SMITHGALL: Do you feel that PDMS makes Three Mile Island a long-term storage for radioactive waste?

MR. MASNIK: In a sense it does make it a storage area for some additional period of time. And it was something that we hadn't planned on earlier.
But I don't think anyone envisioned it being permanent long-range form of waste storage facilities.

MR. SMITHGALL: Ninety years is permanent--not as far as I'm concerned, and probably children, unfortunately. I'll ask a question--and if anybody else wants to ask questions, certainly just jump right in.

CHAIRMAN MORRIS: Is there any other panel member that wants to ask any questions at this point?

MR. RICE: I have a question. Everything we hear assumes that the water evaluation process has been completed, is that correct?

CHAIRMAN MORRIS: Well, the water evaporation process would not be part of the PDMS. So it's expected that that would be completed, I believe, prior to the PDMS.

MR. RICE: No--

CHAIRMAN MORRIS: Oh, you're not asking if it started yet, are you?

MR. RICE: No, no. The assumption is that the water solution--the solution to that problem would be the evaporation technique, is that correct?

CHAIRMAN MORRIS: The tactic in storage is supposed to be under the plan that's proposed by the operator is supposed to the evaporated. And that is presently being contested. And Mike Masnik went through that process earlier on.
If that is approved in a timely fashion, it's expected that the evaporation of it would be completed, I believe, by the time the PDMS goes in effect.
However, we don't know whether it's going to be evaporated or not at this point.

MR. MASNIK: It would be close. There may be an overlap of a number of months. But for practical purposes, there are two separate issues.

(18-26)

CHAIRMAN MORRIS: And they're not really considered, were they, as part of the EIS and the PDMS? That was a separate issue from the PDMS?

MR. MASNIK: Yes.

CHAIRMAN MORRIS: That's what I had said.

[DISCUSSION]

DR. WALD: I have comment and answer--or comment on Tom's comment about the long-term storage aspect of it. But apparently it's the Commission's view that in order to get to decommissioning that has reduced residual radioactivity to a level permitting release of the property for unrestricted use in termination of a license, there are alternatives, one of which is to permit a storage period during which radioactive decay can occur prior to dismantlement of the facility.

In other words, there's storage in storage. If it's deliberate delay in order to take advantage of physical decay of the radioactivity, this is one of the alternative ways to get to the point of decommissioning.

And I'm not sure you can turn it around simply and say this is also waste storage.

CHAIRMAN MORRIS: Well, I think it would really depend on the level to which one would expect the radioactive storage to help.

And when you look at the PEIS numbers, they are not, I don't think, terribly convincing. When you look at maybe what the operator is proposing tonight, that may be a different story, which makes it again difficult for us this evening because I'm not hearing anything from the NRC.

And maybe they're preferred to speak to this tonight. But without some comment on the NRC on what's being presented by GPU in the way of worker exposure, it's still hard to judge how helpful that delay is to the worker.

MR. MASNIK: I think all we can say is that the new numbers certainly put PEIS in a better light in the sense of comparing the two. But we have only had these numbers for two or 3 days. And I would feel a lot more comfortable if we had our people check these numbers out and see what we can do with their reasonable estimate. And that's all I can say.

CHAIRMAN MORRIS: --Neil.

DR. WALD: I think it was mentioned that the new numbers for 30 years reduces the physical activity of the facility by half, I believe someone said. Therefore--am I correct on that?

(18-27)

CHAIRMAN MORRIS: Yes.

MR. STANDERFER: I made that statement--which is just 2 1/2--

DR. WALD: Yes.

MR. STANDERFER: --percent.

DR. WALD: Which means, of course, if it ends up 90 years that it'll be that much greater a reduction by several half lives. Which may be part of the technique facilitating decommissioning.

CHAIRMAN MORRIS: Well, that would make one wonder just how well protected that plant would be for those 90 years, and how secure it would be in all of those factors.
And I kind of hate to think what that would mean.
I just think there's a lot of things that go into consideration other than what the level is of radioactivity, when you extend something out 90 years.
I think one needs to look at that. But I guess as you try to take notes on the issues, one that comes forward is the money issue, and we talked about that.
The other one is worker exposure and the others you've mentioned here. I personally would like to see the NRC at least review that and let the panel know how they feel about the numbers that have been presented tonight by GPU.
And maybe there are other major issues as well. I see them personally as the two major points--money and advantage to the worker in the way of worker exposure.
And just to complete the thought, if we don't get information on both of those items, and particularly the latter one, worker exposure is definitely a PEIS matter.
How do we comment on that until we get your information, and yet we're not going to meet again. And we have an August 1 deadline?
And I still feel that as a panel we should be given the opportunity to have that piece of information so that we can at least decide whether we want to comment or not.
And unless we meet again in August it seems to me we need some kind of extension so that we can discuss this.

MR. MASNIK: I would--first, well, I guess I can make a commitment that I will get that information to you as soon as I can.

[DISCUSSION]

CHAIRMAN MORRIS: The next part of the agenda is to allow public comment. And just briefly, before we go into that, I would like to, if we could, have the NRC come forward and explain--and I

(18-28)

don't know whether that's Mike Masnik or whoever--but I would like somebody from the NRC to explain how the PEIS license amendment and the July 1990 submittal on the funding, how they fit together or how they don't fit together.
In other words, is the funding involved in PEIS as one item reviewed, or was it involved with the license amendment review? Because during the break I got the impression that really funding is involved with neither one of those. And I just would like a little clarification on the process, maybe timing of it. And maybe, if you could, at some point, Mike, you can talk a little bit about the funding and how if fits into each one.

[DISCUSSION]

MR. MASNIK: My understanding of how this would work is that the NRC would issue the draft impact statement, get comments and issue a final impact statement.
That impact statement would form part of the basis of the future licensing action.
We anticipate a request from the licensee to change the TMI-2 operating license to align it such that PDMS is possible.
And that license change would change certain surveillance requirements and certain conditions that are within the license, presently, that can ensure the safety of the facilities.
The license amendment request would be reviewed by the staff.
And there would be a safety review. And this safety review would determine whether or not public health and safety could be assured based on these changes.
The impact statement would form a part of that review in that it would look at the environmental impacts of the storage period.
The impact statement is written in such a manner that it is our best guess. And it's generally a very large envelope, only because we want to be certain that we anticipate all possibilities in the future.
And that's why a lot of these numbers have big ranges.
If the licensee at some time in the future does something that violates one of these envelopes--well, let's put it this way.
The licensee cannot intentionally violate one of these envelopes by any of their activities.
And in fact, now when there is activity on the island, licensing activity, the licensee has to review that activity on the basis of the PEIS up to that day.
So the original PEIS in supplements one and two were taken into account.
Once the staff has come to the conclusion that the request for the license change is acceptable from a safety and environmental point of view, then there would be a change in the license.

(18-29)

Now that license change--the Commission has some certain procedures. And during that licensing, or that change in the license, there is an opportunity for the public to request a hearing. It's somewhat similar to the water issue in that the licensee came in with a request for a license change. And we had a request for a hearing. And the request was granted.

CHAIRMAN MORRIS: On that, Mike, that is--the license amendment is a determination by staff?

MR. MASNIK: Right.
In this case--the water issue is peculiar in that long ago it was decided that the Commission reserve the right to actually make the decision on the disposal of the water.
But normally, in our licensing activities, the staff makes that determination.

CHAIRMAN MORRIS: Okay. But unless the Commissioners would decide to make the determination, the staff would make this particular license amendment determination.
And so far, on the final PEIS and the determination in the license amendment you haven't stated any particular dependence on financing.
I'm hearing you saying it's more of a safety question?

MR. MASNIK: That's correct.

CHAIRMAN MORRIS: The license amendment. And therefore, the whole question we've got in here on funding, at least from the staff standpoint, would not be a consideration during the license amendment.

MR. MASNIK: That's correct. That's not something that the staff typically reviews when they do a license amendment.

CHAIRMAN MORRIS: Now if the public or this panel would want that considered--just giving you a possible circumstance--would want it considered, and requested a hearing, would the guidelines so stick that they don't allow one to look at the financing end of it; that it's strictly a safety consideration?
And I realize this is a judgement we're asking you to give us. But I guess from the panel's standpoint, we want to know at what point financing would be under consideration, and whether it would only really be under consideration come July of 1990 when the Commission deadline is required?

MR. MASNIK: I would say that unless something changes that that would be the case. That finance would not be the consideration in this situation.

(18-30)

Now I think that near term financial issue to some extent is, but in 30 years, that would not form the basis of the determination to grant the license to allow the licensee to enter PDMS.

[DISCUSSION]

CHAIRMAN MORRIS: Panel members have any question on what Mike has explained here at this point?
If not what I'd like to do--go ahead.

MR. SMITHGALL: I just have a question, back to the decommissioning rule. Do you feel it was the intent of safe store to take into consideration TMI?
7.10.b Maybe I'm not phrasing that correctly. Do you feel that TMI falls under those guidelines?

MR. MASNIK: I view TMI as an operating facility in the sense that it has an operating license, and therefore falls under the regulations that are applicable to operating--

MR. SMITHGALL: So it could fall under the safe-store option?

MR. MASNIK: I would think so, yes.

MR. SMITHGALL: Just wanted to clarify that.

CHAIRMAN MORRIS: Mr. Masnik, thank you, sir, for taking the table. There were several requests to be put on the agenda for public comment.

[DISCUSSION]

ERIC EPSTEIN, DIRECTOR, THREE MILE ISLAND ALERT, INC.: My name is Eric Epstein. My credentials are that I am a citizen in America. I believe I have the right to speak so I'm going to do so.
It's been quite a parade today. If I had known it would have been like this I would have cancelled my plans to go to Ickyburg Carnival later in the week.
Let me begin by saying I'm going to focus on a few events from last week. And I'm going to read through comments I had. And they basically deal with economics.
And another issue that the PEIS put forth as a positive aspect of delayed cleanup, and that is that there would be technology in the future.
So let me without further ado just read my comments.
Tonight I intend to focus on the research and economic parameters of postponing the cleanup of TMI-2, referred to as the post-defueling monitored storage option.

(18-31)

This discussion must necessarily encompass several generic issues associated with decontamination and decommissioning of nuclear power plants.

However, before I begin I would like to clarify several outstanding issues from the last meeting, and comment on some recent developments.

First, I would like to draw the panel's attention to an incident on May 13, 1988, in which GPU, and I quote, "misclassified" a piece of reactor core debris.

Similar incidents occurred in August of 1985 and December of 1987. In both incidences GPU's license to ship radioactive waste was temporarily suspended.

Waste management is a programmatic problem at Unit 2. Moreover, the NRC noted, and I quote, "We are concerned that your root cause analysis may not be affective in addressing human performance problems in distinction to related technical problems."

With these events in mind, how can the public be assured that GPU is competent to manage Unit 2 during PDMS with a substantially scaled-down staff?

And perhaps GPU has sensed the public's apprehension. Recently, they have bombarded local newspapers with ads portraying the merit of PDMS.

This is not a low-budget venture. A full-paged ad during the week in the Patriot News costs $3,553.95. And on Sunday that same ad sells for $3,760.35. Anybody reading the local newspapers have been seeing these ads consistently throughout the week, and on Sundays, the last few weeks.

Is the public subsidizing the slick PR campaign? How much has this campaign cost GPU? The cost and source of the funding should be disclosed so that the public can make an intelligent decision in this matter.

I would like to clarify several issues from the last meeting relating to decommissioning. TMIA is well aware that the Public Utility Commission factors decommissioning into the rate base, but (A) there is no criteria to determine dollar amounts, and (B) there is no provision for early retirement. 7.10.2

In addition, there is no mechanism in place to put money aside for an immediate or delayed cleanup. This is a fact. There is simply no accounting mechanism around, or ever devised to take care of what we would call an immediate cleanup or a delayed cleanup. It doesn't exist.

Today, GPU has failed to detail funding plans for the final phase of the cleanup, and they've failed tonight again.

And I'll address this issue in more detail later.

Also, I'll challenge Dr. Travers' estimates on the generic cost of decommissioning nuclear power plants. To begin with, Fred addressed it, and I think to some extent Tom did.

There is no clear definition for the term "decommissioning." Therefore, there is a wide variation in published estimates.

(18-32)

Of course estimates vary depending on costs, operational life, activity, design, et cetera. Dr. Travers stated it was approximately $200 million in 1988 dollars to decommission the nuclear power plant.

Tonight Mike said--at least 100 million? What is decommissioning to Dr. Travers? What is it to Dr. Masnik? What were his projections based on?

It's interesting to note that the nuclear power industry, the atomic industrial forum has estimated the cost for decommissioning from 30.1 to $129.3 million.

That's $29.3 million over the cost projected by the NRC's most recent document.

Analysis and Inference, Inc. estimated $173.3 to $694.9 million for a large pressurized water reactor, which is what TMI is.

And Duane Chapman, an economist at Cornell University has projected the cost to be $3 billion.

As you can see, estimating decommissioning costs is an inexact science. For this reason, Dr. Travers' estimate is objectionable, and points to the need to closely scrutinize all the NRC's and GPU's estimates and projects related to decontamination and decommissioning.

7.b.5 Let me proceed with the business at hand.

Many people who work with the public utility issue that I've spoken to express concern over the economic aspects of a delay cleanup.

Indeed, some of you on the panel have expressed doubt that money will somehow be available for decontamination activities in the eventual decommissioning of TMI-2.

This skepticism is commendable and warranted, as we've seen tonight. The reality of that matter is that the financing of an immediate or a delayed cleanup is sketchy at best. That's a fact.

Already--and this is important to keep in mind--already, GPU customers have shouldered a huge economic burden. TMI-2 was briefly in the rate base just for months. No cleanup funds accumulated, and that decommissioning account is broken.

While the general consensus by experts in the field is that rate payer equity should be maintained, GPU rate payers have already assumed an inequitable status.

Now for your knowledge, the rate payer equity theory stipulates that a person enjoyed the benefits of electrical genera--excuse me.

The theory stipulates that the rate payer's responsible for decommissioning cost since the person enjoyed the benefits of electrical generation.

However, the TMI rate payer was deprived of this benefit since Unit 2 was shut down prematurely.

While rate payer equity is a valid principle, in the TMI case it doesn't work. The TMI rate payer has been burdened enough.

(18-33)

For example, construction cost, cleanup cost and energy replacement cost. Now I want you all to consider these questions. Should the principal of rate-payer equity hold when imprudent management decisions encourage huge unknown costs? When management failure is responsible for the destruction of a $700 million investment, when an investment was rendered unusable after 1/120 of its projected life, should the next generation of rate-payers be liable because GPU does not want to engage in timely decontamination, and decommissioning activities?

With such obvious inequity, it is improbable that adequate funds will be forthcoming in the future.

If not, the rate payers, then who? GPU doesn't know where the funds will come from. I talked to Gordon Tomb who's in attendance tonight. And he indicated in a phone conversation to me on June 30th that the further decontamination funding goes beyond the Thornburg plant.

In fact, Gordon said to me that further cleanup funding is--and I quote--"is a little fuzzy."

I talked to Doug Bedell and he wasn't too forthcoming with information. He told TMIA on July 8th that the funding, and I quote, "The funding question should be addressed to the advisory panel." I'd be very surprised if people thought that the funding question was adequately addressed this evening.

PDMS further complicates the funding picture. At the time delayed cleanup is projected to take place, almost every license for a commercial nuclear power plant will have been expired.

By the year 2010 almost every license in this country for a nuclear power plant will have been expired. That's a fact.

The nuclear industry will be undergoing simultaneous decommissioning. Therefore, funding sources utilized for the TMI cleanup will either be unavailable or under pressure to bail out other nuclear utilities.

TMI-1 and Oyster Creek will also be undergoing decontamination and decommissioning. And those projects are likely to be underfunded.

In actuality, what we're dealing with here is generic economic questions related to the back end of nuclear power production.

These are the hidden costs of decontamination and decommissioning which GPU and the NRC would like to hide for another 20 years--if I understand them correctly tonight, maybe 60 years; maybe 90 years.

This is not a site specific problem. This is a huge headache.

To date, there has been no decommissioning of a large commercial nuclear power plant. That is a fact.

Costs are unknown and typically underestimated.

Let me give you an example. Battelle, Pacific Northwest Laboratory conducted several studies examining decommissioning costs between 1979 and 1982.

Battelle studies provided the basis for utility estimates. But these studies were based on the decommissioning of a 22.5 megawatt Elk River plant which operated for only 4 years.
This reactor was 1/40th of the TMI size.
Let me give you a quote here. "Many modern reactors can produce 50 times more power, and will operate at some seven times as long as Elk River." That's from Cynthia Pollock.
Moreover, there was no peer review. And the objectivity of the Battelle study is called into question due to their heavy reliance on contracts from DOE, the NRC, and the Electrical Power Research Institute.
When the study was updated in 1984, and I quote, "Costs had indeed risen much faster than inflation over the preceding 6 years."
This is nothing new to you. Everybody knows that projecting costs are an inexact science.
Just quickly, other reports from DOE and the Rand Corporation suggest that we can expect cost overruns. For example, and I quote, "A January 1984 report by DOE showed that out of the 47 reactors surveyed, 36 reactors cost at least twice as much to complete as originally projected, and 13 cost at least four times as much."
This demonstrates how unrealistic economic projections at the front end or the back end of nuclear power production are when based on unknown variables.
And we'll get to the issue at hand. Although the NRC stated that they have, and I quote, they "have had considerable experience with reactors that have not had a significant accident before the end of their usable lives," that experience is limited to small reactors.
In fact, many commercial reactors are not anywhere close to being decontaminated or decommissioned, primarily due to a lack of available technology.
This is what the NRC stated that one of the advantages of delaying the cleanup is. This is from the PEIS. This is one of the advantages.
"The monitored storage period allows time for continued development of decontamination technology so that the most effective and efficient techniques may be applied."
"Further reduction of occupational doses would be achieved through the use of advanced robotic technology, automatic chemical cleaning techniques, and advanced waste treatment methods."
The NRC anticipates--end of quote--the NRC anticipates an emerging technology. Yet, on Page 10 of this same document, the staff noted, and I quote, "The NRC has no plans to develop technology for cleanup following PDMS."
"This task would be left to the licensee. No commitment will be obtained by the NRC from the licensee to finance further development of technology."

(18-35)

Frank Standerfer said tonight the technology of compaction will be developed. And what he said, and I quote, Frank said, "Not a guarantee but a prediction."

Gentlemen and gentlewomen, these are predictions. All right? Where is this new technology going to come from? In 1984 Dr. Paul Woolam, a member of the Commission of the European Communities Team that studied decommissioning capabilities stated, and I quote, "Design of equipment for dismantling, especially remote equipment, is in its infancy."

In this field, GPU has portrayed itself as a pioneer, but is now content to sit idly by and wait for new technologies to be developed.

If not the NRC, if not GPU, and if not international agencies, then who?

Well, some people suggest, what about DOE and the Shippingport experience? Let's look at that.

Shippingport is a 72 megawatt pressurized water reactor owned by the Department of Energy. In order to cut costs, this is the plan.

The 800 ton 5 million curie pressurized vessel reactor, and the neutron shield will be put on a barge, which will sail down the Ohio and Mississippi Rivers, across the Gulf of Mexico, through the Panama Canal, up the West Coast, up the Columbia River, to the Hanford Reservation.

Pretty impractical for reactors that are 1000 megawatts.

The federal government is avoiding a valuable decommissioning experience by barging the entire reactor as a unit.

The radioactive debris has a guaranteed burial site, unlike the dilemma faced by commercial reactors which have no place to go after retirement, which Frank admitted today.

Therefore, the waste will be disposed of under unrealistically lax DOE waste site regulations.

Shippingport doesn't do us any good. As a footnote to this--I think you might find this interesting--DOE's funds have come under increasing pressure to clean up hazardous waste sites at defense plants. They're not going to have funds to research this technology.

The total costs range from 40 to 70 billion to clean up hazardous waste sites. These are just in military plants. We're not even going to get to decommissioning.

Therefore, increased research and development funding for decommissioning nuclear power plants from this agency is unlikely.

Not much in the way of research is being conducted by the utilities who have had to close plants prematurely. The entire industry is deferring instead of developing.

Take a few more minutes of your time. TMI is not the only plant that was prematurely shut down. Let's look what happened to the other plants, and I'll show you the nightmare that we're rushing into--or we're not rushing into, as a matter of fact. This

(18-36)

temporary storage has become a generic way of doing nothing.
Humboldt Bay. It was shut down 12 years ago because the cost of refurbishing it to withstand a major earthquake was more than the original construction and licensing cost.

Despite appeals from local citizens groups to dismantle the plant, it was put into temporary storage with no decommissioning fund set aside. Sound familiar? Let's look at Dresden 1.

Shut down 10 years ago due to radioactive corrosive products inside the piping. Partially decontaminated with chemicals in the early '80s, the plant is in temporary storage until Units 2 and 3 are ready for retirement.

Indian Point 1. Shut down in compliance with the Atomic Energy Commission regulations in 1974 because it lacked an emergency core cooling system, waiting for Indian Point 2 decommissioning at 2006.

Fermi 1. Put into temporary storage in 1975 due to an accident.

Peach Bottom 1. Put into temporary storage 13 years ago. If Peach Bottom doesn't open--there's no money. There's not enough money right now to decommissioning Unit 2 and Unit 3.

Why don't we look at GPU? They have a plant, a little known plant known as the Saxton Nuclear Experimental Facility, this utility that was before you this evening. They've got a little plant.

Owned and operated by GPU, this 7-megawatt reactor operated from 1962 to 1972. Saxton was placed in--you guessed it--temporary storage in 1972, and is scheduled to be dismantled in 1997.

Listen to this figure. Dismantling costs are estimated to be $12 million, 200 percent of the original capital cost, okay?

Several trends are readily apparent by examining these reactors. In each case, deferring was prompted by inadequate funding.

There is reluctance to undertake unknown tasks. Very little is being done in the way of research and development to decommission and decontaminate reactors.

All the above reactors were shut down prematurely, placing a strain on the licensee's cash flow, making research and development impractical.

And the NRC clearly accepts temporary storage as a means of getting around decontamination and decommissioning.

Final page. It is clear that the cost of postponing the cleanup is immense and likely to be unfairly distributed. The NRC and GPU's claims of future technologies and robotics will be developed appear to be wishful thinking.

As was noted, every utility is playing a waiting game, gambling that someone else will pioneer decontamination and decommissioning technologies.

(18-37)

I think we should listen to what this woman said. Her name is Cynthia Pollock, and she describes the problems with waiting 30 to 100 years to decontaminate and decommission a plant.
She did an exhaustive study for the United Nations. And I quote, "Assumptions must be made about the evolution of technologies and the likely increase in decommissioning costs, inflation and real interest rates."
"Estimates must also include provisions for stricter government regulations and other unforeseeable events. The staffs most familiar with the plant will have left."
"The company, and excellent record keeping will be required to inform the future crew of the reactor's intricacies and its operating history."
"The longer dismantlement is deferred, the greater the margin of error, and the higher the total costs are likely to be."
Let me remind you all, there's 1100 people working at Unit 2.
Can you imagine the chaos if we wait 20 or 30 years and we have to rehire 1100 new people who have never worked there before, okay?
Imagine the worker exposure, and the exposure to the public of people who haven't had this experience hanging out, trying to figure out what to do.
This is what I feel--or I should say what TMI Alert feels the advisory panel should do. We feel you should oppose PDMS for the following reasons.
Number one, it's more costly. Two, the cost is inequitable and will be born by the next generation of fate payers. Number three, there's an underlying assumption that the technology will suddenly come forward despite a lack of research and development.
The panel should recommend to the NRC that the cleanup of TMI-2 proceed immediately. GPU should be liable for cost and develop appropriate technologies. 7.6.5
In addition, GPU should develop a funding plan based on acceptability and realism to be reviewed by the Public Utility Commission, the consumer advocate, the Commonwealth of Pennsylvania, and citizens. 7.11.2
But also, I also have something else I'd like to say. I'd also like to address the question of worker exposure, which seems to be the fundamental issue GPU is gambling on.
First of all, we have to assume that these new figures that just came out are accurate. And I don't believe it.
I think what we need somehow is to get an independent analysis to either justify the NRC's statistics, or GPU's statistics because the brunt of the argument rests on the worker exposure equation.
I'd also like to say that you can mitigate the amount of worker exposure by using more workers and exposing them to less radiation. 7.4.4

(18-38)

And I would go out on my limb to say, according to sources that I have, that are not the word of God, that the workers that are there would like to stay there, and would like to complete the cleanup now.

That's just some comments on the worker exposure issue.

Finally, regarding the NRC's responses to TMIA's questions, Question 1 concerning the NRC's experience with decommissioning, the staff's answer fails to alleviate our concern regarding the federal government's lack of experience decommissioning in the nuclear reactor. There just isn't experience decommissioning a large scale nuclear reactor.

Question 6, we still remain unconvinced that adequate safeguards are in place for the movement and location of radioactive materials, and to the best of our knowledge, questions 7, 8, 9, 10, 12, 14, 15, 17, and 18 were not answered.

[DISCUSSION]

MR. EPSTEIN: I'm just going to take one minute and request an answer to these questions. And then I'll sit down and you won't hear from me for a little while.

Neil, a question for you--Chernobyl. Is it true that that plant that was in the accident is in the process of being decontaminated and decommissioned now?

DR. WALD: No, the plant is entombed.

MR. EPSTEIN: Okay. So it was entombed, which is an acceptable decommissioning process to some people.

Okay. I think what I heard Frank say earlier, that it's not practical to decommission one while another plant is running, well I want to bring out the fact that there are places like Chernobyl that would be decommissioned while there were others running simultaneously.

Quickly, I would like to--yes.

MR. RICE: But not decontaminated?

MR. EPSTEIN: Okay. Not decontaminated, but decommissioning activities are taking place.

DR. WALD: And entombment wasn't an acceptable solution here.

MR. EPSTEIN: Well, I'm going to move on. I don't want to take time. I was wondering if Mr. Kinter of GPU would implement an immediate cleanup if it was mandated by the NRC. And I'll just stop there since I'm at 20 minutes.

[DISCUSSION]

(18-39)

CHAIRMAN MORRIS: Eric, I appreciate your comments. I appreciate the detail that you went to to present it. Provides, I think, some good background.

(APPLAUSE)

[DISCUSSION]

FRANCES SKOLNICK, DIRECTOR, SUSQUEHANNA VALLEY ALLIANCE: When I'm sitting here tonight I also was reminded of the fact I'm really glad my children don't come to these meetings because I think they would be totally confused by our use of the English language.

I'm just totally amazed that, first of all, with PDMS we were talking about the licensee didn't specify a time period. Then the NRC comes along and says 20 years.

Then somebody comes along and says 30, then 40, then 90. I mean, as far as I'm concerned it could be a thousand--more than a thousand because most of the committee's clients [ph] are going to be around for thousands of years anyway.

These are our official comments, the SVA's official comments on the NRC's environmental impact statement.

We understand that the NRC staff must act upon any proposal submitted by the licensee. However, it is unacceptable to us that the NRC print the draft of its evaluation of this proposal in light of the inadequacy of the data presently available. 7.1.6

Unit 2 is clearly not close to being prepared for PDMS. Much work needs to be done, including the completion of defueling.

Data, particularly that needed to determine the quantity and configuration of remaining radionuclides has not yet been submitted, and will not be available for evaluation until defueling is completed.

The purpose of an EIS is to provide enough information to both the public and all interested parties so that they can carefully evaluate a proposal and determine its consequences.

Furthermore, the information is supposedly to permit public input into the decision-making process. Clearly, if inadequate information is provided, the EIS does not meet its requirement as defined in the Environmental Policy Act.

There are major weaknesses in the evaluation of radionuclides and their impact during PDMS. The most serious weakness is the lack of independence and objectivity in evaluating this proposal. 7.1.5

And that's also very clear in the responses to SVA and TMIA's questions at the last meeting.

The NRC uses the licensee's data rather than any of its own. In doing so, rather than evaluate the licensee's proposal with an open mind, they serve only to confirm and grant the licensee's desires, hardly an appropriate act for an agency supposedly regulating an industry.

(18-40)

Using the licensee's data, the NRC has calculated the inventory of radionuclides that will remain in the reactor and throughout Unit 2.

7.2.1 This inventory is presented in Table 2.4. No references are provided so the public might evaluate the amount of radionuclides which was removed during cleanup and defueling. Other references provided are for research undertaken by GPU Nuclear.

This lack of information makes it more difficult to evaluate the impact of delaying cleanup.

Concerning the discussion about activation products, on Page 2.27, if 90 percent of the activation products is assumed to have been removed during defueling, the research and basis upon which this assumption is made should be referenced.

This is most important in light of the NRC's submission that we find methods for determining the transportation of debris and radionuclides during an accident are not available.

Measurements of fuel and surfaces may be fraught with errors, both mechanical and human. And therefore, public scrutiny of the radionuclide content of Unit 2 during PDMS is essential.

Only full disclosure of information may make this evaluation possible. Furthermore, if 90 percent of the activation product is assumed to have left with the fuel, or to have been incorporated into stainless steel of the components and is inaccessible, as the NRC states, then would not part of this 90 percent also be a part of the inventory at the end of defueling, and hence be in addition to the 10 percent as estimated by the NRC to remain?

7.2.3 And another question I have about manganese-54, if it has a half-life of 312 days, would there not be more than 12 curies left at the end of 10 years as indicated in Table 2.3?

The claim that less than one curie of krypton-85 will remain during PDMS needs further scrutiny. A review of environmental releases of krypton-85 during the accident and subsequent cleanup does not account for the total inventory of krypton-85 present at the on-set of the accident, which I believe was 97,000 curies.

As late as October 1987, in a letter from the licensee to the NRC, the licensee stated that it was unable to account for as much as 335 curies of krypton-85.

We want to know where it is.

The claim that less than one curie of tritium will remain during PDMS also needs further scrutiny. There were 8800 curies of tritium present at the time of the accident.

The NRC claims that the accident-generated water contains 1020 curies. A review of environmental releases and additional reports shows that all of the tritium has not yet been accounted for.

And therefore, there is no basis upon which to conclude that only one curie remains--will remain during PDMS.

(18-41)

This issue is of particular importance to the disposal of the accident-generated water, and furthermore, to the determination of whether or not the water to be used in subsequent cleanup is accident-generated water as defined by the Lancaster City Agreement.

These comments address only manganese-54, krypton-85 and tritium. However, we feel that further scrutiny of the quantity and location of all radionuclides is of vital importance. 7.1.6

The need for independent evaluation of the radionuclide inventory is heightened by the facts that the licensee has on occasions miscalibrated waste, which has left the island, and moreover, by the discovery that instrumentation used for measuring strontium was miscalibrated for some periods of years during cleanup.

The public's trust in the licensee's ability to collect accurate data have suffered irreversible damage. When, in 1984, the licensee was found to have maintained a policy to systematically falsify critical safety data, and destroy documents for months leading to the 1979 accident.

In light of this, it is incomprehensible that the NRC should rely so heavily on the licensee's data. In December 1983, in NUREG 0683 Supplement Number 1, the NRC considered methods to reduce worker dose at TMI Unit 2. 7.3.1.5

One of the methods considered was that following defueling the plant would be placed in storage. The NRC indicated certain obstacles to this procedure, which included, and I'm quoting, "One, uncertainties about the development of robotic technology; two, lack of information about the feasibility and safety of interim storage; and three, lack of assurance that funds will be available for ultimate cleanup."

There is no evidence in the draft supplement that these obstacles have been eliminated. It is therefore appropriate that the NRC notify the public prior to any decision on PDMS how these three obstacles have indeed been overcome to enable the NRC to conclude that the licensee's proposal will have not significant environmental impact.

The public requires assurance that not only are efforts being undertaken by the NRC and the licensee to develop and help finance advanced technology for the cleanup, but also that funding is put in place for PDMS subsequent cleaning and decommissioning. 7.6.5

Furthermore, a mechanism which enables the state of Pennsylvania to take ownership of these funds should be made available. 7.6.4

The licensee stands to save $57 million by a reduction in its work force during PDMS. Those are their figures.

These funds should be laid aside for the people in this area who stand to lose, and who must shoulder the burden of a decaying radioactive site in their backyard.

(18-42)

7.5.7 It's ironic that in evaluating the regulatory considerations of delayed cleanup in the EIS the NRC fails to mention its policy of encouraging licensees to remove all radioactive waste from the site when possible.

This is the policy to which the NRC so fervently clung when the public asked them to consider and accept the storage of accident-generated water on the island until the tritium had decayed.

It is exactly the kind of behavior which continues to erode the public confidence in the regulatory abilities of the NRC.

It is not surprising to us that the NRC concludes that any of the alternatives considered in this draft will not significantly affect our environment.

Even the lack of a firm factual basis could never preclude the NRC from finding in the licensee's favor.

Whether cleanup is immediate or delayed, let's make no bones about it, the public must suffer the consequences of millions of gallons of radioactive water going into their drinking water supply, and the venting of radioactivity into their air from Unit 2 for a nonspecified period of time.

Only those who must carry the burden of radioactive exposure with no provision of electricity to off-set the cost have the right to decide whether GPU Nuclear's proposal will not have a significant environmental impact.

The NRC must provide the public with the tools to make such an evaluation. This draft does not provide those tools.

In conclusion, the NRC must provide more information as it arises. They must provide the basis and research for their assumptions.

Only when the public has been given this information, a sufficient time to evaluate it and provide input to the NRC, only then should the NRC render a decision on this issue which will effect those of us living here for the rest of our lives.

Furthermore, along with any decision on this proposal, the NRC has an obligation to us, the public, to one, establish administrative procedures which will ensure that the licensee will complete cleanup; two, obtain a commitment that should cleanup be delayed, the licensee will not refurbish Unit 2; three, ensure that adequate funding is set aside for use by those who clean up TMI; and four, ensure that both the NRC and the licensee commit money to the research and development of technology to be used in

7.11.2 cleanup.

Thank you.

CHAIRMAN MORRIS: Thank you.

(APPLAUSE)

CHAIRMAN MORRIS: Any other comments from the public?

(18-43)

[DISCUSSION]

BRIAN HUNT, CITIZEN: My name is Brian Hunt. And I'd just like to point out that you all have been asking a lot of questions about economics and funding. You've been getting a lot of double-talk from this side of the room.

Mr. Epstein comes up and presents you with some data which I think will be important when you jump on his case. Maybe you should give them five minutes, and him--30 minutes, and maybe you'd have more meaningful information.

CHAIRMAN MORRIS: Sir, for the record, I do want to respond to that. I didn't jump on Mr. Epstein's case--please let me finish.

We have a standing requirement here that if you want to get on the agenda for additional time beyond five minutes we will go up to ten minutes.

Somebody else gave Eric additional five minutes, which was 15. I was just speaking to the question. It's a long-standing ground rule that he understands.

I did not give him a hard time. I just let him know that he had extended to a certain point. For the record, that's why I made the comments that I did.

MR. HUNT: You heard an extensive amount of double-talk. And you got some meaningful information--

CHAIRMAN MORRIS: I'm not speaking to the information--

MR. HUNT: I'll go on at this point.

CHAIRMAN MORRIS: --I'm speaking to your comment regarding my--

MR. HUNT: I want to talk to the point of rate payer equity. And I want to clarify that that issue is important not from the perspective of fairness, but from the perspective of likelihood. 7.6.5

Will there be a willingness on the part of future rate payers to pay for this? And if there's not then your funding question is once again in doubt.

Many of the rate payers under GPU's proposal here, if you're talking 30 year delay, are not even born yet, that will be asked to bear the cost of that.

And certainly, many, many more of them were not born at the time of the accident. So this issue of equity comes very much to their minds when they will at some point be posed with the question of paying for this decommissioning.

They won't have experienced it, so they will have to go back and read about it. They will read about that pesky little leaky valve.

They will read about how these people falsified documents, obscuring the importance of that leaky valve. They will read about how after only three months of electrical generation these people melted that fuel, and they will know that that leaky valve and that falsification of documents which was a criminal act led to the masking of the loss of the cooling accident, and that in fact it was that event that caused that fuel to overheat twice to the point where it melted.

And those people will say--to GPU and to the government, those people will say, "You did what?" Those people will say, "You want us to pay how much?" Those people will say, "Bullshit." Now you may take offense at my use of that word here, but that's the word they will use then.

What if those people are not the fools that GPU thinks they are. What if they're rational people and say this is not our bill, we're not going to pay it.

What does that mean for this claim? Or what if they aren't the fools and they find out that they have no choice because in fact we were the fools to let GPU get away with this now and force a funding plan on them for acts that they were in no way responsible for, for acts that they weren't even on this earth when they were committed.

What does that mean to all of this discussion that we're having here tonight?

GPU knows that they're making fools, either out of us in this room, or that future generation of rate payers.

And as part of this whole mascarade they're going to the NRC and saying, "Help us with this problem. And we had this little accident a few years back. And we're in a position nobody's ever been in before. Tell us what we should do."

Well, I think you should tell them. Tell them it's your problem, sucker, you pay for it. The future generation is not going to do it. And you putting off this decision is not going to make that money available in the future.

Just recognize that those people aren't the fools that thinks they are. And please don't be the fools that GPU thinks you are. Thank you for your attention.

(APPLAUSE)

CHAIRMAN MORRIS: Who is next? Yes, Ma'am.

DORIS ROBB, CITIZEN: I'm Doris Robb from Lancaster. I have a brief statement I would like to make and then two questions that I would like to address to Mr. Standerfer.

I did not ask for time on the agenda because these questions and comments came out of what I heard this evening.

(18-45)

First of all, this is with interest to Dr. Wald's remarks about his experience in Chernobyl. And as he was talking I heard him say that Unit 4 is now entombed, and that's the way they handle their problem.

I understand that 99.5 percent of the radiation has been removed from Unit 2, and the question that I will address to Mr. Standerfer is why cannot entombment be considered, then, for Unit 2. 7.10.4

Seems to me that that would solve a number of problems which we are discussing. The major concern for GPU Nuclear seems to me worker exposure.

This certainly would reduce the risk of worker exposure. It would also eliminate the expense of future cleanup.

The storage of debris which would be removed in 20 years would possibly eliminate the risk of that one point, or the one in 2 billion chances of cancer which he was referring to, or the one in 27 million chances of genetic defects.

These statistics really do make me recall statistics that I heard prior to the accident at Three Mile Island. I can't recall specifically what it was, but it doesn't make any difference at this point.

But I know that the public was told at that time that there was one in several million chances that an accident such as TMI could occur to begin with.

That was information provided for us by our eminent experts at that time.

We've talked this evening about new technology, the possibility of using robotics and future technology. I would think that entombment would eliminate the necessity for having to depend on new technology for which we do not know that funding will be available or that the technology will be forthcoming, since we have not advanced all that much.

We were told at the beginning--I recall in the '50s we were talking about the wonderful technology of nuclear--and the problems of storage would be solved in the future.

Here we are in the future and those problems have not been solved as yet.

Since it is understood by Dr. Marston speaking for the SAB that no plan is under consideration for restart, my question remains, why not entomb the plant?

My second question to Mr. Standerfer is if the tritium water is so innocuous, why can't it be stored in the reactor building instead of being evaporated?

Thank you for your time.

(18-46)

CHAIRMAN MORRIS: Thank you.

Mr. Standerfer, do you prefer to respond at this time?

I'm going to take your response. I'm not going to take any additional comment regarding your responses. I'm going to go to the gentleman back here next.

MR. STANDERFER: Yes. The NRC decommissioning regulations do provide two ultimate fates. One is entombment; the other is removal.

The NRC regulations with regard to entombment would require that to only apply to facilities which will decay--the radioactivity will decay in roughly a hundred years.

So the fuel must be completely removed. In the Russian case, they entomb fuel and all. That type of entombment would not be allowed under current NRC entombment regulations.

And in fact, if TMI-2 were to be entombed under the regulations, more of the residual fuel would have to be removed.

But entombment is a potential case. Then you look at the environmental situation, and you may decide not to entomb a facility that's on an island in the river.

So while entombment might be acceptable for a commercial reactor located in a different location, it may not be acceptable for this reactor. We haven't evaluated that.

The other thing with regard to waste storage sites and so forth, my understanding of the NRC regulations is if waste has been removed from a facility, and is in a condition which is ready for disposal, the regulations require that it be disposed of.

The water is ready for disposal. And the regulations would require us to dispose of it.

The waste that's in the facility now has not been removed nor packaged, nor ready for disposal. So it's not the storage of waste under the regulation.

MS. ROBB: May I just ask one further question?

CHAIRMAN MORRIS: No, Ma'am. I'm going to let the gentlemen back here--I indicated that he would provide the response but there'd be no follow-up questions.

TOM BAILEY, CITIZEN: Good evening. My name is Tom Bailey from Harrisburg.

I do not have the knowledge that a lot of people who have spoken before me about nuclear events have. I just have some reflections.

First would be times that I come to the Citizen's Advisory Panel. The only persons other than utility persons or NRC persons that speak--citizens that speak--always speak against what the utility's asking for.

When is the last time you heard any citizen advocate--speak for the utility? I've never seen it. I ask you to think about it. Second, in my understanding of what had happened this evening, the utility said we are at a point now in taking care of the plant that we are considering worker contamination.

We feel it might be too dangerous to continue. And, therefore, we like to postpone it and clean it up later possibly.

The first question is, they've already done from the diagram, you saw where Figure 4 was. Figure 4 is approximately, what, 75, 80 percent of the way down?

Why is worker contamination considered now, after the job has already been nine, 10 years down the road? Why is it important now? Because it's a false issue.

We're dealing with a business. And when you're dealing with business, you're dealing with money. And that's what the issue is--is money.

If we were a corporate board here, and if these gentlemen and women were standing as a corporation to look out for the interests of the citizens of this area, you would have a proposal before you.

You have a contractor that's done work for you. And think about it in a business sense, because they're a business.

They have two units here, one, screwed up. They had to clean it up. The other one's still going. Now the proposal is, let us postpone cleaning up that second one until the first one's done, too.

Well, I'm not very smart but I know that one bird in the hand is worth two in the bush. And if they want to keep the other one operating they should be forced to clean up the one they have now because when they're done with that Unit 1, they're going to be gone. They're going to be out of here.

I mean, talk business--talk business sense. They aren't going to be here when they have no more money to make here.

But who is going to be here? Look around the room. People that live here. Fred Rice, this man Mr. Smithgall. Smithgall raises the question, who's going to pay for it. I guess I don't understand, NRC, GPU--who's going to pay for it?

It'll be taken care of; it's going to be in--it's in the NRC regulations. Yes, Mr. Mike is very interested now.

I don't trust the government to enforce the payment of a business debt. It's a business debt that directly affects all the citizens of this area.

And it's going to be there unless they're forced to clean it up now. I'm going to ask the members of the advisory panel that have not spoken to speak so that we can hear what you--especially the three members to the right--what you have to say. We'd like to hear.

(18-48)

My last two comments would be, if this was a business proposal submitted to this as a corporate board, I have no question that it would be denied.

It doesn't make good business sense. The people of this area have put up with this for a long time. It may not have been the smartest thing to do, but now we can't let it continue to where we're put to a detriment forever.

Twenty years down the road--look at the people that propose these things. Where are these people going to be in 20 years? The question is are they going to be?

We are going to be here--my generation. Yes, that's one reason I'm speaking up cause I'm going to be here and I'm going to have to pay.

I don't want to have to pay for it. They made the mess. Let them clean it up in their lifetime.

Thank you.

CHAIRMAN MORRIS: Thank you.

(APPLAUSE)

CHAIRMAN MORRIS: Panel members. At this point is there any additional comment that anybody on the panel would like to offer at this time?

MS. MARSHALL: Perhaps I could just say that the comments of the last speaker do have some legitimate sense to it.

I don't think that any thinking person really wants to put off to the next generation what should be taken care of by the people today.

And the mention of a sinking fund was supposed to provide for building up a fund which will be devoted to the bench for cleaning.

Now whether it should be now, or whether it should be 90 years from now, I think is highly questionable.

CHAIRMAN MORRIS: Any other panel member like to make an observation or a comment?

(NO RESPONSE)

[DISCUSSION]

MR. SMITHGALL: How do you respond to SVA's comments in reference to the configuration on the bottom of the reactor vessel, and also the inventory of radioactive nuclides in relationship to deciding on PDMS now--as issues that would go along with the other two that you just mentioned?

(18-49)

MR. MASNIK: I don't understand the question.

MR. SMITHGALL: In other words, do you feel you have enough information in reference to the inventory question brought up by SVA in configuration as it relates to PDMS?

MR. MASNIK: Well, I think they've raised the point. And to some extent it's a valid point.

MR. SMITHGALL: Do you feel it's one that would be worthwhile extending the comment period to allow that comment to continue, or final EIS position?

MR. MASNIK: But I think we're missing the point of what the procedure is here. That is that the federal agency puts out a draft document. And people comment on that document. And those comments are then taken by the agency. And those comments are factored into the final document.
Somewhere along the line here we're getting in the direction of some intermediate period of question and answer. And I'm not so certain that that's--

MR. SMITHGALL: Maybe you missed something.

MR. MASNIK: Well--and I think they pointed something out. And we have to look at now our document and see if something was missed, and if it was missed that we have the obligation to incorporate it in the final.
And I think that's the direction I want to go. Now these other two issues that were raised--the panel in the last impact statement, we incorporated your comments based on what was contained in the transcript.
And I suspect that we would do the same thing in this case. And if we have another meeting between now and October, those comments would be incorporated in the final.

MR. SMITHGALL: How about the comments of other people, other than the panel?

MR. MASNIK: If they're raised at the advisory panel meeting, I think we can include those.

MR. SMITHGALL: Is it delay that you're speaking of based on travel schedules and convenience, or based on other things?

MR. MASNIK: I think it's based primarily on the fact that we've had one notice. We had a second notice, a second--and extension. And I want to get on with the process of issuing a final on this particular document, or this particular issue.

(18-50)

And I'm willing to consider these other two issues because the panel raises them. And quite frankly, I think they're important. And I think that we can do that. And the final document would reflect it. And I think we can even go so far as to say that the panel will meet with the Commission before the final is issued.

MR. SMITHGALL: I'm just concerned here that there--and I understand the extension already granted and so forth. I'm wanting to keep moving forward with it.
But we're now talking about an extension on an issue that we're dealing with, potentially a storage issue of 60 years, not on an issue as the previous EISs that may have been concerning issues that take place within, say, the next 5- to 10-year period.

MR. MASNIK: I'm not so sure that the final will reflect issues of 60 or 90 years. And the reason is that is a decommissioning issue. Okay? And that decommissioning issue--

MR. SMITHGALL: Twenty years.

MR. MASNIK: --is based on the decommissioning rule which is something that has already been argued before the Commission.
That's an issue that this panel--well, that's an issue that has already been decided. And there is a final rule out on that.

DR. WALD: But the problem is the relationship between the subsequent decontamination and the time of decommissioning.

MR. MASNIK: I understand that. And that is an issue that there's a problem in the finding between the licensee and the NRC. But I think the panel has identified that problem.
And I think that's one we can deal with.

[DISCUSSION]

MR. RICE: I don't want to belabor the point but if immediate cleanup is started does that put Unit 1 out of commission, because of the tie in?

MR. STANDERFER: Well, if some option like that was opted for, we would have to design it. It hasn't been designed. I don't know what would be involved in the effort.
We're taking the plant to the stage that the equipment and systems and so forth that we have on hand will practically do. And we have to start over with a new study and design. And it would take some time to do that. And I don't know whether it would have an impact on Unit 1 or not.

[DISCUSSION]

(18-51)

No. 26

Comments Received at the September 7, 1988,
TMI-2 Advisory Panel Meeting

[DISCUSSION]

CHAIRMAN MORRIS: There was also another letter provided by Dr. Marston regarding my request at the meeting for minutes of the TMI-2 Safety Advisory Board, specifically regarding any discussion that took place at the board regarding providing funds for TMI-2 decommissioning.

He did acknowledge in his letter that there was no such reference in those minutes. He said providing the funds for TMI-2 decommissioning was not considered to be a safety matter and, therefore, only brief recognition was given to the funding requirements in the board's discussion of the PDMS. As a result, there was no mention of them in the minutes of the meeting.

And then, the third letter that I received, I'd like to mention, is from Ed Kintner, Executive Vice President of GPU. There was a discussion at the last meeting regarding funding for the PDMS, and I'd just like to read one sentence out of this, and I believe that this letter, if it's not part of today's minutes, was included in the last--in the minutes of the last meeting.

But the sentence I'd like to read goes as follows: "GPU Nuclear understands that the rule applies to TMI-2 and would cover all activities involved in the decommissioning of the plant starting from post-defueling monitor, storage, conditions", and that's the ruling involving the general requirements for decommissioning of nuclear facilities that was published by the NRC, which requires licensees to submit by July 1990 a report containing plans for decommissioning all licensed reactor plants.

[DISCUSSION]

MR. MASNIK: The final item is PDMS-SAR.

On August 16th, 1988, the licensee submitted a safety analysis for PDMS, and Frank spoke about that earlier this evening.

The submittal included a system-by-system analysis of the plant in the PDMS condition. It included a revised possession-only license and a new set of PDMS technical specifications.

Also included was the man-rem estimate for occupational exposure, which will be the subject of further discussion in a few minutes.

The PDMS-SAR submittal forms the basis of the licensee's safety review. In order for the licensee to enter PDMS, there has to be a change in the license. This license change involves a safety review and an environmental review.

(26-1)

The PEIS Supplement 3 will form the basis of the staff's environmental analysis while a review of the licensee's recent submittal will form the basis of the safety review.
We expect to be working on this review the rest of the year and probably into next spring. The licensee's amendment will be handled just like any other license amendment, allowing for a hearing if genuine issues in the eyes of the ASLB are raised.

[DISCUSSION]

CHAIRMAN MORRIS: Any questions on the first part of the NRC staff report? If not, we can move right on to the, I guess, Number 4, which is Results of NCR Review of Licensee's Occupational Exposure Estimates for PDMS.

[DISCUSSION]

MR. MASNIK: Recall at the July meeting, the licensee provided the comments on the PEIS Supplement 3, which included the licensee's estimate of occupational exposure for both immediate and delayed cleanup.
The NRC staff received these comments just several days before and did not have the time nor the backup information to perform a review of the licensee's submittal.
The licensee provided the detailed technical documentation of their analysis on August 12th, 1988, and our contractor at PNL has been working day and night to complete our review by tonight's meeting.
You met our contractor during the last two meetings, Ms. Becky Harty of Pacific Northwest Labs. She was unable to attend the meeting tonight. So, I volunteered to present the results of her review of the licensee submittal and a re-analysis of occupational exposure.
She has prepared a handout for the panel which I believe you already have.
As a matter of background, there are these components to an analysis such as was submitted by the licensee: task-by-task description of what needs to be done, the exposure rate estimates based on the general radiation levels in the area that the task is to be performed, and the job-hours or manpower and time needed to perform the task.
The methodology superficially is quite simple. You identify what you need to do, you determine the general radiation level in the area that you plan to do the work, and you multiply it by the job-hours required to complete the task.
In actuality, it is not an easy task since much of the data used in these calculations are estimates.
What the NCR staff did was first understand the licensee's methodology, and this involved numerous discussions with the licensee staff and some additional documentation.

(26-2)

Next, we looked at what the licensee submitted and determined if their estimates were reasonable.
This entailed an examination of their lists of tasks, their estimates of general area radiation levels, and their manpower requirements.
Finally, the NCR staff took the new information provided by the licensee in their submittals and re-estimated the occupational exposure for both immediate cleanup and delayed cleanup.
One asks how was the licensee's recent submittal different from the analysis we performed when we wrote Draft Supplement 3 to the PEIS. First, we should explain that the dose estimates in the Draft Supplement 3 were developed using Final Supplement Number 1 to the PEIS, which dealt specifically with occupational exposure.
Tasks were added that had not been previously considered and tasks were deleted that had already been performed, and job-hours were adjusted for tasks that were partially completed.
The licensee, on the other hand, used a recent report which formed the basis for the task descriptions and the task job-hours.
As we mentioned earlier, the three components to an estimate are the list of tasks, the exposure rate estimates, and the job-hour estimates. Let's examine each of these components.
The task-by-task listing of the two estimates differ principally due to the addition of tasks that the NRC had not considered previously and, in some cases, tasks were considered by the licensee which the Draft Supplement 3 had assumed had been largely completed.
The second component, exposure rate estimates, were essentially similar in both the Draft Supplement 3 analysis and the licensee submittal.
The third component, job-hour estimates, differed significantly.
The job-hour estimates for task by the NRC were considerably lower than those estimated by the licensee in their recent submittal.
This difference is due in part to the assumption by the NRC that decontamination methods would be employed to complete the cleanup in the most expeditious manner, by using largely destructive methods.
In some cases, we felt that the licensee's job-hour estimates were too high. However, we felt that they were not unreasonable, and we also felt that the licensee is in the best position to estimate how much time a task would take.
Furthermore, we recognize that the initial estimates for the completion of the cleanup after the action was given in months, and we are now rapidly approaching 10 years.
The methodology used by the NRC and the licensee was found to be essentially the same. So, what can we conclude?

(26-3)

Well, after reviewing the licensee's submittal, we found that there is some disagreement in some of the estimates of the amount of time it would take to complete a task. However, we find the licensee's submittal reasonable.

We also computed our own re-estimate of the anticipated occupational exposure for immediate and delayed cleanup using the licensee's new data and our own methodology, tempering some of the job-hour estimates.

We have summarized our findings in the handout, and we have a slide here that I'll get Lee to put up that compares occupational dose savings.

What we have here is, on the left-hand side, the various documents in which occupational dose is reported and, across the top, we have either immediate cleanup or what the licensee calls post-phase-3 cleanup, and delayed cleanup or what the licensee calls post-PDMS.

The third is the difference between the first and the second column. As you can see under Draft Supplement 3, we talked about an occupational dose savings, the most right-hand column, of only 250 to 1600 person-rem. Appendix 1-A of the SAR, 30 years in PDMS is the licensee's estimate, based on a 30-year period of PDMS.

The third line, Appendix 1-A of the SAR, 20 years in PDMS is most comparable to the NRC's estimate of 20 years between the end of cleanup and the end of PDMS and post or delayed cleanup.

The third line is our revised occupational dose estimates based on the re-analysis using licensee data.

As you can see, our estimates of person-rem for immediate cleanup and delayed cleanup are lower than the licensee's. However, the actual occupational dose savings, which is really the most important column, the right-hand column, is approximately the same. So, although we estimated lower doses, the savings are about the same.

MR. ROBINSON: Mike, did you say 20 years?

MR. MASNIK: Yes. We assumed 20 years. Obviously, if you go to 30 years, you get a greater savings because of decay.

I'd like Lee to come back and talk a few minutes about taking this one step further, and that is what this means from the standpoint of cancer fatalities.

MR. SMITHGALL: Mike, maybe we could leave that chart up there? We might be able to refer to it. Maybe not necessarily blacken the room, but other people might want to refer to that for the discussion.

MR. GERUSKY: Mike, to put this in perspective, what total occupational dose in person-rem to present time mean?

(26-4)

MR. MASNIK: I'm not exactly sure. I think someone from the licensee probably could answer that.

VOICE: 6000.

MR. MASNIK: 6000.

VOICE: 6000.

DR. WALD: That is up to now?

MR. THONUS: That is correct. It's up to the present.
If you look at the bottom line, the 3 numbers, 3 ranges of numbers that we have, the immediate cleanup of 4,300 to 10,900 man-rem, the number of expected fatalities would range from 0.6 to 1.5. The delayed cleanup, which, on the slide, has a range of 1,750 to 4,600 person-rem, would result in, again, a statistical estimate of 0.2 to 0.6 fatalities.
And the dose savings in person-rem of 2,600 to 6,300 would be a savings of 0.3 to 0.8 fatalities. Again, these are stochastic. In reality, we don't have tenths of a person, but it gives you a perspective of what you're looking at.

MR. MASNIK: I think all of this will be set forth in greater detail in the final version of Supplement 3, but that essentially concludes our presentation, and if you have any questions, we'd be happy to try to answer them.

CHAIRMAN MORRIS: Anybody at this point have any questions?

DR. WALD: If I understand right, then the NRC feels there's a greater savings percentage-wise than the licensee has indicated because you start with a smaller total and your savings is equal to that of the licensee.
So, you are saying percentage-wise that there's a greater savings than the licensee has postulated.

MR. MASNIK: That's correct.

CHAIRMAN MORRIS: Any other questions?

MR. SMITHGALL: I'm not an expert in this, but I need to just have something clear in my mind on the job-hour estimates which you said is an area of those three factors that in this report that showed the greatest differences.
And I want to know how you--well, what the methodology was to temper those job estimates, job-hour estimates, that you used versus what the licensee used in line with your comment and your statement that you were initially looking at a forty-eight month or 4-year cleanup and now we're closing in on 10 years.

(26-5)

How do you reconcile those things? I mean, we have been told that these things are going to take so long and they always take that long.

MR. MASNIK: That's correct. I mean, we basically have to defer to a great extent to the licensee on these estimates because they are truly the experts on it.
There are--there were some numbers that were reported that our contractor felt that were certainly extreme estimates, and essentially what she did was, based on her background and the experts that she employed at PNL, reduced some of those numbers. She looked at the licensee's justification for those man-hours and felt that, in some cases, the justification was not there. All I can say is that it was essentially our best estimate of hours. It was broken down by task and each task was looked at in detail.

MR. SMITHGALL: When you're looking at this, using that analysis or that theory, when you look at the experience that you gain in this cleanup, it seems that NRC should have a track record that the licensee has shown in their estimates, and can you rely on them to be even close, such that even tempering them a factor higher--I guess what I'm getting at is whether or not you feel you've factored them appropriately, feel confident in that, because that could skew your numbers, I would suspect.

MR. MASNIK: I think you're correct in saying that it could affect the numbers dramatically, but I think it's our best estimate and I think we feel comfortable with them.

MR. MILLER: Mike, I think it was the EIS, there was an estimate of dose in terms of natural background radiation over the next 20 or 30 years. If I recall, it was the population in the surrounding area.
Has there been done an estimation of the natural radiation burden of this same cleanup population that we can see around the next 20 years, waiting to clean it up?

MR. MASNIK: In other words, the workers themselves?

MR. MILLER: The workers. The workers, not the public.

MR. MASNIK: Not to my knowledge.

MR. GERUSKY: I'm not positive of this, but in looking at that just very quickly, it appeared that the utility also used some dose reduction factors based upon new processes and robotics as part of their total dose reduction package. Is that correct, and if it is, did you also take that into consideration in your review, or is it just the same work performed at a later date?
(26-6)

MR. MASNIK: I'm sorry, Tom, but I can't answer that. I don't know for certain.

MR. GERUSKY: I'm not certain that that's correct in the review. I think it was in there, but I'm not sure.

MR. MASNIK: My understanding was that there was savings from that.

MR. GERUSKY: Not tremendous savings, but it was taken into consideration.

CHAIRMAN MORRIS: Mike, I'm paging through the PEIS and I can't find the chart that showed your numbers for cancer fatalities within the PEIS.

MR. MASNIK: Look on page vii. Right at the very beginning. It's maybe four-five pages in. Three pages in from the front.

CHAIRMAN MORRIS: Okay. I have it.
Could you tell us how these revised numbers vary from what was in this report, and could you give us that in the form of cancer fatalities at all, if possible?

MR. THONUS: I guess the audience can't see what you have in your book that I have in front of me, but what we had published in Draft Supplement 3 was a range of estimates of 0.04 to 0.4 fatalities based on an immediate cleanup over a 4-year period which would result in 300 to 3100 person-rem.
Our revised estimates are up there on the slide, and that came out to be 0.6 to 1.5 for the immediate cleanup in fatalities, and for the delayed cleanup, it came out to be 0.2 to 0.6.

CHAIRMAN MORRIS: So, you significantly changed your numbers since the PEIS. Is that what you're saying?

MR. THONUS: Yes.

CHAIRMAN MORRIS: Taking the lower end and increased it by a factor of ten, I think, or nine or something like that and you're going to just about double it.

MR. THONUS: Yes. The lower end is actually a little more than a factor of ten: 4300 versus 300.

CHAIRMAN MORRIS: Okay.

MR. THONUS: And the--

(26-7)

CHAIRMAN MORRIS: I'm looking at your difference and I shouldn't be doing that. I should be looking at the 4300. So, you've gone almost fourteenfold in the lower end and over threefold in the upper end.

MR. THONUS: That's correct.

CHAIRMAN MORRIS: Okay. Does anybody else have any questions at this point on what's been presented?

[NO RESPONSE]

CHAIRMAN MORRIS: If not, I'd like to move along to the next item on the agenda, which is a presentation by GPU on the Funding Plan.

MR. STANDERFER: Frank Standerfer, Director of the TMI Cleanup. Chairman Morris, my intention at this point was to introduce Ed Kintner's letter into the record, and read the same passage which you read at the beginning of the meeting. We believe that satisfies the commitment that the company has made to provide funding plans in accordance with the NRC regulations for future work in the plant, and it would include all work from the PDMS condition through the end of decommissioning.
And I simply wanted to make the point you made earlier.

CHAIRMAN MORRIS: Okay. Does anybody on the panel have any questions on the letter that we now have received and the one that I read an excerpt from earlier in the meeting?

7.10.1 DR. WALD: I may have missed it, but does the NRC representative confirm the applicability of the rule at TMI-2?

MR. MASNIK: Yes, it does. It is applicable, and I think we're construing the letter as a commitment to include in the NRC-required funding plan financial planning for all activities involving the decommissioning of the plant, starting with PDMS.
The rule, as it's written, doesn't require that it be broken down by activity, but that it just make a commitment to raise the money that's required by the rule.
We're construing this letter as a commitment to go further than that and include all activities necessary for the cleanup, for decommissioning.
Since we must submit plans for TMI-1 and Oyster Creek at the same time, I believe, as we have said in earlier statements, we would be looking at the decommissioning of the two reactor sites as one activity, including all of the work requirements.

CHAIRMAN MORRIS: On the severe report.

MR. SMITHGALL: Let me ask a hypothetical in reference to your interpretation of the new decommissioning rules. What if 30, 60, 90 years from now, the decommissioning costs put the licensee in a situation where they cannot ensure the public health and safety at one of their operable plants by incurring the costs of decommissioning at that time of plants that they want to decommission? How would the NRC interpret that then as it would pertain to these new decommissioning rules? 7.10.8

MR. MASNIK: I think the Commission has recognized that this possibility may occur and, I believe, in the Atomic Energy Act there is the option of the Federal Government actually stepping in and taking over decommissioning if public health and safety is jeopardized by inactivity on the part of the licensee. That's the only thing we can commit to.

MR. SMITHGALL: Because I think the concern of a lot of people in this area as to deferred cleanup is whether the licensee will be around at that time, whether the plumbing will be in place, and whether the NRC will allow them.

MR. MASNIK: Well, I think that's why this funding plan has to be looked at carefully, to make certain that it includes the activities necessary for a complete decommissioning and that there is a plan in place to raise some money.

MR. SMITHGALL: I mean, we all make these commitments daily. I guess I'll have enough money to pay off my mortgage assuming I still have a job. So, it's clear that GPU wants to make the effort. It's whether or not they can make the effort that I'm concerned with 30 years hence.

MR. MASNIK: But the banks still lend money for mortgages, you know. It's a question of trust, I guess.

MR. STANDERFER: I might say, Tom, that it's more than a whim. It's actually the accumulation of the funds, also, as part of the whole process.

MR. SMITHGALL: That's right.

CHAIRMAN MORRIS: But we don't know, I guess, at this point what would be required in order to accumulate the funds. In other words, it could turn out that you submit a 30-year plan to provide $10 million a year, whatever, some fictitious number like that. It might be more--make us feel more comfortable if the plan would say that in the first year, you would put all of the money into a fund, and I'm sure that won't happen.

(26-9)

So, you know, it's still a mortgage situation that I'm sure you will outline in your plan.

MR. STANDERFER: That's right.

CHAIRMAN MORRIS: Which will vary your ability to pay for that, will vary with time.

MR. STANDERFER: And depends on revenues from our existing activities.

CHAIRMAN MORRIS: Well, I appreciate the clarification tonight. I think that was very helpful to us.
Anybody on the panel have any questions at this point?

[NO RESPONSE]

CHAIRMAN MORRIS: If not, I'd like to move on to the three individuals from the public at this time to offer their comments.
I believe the first person is Debra Davenport for five minutes, if she is present.
Good evening.

MS. DAVENPORT: I have some questions, not so much comments.
This is sort of going back to an original subject, but it does relate to PDMS, and that would be the evaporator.
Since that is going to be used by GPU for designing, will that be taken out of cleanup costs? Will that--could that be public in some way--

CHAIRMAN MORRIS: Let me ask. Are your comments basically related to the evaporator issue?

MS. DAVENPORT: No. Really, only to PDMS and the evaporator costs.

CHAIRMAN MORRIS: Okay.

MS. DAVENPORT: I can wait until you get to that section.

CHAIRMAN MORRIS: Fine. If it's strictly related to the cost part of the PDMS and involved with that, fine. If that's what it is, fine. But if it's strictly on the evaporator issue itself, I feel this evening is really not to address that specifically. It is to address the PDMS issue.

MS. DAVENPORT: I think PDMS because, really, I'm wondering what the cost of that will be. Will that string out the cost as opposed to fueling storage, and why wasn't the design royalty issue included in the original PDMS.

[DISCUSSION]

(26-10)

MR. STANDERFER: I'm not sure I understand the question with regard to design royalties.

We have contracted for the design and fabrication of the evaporator, and we have contracted with that firm to operate the evaporator, and there are provisions in the contract if we do not need the evaporator, there are cancellation charges and so forth. So, Debra, I'm not quite sure I understand the question.

MS. DAVENPORT: And I think it was May's meeting or June's, I had asked what they would do if the evaporator, once it was done being used for PDMS, and you had said, I think, for design royalties, but when the thing was printed up, it looked like it had been corrected.

In other words, the unit would then be either the design, for the design of it, would be used and that would bring profit back to GPU for by the rental of the machine, I'm assuming.

MR. STANDERFER: At the end of the job, the contractor that we had bought the equipment from will own the equipment. We will not own the equipment. Through the operations phase, we're essentially selling the equipment back to him. We do not want to own an evaporator. He would like to own an evaporator. So, that contractor then ends up owning the evaporator. He will remove it from the site, and he will offer it for use in other sites that have evaporation tasks.

MS. DAVENPORT: Well, in this, I would think, then, that you do get back the cost of what it cost to use the evaporator and would the public get back any of that costs? Is that coming out of TMI cleanup money or what?

MR. STANDERFER: The total cost for the evaporator and the services run slightly under $2 million. Now, we had six bids. Some of them ranging as high as $6 million. This was the cheapest bid, also by a very well-qualified vendor. He obviously wanted to end up owning an evaporator and was willing to offer a price which was half of the next vendor, and, so, we get the services at about half of what the other five bids were, and he ends up owning an evaporator.

So, I think we both win in that process.

MS. DAVENPORT: Would you be getting actual funds and money back in the process then?

MR. STANDERFER: No, no. We're paying for evaporator services which will run about $2 million, and that is about half of what we thought we were going to have to pay. In fact, it's about half of what the other five bidders were offering.

MS. DAVENPORT: So that you're just saving money on the price then?

(26-11)

MR. STANDERFER: Yes. This--if this bidder had not bid this arrangement, we would be paying about $2 million more for the evaporation of the water.

MS. DAVENPORT: That was my first question.

CHAIRMAN MORRIS: Are your other questions directed to GPU?

MS. DAVENPORT: Actually, yeah. The second one, I've been reading the Reuter Stokes Monitor that comes into Emergency Management, and over the summer, there have been a series of elevated readings. Now, some of them, there have been letters that have been sent out explaining there were malfunctions due to the heat wave and so forth, but when I finally called, when things got more and more repetitive, I was told that the Reuter Stokes system was aging, and that GPU was considering meeting with Reuter Stokes representatives in September.

They were thinking of, I guess, updating or replacing their system.

Now, my concern is that that system could be left there during post-defueling monitoring storage, that it would still continue to be run, still be accessible to citizens or anyone--well, any citizen who wanted to go in and read it.

Are they absolutely going to replace--to update the system and get it working again in a timely fashion so it's reliable?

MR. STANDERFER: Since this is clearly in Mike Roche's current responsibility, I wonder if he could assist us with this answer.

MR. ROCHE: I might as well get used to this.

The company offers the Reuter Stokes--Reuter Stokes is a subsidiary of GE. Reuter Stokes manufactures a device which measures gamma radiation on a real-time basis, and we have sixteen of the monitors located around the facility, and we've had them in operation probably since '82 or '83.

The U.S. EPA has also had a network of similar monitors also around TMI. Two of the monitors are on the islands, and when we have a communications system, radio communications system, we've had lots of trouble with our radio communication.

The system itself, the company, Reuter Stokes, had been looking at upgrading what they sell, but there is problems because there is not that much of a market for that product. So, they're kind of--I recently had a meeting with one of their people and they're trying to decide what they're going to do.

Clearly, the devices have capacity factors, 24 hours a day, 7 days a week. We traditionally, at least up to this summer, before we had the real hot weather, we had for the 14 that operate with telephone lines as opposed to a radio connection, those 14, we had capacity factors that cleared 90 percent.

For the two that we communicate, we have not had that good a capacity factor with them, but they are a tremendous amount of maintenance for us to keep them operating. We have made a commitment to continue their operation until the cleanup is completed, and I'm not exactly sure of what the--relative to a decision in this September, we constantly are working on them trying to get them improved, and we've had lots of communications.

Reuter Stokes feels because it's one of the first systems that they sold, they felt, they feel some responsibility for it, and they have to try to keep them operating, but it's kind of a long-winded answer that we intend to keep them operating until after the cleanup is completed, at least, and we will continue scratching our heads as to whether it would be wise for us to replace them, although, as I say, there's not that much of a competition for this type of a product.

I don't know if that helps.

MS. DAVENPORT: Yeah. How would you define, then, the cleanup?

CHAIRMAN MORRIS: I didn't hear the question.

MS. DAVENPORT: Oh. How would he define the cleanup.

MR. ROCHE: At this point, I would say at least to the end of the defueling, we haven't exclusively stated when we would stop operating them.

CHAIRMAN MORRIS: I think the question specifically was that during--if PDMS would be approved, would those--would that equipment be in place, and I hear you saying you don't know.

MR. ROCHE: Well, our intent at this point would be that we would have them operating up to the point where we have the PDMS.

CHAIRMAN MORRIS: And with PDMS, you would not then have them.

MR. ROCHE: That would be our intent currently, yes.

MS. DAVENPORT: That can be as early as the spring of next year?

MR. ROCHE: Whenever it would be. I'm not sure if it's quite that early.

CHAIRMAN MORRIS: Let me just indicate that--and this is not an attempt to indicate that this is not an important issue for discussion, I think it is--I do think that tonight we have a main item that we must get to, and I think you've been clear on what your intent is.

I don't know that the panel would feel comfortable with that or the public would feel comfortable with that, but I think you've indicated at this point what the intent is of GPU, and unless there's another question to clarify that statement, I think what we need to do is schedule this for a specific agenda item, I feel, in the future.

MS. DAVENPORT: Yeah. I do think really we have to look at what long-term monitoring capacities are--

CHAIRMAN MORRIS: Absolutely.

MS. DAVENPORT: --and the people who do them, how they are committing to them, too. Because right now, I don't think--I think that the utility always had the first option of telling anyone that something is wrong.

I know the state monitors, but I just saw the radiation book for last year, and I can see in November of last year, 90,000 pico-curies per liter of tritium floating down the river and that's a lot more than there used to be, when there would be days when there would be none.

It seems in the last 2 years, that's increased. Are we going to be protected if that continues? Is there a limit to this? I'm glad the state is watching because here's the complete book. I'm concerned over time.

CHAIRMAN MORRIS: Well, again, I think the statement I need to make is that it is an issue that needs to be discussed and that is, I think, monitoring during PDMS-type of circumstances, long-term, and I assure you we will schedule that for a specific discussion item in the future.

MS. DAVENPORT: Thank you.

CHAIRMAN MORRIS: Thank you.
Eric Epstein.

[PAUSE]

CHAIRMAN MORRIS: Eric Epstein from Perry County, spokesperson for TMI Alert.

[DISCUSSION]

MR. EPSTEIN:

[DISCUSSION]

(26-14)

I want to take care of some old business first, including a brief review of some of the events that have happened at Three Mile Island Unit 2, which I think do bear some importance on PDMS.
I would also like to take the time to thank Michael for responding to TMIA's other questions, outstanding questions, and would like to comment that I did not receive GPU's letter addressing the issue of funding as was indicated on my cover letter.
I don't know if I'm entitled to get that or if that was just going to the panel. So, I wanted to clarify that, if I could.
And a few other questions, I don't need a response to now from GPU. We are resubmitting a request to GPU to reveal the full cost and source of their advertising campaign to promote PDMS, and I just want to remind the panel that several months ago, GPU thought $800,000 was a worthwhile gamble to underwrite for the purchase of the evaporator.
Moreover, it is estimated, and I quote, "it will cost $10 million in the first year and $5 million in the subsequent years to keep Unit 2 in monitored storage." With funding in doubt for continued cleanup, the public has a right to know how much it is spending to convince itself that PDMS is the right course of action or inaction.
So, that is a formal request.
The second request would be, I asked Mr. Kintner if GPU would honor an order for them to immediately clean up Three Mile Island Unit 2 and just a response to that would be appreciated.
Also, I thought it would be good to draw your attention that drawing from GPU's and the NRC's actions and observations, one gets the distinctive impression that the plant has already been placed in a post-defueling monitored storage.
According to the plant status report for the period of July 9th to August 6th, 1988, the staff noted, and I quote, "One plant area has been isolated and placed in interim post-defueling monitored storage status. Seven other plant areas are in the process of being verified to meet the interim PDMS isolation criteria." 7.2.12
So, this passage facilitates several logistical questions for the NRC and GPU. What are the interim PDMS criteria? What are the seven areas that may be placed into isolation? And please define interim and isolation.
On the surface, it seems like a replay of GPU's decision to purchase, design, fabricate, install, and test an evaporator prior to the resolution of the accident-generated water issue.
So, if I could have, not now, but at some later date, either from the NRC or GPU, a response to those questions, it would be much appreciated.
Also, I think as a summary, drawing to a close, I thought it would be appropriate to draw to the panel's attention some of the highlights of the action or inaction at the island.

(26-15)

On June 9th, during a routine inspection, and I quote, "six pages of word puzzles were found in the procedures book at the defueling platform in the reactor building."

On July 20th, Mr. Stier concluded in his investigation on TMI-2 sleeping allegations, and I quote, this is from a GPU press release, "Stier's further investigation into management response to the allegations revealed inadequacies in management's response to the allegations that the shift supervisor slept or was otherwise inattentive to duties. These inadequacies led to inaccurate or distorted information reported to higher levels of TMI-2 and other GPU Nuclear management and to the NRC."

July 26th, an event which you're probably all aware of, and I quote, "A rail car carrying a loaded shipping cask and its unmanned yard engine drifted for approximately 60 years on the site tracks. The engine and the rail car came to a final rest as a result of an increase in the natural grade of the rails."

Then, a final incident on August 31st, a Unit 2 operator was fired after an eleven-day investigation, including a medical probe, and I quote, "So, the licensed operator who has not been identified had been drinking and taking drugs either before he reported to work or while he was at work."

Although the utility prohibits its workers from reporting to work under the influence of drugs and alcohol, "those who have tested positive are not always fired," and we refer back to a June 15th incident in which thirty workers tested positive and not all were fired.

Unfortunately, this is more--there is more than a thread of continuity to these problems. On July 1st, 1988, the NRC, the GPU, and the Commonwealth met to discuss "poor human performance such as complacency with respect to the changing plant status leading to post-defueling monitored storage and/or the influence of poor procedures or work schedules."

At the meeting, GPU acknowledged, and I quote, "That potential for apathy in light of the end of the cleanup project." If they're apathetic, sleeping, and having trouble following directions now, what can we expect in the next 20 to 30 years when the plant is idle, and I think this is a pertinent question.

Let me go on to the issue at hand, which is, I believe, decommissioning economics and PDMS. At this point, it is clear that PDMS is analogous with decommissioning. GPU recently stated in a press release on August 25th that they are, and I quote, "proposing to maintain Unit 2 in safe monitored storage until it is decommissioned along with TMI-1 some time in the next century."

And earlier in the summer, the NRC issued on June 27th, 1988, a final rule on decommissioning, which became effective on July 27th of this year. This new rule has a direct impact on PDMS since PDMS is little more than a precursor to decommissioning at best, and an initial phase at worst.

(26-16)

Just for your clarification, I went through the Act and tried to demonstrate how some of the passages related to PDMS.

There is a section on decommissioning alternatives. The NRC noted, and I quote, "delaying the completion of decommissioning to allow short-lived nuclides to decay may be justified in some cases. However, any extended delay would be rarely justifiable."

At this point, I believe GPU is asking for at least a 30-year delay. It might be 20. I'm unclear on that. To allow worker exposure rates to diminish. I would add if they are very concerned about workers, they should start compiling a cancer and/or health register to track the health effects to the workers during cleanup.

At any rate, at the last meeting, we witnessed an appreciable difference between the radioactive levels projected by the NRC and GPU, which has been somewhat clarified tonight.

This is indeed a puzzle since GPU supplied the majority of the data for the EIS. It seems to us as if GPU's motto for this project is "if at first you don't succeed, lower your standards."

Who is to say that GPU or the NRC will not revise their figures after 20 to 30 years and ask the community to wait another 20, 30, or maybe 60 years before finishing the cleanup. An expedited cleanup will result in lingering questions related to radiation levels and locations and allow GPU to make good on their promise to clean Unit 2 up.

We agree, which is probably rare, we agree with the NRC that, and I quote, "20 to 30 years is not justified as far as letting a reactor sit idle and not cleaned up."

Under the section on planning, the NRC noted, and I quote, "Planning for decommissioning is a critical item for ensuring that the decommissioning activities can be accomplished in a safe and timely manner."

Yet, for PDMS, the NRC does not stipulate any research or development to be employed to ensure that the cleanup can proceed at a later date. In fact, later in the passage, the NRC acknowledges, "Development of detailed plans at the application stage is not possible because many factors, e.g., technology, regulatory requirements, economics, will change before the license period ends."

Thus, PDMS allows GPU the luxury of cutting costs, laying off experienced workers, and postponing cleanup until a time in a distant future when, in their judgment, it will be safe and timely to resume the cleanup. To date, GPU and the NRC have failed to provide data to demonstrate that any research and development will take place during the layoff. That's anywhere in the country.

It is clear in our opinion that GPU and the NRC have adopted former NRC Chairman Hendrie's infamous policy, don't turn over new rocks.

(26-17)

Finally, under the section of residual radioactivity levels, and I quote, "The cost estimate for decommissioning can be based on the current criteria and guidance regarding residual radioactivity levels for unrestricted use. Further, the cost of decommissioning is relatively insensitive to the radioactivity level and use of cost data based on current criteria should provide a reasonable estimate." And finally, "it is expected that the decommissioning fund have available at the end of the facility life or approximate closely the actual cost of decommissioning." This is disturbing because already there is a disparity between GPU's estimate for decommissioning and the NRC's generic projections. All you've got to do is consult GPU's latest shareholder report to be updated on the economics of decommissioning.

I am a shareholder. So, I am privileged to that material.

GPU acknowledges that there is no money in the Unit 2 decommissioning fund and, as Frank said later, he said, well, you've got to remember that funds accumulate. Zero dollars on zero dollars is nothing. There's nothing there for Unit 2. I think it's in the 120's for Unit 1 and I'm not sure what it is for Oyster Creek.

In fact, they even said that the money for the site thus far at Three Mile Island would be inadequate if you take into consideration what they're projecting, and the GPU's estimate for decommissioning costs is millions of dollars above the NRC's generic estimate, and this is in their own newsletter.

Once again, GPU failed to supply data on how they are planning to meet this shortfall. What I would suggest is that the publisher of the newsletter be invited to the next advisory panel meeting. Perhaps that way, we can get some information on funding packages for the continued cleanup and decommissioning of TMI.

Let me reiterate what TMIA believes you all should do. We believe the panel should recommend to the NRC that the cleanup of TMI-2 proceed immediately. GPU should be liable for the costs and develop appropriate technologies.

In addition, GPU should develop a funding plan based on equitability and realism to be reviewed by the PUC, the consumer advocate, the Commonwealth of Pennsylvania, and the citizens.

As an addendum, I wrote this and I'm quite sincere about this, I really don't know what else I can say that would truly affect you people. The last time I was here, I spent a lot of time researching and talking to competent well-versed people in the field of economics and decommissioning, which included people at the PUC and the Consumer Advocate's office, that I will not name. One member questioned my credentials, which is your privilege, and I respect that, but let me remind you that we're all citizens with rights and responsibilities. The federal, state and local governments provide public document rooms, libraries, research material and, if necessary, one can also utilize the Freedom of Information Act to obtain information.

The data our organization presents at these meetings is documented, and I go out of my way to document that material. In addition, I think it's worth noting, we have no financial stake in the matters before you.

Let me close by saying that I think the case against PDMS, at least in our opinion, is clear and overwhelming. However, as I look around, I'm reminded of what George Orwell once said. People can perceive the future only when it coincides with their own wishes and the most grossly obvious facts can be ignored when they are unwelcome.

So, what I hope you do is scrutinize the material as best you can and I know you usually do, and make the right decision, which is, in our case, to proceed with immediate cleanup, and I really appreciate your indulgence, Chairman Morris.

CHAIRMAN MORRIS: Thank you.

I would hope that, Mike, if you would, there are several questions at least initially in the first page or so of Eric's presentation, that I would hope you would work with GPU on or at least bring to their attention and ask them if they would provide answers.

MR. MASNIK: Okay. I'll coordinate it.

MR. EPSTEIN: And there were two questions for GPU. I don't know if Mike is going to be here next time. I don't think so. The one concerning if they're going to disclose how much advertising campaign costs and if they would proceed with an immediate cleanup, if it is mandated, and I'm not sure, I think the other questions are just for the NRC.

[DISCUSSION]

CHAIRMAN MORRIS: Are you asking that Frank attempt to respond to your questions this evening? Is that what you're suggesting?

MR. EPSTEIN: I doubt Frank can respond to how much they are putting on the media campaign. Doug Bedell probably could and I'd love to have Doug come up here and address it or not address it. Just have it clarified.

CHAIRMAN MORRIS: Is Doug present and is he able to come forward and respond?

Eric, do you want a copy of this letter from GPU on funding?

MR. EPSTEIN: Sure.

MR. BEDELL: Doug Bedell, GPU.

We will provide that for the record, that answer.

(26-19)

CHAIRMAN MORRIS: Thank you.

[DISCUSSION]

MR. ROTH: I was not at the last meeting, and never received this, some other panel members did, you know, a copy of the transcript, and I have to admit that my copy of the transcript did come from Eric.

So, I would just like to say that I found your comments last time to be excellent and it did show a lot of research, and I certainly appreciated reading and having seen that.

But I do have a question for you tonight.

MR. EPSTEIN: Sure.

MR. ROTH: And that is, what would TMIA or SVA's definition be of the end of cleanup? In other words, what is satisfactory to the group?

MR. EPSTEIN: Well, I think that's a good question because I'm not really sure it's clear in our mind. I think what we're aware of is that there's more that can be done before the unit is placed into decommissioning, and that's what we're hoping is done.

It appears that levels, and I think the utility and NRC would acknowledge that it's probably destructive methods of decontamination could take effect prior to decommissioning, and that's what we would hope would happen.

I'm not really sure what destructive as opposed to nondestructive methods of decontamination are, but it's clear to us that the basin is still highly radioactive and, in our opinion, poses a threat to the community, and we're not--I don't know how else to put this gently.

We don't take the utility's word necessarily about radiation levels and locations. We feel a continued, you know, decontamination of the plant would be in the best interests of the community.

I know I'm being vague because nobody really put a definition on the cleanup, and I think even tonight it's even more fuzzy, but it's apparent to us that more can be done before the plant is decommissioned, and we'd like to see that.

We would like to see the maximum effort applied before the plant is mothballed because it's a fear of ours that this plant is going to lay idle for quite some time. There's five plants in Pennsylvania that are licensed and they're all going to come up at the same time.

We think at this point, while TMI is a unique plant, we can get funding to continue the decontamination.

So, I don't know if that answers your question because we're still grasping at what exactly the utility intends to do and what the end of cleanup is.

(26-20)

MR. ROTH: Good enough. Thank you.

MR. EPSTEIN: Okay.
I would also add that decommissioning in the NRC's recent rules, I think decommissioning is achieved when the site is restored back to its unrestricted use.

MR. SMITHGALL: Unrestricted access.

MR. EPSTEIN: That means you could just go around and perhaps build a housing complex on Unit 2. Theoretically.

CHAIRMAN MORRIS: Thank you, Eric.
And the last person is Frances Skolnick.

MS. SKOLNICK: Good evening, everybody.
Frances Skolnick, Susquehanna Alliance.
First of all, I'd like to comment on the old question as well, what's SVA's position on the definition of the end of cleanup.
I think it is a really difficult question to answer, mostly because I asked a question of Mike about this, as well. We have not researched what tasks followed the end of cleanup. So, I honestly can't evaluate what the end of cleanup is.
I think that's one of the problems that we always have to grapple with in environmental organizations. We're never given the full amount of information, and the information that we are asked to look at, we do find holes in it, and it never seems that we can get answers, proper answers and, therefore, we're stuck in a position of still grappling with a lack of information.
And, Mike, if I could just ask, in your presentation, you were telling us that you looked up immediate cleanup versus delayed cleanup, and you list the list of tasks, the exposure estimates, and the hours per job.
I'm not quite sure where you got your list of tasks from to be done after defueling. Could you just explain that?

MR. MASNIK: Okay. I guess when you asked that question, are you talking about our current estimate or our estimate that we have presented previously in Draft Supplement 3?

MS. SKOLNICK: This issue, the current estimate.

MR. MASNIK: The current was developed principally from what the licensee submitted in these two documents here. They are a post-defueling monitored storage safety analysis report.
In other words, we started with that and evaluated the tasks.

MS. SKOLNICK: That would be done following--

MR. MASNIK: That would be done following--

(26-21)

MS. SKOLNICK: --defueling?

MR. MASNIK: --defueling in what we call immediate cleanup, and they had post-phase-3 cleanup, and then, at the end of PDMS, which we call the delayed cleanup.

MS. SKOLNICK: So, whenever you list those tasks, presented by GPU, did you list other alternatives to those tasks? Did you evaluate the kinds of machinery that might be needed?

MR. MASNIK: That's correct. What we did was we looked back at what we had evaluated earlier and compared that to what was presented at the present time, and I don't know if you recall, we talked about some techniques being more destructive than others. When we did the initial Draft Supplement 3 or the Draft Supplement 3, we relied heavily on an earlier supplement, Supplement 1, which looked at various tasks, because we were evaluating specifically occupational exposure, and some of those tasks involved methods that the licensee no longer plans to employ, and some of them, we essentially developed ourselves based of the type of decontamination that was necessary. So, the current document provided a more detailed description of how they would plan to do this.

MS. SKOLNICK: And did you consider--I know you said originally that it would be a 4-year period for immediate cleanup. Okay. Originally, you said 4 years. Are you still saying it would be an additional 4 years?

MR. MASNIK: Yeah. The period of time didn't change.

7.3.2.3 MS. SKOLNICK: It would be the same. Did you consider that perhaps it would be possible to continue with cleanup for either more or less than 4 years?

MR. MASNIK: Yeah. If you recall in Supplement 3, we looked at a number of alternatives, and one of those, for example, one of them was continued cleanup at a reduced level of effort, which essentially would mean that instead of immediate cleanup in 4 years, it would be immediate cleanup in 8 years with a 50-percent reduction in effort.
But we found that it really was essentially somewhat insensitive because the two alternatives we looked at bounded those other alternatives, and, you know, you run into some problems associated with when you draw something out like that, you have undefined problems associated with training and continuity of programs and such.
So, you know, we felt that the two alternatives we'd pick, immediate cleanup, a period of approximately 4 years, and the delayed cleanup, bounded these other alternatives.

(26-22)

MS. SKOLNICK: I noticed that you addressed continuity of cleanup and problems with trend, but I don't think you addressed that in the prospect of leaving cleanup for twenty or 30 years, did you?

MR. MASNIK: Yes, we did. We did. In fact, the period of time for delayed cleanup was extended some time, primarily because we knew that there would be significant startup activities associated with additional training and such.

MS. SKOLNICK: Thank you.

And I appreciate your answering my questions which brings me to the next point. I really think that there is a show of discrimination at these public meetings, and the NRC published its Draft Supplement, presents data on worker exposure.

GPU can come back and say, we disagree with these figures. Subsequently, the NRC uses the resources and energy to re-evaluate their findings, and we know the story that you came up with the same figures as the licensee.

We come forward, as Eric pointed out, we do an endless amount of research, we don't get any money for doing this, there's nothing in this for us, except our concerns for the community. We come up and raise genuine concerns about estimates of the radiological content that will be left in the plant.

Our concerns are noted in the record and we are informed that it won't be discussed any further until the NRC responds in the final draft. It limits further discussion.

I find really that's insulting because I believe we are being discriminated against.

We brought major concerns here about the evaporation of water, and for most of the panel, it did fall upon deaf ears, and like I said, we do constant research, Commissioner Rice, and you know, all you need really is the power of critical thinking. You don't need an endless list of university degrees and a large packet from a licensee.

Unfortunately, this time, the judges at least did listen to some of our concerns. Some of our concerns have been noted, others have been drawn up, but I just want to read you one quote, which I tried to impress and permit this panel to conclude some time ago, as well.

The judges concluded, "We are not convinced at this stage of the proceeding that forced evaporation meets the Commission's policy of providing expeditious decontamination consistent with ensuring protection of public health and safety and the environment. Therefore, there is a genuine issue of facts concerning whether the no-action alternative may be obviously superior to forced evaporation."

(26-23)

I did also raise a question about the character of the water and the judges have admitted that I have raised enough material facts to show that the water may have been characterized incorrectly and, therefore, the dose from the people may have been incorrectly evaluated.

I just think it's so important that--the important point is not that we cannot question. I think that we should come back to question more.

CHAIRMAN MORRIS: Let me just say for the record, since we're all trying to make sure that the record is correct, and I have to say that you were quite critical of this panel on evaporation, while I was not one of the people that voted against evaporation, this panel did vote, the majority of this panel did vote against evaporation.

So, I think your criticism there when you say only a few is misplaced on that issue.

MS. SKOLNICK: I don't know, and I'm glad that the panel did vote against evaporation, but I think--

CHAIRMAN MORRIS: But I think your statements would indicate that people reading this particular transcript, that this panel did not vote that way, and I just don't want to get into a debate with you. I just want to clarify the issues.

MS. SKOLNICK: Okay. Your point is well taken.

CHAIRMAN MORRIS: The panel did vote that particular way.

MS. SKOLNICK: Yes, but I do think, too, there is a feeling that our information is not worthy of consideration in many cases.

CHAIRMAN MORRIS: Well, I appreciate your earlier comments and specifically on that issue, we did ask, so that we as a panel have to, in a timely fashion, given the constraints, you were here at the last meeting, you heard us discuss asking for extensions of time, we do not have the luxury that a judge has. They can schedule whatever they want on their time frame, but we have a separate time frame that we must meet.

We did not want to take action until we heard two specific questions answered. One, the NRC's position on the submittal by GPU. So, we asked them to do that evaluation for the panel.

And, secondly, on the funding question regarding the cost of PDMS being included in the decommissioning.

We did not want to meet again until we got that information. So, we were the ones that asked for it to allow us to at least consider as much as we could. We've heard what you've said. We thought we needed clarification. That's all. We're not attempting to discriminate, but we have a time frame that we have to try and meet, as well.

I think we've tried to do that. We extended that comment period for the public, for you, to comment on this this evening. We fought for that at the last meeting.

So, we try hard to involve the public and give you a chance to at least have some influence on what determination is made.

MS. SKOLNICK: Yes. I appreciate that, but I think particularly to my statement, too, I did direct my comments to the NRC, a show of discrimination in treating GPU as a need to re-evaluate--

CHAIRMAN MORRIS: Yes. But all I'm saying on that, Frances, is that we as a panel specifically requested that information at the last meeting. I think we--

MS. SKOLNICK: Yes, but Tom also asked for the SVA matters to be brought up again and that was refused.

CHAIRMAN MORRIS: Okay. If that's the case, I apologize.

MS. SKOLNICK: Thank you.

CHAIRMAN MORRIS: Thank you.

[DISCUSSION]

CHAIRMAN MORRIS: I know you may not be ready at this point for the questions, but if you could take us back and remind us of the schedule involving the PEIS.

MR. MASNIK: Essentially, there isn't much of a schedule at this point. What I have planned is that after the panel meets with the Commission, to essentially finalize the documents, and try to get it published.

I suspect that at this point, we're talking towards the end of the year. Certainly, not before the middle or end of November, and it's probably more like the middle or end of December.

CHAIRMAN MORRIS: Okay. As I understood the last meeting, that we put out the meeting with the NRC with the hope of probably meeting with them some time in October, which would allow us to meet here today and hopefully figure out what it was we wanted to do regarding the PEIS, then meet with the Commissioners in October, relay to them to our feelings on the PEIS and anything else we want to discuss on the cleanup, and then, thereafter, you were--the clock kind of stopped ticking and you were going to be then finalizing the PEIS.

(26-25)

MR. MASNIK: That's correct.

We are in the process of addressing a lot of the comments that we've already received, but the record essentially will stay open until the panel meets with the Commissioners.

CHAIRMAN MORRIS: Okay. I raise that question simply to get into this part of the agenda, which really, I believe, is the time for the panel to really determine just what it is we want to do at this point regarding comment on the PEIS.

I guess there are several options. One is to offer no comment. There would have to be some type of consensus for that. The others would be to offer comments in support of our interest or if there are problems with it, maybe state what the problems are and either offer them as amendments or offer them in opposition to PEIS. There may be other options that others will suggest this evening.

It is my hope, quite frankly, that the panel take a position this evening and other people might have a different viewpoint than that, and I would hope you would express them. I would hope this evening that after we have a chance to discuss our options, that we do, in fact, take some formal position.

I think this represents the third meeting that we've had on this particular document. We have delayed the meeting with the NRC to allow us to have this particular meeting. So, I certainly hope that we are in a position to offer some comments, take a position here.

With that, I open it up and ask the panel members if they want to make any observations or ask any additional questions that they felt they need to ask.

MR. RICE: Mr. Chairman, Mr. Roche commented that when Unit 2 goes into the PDMS, that the Reuter Stokes system would be removed, is that correct?

CHAIRMAN MORRIS: He indicated that it was the plan of GPU to remove that system once, actually once it went into PDMS or once the fuel was removed. That's what he said, I think, pretty clearly this evening.

That at least is the plan of GPU.

MR. RICE: Regardless of the Unit 1 operation?

CHAIRMAN MORRIS: Well, I think he didn't include Unit 1 in that comment. He just spoke specifically--he indicated that that was in place because of TMI-2 and actions at TMI-2 would decide what happens to the system.

That's what I thought was their plan and I think he's nodding his head at this point. I did indicate that that was an issue I thought we needed to discuss at a future meeting. But that was their position as of this evening.

(26-26)

MR. RICE: Thank you.

CHAIRMAN MORRIS: Come on, folks. I mean, I'd be happy to offer some comments of my own, but I don't want to jump into that so quickly. I think that there's other people that may have other observations they might want to make.

MR. GERUSKY: Mr. Chairman, there's a difference between commenting on the environmental impact statement and commenting on the proposal, and I wonder what we're supposed to do.
I'd like to see us comment on the proposal, not on necessarily the documents the NRC perused, but I'm not sure that that's what we've been granted an extension to do.

CHAIRMAN MORRIS: Well,--

MR. GERUSKY: What is the procedure?

MR. MASNIK: Well, there are two things at work here.
First of all, commenting on the draft supplement. I understand your problem with that in that it has changed and it has changed considerably over the last couple of months based on primarily what has gone on here.
The comments that the panel has already raised on the impact statement will be addressed in the impact statement if they're still appropriate.
The other requirement that the panel has is to act in its capacity as an advisory panel to the Commission, which is to act as a conduit of public concern to the Commission and provide advice, and that, in my mind, is somewhat independent of the impact statement or it's a synthesis of the impact statement plus what has transpired at these meetings.
So, I think that the panel certainly can go to the Commission and provide its comments on the proposal.

CHAIRMAN MORRIS: So, we're saying that we can separate PDMS and the PEIS as a proposal or we can--I guess if we feel we have to make some--somebody agreed we had that option.
I think in my mind, they are somewhat mixed. I felt maybe a month or two ago that you could separate them, but, you know, some of the problems I had with regard--one of the problems I had with the PEIS is it doesn't deal with the likelihood of funding in each scenario.
One of the discussions we've had here is what would be the funding plan in each scenario, and I realize the problem in dealing with that, but I think it is a flaw in the PEIS. I think it makes it a very difficult--makes it very difficult to review the PEIS, I think, in a logical way.

(26-27)

The other scenario that bothers me is the risk to the environment if it is--if the plant is mothballed indefinitely, and at the last meeting, you know, you used here in the review on PDMS a 20-year period of time and, yet, at the last meeting, we heard that 20 years could be 60 years, it could be a hundred years.

I don't want to imagine things, but I think the likelihood is that the PDMS will be much longer than 20 years. That's the sense I get, rightly or wrongly, that once PDMS occurs, that it's going to be combined with decommissioning at some point and the whole thing is going to continue to be mothballed for much longer than 20 years.

I think that's the most likely scenario, personally, and that that is not really considered and what then is the risk to the public with a plant that's mothballed for eighty or a hundred years. I mean, who even knows after 50 years what that plant really is and is there a threat to the public or to the environment because of that.

That's my concern as a person going into this. I stated early on that I felt that PDMS was a right position. I said that publicly, but I have also said that at what point should that PDMS begin, and I continue to have that same concern, and our discussion really has just clouded that issue for me on it.

So, I think, I guess I'm saying that I see them combined. I see PEIS and PDMS as very hard to separate because one is somewhat dependent on the other.

MS. MARSHALL: Well, doesn't PD mean post-defueling? I mean, wouldn't that point that when the fuel has been defueled? removed?

CHAIRMAN MORRIS: Basically, that's what we're saying. Defueled. They can define this better than I can. Apparently, it's readily available to get to it, the reactor, but there is a lot of fuel that is throughout the system, that is not so easy to reach, that they're saying they want to put into a storage situation so that they can have it decay over a period of time and maybe with new technology would be easier, more easily removed, and it will lower the amount of radioactivity to the worker.

So, there's two things I've heard from a period of time. There's not so much the money from the operator but more new technology and lower radiation exposure to workers. That seems to have been the argument that they have presented for PDMS.

MS. MARSHALL: There would be more exposure to workers who are involved with cleaning up Unit 2 than with the ordinary nuclear facility.

I guess what bothers me was that including TMI-2 in this rule business, that, you know, you don't have to submit until July 1990, it's almost as though, well, this is put in the same category with all the other nuclear plants.

(26-28)

I was under the impression that Unit 2 and the accident that took place really was something pretty special, and it bothers me that a, you know, plan for decommissioning it is being postponed because it is being lumped with all the others.
I think that, you know, something should be done about it now, whether it is the physical thing of actually restoring it to the ultimate goal that it would be restored to or, at least, it seems to me, that the funds for detailing with that should be dealt with, the plan should be submitted and not be put on hold until, you know, we follow through with this rule for 1990.
I don't know when that means that the funds would be set aside, the time. I imagine that PUC would be involved in it at some point.

CHAIRMAN MORRIS: Well, it all becomes very complicated when you consider PUC and what they would allow to go into the cleanup, and it becomes very complicated when we try to figure out what will the NRC accept as a funding plan.
As you're pointing out,--

MS. MARSHALL: But why delay it until 1990? Why hasn't it been started already? It's 11 years.

CHAIRMAN MORRIS: Because what they're saying is that that is for the decommissioning of any plants and this is a new order that was put out by the NRC that said the plan must be equipped to get funding for decommissioning, and what's happening with us here is that they are combining the PDMS with the decommissioning as one funding plan to be presented in July of 1990, and I share the same concern you have, that we have no real funding plan before us to review as part of this PEIS.
Part of the PEIS was the cost of this particular phase of the cleanup, but there's nothing to address as to how would those funds be put in place. So, I hear what you're saying. I'm just indicating there's not an NRC standard and there is no requirement for that funding plan until July of 1990.

MS. MARSHALL: Well, it makes you wonder if, you know, that the politics of the thing doesn't make it tempting to just simply delay and delay and delay, wrestling with coming to grips with what are we going to do.

CHAIRMAN MORRIS: Let's--

MS. MARSHALL: So--

CHAIRMAN MORRIS: I don't know if you followed the discussion at the last meeting, but that was precisely one of the points that was made, that under PDMS, under one option here, the 20-year delay until they begin that cleanup and, yet, it was readily agreed

(26-29)

to at the last meeting by even Mr. Standerfer or Mr. Kintner that, in fact, 20 years may be a moving target way into the future, that PDMS could be combined with decommissioning, and decommissioning could be put off for many, many years more than twenty. Sixty, eighty, maybe a hundred. I think they're not unreasonable numbers to talk about, and as I said earlier, it could be maybe more in line in reviewing the PDMS than the 20-year period. So, it is a delay, could very well be a delaying game.

MS. MARSHALL: Well, I don't think the panel should support evasion of responsibility. I don't know what we can do about it, but except to go on record.

CHAIRMAN MORRIS: Okay. Are there any other observations?

MR. GERUSKY: I have a question concerning what NRC had authority to do.

If--under the decommissioning rule now, could the Commission decide that TMI-2 must be--that cleanup must be continued through decommissioning at this point and require the utility to continue all the way through decommissioning and forgetting about that rule, or can they--or do they have a choice at all? Could they require some stopping between that point down to a level in which "normal reactor," which was never really defined, and then decommissioning at a later date?

In other words, if there is another stopping point in between what is being proposed and final decommissioning, can NRC require that or can they only react to what the utility proposes?

MR. MASNIK: My understanding is that the Commission has not come up with criteria for decommissioning criteria as far as, you know, what sort of cleanup levels are required before, for example, you go into a safe-store condition.

So, obviously, we can't require that at the present time. That's something that it's my understanding is under development at the present time.

MR. GERUSKY: I guess the question is, what are the options available to us? I don't really understand what they are right now.

MR. SMITHGALL: Excuse me, Tom. Am I missing something there? When they talk about safe-store and containment in that new decommissioning rule--

MR. MASNIK: Right.

MR. SMITHGALL: --where it--am I missing the point where decon is the alternative in which equipment and structures of the facility

(26-30)

containing radioactivity are removed and decontaminated to a level that permits property to be released from restrictive use? That being decon. Safe storage is the alternative which is in essence deferring decontamination.

MR. MASNIK: That's correct.

MR. SMITHGALL: Aren't those criteria for--

MR. MASNIK: What I'm saying is that there's no criteria to clean up a plant to a certain level before it goes into safe-store. Now, there is obviously criteria for unrestricted use of an area. So, under the dismantlement option, there is an endpoint there.

CHAIRMAN MORRIS: I think, though, even though it seems to be certainly an undefined situation here, I think the panel should feel free to, if they have a sense or a feeling on this particular question, they should feel free to offer that sense to the Commission.
What they can and can't do with it, I think at this point, we don't know.

MS. MARSHALL: Can somebody tell me, is unrestricted use the goal for the cleaning up of any--

MR. MASNIK: Any facility.

MS. MARSHALL: Any facility.

MR. MASNIK: That's correct.

MS. MARSHALL: Is it contemplated that that would be the goals of TMI-2? 7.10.5

MR. MASNIK: That's correct.

MS. MARSHALL: By unrestricted use, does that mean that the physical plant would still be there, that people could walk in and out and it could be used for a museum or something?

MR. MASNIK: Conceivably, it could be farmed or houses built on the site, and it's to a point at which people can inhabit it and not have any restrictions due to radiological considerations.

MS. MARSHALL: Have there ever been any nuclear plants anywhere in the world that have been decommissioned and there has been that type of restoration?

(26-31)

DR. WALD: The plan for Shippingport, which is currently in the process of decommissioning, is for it to be resorted to public uses. A public park. That is the goal and the Chairman was talking about it about three or 4 years from now.
But that's the objective there.

MS. MARSHALL: Where is that located?

DR. WALD: It's near Pittsburgh. Twenty miles from Pittsburgh.

MR. MASNIK: There have been reactors that have been completely dismantled. One, I believe, is Elk River, where they essentially leased the ground for unrestricted use.

MS. MARSHALL: I should think they would have a handle on costs, if it's already been done.

[DISCUSSION]

DR. WALD: It seems to me that Tom has a very interesting suggestion which has not been broached before, which is a stopping point somewhere along the line which I would define as an environment which is no different than any active operating plant, and that may make a lot more sense than all or nothing, which is what's been discussed up to now.

MR. MASNIK: But that's precisely what the impact statement defines as the endpoint of our evaluation. It is conditions closely approximating the operating plant nearing the end of its life.

CHAIRMAN MORRIS: Is that the endpoint of PDMS?

MR. MASNIK: In our mind, yes.

CHAIRMAN MORRIS: Right. I understood that.

MR. MASNIK: That's correct.
Now, the next step after that would be decommissioning.

CHAIRMAN MORRIS: I understand.

MR. MASNIK: But the problem to understand is that they're getting bloodied.

CHAIRMAN MORRIS: But I think if we're looking for an action here and it would be one where it would be a plant equivalent to, as Neil pointed out, a normally operating plant, that is at least more of a definite position than maybe what we've been discussing at this point, and I think Tom was trying to say the same thing.
Anne?

(26-32)

MS. TRUNK: Couldn't we put a deadline, say, 20 years, you have to have the PDMS, you know, completed and start decommissioning, instead of going for 30 years and 60 years?

CHAIRMAN MORRIS: Well, I guess this panel could make--I think we can offer any observation we want to at this point.

MS. TRUNK: But uphold it, too. Not like that water thing that we were going to look at every couple of years and eventually gather up--and have something that, you know, you make it stick.
Then, I also want to know, what is the safe plant. If they put into storage, just what is safe for the environment and for me living in Middletown?

CHAIRMAN MORRIS: I think there's been attempts to try to define what that is, and I think one definition has been at least equivalent to radiation levels in a normally operating plant. Whatever that means.
Obviously, there's a lot of technical questions that we could not provide answers to, and that we will not have answers to as we deliberate on this. It just isn't possible. It's such a complex issue for us to take on, and that's why I'm saying all I think we can offer as a panel is a sense of after three meetings, full lengthy meetings, what is the sense of the panel, and I don't think we ought to feel that we're giving something that we can technically support.
I think we have to--we've heard public comment. We've heard GPU's positions and certain comments from the NRC and these have developed a sense of the position that we have, and I think that's what I'm trying to get to.

MR. MILLER: I think we're all expressing the same frustration at not having clearly defined endpoints of things that seem to be rather generic, and I think that we need to express this frustration to the Commissioners.
I'm not sure it's the function of this panel to define what those endpoints ought to be for any of those conditions.

CHAIRMAN MORRIS: Thank you.

MR. GERUSKY: Just a comment on that.
In the SAR, there is a table indicating what the levels of radiation, radioactivity, inside the plant will be under PDMS versus what it would be in a normal operating plant, and you can get a comparison, but, you know, the first time I saw that table was this afternoon.
We haven't had an opportunity to look at it and ask questions about it. So, it is in there. It's available. So, there is something in the SAR that can provide us with the guidelines as to what at least the utility believes is a reference plant.

(26-33)

MR. MASNIK: I also believe in the supplement, there is a table on endpoint criteria for cleanup.

MR. SMITHGALL: Mike, could you see what you can find on that and while you're looking, if--Ken--

MR. MASNIK: It's on page 3.2. It's "Licensee's Radiological Goals for TMI-2 Facility at the End of Its Use."

MR. GERUSKY: What was that page? Does that give a reference point, too?

MR. MASNIK: No.

MR. GERUSKY: It's a comparison of the two, as I was pointing out.

CHAIRMAN MORRIS: Mike, while you're looking, I realize we're pursuing that one question, I'm just going to see if Tom has any thoughts. Ken, did you have anything additional you wanted to add?

MR. MILLER: The only thing that I would like to add is in looking at the dose savings that are to be gained through PDMS, if you compare that to a cleanup population of about a thousand persons over the same 20 or 30 years, you're looking at dose savings that are comparable to the same committed doses people are going to get from natural background radiation.

And if you throw in the radiation dose from radon, you're going to get levels that reach the extremes of what your projections are there.

So, I personally don't see justification for going into PDMS based upon the dose projections that are in the impact statement.

MR. SMITHGALL: Excuse me. To go back to Mike's comment a little earlier that we can comment on the PEIS and the PDMS and be a conduit of public opinion and advice, I guess my thought there is that I don't think we're confident enough in the numbers that are being used to estimate the dose savings and that was interesting to hear Ken's comments on it right now.

Secondly, and more importantly for me, I don't think it can be certain that funding would be in place despite the assurances of Mr. Kintner in his letter and us making comment on that without even seeing the plan.

So, I'm a little dubious. I would rather comply with the Commission's past stance on an expeditious cleanup and not leave a waste site on the Susquehanna River for 90 years.

Again, I see no justification for PDMS based on that.

CHAIRMAN MORRIS: Joel?

(26-34)

MR. ROTH: Yes. Try to make some sense of this. I have a feeling that to a certain extent, we've been caught in the trap of dealing with NRC rules or GPU rules that in a time past we sort of rebelled against sometimes and said, well, this is how we feel and we should go on record in saying that.

For instance, the funding which we were told we had no business dealing with, but, yet, for about 2 or 3 years, we continued to do it and kept pressure on, and I'm glad we did.

I just have a sense tonight that NRC would probably be a lot more comfortable if we would just be good children and go along with the rules, and I just have a real strong sense that we can try to cut through all that and just really say there's no justification for the PDMS and for the cleanup to proceed immediately, and let the NRC deal with what is, you know, what are the finer points, that we are representing, say, the public, the public sense is that, and stop trying to maybe, you know, complicate ourselves, you know, with the issue.

What I hear, you know, Ken Miller make the statement, you know, no justification, as a scientist, that's very meaningful to me. When I hear, and I did hear, I read Mr. Kintner's, you know, promise of funding, it reminds me of what George Bush probably meant in 1980 as "voodoo economics" has come to roost at this point.

I just don't see any reason for us to really try to make it maybe too complicated and just merely say this is our feeling as a panel that PDMS is not justified at this point and we throw it back to you to deal with getting on with cleanup, and if, you know, someone would like to put that into a motion, I'd be very happy to accept that.

CHAIRMAN MORRIS: What I'd like to do, hopefully we can allow each person to have a comment, and then if somebody would like to make a motion to at least begin the process, I think that would be wonderful.

Gordon?

MR. ROBINSON: I couldn't agree with your earlier comments. I have a problem distinguishing between a PEIS and an SAR from the standpoint of the information that I got. I had a chance to look at the SAR, but I don't have too much of a problem with PDMS, the two criteria, neither of which show up in the PEIS. It's terrible letters.

One is the funding, is the funding going to be in place. The second one is, and there's a statement in the PEIS that says, "In addition, the staff concludes that no further cleanup following defueling or no action alternative is not acceptable because this course would not result in elimination of public health and safety risks associated with the damaged facility."

(26-35)

So, that indicates that there is some time limit that has to be satisfied as far as completion of the decommissioning and cleanup is concerned.

Yet, I have seen no indication of why there is and what the risks are to safety. It may show up in the SAR. It may just be good common sense. I just don't know the answer to that. Those are the contents that are bothering me.

CHAIRMAN MORRIS: Thank you, Gordon.

Fred?

MR. RICE: Thank you.

Gordon asked a question, is the funding going to be in place. My question is, what is the procedure to guarantee the funding. If I knew that, then I think I could take a better position as to whether the cleanup should be immediate or 10 years or 15 or 20, but how do we guarantee the funding. That's my question.

CHAIRMAN MORRIS: Neil? We finally got over to your side.

DR. WALD: I really want to raise the same concerns that some of the issues have not been quantitated the way they say the occupational exposure is. I'm not sure the quantification of exposure at the twenty, thirty, sixty, ninety, or whatever number of years, the costs would be to weigh against this occupational exposure.

I'm not sure that the PEIS gives that. If it does, I may have missed it or forgotten what I read.

So, I think there are variables here that we really don't know and certainly funding is one of the biggest. I think that is the comment from the panel that I would expect the NRC needs to know.

CHAIRMAN MORRIS: Which one specifically, Neil? I didn't catch the last. Funding?

DR. WALD: You finally got to me and you didn't listen.

CHAIRMAN MORRIS: I listened to the first for a minute or so when you were talking about agreeing on the funding, but I missed the last part.

DR. WALD: I said that there are so many variables to weigh against the quantitative figure for occupational exposure, say, are not in place, certainly not in any time frame, like 20, 30, 60, or 90 years, and the funding is another area for which we don't have any quantitative information and it makes it very hard to have a reasonable judgment on it. I think that's a comment or a complaint or frustration.

(26-36)

CHAIRMAN MORRIS: Well, I certainly share that, and I think I've heard most people here share that very same thing. Both the radiation exposure, moving target type of thing, and the funding problem. I wonder if anybody is in a position here to share with us a proposed motion. Joel keeps whispering he's working on something, but I don't know if he's ready or not.

MR. ROTH: Well, with my luck in the voting, I'm going to be very careful, you know, on what I say.
But just as a start, I guess, and I'm certainly open to friendly amendments or whatever to it, and it's going to be not worded correctly, but I'd just like to see us, you know, move off center like and act responsibly and quickly, is just to say that we see, the panel sees no compelling reason for the PDMS and under that, we can use the worker exposure and the funding and, therefore, to proceed with the cleanup expeditiously.
I'm certainly open to any friendly changes. Hearing silence, it's passed, right?

CHAIRMAN MORRIS: Okay. Let's just take it slowly here. The panel sees--the motion would be that the panel sees no compelling reason for the PDMS and then following the PDMS, you express some concern regarding funding and the worker exposure question.
I guess on the funding, you said it's the uncertainty of the funding for the PDMS and on the worker exposure, it's the uncertainty of just what level of worker exposure is saved due to the delay, whether it's a 20-year period or a 40-year period, worker exposure would change. There's a great deal of uncertainty to that. Therefore, cleanup should proceed expeditiously.
Neil, comment? Clarification?

DR. WALD: I don't entirely share Ken Miller's position about the worker exposure. If weighed against the additional worker exposure, there is nothing, then I can wait for the worker exposure.
My problem is I don't know what to weigh against it and the cost issue is one reason I vote. In other words, will this actually be taken care of in 20 years or not? I don't know how to weigh what's in the balance against the worker exposure, but given an improvement or reduction of worker exposure and no loss anywhere up and down the line, I would have to vote for the worker exposure.

MR. MILLER: Can I clarify my comments?

CHAIRMAN MORRIS: Certainly.

(26-37)

MR. MILLER: I was not saying that I didn't think the worker exposure was significant. I was trying to put it into context in terms of its significance, and I was saying that, just doing a quick calculation, it turns out to be that the dose savings, the total dose savings amounts for the amount of natural background radiation on the same worker population you get over 20 years. I didn't say that it was insignificant. However, on the other hand, this population in this area has been given a lot of these dose projections and dose estimates and so on. Following the accident, an analysis was done to indicate that the total population dose commitment in this area or at least radioisotopes was 3300 person-rem, and the people of this area were told that this would be expected to produce approximately one-half of one case of fatal cancer, and, therefore, this is insignificant. So, if that 3300 person-rem was insignificant in that sense, this 3300 person-rem should really be somewhat insignificant in the same sense.

DR. WALD: Can I comment?

CHAIRMAN MORRIS: Sure.

DR. WALD: Except that one was already received and the other is being planned and that is a big difference there.

MR. MILLER: Not in the calculation. I would also like to add to that list that I think we need to convey to the Commissioners our concern, our frustrations over these poorly defined endpoints. I think that's the real problem here, and that's what's got us all bogged down in trying to come to some sort of decision and throwing out something we could all vote on.

MR. RICE: Mr. Chairman, let me ask another question.

CHAIRMAN MORRIS: Yes, sir.

MR. RICE: The Federal Register, dated Monday, June 27th, 1988, deals with the financial assurance and record keeping for decommissioning. Paragraph F says, "Financial assurance for decommissioning must be provided by one or more of the following methods: prepayment," that would be one, "or, two, a slurry method of insurance or other guarantee methods," but there's an entire section here that explains exactly what the licensee must do. So, has a funding plan been submitted?

CHAIRMAN MORRIS: The answer is no. A funding plan would not be submitted until July of 1990.

MR. RICE: That's July 1990?

(26-38)

CHAIRMAN MORRIS: That's the deadline.

MR. RICE: Well, I think we ought to suggest that that be updated so that we can consider it because I just think that we cannot come to a proper conclusion.

CHAIRMAN MORRIS: And I think that's the point of the motion, that, again, if I could attempt to clarify where we are at this point, the motion is the panel sees no compelling reason for the PDMS and after that, I think some points have been made regarding conditioning that statement on PDMS's poorly defined endpoints. Worker exposure savings argument is not convincing when you compare it to the uncertainty of the funding and uncertainty of the length of time of the PDMS.

I mean, that--at least I'm finding in this a sense that whether you agree with the comment Ken is making or Neil has been making, I think there is a sense of the panel that the worker exposure savings, the argument for that, is just not convincing when you compare it to some of the other open-ended things that are just funded and the moving target when it comes to the PDMS itself. Therefore, the cleanup should not proceed--therefore, the cleanup should proceed expeditiously, and express also in the motion that we define endpoints that have caused the panel to feel a sense of frustration in dealing with the PEIS and the PDMS.

Again, I'm just throwing out some guidelines here that we can clean up if we so desire.

MR. ROBINSON: I have a problem with making a decision on PDMS at this point until some of the other things are defined, and it seems to me that the way the motion reads now, we are making a decision against PDMS, and I'm not ready to do that yet.

I'd like to see some more--the other problems defined and then make the decision rather than make the decision and say these have been weighted against each other.

We haven't had a chance to weigh them yet because we don't know what the answers are.

CHAIRMAN MORRIS: Well, we could change the language to say that until such time as other information is available, that the panel takes the position.

Again, I understand what you're saying. That information is not forthcoming. We've had nobody come forward and say, well, we're going to give you a funding plan tomorrow, and unless it's forthcoming, how can we deal with it?

DR. WALD: I think that I would subscribe to what Gordon said, is to say that there's no reason to go for that. The panel is not in favor of going forward with the PDMS until the justifications are made much more clearer.

(26-39)

MR. ROTH: Yes, but as the maker of the motion, that is not a friendly amendment. It's not open just for friendly amendments. Right. I understand that. But I certainly wouldn't incorporate that in my proposal, my resolution, whatever you wish to call it at this point.

No, I could not accept that. I think it's up to the--

CHAIRMAN MORRIS: That would be a whole new motion.

MR. ROTH: Right.

CHAIRMAN MORRIS: And I guess what we should do here is try to move towards a wording that maybe is a sense to here and vote up and down, you can certainly--Neil, yes, I hear what you're saying. I think if you have another position on this that you'd like to offer, that you will vote up or down on this motion or you will try to amend this motion or have a substitute motion on it.

But at this point, before as again, the panel sees no compelling reason for PDMS and because of--again, because of no convincing reasons being presented on worker exposure and the uncertainty of the funding and the uncertainty of length of time of the PDMS, we basically are opposing PDMS and suggesting that cleanup proceed expeditiously.

That's the sense of what is before us at this point.

MR. ROTH: Can I just give one other reason for that motion? As I agree with what you're saying, but I think the onus is on the utility and the NRC to step forward and do that and not for us to say, well, when you do, you know,--I mean, to ask them, I don't think we should have to ask them.

I think we should say if we agree, there is no compelling reason at this time, let the utility step forward, let the NRC step forward, and show us compelling reasons.

I don't think we have to, you know, amend and maybe weaken the stand. I don't think we should wait till 1990 to give the funding. If they wish to move it up, I think that we should make our stand and they then have every right to come back to us and say here's what we're going to do about that.

I would rather not see us start anew our feelings, you know, at this point, and I use, for example, what we did on funding. I use, for example, when--I mean, God must have been listening that night because a number of years ago, I had made a motion that the cleanup of Unit 1 shouldn't be started until there was a funding plan for cleanup. This panel actually voted in favor of that motion, and we did bring it up before the NRC, and they were startled, but at least it showed our feelings.

I guess that's all I'm trying to do at this point.

(26-40)

MR. GERUSKY: Could you make a minor modification in it and say, cut out the phrase "we are opposed to PDMS" and say we propose expeditious cleanup?

CHAIRMAN MORRIS: I--

MR. GERUSKY: And that would solve everybody's problem.

CHAIRMAN MORRIS: I would state again for the record, again, the panel sees no compelling reason for the PDMS. It doesn't say we're opposed.

MR. ROTH: Right.

CHAIRMAN MORRIS: We see no compelling reason for the PDMS.

MR. ROTH: Right.

CHAIRMAN MORRIS: Now, comments on something like that. Worker exposure savings. Worker exposure savings argument is not convincing compared to the uncertainty of the funding and the uncertainty of length of time of the PDMS. Therefore, cleanup should proceed expeditiously.

MR. ROTH: Exactly.

CHAIRMAN MORRIS: Obviously, it needs cleaning up some, but that's again the sense of what we're saying and part of the motion then is the statement that poorly defined endpoints of cleanup caused the panel to feel a sense of frustration in dealing with the PEIS and PDMS.
Now, again, just to clarify items, I personally agree with what Joel is saying. I think we're not closing off the chance to return to this issue if somebody comes forward and presents information that we are lacking.
So that, you know, for the record, my vote--I'm certainly open to receive information on both of those arguments, but until we do, I have been expressing the opinion on what we've heard, and what we've heard is that there's no funding plan until 1990 and this PEIS is supposed to be completed by this year some time, which is a whole year-and-a-half before the funding plan is put in place. So, if that's the case and with that kind of uncertainty, I personally don't feel like I've got much of a choice but to vote for the motion.

MS. MARSHALL: Couldn't we be a little more specific and request that a plan for decommissioning be started at this time with the ultimate goal of unrestricted use?

(26-41)

CHAIRMAN MORRIS: I think, if I could--that's a separate--in the decommissioning issue is somewhat separate from the PDMS.

MS. MARSHALL: It's the decommissioning that they're talking about in this Kintner letter.

CHAIRMAN MORRIS: On the funding.

MS. MARSHALL: And putting it with all the other licensed reactor plants in the country.

CHAIRMAN MORRIS: That's the way it's tied into decommissioning because they have agreed that the PDMS funding would be included in the submission.

MS. MARSHALL: Did the--TMI-2 is a licensed reactor plant. It hasn't been an operating plant for 11 years.

CHAIRMAN MORRIS: I think the point that's being made is you can certainly try to make a motion to amend this, and I would encourage you to do that if you have a thought on it, but I think what was said in the motion is again is that this panel is making a strong statement based on information that's been provided to us. If somebody wants to come along and try to change the sense of the panel by providing information on decommissioning, funding plan, or something on the PDMS or some changes, by all means, feel free to do that.

But the given information we have, this is the sense of the panel.

MS. MARSHALL: That--

CHAIRMAN MORRIS: Which includes the sense of frustration throughout.

MS. MARSHALL: We are just, in other words, going to put simply on record that we're opposed to the monitored storage, post-defueling monitored storage?

CHAIRMAN MORRIS: But we are conditioning that on the fact that we have not -- the worker exposure question has not been compelling when you compare it to the lack of information on the funding, and the lack of information on the length of PDMS.

So, we're conditioning it.

MS. MARSHALL: It's a unique plant, though.

CHAIRMAN MORRIS: They understand that. They're going to read the transcript. If somebody wants to come along and offer something to help us, fine, but until they do.

Again, it's such an open-ended question for us to answer.

(26-42)

MS. MARSHALL: They have to start the plan some time.

CHAIRMAN MORRIS: I understand that.

MR. ROTH: Can I just--Arthur has been a very fine spokesman for my motion, and I certainly don't want to stop it. He's on a roll at this point.
But all I'm trying to say is condensing all this into the no-compelling reason and let them come with all the other reasons and points they wish to. That's not for us to do, you know, at this point.
We just have heard no compelling reason yet, you know, at this point, and I think that's all my motion is addressing, is that. It's not addressing decommissioning or any of these other issues which I certainly feel strongly about.
What the people to my right, which is a great position for you guys to be in, is just trying to get to the heart of the issue, where we are. That's all I'm trying to do, and not bring in, you know, all these other things, which I'm agreeing with.
But I don't think that belongs. I think the onus, the responsibility belongs on GPU and NRC, not on the public that keep coming forward endlessly and not for us to try to develop, you know, ideas at this point, but just to say what we have heard, you know, is just not sufficient.

CHAIRMAN MORRIS: Neil?

DR. WALD: You still pointed out Neil rather than him.

MR. ROTH: Good, Neil.

DR. WALD: I have to agree with the intent. I think we're close in that. My concern is--well, if you say at this time, for instance, as you just did, if it's clear that at this time, there's no compelling reason, I agree with you, the burden of proof is on the NRC and GPU to be convincing about what to weigh against the worker exposure, and I agree with the question that we don't have is important and needs to be built in, and I think by these people, not by us.
So, I agree with you. I don't want it to appear that we're closing out for all time consideration of this.

MR. ROTH: Right. At this point, there's no compelling reason at this time. I would certainly accept that as a friendly addition.

DR. WALD: Okay.

MR. RICE: I have one question. What is the period for cleanup under immediate? Four years? Is that correct?

(26-43)

I thought they submitted many reasons for post-defueling and one of the reasons was that they had to tear the whole thing apart and cause a lot of restructuring and so forth.
I'm still not prepared to support your resolution.

CHAIRMAN MORRIS: Okay. The motion as it now reads has been amended in a friendly fashion to say at this time, the panel sees no compelling reason for the PDMS, worker exposure savings--the worker exposure savings argument is not convincing when compared to the uncertainty of funding and uncertainty of length of time of the PDMS. Therefore, cleanup should proceed expeditiously. Poorly defined endpoints of cleanup caused the panel to feel a sense of frustration in dealing with the PEIS and PDMS. That is basically the motion before us.
I would ask permission that if we go forward, that I am allowed to have some editorial right to clean up simply the language, not the intent.

MR. ROTH: As long as I can hear that, sir.

CHAIRMAN MORRIS: Again, I will send copies of anything like that to the commenters. If anybody has a problem with it and want to restate it, it would only be in order for people to understand it maybe a little bit better and not argue about crossing the t's.

MR. ROTH: I would certainly accept that. Yes.

MR. SMITHGALL: I have heard somebody ask for a call of the question. I'll second it.

CHAIRMAN MORRIS: Okay. It's been moved by Joel Roth. That motion has been moved by Joel Roth and seconded by Tom Smithgall. The question has been called for, and I would ask all those in favor--if you will wait a second, I will ask you again, I will ask you to raise your hand if you're for it and raise your hand if you're against it, so it's easier to figure out.
So, all those in favor of the motion, signify by raising your hand, please.

(Show of hands.)

CHAIRMAN MORRIS: There are eight individuals for it and, for the record, they are Gerusky, Marshall, Trunk, Miller, Smithgall, Morris, Roth, and Wald.
Those against, raise your hands, please.

(Show of hands.)

CHAIRMAN MORRIS: I guess the two other individuals that are present here this evening, Fred Rice and Gordon Robinson.

No, you will not be discriminated against. I didn't know whether to use the names or not. It's on the record.

Okay. That basically completes the agenda items for this evening.

[DISCUSSION]

(26-45)

No. 29

United States Nuclear Regulatory Commission Periodic Briefing by TMI-2 Advisory Panel - October 25, 1988

CHAIRMAN ZECH: Good morning, ladies and gentlemen. Today, the Advisory Panel for the Decontamination of the Three Mile Island Unit 2 is going to present a briefing to the Commission on their recent activities and the current concerns and comments they have on the plans regarding TMI-2. This is an information briefing and no Commission action is planned at this meeting today.

[DISCUSSION]

Since the Three Mile Island accident took place over 9 years ago, the world has been following the progress of the defueling and cleanup of the plant. The Advisory Panel for the Decontamination of Three Mile Island Unit 2 provides an independent assessment of the activities at the plant to the Commission through these meetings and brings us the concerns and perspective of the communities in the vicinity of the plant. The Commission has found these briefings to be informative and of value to us in our deliberations regarding TMI-2 and in considering related safety issues brought to the Commission for decision.

[DISCUSSION]

MR. MORRIS:

[DISCUSSION]

The panel members do wish to discuss two specific topics with you today. One is the post-defueling monitored storage concept or the PDMS concept or proposal, and the second would be the future work of the panel.

Regarding the PDMS, Tom Gerusky, one of our panel members who is with the Department of Environmental Resources in Harrisburg who could not be with us today, raised the issue of PDMS back in February of 1984. We had, at that time, in December of 1986 I should say, an original presentation by GPU on that proposal. Then they gave us a re-briefing of that proposal back in January of this year, in 1988, for the second time we discussed with them and the public, and since that time we've had three other meetings with them. So in total, we've really met with them five different times in the public domain at our meetings to discuss the PDMS concept. I hope that you did receive the letter that I sent, I believe dated September 13th, which was sent on behalf of the panel. And if I could for the record go through that, it's not a long letter and I'd like to go through at least parts of it.

CHAIRMAN ZECH: Certainly. We did receive it but you may certainly go through as much of it as you'd like.

MR. MORRIS: Okay, thank you. Beginning in paragraph 2 I will read it, "The majority of the time in our meetings of May 26th, July 14th and September 7th was spent discussing the draft supplement No. 3 of the Programmatic Environmental Impact Statement dealing with the post-defueling monitored storage (PDMS) and subsequent cleanup. An initial presentation was made on the document by the staff of the NRC with subsequent comment and observations by the NRC, GPU, the general public and panel members. "At the conclusion of the public portion of the discussion at our last meeting. . ."--and again, that was on September 7th--". . . the panel decided that we should take a position on the PDMS. Prior to my outlining that position, I do wish on behalf of the panel to make several observations to you as follows:

"One, while there clearly is a reduction in worker exposure in cleanup following the PDMS plan, the amount of reduction was not as significant as we had anticipated. Two, there is no specific funding plan in place, and consequently no guarantee that monies will be in place for cleanup following PDMS. Three, after listening to the discussion, it became clear that the 20-year period for PDMS was not definite, and in fact after a 20-year period the PDMS could be coupled with decommissioning and continue in the same basic state for an additional 30 to 60 years. This uncertainty troubled the panel.

"By a vote of 8 to 2, the panel took the following position: at this time, the panel does not recognize any compelling reason to follow the PDMS. The advantage of reduced worker exposure was not convincing when considered against the uncertainty of funding and the uncertainty of the length of the PDMS. Therefore, the panel believes that cleanup should proceed expeditiously. The poorly-defined endpoints of cleanup cause the panel to feel a sense of frustration in dealing with the PEIS and the PDMS.
"I would like to point out that throughout our deliberations, members of the public were invited to comment. All comments from the public were in opposition to the PDMS concept, and as such, I feel comfortable in saying that the above-stated position of the panel also reflects the sense of the public who attended our meetings."

[DISCUSSION]

(29-2)

MR. MORRIS: Is there anybody that has specific comment?

[DISCUSSION]

MR. ROBINSON: Gordon Robinson. I was opposed to this motion more because of the way it was worded than most of the substance. I agree that there should be a more comprehensive plan to pay for the completed cleanup, and there should be a definite time, say 20 years or whatever the time that is realistic for completing the cleanup. As far as no compelling reason, I somewhat disagree with that. I think there are reasons. I don't think they've been well articulated, and I think that more information should be provided in that area.

CHAIRMAN ZECH: Thank you very much. Any other panel members like to make any comments?

MS. MARSHALL: Yes. I'm Elizabeth Marshall, a member of the panel, and it occurred to me that precisely because the attention of the world has been focused on Three Mile Island, that it might be a very positive state to clean up as quickly as possible and restore it to the ultimate state which is anticipated 20, 40, 60 years from now. That this would be -- if it sits there, that it would have a very negative impact on nuclear power generally, and that working with today's dollars, it might be more sensible to address the whole problem now. And I say particularly in view of the worldwide attention that this particular accident received.

CHAIRMAN ZECH: Thank you very much, Ms. Marshall. Yes?

MR. LUETZELSCHWAB: I wasn't at the meeting but I think I have to say that I have to add my vote to the eight who were in favor of the motion. I voted previously to get the water off the island and I guess for that reason also, I want to get it cleaned up as quickly as possible. So I think they ought to just keep on going and get it done as soon as possible.

CHAIRMAN ZECH: Thank you very much. Any other comments?

DR. WALD: The problem that I think we as a panel faced was that we are being asked to accept an endpoint to this cleanup that was being proposed by the utility when we really don't have any sort of guide from your side of the question as to what an acceptable endpoint ought to be. And I think we all realize that there is going to have to be some period of PDMS; we just don't know at what point PDMS should start, and that's been our dilemma through the whole discussion of the situation.

CHAIRMAN ZECH: All right, thank you very much. Any other comments?

(29-3)

MR. SMITHGALL: Tom Smithgall. To comment on PDMS one comments directly and indirectly on all aspects of the cleanup process. By that I mean that I think the people that surround TMI need more rather than less assurances that Three Mile Island 2 will be cleaned up. My comments follow the comments that were submitted after the comment period for the PEIS of the Commonwealth of Pennsylvania. Basically, I think number one, the general public needs to know that the entire cleanup, including decommissioning, will have a defined and very specific endpoint. We've been dealing with this over 9 years now and I think there is a need for that. Secondly, the environmental impacts of any storage should be kept within the bounds of the PEIS, not only by required surveillance and monitoring by GPU Nuclear, but certainly by the NRC's active oversight that has been evident over the last years over your regulatory surveillance. And thirdly, I think importantly for people in southcentral Pennsylvania that the financial assurances for cleanup and decommissioning become more specific and more defined. More than overall general guarantees are needed at this point in light of the fact that the plant generates no revenues for set-aside, that the actual cleanup goes well into the future, and that they will be dealing with two plants rather than one. Therefore, as a member of our advisory panel, or your advisory panel I should say, I'm asking that you reject the PDMS proposal in favor of the expeditious cleanup, and I thank you for the opportunity to come to speak.

CHAIRMAN ZECH: Thank you very much. Are there other comments?

MR. RICE: I'm Fred Rice, former Dauphin County Commissioner where Three Mile Island is located. I sense that the people in Dauphin County would like to get it cleaned up as quickly as possible. I opposed the motion, the resolution, because I felt that we just do not have the specifics for the funding set up. That's why I was the other negative vote. Thank you.

CHAIRMAN ZECH: Thank you very much, appreciate it.

[DISCUSSION]

DR. WALD: I don't want to reiterate many of the points which were already raised but I just wanted to state that a matter of chronic anxiety for the population is a health impact of the accident. We're fortunate there were no others. But anything we can do to have a firm timetable and firm and definitive action would be desirable to reduce public anxiety. And I voted for the motion because of that.

CHAIRMAN ZECH: Thank you very much, appreciate that. Mr. Roth?

(29-4)

MR. ROTH: Thank you. I appreciate what my fellow panel members have said. I happened to be -- it's called the Roth Motion, I just had to say that, get that on my resume. For the last almost 10 years or 9 years that the panel has been in existence, I guess I played the role of almost the citizen from the area and what they think and what the people feel, and it seems that this one, the utility seems to have looked at this PDMS as a given and sort of expected us to just go along with it; and hence the term "no compelling reason at this point" was at least shown to the panel. And I was glad to hear John say that would make it a 9 to 2 rather than 8 to 2 vote. It just seems that it's so wide open, and the public is thoroughly concerned with well, is it going to be 20 years, 40 years? The utility said it can be any period of time. And it just seems that there is such a loophole, a loophole probably large enough for a cooling tower to pass through, on this issue. It just seems to be so nebulous. What is it? What does it mean? How can they get away with it? How can it, you know, just stop right now. I appreciated the members of this panel who represent the scientific community, we depend on them a lot. And when the majority of them agreed with this motion, to me that was a compelling reason for our situation at this point to say it just is not enough, we just can't leave it here, there has got to be a lot more delineation of this issue and not just accept, that is at this point. There's very much concern -- I think it started on the economics of where the dollars are coming from. I don't think I as one person and perhaps others here are ready to accept the utility's promise that they will have the money. In other words, that "trust us" mode I don't believe is enough for the panel and also for the citizens of the area. And I thank you.

CHAIRMAN ZECH: Thank you very much, appreciate those comments also. Are there any other comments?

MR. MORRIS: If I could just add just a couple. One is that when we talk about funding, we are aware, Mr. Chairman, and I would like to say that if you've had a chance, I realize our minutes are pretty lengthy and you may not have had a chance to see them all, but in there if you would have a chance to read them you'd see that we are aware of the fact that I think it's by July of 1990 or something like that, there's a requirement for plants to submit to the NRC some kind of funding plan for decommissioning. We understand that, but that's 2 years away. We have no knowledge of what that plan really will entail, how specific shall it be. So we're in a position now of not knowing what they're going to submit, not knowing what the funding plan will be, how specific will it be, and trying to act on a PDMS plan with that concern. And then secondly, the longevity of the PDMS process possibly being longer than 20 years, maybe even 50 or 90 or whatever if

(29-5)

coupled with decommissioning. So that uncertainty. And then the third one I think that Ken Miller mentioned, and I know I'm repeating some of the things here but I think it's important to make the point that we have discussed the July 9, 1990, submission, when is the endpoint of cleanup really the endpoint is a good question. We did wrestle with that. When what is known as the cleanup finishing now, there will still be radioactivity in the piping, in equipment that they say is harder to get at. We're not sure whether that--I think the sense of the panel is that we're not sure that they can continue to at least remove the piping and equipment that has that radioactivity in it before they would then get to the point where they say, now we need to go into PDMS. So again, the question of when is the endpoint really the endpoint--I'm not sitting here as a member saying I never believed that that plant needs to have some monitored storage to it. The question is when does that point begin, and what funding will be available for the ultimate cleanup, and how long will the PDMS be allowed to continue, I think are three main unanswered questions at this particular point. And I think because of that, you had the panel members not unanimously but close to it supporting the position. And realize again that we spent five meetings on this, and our meetings generally start at 7:00 p.m. and go to 10:00 at night, they're three-hour meetings. And while the first two may not have been totally devoted to this issue, the last three were. And we don't always stop at 10:00, there have been times in those meetings when we went on until 10:30, 11:00 o'clock at night. So we really got into the issue. We do not take our position on this lightly. So I just offer those last words at least on my behalf, and I don't know if anybody else has anything they want to add on this issue, or maybe the Commissioners have some questions you want to ask or some comments you want to make on it, too.

CHAIRMAN ZECH: Are there any other comments that any of the other panel members would like to make, the advisory panel?

[NO RESPONSE]

CHAIRMAN ZECH: We thank you very much for those comments. Before we go to the next issue, perhaps I'll ask my fellow Commissioners if they have any questions or comments they'd like to make.

COMMISSIONER CARR: Yes. It seems to me that the consensus is that you're not against PDMS per se, but the indefiniteness of when they'll go into it. In other words, what right point to shift to PDMS, how long it will be, and the assurance that the money will be there to finally do whatever is decided to be done with the site--whether it gets to unrestricted use or whatever. Is that an accurate summary?

(29-6)

MR. MORRIS: I personally feel that while we might not have unanimous comment on that, I would think that would be the consensus of the panel, yes.

COMMISSIONER CARR: So it was the indefiniteness of the plan rather than the idea itself that got you uneasy.

MR. MORRIS: I speak as Chairman and I think there are other panel members who voted the same way that would say yes, that's true.

COMMISSIONER CARR: Thank you.

CHAIRMAN ZECH: Commissioner Rogers?

COMMISSIONER ROGERS: Well, that was really my question. I think that's the issue that is so central here; whether the panel feels that with further work and further definition and further elucidation of remedies for your concerns, whether, PDMS would then be a reasonable approach.

MR. MORRIS: I think the answer to that would be yes but that GPU has a lot of work to do. Again, as a panel member and as Chairman, they have a lot of work. There's a lot of things they need to do to answer those questions in a definitive way. And I wouldn't want anybody to feel that that is an easy thing for them to do; they've got work to do and they've got some commitments I think they need to make in order to at least have the panel feel comfortable in supporting such a concept. But I think in the end, it's only practical to assume that PDMS--there has to be a place for PDMS at some point under certain circumstances.

DR. WALD: One amplification. We did discuss very thoroughly the addition of the opening words of the panel's position, "At this time..." and it was the consensus after some disagreement that that really reflects our feeling. At this time.

CHAIRMAN ZECH: That's an important thought, appreciate that. Commissioner Curtiss, any comments?

COMMISSIONER CURTISS: No, thank you.

CHAIRMAN ZECH: Well, I think my colleagues have summed up essentially your views; I think we understand them. Defining the endpoint, when is it; how long the PDMS should continue; the financial assurances. I think the regulatory oversight point was also one that I would say was an important point to be brought up, too, and we certainly intend to continue our responsibilities in that area. But I think you have made your position clear. I appreciate very much your thoughts in that regard, and certainly they will be carefully considered.

(29-7)

COMMISSIONER CARR: Just one more question. During your deliberations did you look at the question of when it becomes too expensive to clean up?

MR. MORRIS: When it becomes too expensive to clean what up? First of all, let me say--

COMMISSIONER CARR: How will the panel decide when you're on what slope of the curve beyond which it's probably reasonable not to go any further?

MR. MORRIS: Well, I personally feel that is obviously the question--the answer that we're seeking when we talk about when do we go into PDMS.

COMMISSIONER CARR: And I'm looking for criteria.

MR. MORRIS: I think at this point what we're saying is based on what we've heard, we don't feel comfortable in supporting PDMS. We are looking to those individuals, particularly the operator, GPU, and the NRC--and I speak, again, as one--to provide the parameters for us to review. And we're saying we're open for that kind of discussion, but there's been very little as far as I'm concerned information offered to resolve that particular issue. And I'm not sitting here saying I'm an expert on this and saying that I know those answers, but I am saying that I am open to supporting PDMS. But--

COMMISSIONER CARR: I guess my question then should be, are you open to an argument that at some point it's too expensive to continue the cleanup?

MR. MORRIS: Well certainly. I mean, if you didn't consider that you would say we should go forever and a day and we should get every single bit of radioactivity out of that plant, then you can mothball it. That's not what is being said here. Obviously you've got to look at the finances and the benefit, and those come together at some point.

COMMISSIONER CARR: Well, I was reading your position as really we should go ahead and do the final--whatever the final cleanup is--do it now and if that happens to be unrestricted use, we should proceed in all haste and clean it up.

MR. MORRIS: Well, that--in the end if they come along and say we can do that for $3.50, we'll say sure, we want to go right until the end. Now clearly, that's not going to be the answer, but we don't know those dollars and cents. We've heard the numbers given by the staff of the NRC in the PEIS of $240 million or so if you would continue to remove all the piping and what have you, or up to $300 million; and we've heard the GPU say well, they're not sure that those numbers are accurate. We've heard those kind of things. But again, the specifics of it, the commitments that that money is going to be there--that's a key point. At some point they're going to have to decommission the plant, and if they leave PDMS run into decommissioning, we feel we need to be assured that that money is going to be there. So you can't just take the one question out because then you still say all right, when they do have to spend money is it going to be there. And how long down the line will that be? So we've raised three issues here and I think yours really speaks to when is the cleanup finished and PDMS begins. And it goes to money and degree of removal. And most of the panel members that I've spoken with individually agree with the PDMS concept; it's the beginning point, your question. And if you would read our--

COMMISSIONER CARR: Well, Ms. Marshall particularly said she would like to restart so people would look at Three Mile Island and see it as never had a problem. I assume. Is that what-- ?

MS. MARSHALL: Well, I think that's the ultimate goal, but it seems to be projected for the future, the uncertain future. In the meantime it sits there and I think has a very negative impact on nuclear power throughout the country. If it is conceived that that is a continuing source of power for our country, then it seems to me we've got to clean as we go and not leave it to the next generation.

MR. MORRIS: And I would just like to add on to what Elizabeth is saying, and I know that Joel has some comments he want to offer, too. But if you have a chance, and I don't know if you've had a chance to go through our last three meeting minutes, but if you have a chance to do that the reading is pretty quick and it doesn't take that long, but I think you would get a sense for the information that we were provided and the lack of specificity in many cases that led to the uncertainty and the frustration of the panel in making this determination. And I think when you go through that you'll see that there is not a lot of meat to the proposal of the variety that we're looking for and need to make a determination.

CHAIRMAN ZECH: Thank you. Yes, Mr. Rice.

MR. RICE: It appears to me that the panel is very cost conscious from that standpoint and we haven't been able to get any answer. The people that appeared before the panel, however, they don't care how much it costs; they want it cleaned up.

COMMISSIONER CARR: Sure.

(29-9)

CHAIRMAN ZECH: Any other comments?

MR. ROTH: Yes, basically to Commissioner Carr's statement. I think that if one reads the minutes of that meeting where the motion was made, I think the principle that I was going under just as one individual was the fact that it wasn't up to us as a panel to make a determination of numbers, but rather to see what the presenters, the utility, was doing. And I just felt as an individual that it was almost non-existent, it was almost a fait accompli that they were looking at on their part and we weren't buying it.

COMMISSIONER CARR: They didn't make their case as far as you were concerned.

MR. ROTH: Didn't make their case at all. Yes, sir.

CHAIRMAN ZECH: Commissioner Rogers has a comment.

COMMISSIONER ROGERS: Just, how much credibility or how much weight perhaps is the better way to put it, would you place on the notion that by waiting a longer period of time before the ultimate cleanup, that there is less personnel exposure of those individuals that have to perform the cleanup. And there is an ALARA concept involved here to some extent that as little radiation exposure as possible ensues from the total process.

MR. MORRIS: As a lay person--and I would hope that maybe Ken Miller and some others would speak to this, but I must say that when those numbers were presented to us--and they put it in the number of exposures as far as how many people might die from cancer as a result of continuing to clean up now versus waiting. And the two-tenths of a life or whatever isn't important, but the number --and it's something like that, two-tenths or three-tenths--was not nearly as convincing as what one person expected it would be. I thought there would be significant savings in risk to life as a result of waiting. And while there is a number and there is a difference, it was not very convincing. And there has to be--I think if that's the best that can be done in that, there has to be something else built on top of that to make the argument convincing to go with PDMS. One may be finances, certainly. One may be just common sense that you can only get to a certain point. But exposure to workers alone from one person was not the compelling reason to go into PDMS.

COMMISSIONER ROGERS: Well, is the panel also able to deal with the possibility that there will be no compelling reason to go one way or the other; that a choice has to be made, a decision has to be made that is not based on an obvious, compelling reason but

(29-10)

simply a collection of reasons that put together could lead to a decision one way or the other, either of which might be a reasonable decision?

MR. MORRIS: Mr. Commissioner, yes, I would say I am prepared to say that that may happen, and under those circumstances I know the Commission would say let's proceed, because under those circumstances the Commission has always said, at least staff has said, that cleanup must proceed expeditiously. That that has to be the goal. And as one, I supported--I don't want to necessarily get into the evaporation of water but I want to tell you that I supported the evaporation of water for that concept--we need to proceed, we need to rid the island, if we can't use it as a storage area. That has been the position and unless something compelling comes along to change that, that has been the direction of the NRC, and I think it speaks a lot to what Elizabeth Marshall said before, that there are people in the area that have great concerns about the plant. The world has looked at TMI and I still think there's a great deal of interest in it. And when everything else is even, the answer has to be we're going to clean that up. If there's no compelling reason not to, then we ought to proceed with it. So that's the problem. I'm not saying they can't build a strong case but they've got to go back and they've got to sit down and say, jeeze, we'd better do a better job on this.

CHAIRMAN ZECH: Thank you very much.

[DISCUSSION]

I think that what you've said to us this morning is very important. We hope that you would keep us apprised of any other activities or any other concerns you might have that we haven't talked about here today. I'm informed that our staff is aware of your comments and your concerns regarding the PDMS issue in particular and are addressing them in their preparation of the final Environmental Impact Statement on PDMS. The Environmental Impact Statement documents--the purpose, of course, is to document the staff's analysis of this whole situation and look at all the alternatives. It will be used eventually to evaluate the application that GPU has made to terminate the cleanup activities. I think that the points you've raised on endpoint and the point you've raised on the specifics, the parameters, how long the PDMS should continue, are very important issues that should be carefully considered. I would ask that the staff do so very carefully and bring the thoughts of your advisory panel to the attention of all those who will be analyzing what positions we will be taking, specifically regarding the PDMS issue. And I think that, needless to say, decisions will be made and I can

(29-11)

only assure you that your concerns will be carefully considered and with great respect for the public service that all of you are performing, again, to our agency and to our fellow citizens.

[DISCUSSION]

(29-12)

APPENDIX B

CONTRIBUTORS TO THE SUPPLEMENT

APPENDIX B

CONTRIBUTORS TO THE SUPPLEMENT

The overall responsibility for the preparation of this supplement was assigned to the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The supplement was prepared by members of the Office of Nuclear Reactor Regulation with assistance from other NRC organizations and the Pacific Northwest Laboratory (PNL). The major contributors to the supplement, their affiliations, and function or expertise are listed below.

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APPENDIX C

MAXIMUM PERMISSIBLE CONCENTRATIONS IN AIR AND WATER

APPENDIX C

MAXIMUM PERMISSIBLE CONCENTRATIONS IN AIR AND WATER

The regulations in 10 CFR 20, "Standards for Protection Against Radiation," specify the allowable concentrations for discharge of radioactivity in effluents to air and water in unrestricted areas. Table C.1 lists the maximum permissible concentrations in air and water in unrestricted areas for those isotopes present in the TMI-2 facility following defueling. The maximum permissible concentrations, obtained from 10 CFR 20, Appendix B, Table II, are concentrations above background.

TABLE C.1. Maximum Permissible Concentrations in Air and Water Above Background in Unrestricted Areas[a] (from 10 CFR 20, Appendix B, Table II)

Isotope[b]		Air, µCi/mL	Water, µCi/mL
Hydrogen-3 (tritium)	S	2×10^{-7}	3×10^{-3}
	I	2×10^{-7}	3×10^{-3}
	Sub	4×10^{-5}	---[d]
Carbon-14	S	1×10^{-7}	8×10^{-4}
	Sub[c]	1×10^{-6}	---[d]
Manganese-54	S	1×10^{-8}	1×10^{-4}
	I	1×10^{-9}	1×10^{-4}
Iron-55	S	3×10^{-8}	8×10^{-4}
	I	3×10^{-8}	2×10^{-3}
Cobalt-60	S	1×10^{-8}	5×10^{-5}
	I	3×10^{-10}	3×10^{-5}
Nickel-63	S	2×10^{-9}	3×10^{-5}
	I	1×10^{-8}	7×10^{-4}
Selenium-79		1×10^{-10}	3×10^{-6}
Krypton-85	Sub	3×10^{-7}	---[d]
Strontium-90	S	3×10^{-11}	3×10^{-7}
	I	2×10^{-10}	4×10^{-5}
Yttrium-90	S	4×10^{-9}	2×10^{-5}
	I	3×10^{-9}	2×10^{-5}

TABLE C.1. (contd)

Isotope[b]		Air, μCi/mL	Water, μCi/mL
Zirconium-93	S	4×10^{-9}	8×10^{-4}
	I	1×10^{-8}	8×10^{-4}
Niobium-93m	S	4×10^{-9}	4×10^{-4}
	I	5×10^{-9}	4×10^{-4}
Technetium-99	S	7×10^{-8}	3×10^{-4}
	I	2×10^{-9}	2×10^{-4}
Ruthenium-106	S	3×10^{-9}	1×10^{-5}
	I	2×10^{-10}	1×10^{-5}
Rhodium-106	Sub	3×10^{-8}	---[d]
Cadmium-113m		1×10^{-10}	3×10^{-6}
Tin-126		1×10^{-10}	3×10^{-6}
Antimony-125	S	2×10^{-8}	1×10^{-4}
	I	9×10^{-10}	1×10^{-4}
Antimony-126m	Sub	3×10^{-8}	---[d]
Tellurium-125m	S	1×10^{-8}	2×10^{-4}
	I	4×10^{-9}	1×10^{-4}
Cesium-134	S	1×10^{-9}	9×10^{-6}
	I	4×10^{-10}	4×10^{-5}
Cesium-135	S	2×10^{-8}	1×10^{-4}
	I	3×10^{-9}	2×10^{-4}
Cesium-137	S	2×10^{-9}	2×10^{-5}
	I	5×10^{-10}	4×10^{-5}
Barium-137m	Sub	3×10^{-8}	---[d]
Cerium-144	S	3×10^{-10}	1×10^{-5}
	I	2×10^{-10}	1×10^{-5}
Praseodymium-144	Sub	3×10^{-8}	---[d]
Praseodymium-144m	Sub	3×10^{-8}	---[d]

TABLE C.1. (contd)

Isotope[b]		Air, $\mu Ci/mL$	Water, $\mu Ci/mL$
Promethium-147	S	2×10^{-9}	2×10^{-4}
	I	3×10^{-9}	2×10^{-4}
Samarium-151	S	2×10^{-9}	4×10^{-4}
	I	5×10^{-9}	4×10^{-4}
Europium-152	S	4×10^{-10}	8×10^{-5}
	I	6×10^{-10}	8×10^{-5}
Europium-154	S	1×10^{-10}	2×10^{-5}
	I	2×10^{-10}	2×10^{-5}
Europium-155	S	3×10^{-9}	2×10^{-4}
	I	3×10^{-9}	2×10^{-4}
Thorium-231	S	5×10^{-8}	2×10^{-4}
	I	4×10^{-8}	2×10^{-4}
Thorium-234	S	2×10^{-9}	2×10^{-5}
	I	1×10^{-9}	2×10^{-5}
Protactinium-234m	Sub	3×10^{-8}	---[d]
Uranium-234	S	2×10^{-11}	3×10^{-5}
	I	4×10^{-12}	3×10^{-5}
Uranium-235	S	2×10^{-11}	3×10^{-5}
	I	4×10^{-12}	3×10^{-5}
Uranium-236	S	2×10^{-11}	3×10^{-5}
	I	4×10^{-12}	3×10^{-5}
Uranium-237		1×10^{-10}	3×10^{-6}
Uranium-238	S	3×10^{-12}	4×10^{-5}
	I	5×10^{-12}	4×10^{-5}
Plutonium-238	S	7×10^{-14}	5×10^{-6}
	I	1×10^{-12}	3×10^{-5}
Plutonium-239	S	6×10^{-14}	5×10^{-6}
	I	1×10^{-12}	3×10^{-5}
Plutonium-240	S	6×10^{-14}	5×10^{-6}
	I	1×10^{-12}	3×10^{-5}

TABLE C.1. (contd)

Isotope(b)		Air, μCi/mL	Water, μCi/mL
Plutonium-241	S	3×10^{-12}	2×10^{-4}
	I	1×10^{-9}	1×10^{-3}
Americium-241	S	2×10^{-13}	4×10^{-6}
	I	4×10^{-12}	3×10^{-5}

(a) When more than one radionuclide is present, the sum of the concentrations of each radionuclide, divided by the concentration in the table, must be less than or equal to 1 (10 CFR 20, Appendix B, Footnote 1).
(b) S = soluble
I = insoluble
Sub = submersion in a semispherical infinite cloud of airborne material.
(c) As carbon dioxide, CO_2.
(d) "---" indicates no value was given.

REFERENCE

U.S. Nuclear Regulatory Commission (CFR). Energy. Title 10, Part 20. (10 CFR 20), U.S. Government Printing Office, Washington, D.C.

APPENDIX D

ESTIMATED RADIONUCLIDE RELEASES AND RELEASE RATES

APPENDIX D

ESTIMATED RADIONUCLIDE RELEASES AND RELEASE RATES

This appendix provides the calculated release rates (Ci/yr) for routine releases of radioactive material and the calculated releases (curies) for accidental releases of radioactive material from the TMI-2 facility. The calculated releases are based on the information given in Section 3.0.

TABLE D.1. Routine Atmospheric Release Rates During Post-Defueling Monitored Storage

Radionuclide	Release Rate, Ci/yr[a]
Tritium	4.5×10^{-7}
Carbon-14	2.5×10^{-7}
Manganese-54	7.5×10^{-11}
Iron-55	2.0×10^{-7}
Cobalt-60	8.3×10^{-7}
Nickel-63	2.2×10^{-7}
Selenium-79	5.6×10^{-8}
Krypton-85	7.0×10^{-7}
Strontium-90/Yttrium-90	9.8×10^{-4}
Zirconium-93	6.3×10^{-10}
Niobium-93m	1.1×10^{-7}
Technetium-99	1.9×10^{-6}
Ruthenium-106/Rhodium-106	2.1×10^{-5}
Cadmium-113m	3.1×10^{-8}
Antimony-125	1.4×10^{-5}
Tellurium-125m	4.0×10^{-6}
Tin-126/Antimony-126m	3.8×10^{-8}
Cesium-134	8.5×10^{-5}
Cesium-135	3.8×10^{-8}
Cesium-137/Barium-137m	1.1×10^{-2}
Cerium-144/Praseodymium-144	2.6×10^{-7}
Praseodymium-144m	3.7×10^{-9}
Promethium-147	4.6×10^{-6}
Samarium-151	2.8×10^{-4}
Europium-152	9.4×10^{-11}
Europium-154	1.2×10^{-7}
Europium-155	3.4×10^{-7}
Uranium-234	4.7×10^{-9}
Uranium-235/Thorium-231	1.6×10^{-10}
Uranium-236	1.4×10^{-10}
Uranium-237	8.2×10^{-11}
Uranium-238/Thorium-234/Protactinium-234m	1.1×10^{-9}
Plutonium-238	2.8×10^{-8}
Plutonium-239	3.6×10^{-7}
Plutonium-240	9.5×10^{-8}
Plutonium-241	3.6×10^{-6}
Americium-241	9.3×10^{-8}

(a) Release rate is for the first year of PDMS. Release rates for subsequent years are based on the first-year release rates and account for radioactive decay.

TABLE D.2. Routine Atmospheric Release Rates During the 1-Year Preparation Period Before Decommissioning (Delayed Decommissioning Alternative)

Radionuclide	Release Rate, Ci/yr[a]
Tritium	5.9×10^{-9}
Carbon-14	1.2×10^{-8}
Selenium-79	2.6×10^{-9}
Krypton-85	4.8×10^{-7}
Strontium-90/Yttrium-90	1.6×10^{-5}
Niobium-93m	3.0×10^{-9}
Technetium-99	8.8×10^{-8}
Ruthenium-106/Rhodium-106	1.4×10^{-13}
Cadmium-113m	4.7×10^{-10}
Antimony-125	2.1×10^{-9}
Tellurium-125m	5.1×10^{-10}
Tin-126/Antimony-126m	1.8×10^{-9}
Cesium-134	1.3×10^{-10}
Cesium-135	1.8×10^{-9}
Cesium-137/Barium-137m	9.2×10^{-6}
Samarium-151	1.1×10^{-5}

(a) Release rate is for the 1-year preparation period following 23 years of PDMS (base case). Release rates for preparation periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.3. Routine Liquid Release Rates to the Susquehanna River During Post-Defueling Monitored Storage

Radionuclide	Release Rate, Ci/yr[a]
Tritium	3.0×10^{-8}
Carbon-14	1.7×10^{-8}
Selenium-79	3.6×10^{-9}
Strontium-90/Yttrium-90	3.9×10^{-5}
Niobium-93m	7.4×10^{-9}
Technetium-99	1.2×10^{-7}
Ruthenium-106/Rhodium-106	1.3×10^{-6}
Cadmium-113m	2.1×10^{-9}
Antimony-125	9.0×10^{-7}
Tellurium-125m	2.5×10^{-7}
Tin-126/Antimony-126m	2.5×10^{-9}
Cesium-134	5.6×10^{-6}
Cesium-135	2.5×10^{-9}
Cesium-137/Barium-137m	7.0×10^{-4}
Samarium-151	1.8×10^{-5}

(a) Release rate is for the first year of PDMS. Release rates for subsequent years are based on the first-year release rates and account for radioactive decay.

TABLE D.4. Routine Liquid Release Rates to the Susquehanna River During the 1-Year Preparation Period Before Decommissioning (Delayed Decommissioning Alternative)

Radionuclide	Release Rate, Ci/yr[a]
Tritium	5.5×10^{-8}
Carbon-14	1.1×10^{-7}
Selenium-79	2.5×10^{-8}
Strontium-90/Yttrium-90	1.5×10^{-4}
Niobium-93m	2.8×10^{-8}
Technetium-99	8.3×10^{-7}
Ruthenium-106/Rhodium-106	1.3×10^{-12}
Cadmium-113m	4.5×10^{-9}
Antimony-125	1.9×10^{-8}
Tellurium-125m	4.8×10^{-9}
Tin-126/Antimony-126m	1.7×10^{-8}
Cesium-134	1.7×10^{-8}
Cesium-135	1.7×10^{-8}
Cesium-137/Barium-137m	2.8×10^{-3}
Samarium-151	1.0×10^{-4}

(a) Release rate is for the 1-year preparation period following 23 years of PDMS (base case). Release rates for preparation periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.5. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During Post-Defueling Monitored Storage[a]

Radionuclide	Release, Ci[a]
Tritium	7.9×10^{-7}
Carbon-14	4.4×10^{-7}
Manganese-54	3.2×10^{-10}
Iron-55	8.5×10^{-7}
Cobalt-60	3.6×10^{-6}
Nickel-63	9.5×10^{-7}
Selenium-79	9.7×10^{-8}
Krypton-85	3.0×10^{-6}
Strontium-90/Yttrium-90	1.1×10^{-3}
Zirconium-93	2.7×10^{-9}
Niobium-93m	2.0×10^{-7}
Technetium-99	3.3×10^{-6}
Ruthenium-106/Rhodium-106	3.8×10^{-5}
Cadmium-113m	5.5×10^{-8}
Antimony-125	2.5×10^{-5}
Tellurium-125m	7.1×10^{-6}
Tin-126/Antimony-126m	6.6×10^{-8}
Cesium-134	1.5×10^{-4}
Cesium-135	6.6×10^{-8}
Cesium-137/Barium-137m	1.9×10^{-2}
Cerium-144/Praseodymium-144	1.1×10^{-6}
Praseodymium-144m	1.6×10^{-8}
Promethium-147	2.0×10^{-5}
Samarium-151	4.8×10^{-4}
Europium-152	4.0×10^{-10}
Europium-154	5.2×10^{-7}
Europium-155	1.5×10^{-6}
Uranium-234	2.0×10^{-8}
Uranium-235/Thorium-231	6.8×10^{-10}
Uranium-236	6.1×10^{-10}
Uranium-237	3.5×10^{-10}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-9}
Plutonium-238	1.2×10^{-7}
Plutonium-239	1.5×10^{-6}
Plutonium-240	4.1×10^{-7}
Plutonium-241	1.5×10^{-5}
Americium-241	4.0×10^{-7}

(a) Assumes accident occurs during the first year of PDMS.

TABLE D.6. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the 1-Year Preparation Period Before Decommissioning (Delayed Decommissioning Alternative)[a]

Radionuclide	Release, Ci[a]
Tritium	2.2×10^{-9}
Carbon-14	4.4×10^{-9}
Manganese-54	2.3×10^{-20}
Iron-55	2.2×10^{-11}
Cobalt-60	1.7×10^{-9}
Nickel-63	8.1×10^{-9}
Selenium-79	9.7×10^{-10}
Krypton-85	6.8×10^{-9}
Strontium-90/Yttrium-90	6.5×10^{-6}
Zirconium-93	2.7×10^{-11}
Niobium-93m	1.1×10^{-9}
Technetium-99	3.3×10^{-8}
Ruthenium-106/Rhodium-106	5.4×10^{-14}
Cadmium-113m	1.8×10^{-10}
Antimony-125	8.0×10^{-10}
Tellurium-125m	2.0×10^{-10}
Tin-126/Antimony-126m	6.6×10^{-10}
Cesium-134	6.5×10^{-10}
Cesium-135	6.6×10^{-10}
Cesium-137/Barium-137m	1.1×10^{-4}
Cerium-144/Praseodymium-144	1.5×10^{-17}
Praseodymium-144m	2.1×10^{-19}
Promethium-147	4.5×10^{-10}
Samarium-151	4.1×10^{-6}
Europium-152	1.3×10^{-12}
Europium-154	8.5×10^{-10}
Europium-155	5.7×10^{-10}
Uranium-234	2.0×10^{-10}
Uranium-235/Thorium-231	6.8×10^{-12}
Uranium-236	6.1×10^{-12}
Uranium-237	1.2×10^{-12}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-11}
Plutonium-238	9.8×10^{-10}
Plutonium-239	1.5×10^{-8}
Plutonium-240	4.1×10^{-9}
Plutonium-241	5.1×10^{-8}
Americium-241	7.2×10^{-9}

(a) Releases were based on the assumption that the facility had been in PDMS for 23 years before the accident. The releases during preparation periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay. Releases for a fire in stairwell/elevator structure during the cleanup phase of the delayed cleanup alternative would be the same as those in this table.

TABLE D.7. Postulated Accidental Atmospheric Release from a HEPA Filter Failure During the 1-Year Preparation Period Before Decommissioning (Delayed Decommissioning Alternative)[(a)]

Radionuclide	Release, Ci[(a)]
Tritium	2.6×10^{-7}
Carbon-14	9.3×10^{-9}
Manganese-54	1.3×10^{-19}
Iron-55	1.2×10^{-10}
Cobalt-60	9.4×10^{-9}
Nickel-63	4.4×10^{-8}
Selenium-79	2.1×10^{-9}
Krypton-85	3.7×10^{-7}
Strontium-90/Yttrium-90	1.5×10^{-5}
Zirconium-93	1.5×10^{-10}
Niobium-93m	2.4×10^{-9}
Technetium-99	6.9×10^{-8}
Ruthenium-106/Rhodium-106	1.3×10^{-13}
Cadmium-113m	3.7×10^{-10}
Antimony-125	1.8×10^{-9}
Tellurium-125m	4.5×10^{-10}
Tin-126/Antimony-126	1.4×10^{-9}
Cesium-134	1.4×10^{-10}
Cesium-135	1.4×10^{-9}
Cesium-137/Barium-137m	1.1×10^{-5}
Cerium-144/Praseodymium-144	8.1×10^{-17}
Praseodymium-144m	1.2×10^{-18}
Promethium-147	2.4×10^{-9}
Samarium-151	8.5×10^{-6}
Europium-152	6.8×10^{-12}
Europium-154	4.6×10^{-9}
Europium-155	3.1×10^{-9}
Thorium-231	3.7×10^{-11}
Thorium-234/Protactinium-234m	2.5×10^{-10}
Uranium-234	7.6×10^{-10}
Uranium-235	2.5×10^{-11}
Uranium-236	2.3×10^{-11}
Uranium-237	6.3×10^{-12}
Uranium-238	1.7×10^{-10}
Plutonium-238	3.7×10^{-9}
Plutonium-239	5.7×10^{-8}
Plutonium-240	1.5×10^{-8}
Plutonium-241	2.8×10^{-7}
Americium-241	2.7×10^{-8}

(a) Releases were based on the assumption that the facility had been in PDMS for 23 years before the accident. The releases during preparation periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.8. Routine Atmospheric Release Rates During the Cleanup Phase of the Delayed Cleanup Alternative

Radionuclide	Release Rate for 3-year period, Ci/yr[a]	Release Rate for 1-year period, Ci/yr[a]
Tritium	4.0×10^{-9}	4.0×10^{-7}
Carbon-14	8.3×10^{-9}	8.3×10^{-7}
Manganese-54	1.1×10^{-19}	1.1×10^{-17}
Iron-55	1.1×10^{-10}	1.1×10^{-8}
Cobalt-60	8.4×10^{-9}	8.4×10^{-7}
Nickel-63	3.9×10^{-8}	3.9×10^{-6}
Selenium-79	1.8×10^{-9}	1.8×10^{-7}
Krypton-85	3.3×10^{-7}	3.3×10^{-5}
Strontium-90/Yttrium-90	1.4×10^{-5}	1.4×10^{-3}
Zirconium-93	1.3×10^{-10}	1.3×10^{-8}
Niobium-93m	2.1×10^{-9}	2.1×10^{-7}
Technetium-99	6.1×10^{-8}	6.1×10^{-6}
Ruthenium-106/Rhodium-106	1.1×10^{-13}	1.1×10^{-11}
Cadmium-113m	3.3×10^{-10}	3.3×10^{-8}
Antimony-125	1.6×10^{-9}	1.6×10^{-7}
Tellurium-125m	4.0×10^{-10}	4.0×10^{-8}
Tin-126/Antimony-126m	1.2×10^{-9}	1.2×10^{-7}
Cesium-134	1.3×10^{-10}	1.3×10^{-8}
Cesium-135	1.2×10^{-9}	1.2×10^{-7}
Cesium-137/Barium-137m	9.2×10^{-6}	9.2×10^{-4}
Cerium-144/Praseodymium-144	7.2×10^{-17}	7.2×10^{-15}
Praseodymium-144m	1.0×10^{-18}	1.0×10^{-16}
Promethium-147	2.1×10^{-9}	2.1×10^{-7}
Samarium-151	7.6×10^{-6}	7.6×10^{-4}
Europium-152	6.0×10^{-12}	6.0×10^{-10}
Europium-154	4.1×10^{-9}	4.1×10^{-7}
Europium-155	2.7×10^{-9}	2.7×10^{-7}
Thorium-231	3.3×10^{-11}	3.3×10^{-9}
Thorium-234/Protactinium-234m	2.2×10^{-10}	2.2×10^{-8}
Uranium-234	6.6×10^{-10}	6.6×10^{-8}
Uranium-235	2.2×10^{-11}	2.2×10^{-9}
Uranium-236	2.0×10^{-11}	2.0×10^{-9}
Uranium-237	5.6×10^{-12}	5.6×10^{-10}
Uranium-238	1.5×10^{-10}	1.5×10^{-8}
Plutonium-238	3.2×10^{-9}	3.2×10^{-7}
Plutonium-239	5.0×10^{-8}	5.0×10^{-6}
Plutonium-240	1.3×10^{-8}	1.3×10^{-6}
Plutonium-241	2.4×10^{-7}	2.4×10^{-5}
Americium-241	2.3×10^{-8}	2.3×10^{-6}

(a) Release rate is for the cleanup period following 23 years of PDMS (base case). Release rates for cleanup periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.9. Routine Liquid Release Rates to the Susquehanna River During the Cleanup Phase of the Delayed Cleanup Alternative

Radionuclide	Release Rate, Ci/yr[a]
Tritium	5.7×10^{-7}
Carbon-14	1.3×10^{-6}
Manganese-54	1.6×10^{-16}
Iron-55	1.5×10^{-7}
Cobalt-60	1.2×10^{-5}
Nickel-63	5.5×10^{-5}
Selenium-79	2.9×10^{-7}
Krypton-85	4.6×10^{-5}
Strontium-90/Yttrium-90	5.3×10^{-3}
Zirconium-93	1.9×10^{-7}
Niobium-93m	4.4×10^{-7}
Technetium-99	9.8×10^{-6}
Ruthenium-106/Rhodium-106	3.9×10^{-11}
Cadmium-113m	5.2×10^{-8}
Antimony-125	4.8×10^{-7}
Tellurium-125m	1.2×10^{-7}
Tin-126/Antimony-126m	2.0×10^{-7}
Cesium-134	1.8×10^{-7}
Cesium-135	1.9×10^{-7}
Cesium-137/Barium-137m	3.1×10^{-2}
Cerium-144/Praseodymium-144	1.0×10^{-13}
Praseodymium-144m	1.5×10^{-15}
Promethium-147	3.0×10^{-6}
Samarium-151	1.2×10^{-3}
Europium-152	8.5×10^{-9}
Europium-154	5.8×10^{-6}
Europium-155	3.9×10^{-6}
Uranium-234	1.4×10^{-6}
Uranium-235/Thorium-231	4.6×10^{-8}
Uranium-236	4.2×10^{-8}
Uranium-237	7.9×10^{-9}
Uranium-238/Thorium-234/Protactinium-234m	3.1×10^{-7}
Plutonium-238	6.7×10^{-6}
Plutonium-239	1.0×10^{-4}
Plutonium-240	2.8×10^{-5}
Plutonium-241	3.5×10^{-4}
Americium-241	4.9×10^{-5}

(a) Release rate is for the cleanup period following 23 years of PDMS (base case). Release rates for cleanup periods following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.10. Postulated Accidental Atmospheric Release from a HEPA Filter Failure During the Cleanup Phase of the Delayed Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	2.7×10^{-6}
Carbon-14	5.5×10^{-6}
Selenium-79	1.2×10^{-6}
Strontium-90/Yttrium-90	7.4×10^{-3}
Niobium-93m	1.4×10^{-6}
Technetium-99	4.1×10^{-5}
Ruthenium-106/Rhodium-106	6.2×10^{-11}
Cadmium-113m	2.2×10^{-7}
Antimony-125	9.5×10^{-7}
Tellurium-125m	2.3×10^{-7}
Tin-126/Antimony-126m	8.3×10^{-7}
Cesium-134	8.1×10^{-7}
Cesium-135	8.3×10^{-7}
Cesium-137/Barium-137m	1.4×10^{-1}
Samarium-151	5.0×10^{-3}

(a) Releases were based on the assumption that the facility had been in PDMS for 23 years before the accident. The releases during cleanup phases following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.11. Postulated Accidental Atmospheric Release from a Spill of Reactor Coolant System Decontamination Solution During the Cleanup Phase of the Delayed Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Carbon-14	1.6×10^{-9}
Manganese-54	1.4×10^{-18}
Iron-55	1.3×10^{-9}
Cobalt-60	1.0×10^{-7}
Nickel-63	4.7×10^{-7}
Selenium-79	3.3×10^{-10}
Krypton-85	4.0×10^{-7}
Strontium-90/Yttrium-90	3.2×10^{-5}
Zirconium-93	1.6×10^{-9}
Niobium-93m	1.3×10^{-9}
Technetium-99	1.1×10^{-8}
Ruthenium-106/Rhodium-106	2.3×10^{-13}
Cadmium-113m	5.8×10^{-11}
Antimony-125	2.4×10^{-9}
Tellurium-125m	6.0×10^{-10}
Tin-126/Antimony-126m	2.3×10^{-10}
Cesium-134	1.2×10^{-10}
Cesium-135	1.2×10^{-10}
Cesium-137/Barium-137m	2.0×10^{-5}
Cerium-144/Praseodymium-144	8.8×10^{-16}
Praseodymium-144m	1.3×10^{-17}
Promethium-147	2.6×10^{-8}
Samarium-151	1.4×10^{-6}
Europium-152	7.4×10^{-11}
Europium-154	5.0×10^{-8}
Europium-155	3.4×10^{-8}
Uranium-234	1.2×10^{-8}
Uranium-235/Thorium-231	4.0×10^{-10}
Uranium-236	3.6×10^{-10}
Uranium-237	6.9×10^{-11}
Uranium-238/Thorium-234/Protactinium-234m	2.7×10^{-9}
Plutonium-238	5.8×10^{-8}
Plutonium-239	9.0×10^{-7}
Plutonium-240	2.4×10^{-7}
Plutonium-241	3.0×10^{-6}
Americium-241	4.2×10^{-7}

(a) Releases were based on the assumption that the facility had been in PDMS for 23 years before the accident. The releases during cleanup phases following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.12. Postulated Accidental Liquid Release from a Ruptured Storage Tank During the Cleanup Phase of the Delayed Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	5.4×10^{-3}
Carbon-14	4.2×10^{-3}
Manganese-54	1.7×10^{-6}
Iron-55	2.0×10^{-5}
Cobalt-60	2.0×10^{-5}
Nickel-63	2.5×10^{-5}
Selenium-79	2.9×10^{-6}
Strontium-90/Yttrium-90	4.2×10^{-4}
Zirconium-93	2.9×10^{-6}
Niobium-93m	2.9×10^{-6}
Technetium-99	4.2×10^{-5}
Ruthenium-106/Rhodium-106	1.4×10^{-5}
Cadmium-113m	2.9×10^{-6}
Antimony-125/Tellurium-125m	9.7×10^{-6}
Tin-126/Antimony-126m/Antimony-126	2.9×10^{-6}
Cesium-134	3.7×10^{-6}
Cesium-135	2.9×10^{-6}
Cesium-137/Barium-137m	1.7×10^{-4}
Cerium-144/Praseodymium-144	7.6×10^{-5}
Praseodymium-144m	2.9×10^{-6}
Promethium-147	2.0×10^{-4}
Samarium-151	2.9×10^{-6}
Europium-152	1.6×10^{-8}
Europium-154	1.8×10^{-6}
Europium-155	4.6×10^{-6}
Uranium-234	4.2×10^{-7}
Uranium-235/Thorium-231	5.0×10^{-7}
Uranium-236	1.7×10^{-7}
Uranium-237	2.9×10^{-6}
Uranium-238/Thorium-234/Protactinium-234m	5.0×10^{-7}
Plutonium-238	5.0×10^{-7}
Plutonium-239	5.9×10^{-7}
Plutonium-240	5.9×10^{-7}
Plutonium-241	2.7×10^{-5}
Americium-241	5.0×10^{-7}

(a) Releases were based on the assumption that the facility had been in PDMS for 23 years prior to the accident. The releases during cleanup phases following other postulated periods of PDMS (5 years and 33 years) would differ only by radioactive decay.

TABLE D.13. Routine Atmospheric Release Rates During the Engineering Study Phase of the Immediate Cleanup Alternative

Radionuclide	Release Rate, Ci/yr
Tritium	1.9×10^{-8}
Carbon-14	9.9×10^{-9}
Manganese-54	4.2×10^{-11}
Iron-55	6.3×10^{-8}
Cobalt-60	2.3×10^{-7}
Nickel-63	5.4×10^{-8}
Selenium-79	2.2×10^{-9}
Krypton-85	1.9×10^{-6}
Strontium-90/Yttrium-90	2.9×10^{-5}
Zirconium-93	1.6×10^{-10}
Niobium-93m	4.5×10^{-9}
Technetium-99	7.3×10^{-8}
Ruthenium-106/Rhodium-106	1.9×10^{-6}
Cadmium-113m	1.2×10^{-9}
Antimony-125	7.8×10^{-7}
Tellurium-125m	1.7×10^{-6}
Tin-126/Antimony-126m	1.5×10^{-9}
Cesium-134	4.0×10^{-7}
Cesium-135	1.5×10^{-9}
Cesium-137/Barium-137m	1.6×10^{-5}
Cerium-144/Praseodymium-144	1.6×10^{-7}
Praseodymium-144m	2.5×10^{-9}
Promethium-147	1.5×10^{-6}
Samarium-151	1.1×10^{-5}
Europium-152	2.4×10^{-11}
Europium-154	3.2×10^{-8}
Europium-155	9.7×10^{-8}
Thorium-231	3.9×10^{-11}
Thorium-234/Protactinium-234m	2.6×10^{-10}
Uranium-234	6.6×10^{-10}
Uranium-235	2.2×10^{-11}
Uranium-236	2.0×10^{-11}
Uranium-237	2.1×10^{-11}
Uranium-238	1.5×10^{-10}
Plutonium-238	3.9×10^{-9}
Plutonium-239	5.0×10^{-8}
Plutonium-240	1.3×10^{-8}
Plutonium-241	9.2×10^{-7}
Americium-241	1.2×10^{-8}

TABLE D.14. Routine Atmospheric Release Rates During the Cleanup Phase of the Immediate Cleanup Alternative

Radionuclide	Release Rate for 3-year period Ci/yr	Release Rate for 1-year period Ci/yr
Tritium	1.6×10^{-8}	1.6×10^{-6}
Carbon-14	9.6×10^{-9}	9.6×10^{-7}
Manganese-54	8.0×10^{-12}	8.0×10^{-10}
Iron-55	3.7×10^{-8}	3.7×10^{-6}
Cobalt-60	1.7×10^{-7}	1.7×10^{-5}
Nickel-63	5.2×10^{-8}	5.2×10^{-6}
Selenium-79	2.1×10^{-9}	2.1×10^{-7}
Krypton-85	1.6×10^{-6}	1.6×10^{-4}
Strontium-90/Yttrium-90	2.7×10^{-5}	2.7×10^{-3}
Zirconium-93	1.5×10^{-10}	1.5×10^{-8}
Niobium-93m	4.1×10^{-9}	4.1×10^{-7}
Technetium-99	7.1×10^{-8}	7.1×10^{-6}
Ruthenium-106/Rhodium-106	4.6×10^{-7}	4.6×10^{-5}
Cadmium-113m	1.1×10^{-9}	1.1×10^{-7}
Antimony-125	4.6×10^{-7}	4.6×10^{-5}
Tellurium-125m	1.1×10^{-7}	1.1×10^{-5}
Tin-126/Antimony-126m	1.5×10^{-9}	1.5×10^{-7}
Cesium-134	2.0×10^{-7}	2.0×10^{-5}
Cesium-135	1.4×10^{-9}	1.4×10^{-7}
Cesium-137/Barium-137m	1.5×10^{-5}	1.5×10^{-3}
Cerium-144/Praseodymium-144	2.6×10^{-8}	2.6×10^{-6}
Praseodymium-144m	3.7×10^{-10}	3.7×10^{-8}
Promethium-147	8.4×10^{-7}	8.4×10^{-5}
Samarium-151	1.0×10^{-5}	1.0×10^{-3}
Europium-152	2.1×10^{-11}	2.1×10^{-9}
Europium-154	2.7×10^{-8}	2.7×10^{-6}
Europium-155	7.1×10^{-8}	7.1×10^{-6}
Thorium-231	3.8×10^{-11}	3.8×10^{-9}
Thorium-234/Protactinium-234m	2.6×10^{-10}	2.6×10^{-8}
Uranium-234	6.6×10^{-10}	6.6×10^{-8}
Uranium-235	2.2×10^{-11}	2.2×10^{-9}
Uranium-236	2.0×10^{-11}	2.0×10^{-9}
Uranium-237	1.9×10^{-11}	1.9×10^{-9}
Uranium-238	1.5×10^{-10}	1.5×10^{-8}
Plutonium-238	3.8×10^{-9}	3.8×10^{-7}
Plutonium-239	5.0×10^{-8}	5.0×10^{-6}
Plutonium-240	1.3×10^{-8}	1.3×10^{-6}
Plutonium-241	8.2×10^{-7}	8.2×10^{-5}
Americium-241	1.4×10^{-8}	1.4×10^{-6}

TABLE D.15. Routine Atmospheric Release Rates During the Post-Cleanup Storage Period of the Immediate Cleanup Alternative

Radionuclide	Release Rate, Ci/yr[(a)]
Tritium	1.2×10^{-7}
Carbon-14	9.0×10^{-8}
Selenium-79	2.0×10^{-8}
Strontium-90/Yttrium-90	1.8×10^{-4}
Niobium-93m	3.4×10^{-8}
Technetium-99	6.7×10^{-7}
Ruthenium-106/Rhodium-106	2.4×10^{-7}
Cadmium-113m	8.7×10^{-9}
Antimony-125	1.4×10^{-6}
Tellurium-125m	3.5×10^{-7}
Tin-126/Antimony-126m	1.4×10^{-8}
Cesium-134	5.6×10^{-6}
Cesium-135	1.4×10^{-8}
Cesium-137/Barium-137m	3.4×10^{-3}
Samarium-151	9.5×10^{-5}

(a) Release rate is for the first year of post-cleanup storage. Release rates for subsequent years are based on the first-year release rates and account for radioactive decay.

TABLE D.16. Routine Liquid Release Rates to the Susquehanna River During the Engineering Study Phase of the Immediate Cleanup Alternative

Radionuclide	Release Rate, Ci/yr
Tritium	3.0×10^{-8}
Carbon-14	1.6×10^{-8}
Selenium-79	3.5×10^{-9}
Strontium-90/Yttrium-90	3.9×10^{-5}
Niobium-93m	7.4×10^{-9}
Technetium-99	1.2×10^{-7}
Ruthenium-106/Rhodium-106	2.6×10^{-6}
Cadmium-113m	2.1×10^{-9}
Antimony-125	1.1×10^{-6}
Tellurium-125m	2.7×10^{-6}
Tin-126/Antimony-126m	2.4×10^{-9}
Cesium-134	7.5×10^{-6}
Cesium-135	2.4×10^{-9}
Cesium-137/Barium-137m	6.9×10^{-4}
Samarium-151	1.8×10^{-5}

TABLE D.17. Routine Liquid Release Rates to the Susquehanna River During the Cleanup Phase of the Immediate Cleanup Alternative

Radionuclide	Release Rate, Ci/yr
Tritium	1.2×10^{-6}
Carbon-14	7.8×10^{-7}
Manganese-54	5.7×10^{-9}
Iron-55	2.6×10^{-5}
Cobalt-60	1.3×10^{-4}
Nickel-63	3.7×10^{-5}
Selenium-79	1.7×10^{-7}
Krypton-85	1.1×10^{-4}
Strontium-90/Yttrium-90	5.2×10^{-3}
Zirconium-93	1.1×10^{-7}
Niobium-93m	3.4×10^{-7}
Technetium-99	5.7×10^{-6}
Ruthenium-106/Rhodium-106	8.2×10^{-5}
Cadmium-113m	9.1×10^{-8}
Antimony-125	6.9×10^{-5}
Tellurium-125m	1.7×10^{-5}
Tin-126/Antimony-126m	1.2×10^{-7}
Cesium-134	1.8×10^{-4}
Cesium-135	1.1×10^{-7}
Cesium-137/Barium-137m	3.0×10^{-2}
Cerium-144/Praseodymium-144	1.8×10^{-5}
Praseodymium-144m	2.6×10^{-7}
Promethium-147	6.0×10^{-4}
Samarium-151	8.4×10^{-4}
Europium-152	1.5×10^{-8}
Europium-154	1.9×10^{-5}
Europium-155	5.1×10^{-5}
Uranium-234	8.1×10^{-7}
Uranium-235/Thorium-231	2.7×10^{-8}
Uranium-236	2.4×10^{-8}
Uranium-237	1.3×10^{-8}
Uranium-238/Thorium-234/Protactinium-234m	1.8×10^{-7}
Plutonium-238	4.7×10^{-6}
Plutonium-239	6.1×10^{-5}
Plutonium-240	1.6×10^{-5}
Plutonium-241	5.8×10^{-4}
Americium-241	1.7×10^{-5}

TABLE D.18. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the Engineering Study Phase of the Immediate Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	8.4×10^{-9}
Carbon-14	4.4×10^{-9}
Manganese-54	7.3×10^{-12}
Iron-55	1.1×10^{-8}
Cobalt-60	4.1×10^{-8}
Nickel-63	9.5×10^{-9}
Selenium-79	9.7×10^{-10}
Krypton-85	3.2×10^{-8}
Strontium-90/Yttrium-90	1.2×10^{-5}
Zirconium-93	2.7×10^{-11}
Niobium-93m	2.0×10^{-9}
Technetium-99	3.3×10^{-8}
Ruthenium-106/Rhodium-106	7.6×10^{-7}
Cadmium-113m	5.8×10^{-10}
Antimony-125	3.3×10^{-7}
Tellurium-125m	7.5×10^{-7}
Tin-126/Antimony-126m	6.6×10^{-10}
Cesium-134	2.1×10^{-6}
Cesium-135	6.6×10^{-10}
Cesium-137/Barium-137m	1.9×10^{-4}
Cerium-144/Praseodymium-144	2.7×10^{-8}
Praseodymium-144m	4.3×10^{-10}
Promethium-147	2.6×10^{-7}
Samarium-151	4.9×10^{-6}
Europium-152	4.3×10^{-12}
Europium-154	5.6×10^{-9}
Europium-155	1.7×10^{-8}
Uranium-234	2.0×10^{-10}
Uranium-235/Thorium-231	6.8×10^{-12}
Uranium-236	6.1×10^{-12}
Uranium-237	3.7×10^{-12}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-11}
Plutonium-238	1.2×10^{-9}
Plutonium-239	1.5×10^{-8}
Plutonium-240	4.1×10^{-9}
Plutonium-241	1.6×10^{-7}
Americium-241	3.7×10^{-9}

(a) Assumes accident occurs during the first year of the 2-year engineering study.

TABLE D.19. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the Cleanup Phase of the Immediate Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	7.5×10^{-9}
Carbon-14	4.4×10^{-9}
Manganese-54	1.4×10^{-12}
Iron-55	6.6×10^{-9}
Cobalt-60	3.1×10^{-8}
Nickel-63	9.4×10^{-9}
Selenium-79	9.7×10^{-10}
Krypton-85	2.8×10^{-8}
Strontium-90/Yttrium-90	1.1×10^{-5}
Zirconium-93	2.7×10^{-11}
Niobium-93m	1.9×10^{-9}
Technetium-99	3.3×10^{-8}
Ruthenium-106/Rhodium-106	1.9×10^{-7}
Cadmium-113m	5.2×10^{-10}
Antimony-125	2.0×10^{-7}
Tellurium-125m	4.8×10^{-8}
Tin-126/Antimony-126m	6.6×10^{-10}
Cesium-134	1.1×10^{-6}
Cesium-135	6.6×10^{-10}
Cesium-137/Barium-137m	1.8×10^{-4}
Cerium-144/Praseodymium-144	4.6×10^{-9}
Praseodymium-144m	6.6×10^{-11}
Promethium-147	1.5×10^{-7}
Samarium-151	4.8×10^{-6}
Europium-152	3.8×10^{-12}
Europium-154	4.8×10^{-9}
Europium-155	1.3×10^{-8}
Uranium-234	2.0×10^{-10}
Uranium-235/Thorium-231	6.8×10^{-12}
Uranium-236	6.1×10^{-12}
Uranium-237	3.4×10^{-12}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-11}
Plutonium-238	1.2×10^{-9}
Plutonium-239	1.5×10^{-8}
Plutonium-240	4.1×10^{-9}
Plutonium-241	1.5×10^{-7}
Americium-241	4.2×10^{-9}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.20. Postulated Accidental Atmospheric Release from a HEPA Filter Failure During the Cleanup Phase of the Immediate Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	9.3×10^{-6}
Carbon-14	5.5×10^{-6}
Selenium-79	1.2×10^{-6}
Strontium-90/Yttrium-90	1.3×10^{-2}
Niobium-93m	2.4×10^{-6}
Technetium-99	4.1×10^{-5}
Ruthenium-106/Rhodium-106	2.2×10^{-4}
Cadmium-113m	6.5×10^{-7}
Antimony-125	2.3×10^{-4}
Tellurium-125m	5.7×10^{-5}
Tin-126/Antimony-126m	8.3×10^{-7}
Cesium-134	1.3×10^{-3}
Cesium-135	8.3×10^{-7}
Cesium-137/Barium-137m	2.3×10^{-1}
Samarium-151	6.0×10^{-3}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.21. Postulated Accidental Atmospheric Release from a Spill of Reactor Coolant System Decontamination Solution During the Cleanup Phase of the Immediate Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Carbon-14	1.6×10^{-9}
Manganese-54	8.4×10^{-11}
Iron-55	3.9×10^{-7}
Cobalt-60	1.8×10^{-6}
Nickel-63	5.5×10^{-7}
Selenium-79	3.3×10^{-10}
Krypton-85	1.7×10^{-8}
Strontium-90/Yttrium-90	5.4×10^{-5}
Zirconium-93	1.6×10^{-9}
Niobium-93m	7.7×10^{-10}
Technetium-99	1.1×10^{-8}
Ruthenium-106/Rhodium-106	8.1×10^{-7}
Cadmium-113m	1.7×10^{-10}
Antimony-125	6.0×10^{-7}
Tellurium-125m	1.5×10^{-7}
Tin-126/Antimony-126m	2.3×10^{-10}
Cesium-134	1.9×10^{-7}
Cesium-135	1.2×10^{-10}
Cesium-137/Barium-137m	3.3×10^{-5}
Cerium-144/Praseodymium-144	2.7×10^{-7}
Praseodymium-144m	3.9×10^{-9}
Promethium-147	8.8×10^{-6}
Samarium-151	1.7×10^{-6}
Europium-152	2.3×10^{-10}
Europium-154	2.8×10^{-7}
Europium-155	7.5×10^{-7}
Uranium-234	1.2×10^{-8}
Uranium-235/Thorium-231	4.0×10^{-10}
Uranium-236	3.6×10^{-10}
Uranium-237	2.0×10^{-10}
Uranium-238/Thorium-234/Protactinium-234m	2.7×10^{-9}
Plutonium-238	6.9×10^{-8}
Plutonium-239	9.0×10^{-7}
Plutonium-240	2.4×10^{-7}
Plutonium-241	8.6×10^{-6}
Americium-241	2.5×10^{-7}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.22. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the Post-Cleanup Storage Period of the Immediate Cleanup Alternative[a]

Radionuclide	Release, Ci[a]
Tritium	1.5×10^{-7}
Carbon-14	1.1×10^{-7}
Manganese-54	2.7×10^{-13}
Iron-55	1.2×10^{-8}
Cobalt-60	9.3×10^{-8}
Nickel-63	4.6×10^{-8}
Selenium-79	2.4×10^{-8}
Krypton-85	1.1×10^{-7}
Strontium-90/Yttrium-90	2.3×10^{-4}
Zirconium-93	1.4×10^{-10}
Niobium-93m	4.2×10^{-8}
Technetium-99	8.2×10^{-7}
Ruthenium-106/Rhodium-106	2.9×10^{-7}
Cadmium-113m	1.1×10^{-8}
Antimony-125	1.7×10^{-6}
Tellurium-125m	4.3×10^{-7}
Tin-126/Antimony-126m	1.7×10^{-8}
Cesium-134	6.9×10^{-6}
Cesium-135	1.7×10^{-8}
Cesium-137/Barium-137m	4.1×10^{-3}
Cerium-144/Praseodymium-144	6.6×10^{-10}
Praseodymium-144m	9.4×10^{-12}
Promethium-147	2.6×10^{-7}
Samarium-151	1.2×10^{-4}
Europium-152	1.6×10^{-11}
Europium-154	1.8×10^{-8}
Europium-155	3.6×10^{-8}
Uranium-234	1.0×10^{-9}
Uranium-235/Thorium-231	3.4×10^{-11}
Uranium-236	3.1×10^{-11}
Uranium-237	1.4×10^{-11}
Uranium-238/Thorium-234/Protactinium-234m	2.3×10^{-10}
Plutonium-238	5.7×10^{-9}
Plutonium-239	7.7×10^{-8}
Plutonium-240	2.0×10^{-8}
Plutonium-241	6.1×10^{-7}
Americium-241	2.5×10^{-8}

(a) Assumes accident occurs during the first year of post-cleanup storage.

TABLE D.23. Postulated Accidental Liquid Release from a Ruptured Storage Tank During the Cleanup Phase of the Immediate Cleanup Alternative

Radionuclide	Release, Ci
Tritium	1.9×10^{-2}
Carbon-14	4.2×10^{-3}
Manganese-54	1.7×10^{-6}
Iron-55	2.0×10^{-5}
Cobalt-60	2.0×10^{-5}
Nickel-63	2.5×10^{-5}
Selenium-79	2.9×10^{-6}
Strontium-90/Yttrium-90	4.2×10^{-4}
Zirconium-93	2.9×10^{-6}
Niobium-93m	2.9×10^{-6}
Technetium-99	4.2×10^{-5}
Ruthenium-106/Rhodium-106	1.4×10^{-5}
Cadmium-113m	2.9×10^{-6}
Antimony-125/Tellurium-125m	9.7×10^{-6}
Tin-126/Antimony-126m/Antimony-126	2.9×10^{-6}
Cesium-134	3.7×10^{-6}
Cesium-135	2.9×10^{-6}
Cesium-137/Barium-137m	1.7×10^{-4}
Cerium-144/Praseodymium-144	7.6×10^{-5}
Praseodymium-144m	2.9×10^{-6}
Promethium-147	2.0×10^{-4}
Samarium-151	2.9×10^{-6}
Europium-152	1.6×10^{-8}
Europium-154	1.8×10^{-6}
Europium-155	4.6×10^{-6}
Uranium-234	4.2×10^{-7}
Uranium-235/Thorium-231	5.0×10^{-7}
Uranium-236	1.7×10^{-7}
Uranium-237	2.9×10^{-6}
Uranium-238/Thorium-234/Protactinium-234m	5.0×10^{-7}
Plutonium-238	5.0×10^{-7}
Plutonium-239	5.9×10^{-7}
Plutonium-240	5.9×10^{-7}
Plutonium-241	2.7×10^{-5}
Americium-241	5.0×10^{-7}

TABLE D.24. Routine Atmospheric Release Rates During the Cleanup Phase of the Immediate Cleanup/Reduced Effort Alternative

Radionuclide	Release Rate for First 4-Year Period, Ci/yr[a]	Release Rate for Fifth Year, Ci/yr
Tritium	1.9×10^{-8}	1.9×10^{-6}
Carbon-14	9.9×10^{-9}	9.9×10^{-7}
Manganese-54	4.2×10^{-11}	4.2×10^{-9}
Iron-55	6.3×10^{-8}	6.3×10^{-6}
Cobalt-60	2.3×10^{-7}	2.3×10^{-5}
Nickel-63	5.4×10^{-8}	5.4×10^{-6}
Selenium-79	2.2×10^{-9}	2.2×10^{-7}
Krypton-85	1.9×10^{-6}	1.9×10^{-4}
Strontium-90/Yttrium-90	2.9×10^{-5}	2.9×10^{-3}
Zirconium-93	1.6×10^{-10}	1.6×10^{-8}
Niobium-93m	4.5×10^{-9}	4.5×10^{-7}
Technetium-99	7.3×10^{-8}	7.3×10^{-6}
Ruthenium-106/Rhodium-106	1.9×10^{-6}	1.9×10^{-4}
Cadmium-113m	1.3×10^{-9}	1.3×10^{-7}
Antimony-125	7.8×10^{-7}	7.8×10^{-5}
Tellurium-125m	1.7×10^{-7}	1.7×10^{-5}
Tin-126/Antimony-126m	1.5×10^{-9}	1.5×10^{-7}
Cesium-134	4.0×10^{-7}	4.0×10^{-5}
Cesium-135	1.5×10^{-9}	1.5×10^{-7}
Cesium-137/Barium-137m	1.6×10^{-5}	1.6×10^{-3}
Cerium-144/Praseodymium-144	1.6×10^{-7}	1.6×10^{-7}
Praseodymium-144m	2.5×10^{-9}	2.5×10^{-7}
Promethium-147	1.4×10^{-6}	1.4×10^{-4}
Samarium-151	1.1×10^{-5}	1.1×10^{-3}
Europium-152	2.4×10^{-11}	2.4×10^{-9}
Europium-154	3.2×10^{-8}	3.2×10^{-6}
Europium-155	9.7×10^{-8}	9.7×10^{-6}
Thorium-231	3.2×10^{-11}	3.9×10^{-9}
Thorium-234/Protactinium-234m	2.6×10^{-10}	2.6×10^{-8}
Uranium-234	6.6×10^{-10}	6.6×10^{-8}
Uranium-235	2.2×10^{-11}	2.2×10^{-9}
Uranium-236	2.0×10^{-11}	2.0×10^{-9}
Uranium-237	2.0×10^{-11}	2.0×10^{-9}
Uranium-238	1.5×10^{-10}	1.5×10^{-8}
Plutonium-238	3.9×10^{-9}	3.9×10^{-7}
Plutonium-239	5.0×10^{-8}	5.0×10^{-6}
Plutonium-240	1.3×10^{-8}	1.3×10^{-6}
Plutonium-241	9.2×10^{-7}	9.2×10^{-5}
Americium-241	1.2×10^{-8}	1.2×10^{-6}

(a) Release rates for the second 5 years of cleanup are based on the first 4-year period and account for radioactive decay.

TABLE D.25. Routine Atmospheric Release Rates During the Post-Cleanup Storage Period of the Immediate Cleanup/Reduced Effort Alternative

Radionuclide	Release Rate, Ci/yr[a]
Tritium	9.8×10^{-8}
Carbon-14	9.0×10^{-8}
Selenium-79	2.0×10^{-8}
Strontium-90/Yttrium-90	1.7×10^{-4}
Niobium-93m	3.1×10^{-8}
Technetium-99	6.7×10^{-7}
Ruthenium-106/Rhodium-106	1.5×10^{-8}
Cadmium-113m	7.2×10^{-9}
Antimony-125	5.2×10^{-7}
Tellurium-125m	1.3×10^{-7}
Tin-126/Antimony-126m	1.4×10^{-8}
Cesium-134	1.5×10^{-6}
Cesium-135	1.4×10^{-8}
Cesium-137/Barium-137m	3.1×10^{-3}
Samarium-151	9.2×10^{-5}

(a) Release rate is for the first year of post-cleanup storage. Release rates for subsequent years are based on the first-year release rates and account for radioactive decay.

TABLE D.26. Routine Liquid Release Rates to the Susquehanna River During the Cleanup Phase of the Immediate Cleanup/ Reduced Effort Alternative

Radionuclide	Release Rate, Ci/yr[a]
Tritium	4.8×10^{-7}
Carbon-14	2.9×10^{-7}
Manganese-54	1.1×10^{-8}
Iron-55	1.6×10^{-5}
Cobalt-60	6.0×10^{-5}
Nickel-63	1.4×10^{-5}
Selenium-79	6.4×10^{-8}
Krypton-85	4.8×10^{-5}
Strontium-90/Yttrium-90	2.0×10^{-3}
Zirconium-93	4.0×10^{-8}
Niobium-93m	1.3×10^{-7}
Technetium-99	2.1×10^{-6}
Ruthenium-106/Rhodium-106	1.2×10^{-4}
Cadmium-113m	3.7×10^{-8}
Antimony-125	4.2×10^{-5}
Tellurium-125m	4.9×10^{-5}
Tin-126/Antimony-126m	4.3×10^{-8}
Cesium-134	1.3×10^{-4}
Cesium-135	4.1×10^{-8}
Cesium-137/Barium-137m	1.2×10^{-2}
Cerium-144/Praseodymium-144	4.0×10^{-5}
Praseodymium-144m	6.3×10^{-7}
Promethium-147	3.8×10^{-4}
Samarium-151	3.2×10^{-4}
Europium-152	6.3×10^{-9}
Europium-154	8.3×10^{-6}
Europium-155	2.5×10^{-5}
Uranium-234	3.0×10^{-7}
Uranium-235/Thorium-231	1.0×10^{-8}
Uranium-236	9.0×10^{-9}
Uranium-237	5.5×10^{-9}
Uranium-238/Thorium-234/Protactinium-234m	6.8×10^{-8}
Plutonium-238	1.8×10^{-6}
Plutonium-239	2.3×10^{-5}
Plutonium-240	6.0×10^{-6}
Plutonium-241	2.4×10^{-4}
Americium-241	5.5×10^{-6}

(a) Release rate is for the first year of cleanup. Release rates for subsequent years are based on the first-year release rates and account for radioactive decay.

TABLE D.27. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the Cleanup Phase of the Immediate Cleanup/Reduced Effort Alternative[a]

Radionuclide	Release, Ci
Tritium	8.4×10^{-9}
Carbon-14	4.4×10^{-9}
Manganese-54	7.3×10^{-12}
Iron-55	1.1×10^{-8}
Cobalt-60	4.1×10^{-8}
Nickel-63	9.5×10^{-9}
Selenium-79	9.7×10^{-10}
Krypton-85	3.2×10^{-8}
Strontium-90/Yttrium-90	1.2×10^{-5}
Zirconium-93	2.7×10^{-11}
Niobium-93m	2.0×10^{-9}
Technetium-99	3.3×10^{-8}
Ruthenium-106/Rhodium-106	7.6×10^{-7}
Cadmium-113m	5.8×10^{-10}
Antimony-125	3.3×10^{-7}
Tellurium-125m	7.5×10^{-7}
Tin-126/Antimony-126m	6.6×10^{-10}
Cesium-134	2.1×10^{-6}
Cesium-135	6.6×10^{-10}
Cesium-137/Barium-137m	1.9×10^{-4}
Cerium-144/Praseodymium-144	2.7×10^{-8}
Praseodymium-144m	4.3×10^{-10}
Promethium-147	2.6×10^{-7}
Samarium-151	4.9×10^{-6}
Europium-152	4.3×10^{-12}
Europium-154	5.6×10^{-9}
Europium-155	1.7×10^{-8}
Uranium-234	2.0×10^{-10}
Uranium-235/Thorium-231	6.8×10^{-12}
Uranium-236	6.1×10^{-12}
Uranium-237	3.7×10^{-12}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-11}
Plutonium-238	1.2×10^{-9}
Plutonium-239	1.5×10^{-8}
Plutonium-240	4.1×10^{-9}
Plutonium-241	1.6×10^{-7}
Americium-241	3.7×10^{-9}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.28. Postulated Accidental Atmospheric Release from a HEPA Filter Failure During the Cleanup Phase of the Immediate Cleanup/Reduced Effort Alternative[a]

Radionuclide	Release, Ci
Tritium	1.0×10^{-5}
Carbon-14	5.5×10^{-6}
Selenium-79	1.2×10^{-6}
Strontium-90/Yttrium-90	1.3×10^{-2}
Niobium-93m	2.5×10^{-6}
Technetium-99	4.1×10^{-5}
Ruthenium-106/Rhodium-106	8.8×10^{-4}
Cadmium-113m	7.2×10^{-7}
Antimony-125	3.9×10^{-4}
Tellurium-125m	9.4×10^{-4}
Tin-126/Antimony-126m	8.3×10^{-7}
Cesium-134	2.6×10^{-3}
Cesium-135	8.3×10^{-7}
Cesium-137/Barium-137m	2.4×10^{-1}
Samarium-151	6.1×10^{-3}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.29. Postulated Accidental Atmospheric Release from a Spill of Reactor Coolant System Decontamination Solution During the Cleanup Phase of the Immediate Cleanup/Reduced Effort Alternative[a]

Radionuclide	Release, Ci
Carbon-14	1.6×10^{-9}
Manganese-54	4.3×10^{-10}
Iron-55	6.5×10^{-7}
Cobalt-60	2.4×10^{-6}
Nickel-63	5.6×10^{-7}
Selenium-79	3.3×10^{-10}
Krypton-85	1.9×10^{-6}
Strontium-90/Yttrium-90	5.7×10^{-5}
Zirconium-93	1.6×10^{-9}
Niobium-93m	6.8×10^{-10}
Technetium-99	1.1×10^{-8}
Ruthenium-106/Rhodium-106	3.2×10^{-8}
Cadmium-113m	1.9×10^{-10}
Antimony-125	9.9×10^{-7}
Tellurium-125m	2.5×10^{-7}
Tin-126/Antimony-126m	2.3×10^{-10}
Cesium-134	3.7×10^{-7}
Cesium-135	1.2×10^{-10}
Cesium-137/Barium-137m	3.4×10^{-5}
Cerium-144/Praseodymium-144	1.6×10^{-6}
Praseodymium-144m	2.5×10^{-8}
Promethium-147	1.5×10^{-5}
Samarium-151	1.7×10^{-6}
Europium-152	2.5×10^{-10}
Europium-154	3.3×10^{-7}
Europium-155	1.0×10^{-6}
Uranium-234	1.2×10^{-8}
Uranium-235/Thorium-231	4.0×10^{-10}
Uranium-236	3.6×10^{-10}
Uranium-237	2.2×10^{-10}
Uranium-238/Thorium-234/Protactinium-234m	2.7×10^{-9}
Plutonium-238	7.0×10^{-8}
Plutonium-239	9.0×10^{-7}
Plutonium-240	2.4×10^{-7}
Plutonium-241	9.5×10^{-6}
Americium-241	2.2×10^{-7}

(a) Assumes accident occurs during the first year of cleanup activities.

TABLE D.30. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the Post-Cleanup Storage Phase of the Immediate Cleanup/Reduced Effort Alternative[a]

Radionuclide	Release, Ci
Tritium	1.2×10^{-7}
Carbon-14	1.1×10^{-7}
Manganese-54	1.1×10^{-14}
Iron-55	4.2×10^{-9}
Cobalt-60	5.5×10^{-8}
Nickel-63	4.4×10^{-8}
Selenium-79	2.4×10^{-8}
Krypton-85	8.5×10^{-8}
Strontium-90/Yttrium-90	2.1×10^{-4}
Zirconium-93	1.4×10^{-10}
Niobium-93m	3.8×10^{-8}
Technetium-99	8.2×10^{-7}
Ruthenium-106/Rhodium-106	1.9×10^{-8}
Cadmium-113m	8.7×10^{-9}
Antimony-125	6.4×10^{-7}
Tellurium-125m	1.6×10^{-7}
Tin-126/Antimony-126m	1.7×10^{-8}
Cesium-134	1.8×10^{-6}
Cesium-135	1.7×10^{-8}
Cesium-137/Barium-137m	3.8×10^{-3}
Cerium-144/Praseodymium-144	1.9×10^{-11}
Praseodymium-144m	2.7×10^{-13}
Promethium-147	9.1×10^{-8}
Samarium-151	1.1×10^{-4}
Europium-152	1.3×10^{-11}
Europium-154	1.3×10^{-8}
Europium-155	2.1×10^{-8}
Uranium-234	1.0×10^{-9}
Uranium-235/Thorium-231	3.4×10^{-11}
Uranium-236	3.1×10^{-11}
Uranium-237	1.2×10^{-11}
Uranium-238/Thorium-234/Protactinium-234m	2.3×10^{-10}
Plutonium-238	5.5×10^{-9}
Plutonium-239	7.7×10^{-8}
Plutonium-240	2.0×10^{-8}
Plutonium-241	5.0×10^{-7}
Americium-241	2.9×10^{-8}

(a) Assumes accident occurs during the first year of post-cleanup storage.

TABLE D.31. Postulated Accidental Liquid Release from a Ruptured Storage Tank During the Cleanup Phase of the Immediate Cleanup/Reduced Effort Alternative

Radionuclide	Release, Ci
Tritium	2.1×10^{-2}
Carbon-14	4.2×10^{-3}
Manganese-54	1.7×10^{-6}
Iron-55	2.0×10^{-5}
Cobalt-60	2.0×10^{-5}
Nickel-63	2.5×10^{-5}
Selenium-79	2.9×10^{-6}
Strontium-90/Yttrium-90	4.2×10^{-4}
Zirconium-93	2.9×10^{-6}
Niobium-93m	2.9×10^{-6}
Technetium-99	4.2×10^{-5}
Ruthenium-106/Rhodium-106	1.4×10^{-5}
Cadmium-113m	2.9×10^{-6}
Antimony-125/Tellurium-125m	9.7×10^{-6}
Tin-126/Antimony-126m/Antimony-126	2.9×10^{-6}
Cesium-134	3.7×10^{-6}
Cesium-135	2.9×10^{-6}
Cesium-137/Barium-137m	1.7×10^{-4}
Cerium-144/Praseodymium-144	7.6×10^{-5}
Praseodymium-144m	2.9×10^{-6}
Promethium-147	2.0×10^{-4}
Samarium-151	2.9×10^{-6}
Europium-152	1.6×10^{-8}
Europium-154	1.8×10^{-6}
Europium-155	4.6×10^{-6}
Uranium-234	4.2×10^{-7}
Uranium-235/Thorium-231	5.0×10^{-7}
Uranium-236	1.7×10^{-7}
Uranium-237	2.9×10^{-6}
Uranium-238/Thorium-234/Protactinium-234m	5.0×10^{-7}
Plutonium-238	5.0×10^{-7}
Plutonium-239	5.9×10^{-7}
Plutonium-240	5.9×10^{-7}
Plutonium-241	2.7×10^{-5}
Americium-241	5.0×10^{-7}

TABLE D.32. Routine Atmospheric Release Rates During 2-Year Preparation Phase Before Decommissioning (Immediate Decommissioning Alternative)

Radionuclide	Release Rate, Ci/yr
Tritium	2.3×10^{-8}
Carbon-14	1.2×10^{-8}
Selenium-79	2.6×10^{-9}
Krypton-85	2.3×10^{-6}
Strontium-90/Yttrium-90	2.9×10^{-5}
Niobium-93m	5.5×10^{-9}
Technetium-99	8.8×10^{-8}
Ruthenium-106/Rhodium-106	1.9×10^{-6}
Cadmium-113m	1.6×10^{-9}
Antimony-125	8.4×10^{-7}
Tellurium-125m	2.0×10^{-6}
Tin-126/Antimony-126m	1.8×10^{-9}
Cesium-134	4.0×10^{-7}
Cesium-135	1.8×10^{-9}
Cesium-137/Barium-137m	1.6×10^{-5}
Samarium-151	1.3×10^{-5}

TABLE D.33. Routine Liquid Release Rates to the Susquehanna River During the 2-Year Preparation Phase Before Decommissioning (Immediate Decommissioning Alternative)

Radionuclide	Release Rate, Ci/yr
Tritium	1.2×10^{-7}
Carbon-14	6.4×10^{-8}
Selenium-79	1.4×10^{-8}
Strontium-90/Yttrium-90	1.5×10^{-4}
Niobium-93m	3.0×10^{-8}
Technetium-99	4.8×10^{-7}
Ruthenium-106/Rhodium-106	1.0×10^{-5}
Cadmium-113m	8.3×10^{-9}
Antimony-125	4.5×10^{-6}
Tellurium-125m	1.1×10^{-6}
Tin-126/Antimony-126m	9.6×10^{-9}
Cesium-134	3.0×10^{-5}
Cesium-135	9.6×10^{-9}
Cesium-137/Barium-137m	2.8×10^{-3}
Samarium-151	7.1×10^{-5}

TABLE D.34. Postulated Accidental Atmospheric Release from a Fire in the Stairwell/Elevator Structure During the 2-Year Preparation Period Before Decommissioning (Immediate Decommissioning Alternative)[a]

Radionuclide	Release, Ci
Tritium	8.4×10^{-9}
Carbon-14	4.4×10^{-9}
Manganese-54	7.3×10^{-12}
Iron-55	1.1×10^{-8}
Cobalt-60	4.1×10^{-8}
Nickel-63	9.5×10^{-9}
Selenium-79	9.7×10^{-10}
Krypton-85	3.2×10^{-8}
Strontium-90/Yttrium-90	1.2×10^{-5}
Zirconium-93	2.7×10^{-11}
Niobium-93m	2.0×10^{-9}
Technetium-99	3.3×10^{-8}
Ruthenium-106/Rhodium-106	7.6×10^{-7}
Cadmium-113m	5.8×10^{-10}
Antimony-125	3.3×10^{-7}
Tellurium-125m	7.5×10^{-7}
Tin-126/Antimony-126m	6.6×10^{-10}
Cesium-134	2.1×10^{-6}
Cesium-135	6.6×10^{-10}
Cesium-137/Barium-137m	1.9×10^{-4}
Cerium-144/Praseodymium-144	2.7×10^{-8}
Praseodymium-144m	4.3×10^{-10}
Promethium-147	2.6×10^{-7}
Samarium-151	4.9×10^{-6}
Europium-152	4.3×10^{-12}
Europium-154	5.6×10^{-9}
Europium-155	1.7×10^{-8}
Uranium-234	2.0×10^{-10}
Uranium-235/Thorium-231	6.8×10^{-12}
Uranium-236	6.1×10^{-12}
Uranium-237	3.7×10^{-12}
Uranium-238/Thorium-234/Protactinium-234m	4.6×10^{-11}
Plutonium-238	1.2×10^{-9}
Plutonium-239	1.5×10^{-8}
Plutonium-240	4.1×10^{-9}
Plutonium-241	1.6×10^{-7}
Americium-241	3.7×10^{-9}

(a) Assumes accident occurs during the first year of preparation activities.

TABLE D.35. Postulated Accidental Atmospheric Release from a HEPA Filter Failure During the 2-Year Preparation Period Before Decommissioning (Immediate Decommissioning Alternative)[(a)]

Radionuclide	Release, Ci
Tritium	1.2×10^{-6}
Carbon-14	1.1×10^{-8}
Manganese-54	4.7×10^{-11}
Iron-55	7.1×10^{-8}
Cobalt-60	2.6×10^{-7}
Nickel-63	6.1×10^{-8}
Selenium-79	2.4×10^{-9}
Krypton-85	2.1×10^{-6}
Strontium-90/Yttrium-90	3.2×10^{-5}
Zirconium-93	1.7×10^{-10}
Niobium-93m	5.1×10^{-9}
Technetium-99	8.2×10^{-8}
Ruthenium-106/Rhodium-106	2.1×10^{-6}
Cadmium-113m	1.4×10^{-9}
Antimony-125	8.7×10^{-7}
Tellurium-125m	1.9×10^{-6}
Tin-126/Antimony-126m	1.7×10^{-9}
Cesium-134	4.6×10^{-7}
Cesium-135	1.6×10^{-9}
Cesium-137/Barium-137m	1.8×10^{-5}
Cerium-144/Praseodymium-144	1.7×10^{-7}
Praseodymium-144m	2.8×10^{-9}
Promethium-147	1.6×10^{-6}
Samarium-151	1.2×10^{-5}
Europium-152	2.7×10^{-11}
Europium-154	3.6×10^{-8}
Europium-155	1.1×10^{-7}
Thorium-231	4.3×10^{-11}
Thorium-234/Protactinium-234m	2.9×10^{-10}
Uranium-234	7.6×10^{-10}
Uranium-235	2.5×10^{-11}
Uranium-236	2.3×10^{-11}
Uranium-237	2.4×10^{-11}
Uranium-238	1.7×10^{-10}
Plutonium-238	4.4×10^{-9}
Plutonium-239	5.7×10^{-8}
Plutonium-240	1.5×10^{-8}
Plutonium-241	1.0×10^{-6}
Americium-241	1.4×10^{-8}

(a) Assumes accident occurs during the first year of the preparation activities.

APPENDIX E

CALCULATION OF RADIATION DOSES FROM WATERBORNE AND AIRBORNE PATHWAYS

APPENDIX E

CALCULATION OF RADIATION DOSES FROM WATERBORNE AND AIRBORNE PATHWAYS

This appendix contains the methods, assumptions, and parameters used in the calculation of the radiation exposure to the public. The pathways are divided into two groups: waterborne pathways from the TMI site and airborne pathways from the TMI site.

E.1 WATERBORNE PATHWAYS

The public radiation doses resulting from the release of accident-generated water to the Susquehanna River were generated by the U.S. Nuclear Regulatory Commission's (NRC) LADTAP II computer code (Strenge, Peloquin, and Whelan 1986). The LADTAP II code generates 50-year dose commitments based on a 1-year release. For the cases where the release occurs for a period longer than 1 year, the 50-year dose commitment for a 1-year release was multiplied by the number of years over which the release extends. Doses were determined for the maximum individual, for the population within a 50-mile (80-kilometer) radius of the power plant, and for the population that consumes shellfish harvested from Chesapeake Bay.

The pathways considered for doses to the maximally exposed individual and the population were drinking water obtained from the Susquehanna River, the consumption of fish from the river, rivershore activities, and boating and swimming in the river. The irrigated farm product/food pathway was not applied to the dose calculations because the river water is not commonly used for irrigation purposes.

The population distributions for each of the years from 1990 to 2028 were interpolated or extrapolated from population data for the years 1981 and 2010. The 1981 population distributions were based on an internal NRC document by A. Sinisgalli, "1981 Residential Population Estimates 0-80 Kilometers for Nuclear Power Plants." The 2010 population distributions were obtained from a letter from F. R. Standerfer to the NRC, February 3, 1988, "Post-Defueling Monitored Storage Environmental Evaluation."

The affected population within the 50-mile (80-kilometer) radius for 1990 was assumed to be 2.5 million people with age-group distributions as follows: 71 percent, adults; 11 percent, teenagers; and 18 percent, children. Of the 2.5 million people, 340,000 were assumed to obtain their drinking water from the river. The affected population within the 50-mile (80-kilometer) radius was estimated for the year 2014 to number 3.3 million people with the same age-group distribution assumed for 1991. Only 460,000 of the 3.3 million people were assumed to obtain their drinking water from the river.

Table E.1 contains the consumption and usage rates by the maximally exposed individual for the various pathways. Table E.2 lists the consumption rates for drinking water and river fish used for the population dose calculations. Additional parameters used for the population doses for 1991 are as follows:

- shoreline usage - 83,000 person-hours/yr
- swimming - 120,000 person-hours/yr
- boating - 520,000 person-hours/yr
- sport fishing (edible) yield - 150,000 lb/yr (68,000 kg/yr)
- commercial fishing yield - none assumed.

TABLE E.1. Consumption and Usage Rates for the Maximally Exposed Individual

Pathway	Target	Rate
Fish	Infant	0 lb/yr (0 kg/yr)
	Child	15 lb/yr (6.9 kg/yr)
	Teenager	35 lb/yr (16 kg/yr)
	Adult	46 lb/yr (21 kg/yr)
Drinking Water	Infant	87 gal/yr (330 L/yr)
	Child	140 gal/yr (510 L/yr)
	Teenager	140 gal/yr (510 L/yr)
	Adult	190 gal/yr (710 L/yr)
Shoreline Use	Infant	0 h/yr
	Child	14 h/yr
	Teenager	67 h/yr
	Adult	12 h/yr

TABLE E.2. Consumption Rates for Population Dose Calculations

Pathway	Target	Rate
Fish	Child	4.8 lb/yr (2.2 kg/yr)
	Teenager	12 lb/yr (5.2 kg/yr)
	Adult	15 lb/yr (6.9 kg/yr)
Drinking Water	Child	69 gal/yr (260 L/yr)
	Teenager	69 gal/yr (260 L/yr)
	Adult	98 gal/yr (370 L/yr)

Additional parameters used for the population doses for 2010 are as follows:

- shoreline usage - 126,000 person-hours/yr
- swimming - 180,000 person-hours/yr
- boating - 790,000 person-hours/yr
- sport fishing (edible) yield - 227,000 lb/yr (103,000 kg/yr)
- commercial fishing yield - none assumed.

In addition to the doses discussed above, doses to the population that consumes shellfish harvested from Chesapeake Bay were also calculated. An annual shellfish harvest of 72 million pounds (33 million kilograms) was assumed for 1991, and 108 million pounds (49 million kilograms) was assumed for 2010. Assuming an edible fraction of one-half, the total shellfish consumption would be 36 million pounds (16 million kilograms) for 1991 and 54 million pounds (24 million kilograms) for 2010. The shellfish consumption rates for the average individual are listed in Table E.3, but the harvest was more than could be consumed by the population living within 50 miles (80 kilometers) of the power plant. Therefore, the population dose from shellfish consumption was calculated for the entire population consuming Chesapeake Bay shellfish. A fraction of this dose (based on the population size and average consumption rate) is assumed to be received by the persons within the 50-mile (80-kilometer) radius that consume Chesapeake Bay shellfish. The remainder is received by persons outside the 50-mile (80-kilometer) radius.

The flow rate of the river was assumed to be 34,000 ft^3/sec (963 m^3/sec) for all except one of the calculations. The exception was the calculation of dose to the maximally exposed individual from the consumption of fish. For this calculation, a flow rate of 3150 ft^3/sec (89 m^3/sec) was used to correspond to the flow rate of the narrow channel near TMI. The fish caught by the maximally exposed individual

TABLE E.3. Average Shellfish Consumption Rates

Target	Rate
Child	0.73 lb/yr (0.33 kg/yr)[a]
Teenager	1.6 lb/yr (0.75 kg/yr)[a]
Adult	2.2 lb/yr (1.0 kg/yr)[a]
Maximum Adult	97 lb/yr (44 kg/yr)[b]

[a] NRC 1977.
[b] Rupp, Miller, and Baes 1980.

were assumed to be caught from this channel. The transport time from the plant discharge point to the maximum individual or the population was neglected during the dose calculations.

E.2 AIRBORNE PATHWAYS

Radiation doses to the public resulting from atmospheric releases from the TMI site during cleanup operations were calculated using the GASPAR II computer code (Strenge, Bander, and Soldat 1986) which uses the calculation methods described in Regulatory Guide 1.109 (NRC 1977). The GASPAR code generated 50-year dose commitments based on 1 year of inhalation or ingestion. For those cases where the release extends for more than 1 year, the 50-year dose commitment was calculated for 1 year of exposure and multiplied by the number of years over which the release occurs.

Doses were determined for the maximally exposed individual and for the population (age-group distribution: 71 percent, adults; 11 percent, teenagers; and 18 percent, children) assumed to be living within a 50-mile (80-kilometer) radius of the power plant. The population within a 50-mile (80-kilometer) radius in 1990 was estimated to be 2.5 million people. The population in 2014 was estimated to be 3.3 million persons with the same age-group distribution. The pathways considered for both the maximally exposed individual and the population doses were inhalation, consumption of agricultural products, and external exposure. The dose (attributable to the TMI-2 cleanup) to the population outside the 50-mile (80-kilometer) radius was also calculated due to inhalation, external exposure, and consumption of agricultural products exported from within the 50-mile (80-kilometer) radius.

The parameters used as input for the calculations include the consumption rates for individual members of the population. The assumed consumption rates were as follows: 434 lb/yr (197 kg/yr) of vegetables, 35 gal/yr (131 L/yr) of milk, and 179 lb/yr (81 kg/yr) for meat. Total annual agricultural production for the 50-mile (80-kilometer) area surrounding the site is 1.2×10^8 pounds (5.32×10^7 kilograms) of vegetables, 1.4×10^8 gallons (5.27×10^8 liters) of milk, and 1.2×10^8 pounds (5.44×10^7 kilograms) of beef. Specific exposure pathway fractions are provided in Table E.4.

Regulatory Guide 1.109 models are also appropriate for short-term releases (accident releases) with certain minor adjustments in application and parameter values, even though the models were originally developed for long-term releases. Short-term accidental releases require special interpretation for two reasons; (1) it is impossible to predict meteorological conditions at the time of an accident, and (2) it is impossible to predict the season during which an accident may occur. As a result, it is also impossible to predict vegetable garden production or cow pasture use (average annual rates of vegetable production and cow pasture use were assumed). For routine releases, the correct interpretation of the results is that they describe the expected maximum doses that actually will occur offsite. These represent maximum values because locations are also chosen that will result in highest doses. On the other hand, for the short-term release, (1) the wind could be in some other direction where the doses would likely be smaller, (2) whatever the direction of the wind, the actual atmospheric dispersion could be very different from the average value in that direction, and/or (3) there may or may not be cows on pasture or garden production, depending on season and wind direction. The most important uncertainty in the accident calculation is the inability to predict the actual meteorological conditions and, thus, dispersion during an accident. For this reason, the hourly atmospheric dispersion parameter values for the location resulting in highest doses were used to calculate the dose to the maximally exposed offsite individual. These results should be interpreted as worst location expected values, rather than worst location actual values. The population doses from accident releases were based on annual average atmospheric dispersion parameter values.

The $\bar{\chi}/Q$ values used for calculation of population doses from routine and accident releases were obtained from Appendix W of the PEIS (NRC 1981). The $\bar{\chi}/Q$ value for the hypothetical maximally exposed individual (assumed to be a child located at the site boundary full time, 0.34 miles [0.55 kilometers] west of the site, who consumes goat milk from that site) was 3.6×10^{-6} sec/m^3 for routine releases. The $\bar{\chi}/Q$ value used for accident releases was 2.9×10^{-5} sec/m^3 which are at 1.05 miles east-northeast for a garden, and 1.02 miles north for a milk goat. This accident $\bar{\chi}/Q$ value was also used for the inhalation pathway. In addition, the absolute humidity for the site is 8.0 g/m^3. No credit for enhanced dilution from building wakes was taken.

Exposure parameters for the calculations that are not specified above are contained in the GASPAR II code.

TABLE E.4. Airborne Exposure Pathway Fractions

Exposure Pathway	Fraction
Leafy vegetables from garden	0.5
Other edibles from garden	1.0
Fraction of time milk cows are on pasture	0.6
Fraction of time beef cattle are on pasture	1.0
Fraction of time milk goats are on pasture	1.0
Milk cow intake from pasture	1.0
Beef cattle intake from pasture	0.8
Milk goat intake from pasture	1.0

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APPENDIX F

WASTE VOLUME ESTIMATES AND WASTE TRANSPORTATION IMPACTS

APPENDIX F

WASTE VOLUME ESTIMATES AND WASTE TRANSPORTATION IMPACTS

This appendix contains the methodologies, assumptions, and parameters used in the calculation of the waste volume resulting from post-defueling operations and the impacts of transporting this waste to a disposal site.

Section F.1 describes the waste volume estimates, waste classification, and radiation dose rate estimates that were used as input in calculating the transportation impacts. Section F.2 describes the calculation of the routine radiation exposure from transportation of the waste, the radiological accident risks, the nonradiological accident risks, and transportation costs. Waste volume estimates and waste transportation impacts were calculated for the licensee's proposal (delayed decommissioning) and the following five alternatives: delayed cleanup, immediate cleanup, immediate cleanup with reduced effort, immediate decommissioning, and incomplete defueling.

F.1 WASTE VOLUME, CLASSIFICATION, AND DOSE RATES

The approximate volumes and classes of waste that would be generated are shown in Tables F.1 through F.4 for delayed decommissioning, incomplete defueling, delayed cleanup, immediate cleanup, immediate cleanup with reduced effort, and immediate decommissioning. Waste volumes for incomplete defueling are the same as those for delayed decommissioning (see Table F.1). Waste volumes for immediate cleanup with reduced effort are the same as those for immediate cleanup (see Table F.3). The principal waste-producing activities occur during the cleanup activities in the delayed cleanup, immediate cleanup, or immediate cleanup/reduced effort alternatives. These activities include decontamination of the reactor coolant system, removal of contaminated portions of the reactor vessel head and control-rod drive mechanisms, removal of the stairwell/elevator structure in the basement, removal of concrete surfaces (primarily in the basement), and removal of temporary shielding that has been placed in the reactor building. These activities would also generate secondary waste consisting of materials such as disposable protective clothing and tools.

Radioactive wastes are classified according to 10 CFR 61 (CFR 1988a) criteria. Class A waste would contain designated radionuclides below the concentrations shown in Table F.5. It would consist mostly of compacted trash, slightly contaminated tools, contaminated equipment from upper elevations, and shielding that was placed in the building to facilitate defueling and cleanup operations. For the

TABLE F.1. Waste Volume Estimates for Delayed Decommissioning and Incomplete Defueling[a]

	Total Waste Volume					
	23-year PDMS		5-year PDMS		33-year PDMS	
Class of Waste[b]	ft^3	m^3	ft^3	m^3	ft^3	m^3
Preparations for PDMS						
Class A or B	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7
PDMS						
Class A dry radioactive waste	690 to 2300	20 to 65	150 to 500	4.3 to 14	990 to 3300	28 to 93
Class B or C air filters	0 to 1400	0 to 41	0 to 310	0 to 8.8	0 to 2100	0 to 58
Class A, B, or C residue from liquid waste treatment	120 to 460	3.4 to 13	25 to 100	0.7 to 2.8	170 to 660	4.8 to 19
1-year Preparation Prior to Decommissioning						
Class A dry radioactive waste	30 to 100	0.9 to 2.8	30 to 100	0.9 to 2.8	30 to 100	0.9 to 2.8
Class B or C air filters	0 to 63	0 to 1.8	0 to 63	0 to 1.8	0 to 63	0 to 1.8
Class A, B, or C residue from liquid waste treatment	5 to 20	0.1 to 0.6	5 to 20	0.1 to 0.6	5 to 20	0.1 to 0.6

(a) Does not include waste volumes associated with decommissioning.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

TABLE F.2. Waste Volume Estimates for Delayed Cleanup[a]

Class of Waste[b]	Total Waste Volume: 23-year PDMS ft^3	23-year PDMS m^3	5-year PDMS ft^3	5-year PDMS m^3	33-year PDMS ft^3	33-year PDMS m^3
Preparations for PDMS						
Class A or B	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7	100 to 200	2.8 to 5.7
PDMS						
Class A dry radioactive waste	690 to 2,300	20 to 65	150 to 500	4.3 to 14	990 to 3,300	28 to 93
Class B or C air filters	0 to 1,400	0 to 41	0 to 310	0 to 8.8	0 to 2,100	0 to 58
Class A, B, or C residue from liquid waste treatment	120 to 460	3.4 to 13	25 to 100	0.7 to 2.8	170 to 660	4.8 to 19
Cleanup Activities						
Class A waste	91,000 to 120,000	2,600 to 3,400	91,000 to 120,000	2,600 to 3,400	91,000 to 121,000	2,600 to 3,400
Class C waste	19,000 to 33,000	540 to 930	19,000 to 33,000	540 to 930	19,000 to 33,000	540 to 930
Class A, B, or C waste	9,600 to 29,000	270 to 810	9,600 to 29,000	270 to 810	9,600 to 29,000	270 to 810
Greater than Class C waste	Some possible	Some possible	Some possible	Some possible	Some possible	Some possible

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

TABLE F.3. Waste Volume Estimates for Immediate Cleanup and Immediate Cleanup/Reduced Effort[a]

Class of Waste[b]	Total Waste Volume ft^3	Total Waste Volume m^3
2-Year Engineering Study[c]		
Class A dry radioactive waste	60 to 200	1.7 to 5.7
Class B or C air filters	0 to 130	0 to 3.5
Class A, B, or C residue from liquid waste treatment	10 to 40	0.3 to 1.1
Cleanup Activities		
Class A waste	91,000 to 120,000	2,600 to 3,400
Class C waste	19,000 to 33,000	540 to 930
Class A, B, or C waste	9,600 to 29,000	270 to 810
Greater than Class C waste	Some possible	Some possible

(a) Does not include waste volumes associated with decommissioning or refurbishment.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.
(c) Waste volumes for 2-year engineering study would not be applicable to the immediate cleanup/reduced effort alternative.

TABLE F.4. Waste Volume Estimates for Immediate Decommissioning[a]

Class of Waste[b]	Total Waste Volume ft^3	Total Waste Volume m^3
2-Year Preparation Period Prior to Decommissioning		
Class A dry radioactive waste	60 to 200	1.7 to 5.7
Class B or C air filters	0 to 130	0 to 3.5
Class A, B, or C residue from liquid waste treatment	10 to 40	0.3 to 1.1

(a) Does not include waste volumes associated with decommissioning.
(b) Waste is classified according to 10 CFR 61 (CFR 1988a) criteria. See discussion in Section 2.3.2.

TABLE F.5. Class A Waste Limits for Isotopes Present at TMI-2[a]

Radionuclide	Maximum Concentration
Tritium	40 Ci/m^3
Carbon-14	0.8 Ci/m^3
Cobalt-60	700 Ci/m^3
Nickel-63	3.5 Ci/m^3
Strontium-90	0.04 Ci/m^3
Technetium-99	0.3 Ci/m^3
Cesium-137	1.0 Ci/m^3
Plutonium-241	350 nCi/g
Alpha[b]	10 nCi/g

(a) To determine the classification of wastes that contain a mixture of radionuclides, the concentration of each radionuclide is divided by the corresponding limit for that radionuclide (for the classification being determined). These fractional limits are summed and the sum must be less than 1. Radionuclides not listed are either not present at TMI-2 or may be present in any concentration in Class A waste.

(b) Alpha means alpha-emitting radionuclides with a half-life greater than 5 years. The following radionuclides discussed in Section 2.0 of this supplement fit this category: uranium-234, uranium-235, uranium-236, uranium-238, plutonium-238, plutonium-239, and americium-241.

volume estimates in Tables F.1 through F.4, it was assumed that compactable material would be compacted and Class A waste would be shipped for offsite burial at a licensed low-level waste disposal facility. All Class A waste was assumed by the staff to be transported in commercially available, Class-A-approved, 217-cubic-foot (6.1-cubic-meter) casks that provided shielding equivalent to 2.7 inches (6.9 centimeters) of lead. Exposure rates 6.6 feet (2 meters) from such a cask, loaded with TMI-2 Class A waste, would average 0.04 mR/h, as calculated using the computer code SIMPLE (Reece et al. 1987). This exposure rate was used to assess the transportation impacts discussed in Section F.2.

Tables F.1 through F.4 list waste of unspecified class (waste that may be either Class A, B, or C). This waste would include insulation and equipment from the basement, some of the apparatus from the reactor vessel head, and other such equipment. Although the class of the waste cannot be predicted at this time, all of the waste would require measurement and classification before it was packaged and shipped to ensure that transportation and disposal regulations were complied with. Although some of the unspecified waste may be Class B waste, the quantity is expected to be small. Most of the unspecified waste, however, is assumed to be Class C waste. Class B waste is waste that exceeds the Class A limits for cobalt-60 or nickel-63 or that contains between 1 Ci/m^3 and 44 Ci/m^3 of cesium-137 or between 0.04 Ci/m^3 and 150 Ci/m^3 of strontium-90. The maximum concentration limits for Class C waste are shown in Table F.6. The rule in footnote (a) of Table F.5 for determining the waste classification for a mixture of radionuclides also applies to Class B and C waste. For this analysis all of the unspecified waste was assumed to be Class C waste.

Waste that is clearly Class C would result from scabbling of the basement walls and floors, from the removal of the enclosed stairwell/elevator shaft, from reactor coolant system decontamination, and from waste generated during other cleanup activities. A much greater quantity of Class C waste would be generated during delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort than during delayed or immediate decommissioning or incomplete defueling. All of the Class C waste would require shipping in shielded transport casks. Commercially available 142-cubic-foot (4.0-cubic-meter) casks, which are approved for Class C waste and provide shielding equivalent to 4.5 inches (11.4 centimeters) of lead, were assumed to be used for the Class C and unspecified waste shipments.

For the purpose of this analysis, the low-level waste disposal facility operated by U.S. Ecology near Richland, Washington, was assumed as the location for the disposal of all waste generated before the year 2001. Beginning with the year 2001, it was assumed that waste would be shipped to a regional low-level waste site. As discussed in Section 2.3.5 of this supplement, regional low-level

TABLE F.6. Class C Waste Limits[a]

Radionuclide	Maximum Concentration
Carbon-14	0.8 to 8.0 Ci/m^3
Strontium-90	150 to 7000 Ci/m^3
Cesium-137	44 to 4600 Ci/m^3
Plutonium-241	350 to 3500 nCi/g
Alpha[b]	10 to 100 nCi/g

(a) For mixtures of radionuclides, footnote (a) in Table F.5 applies.
(b) Alpha has the same meaning as that in Table F.5.

radioactive waste disposal facilities are expected to be available after 1992. For purposes of this supplement, it was conservatively assumed that the regional site would not be available until 2001. Although no site has yet been designated, for this analysis a generic site 250 miles (400 kilometers) from TMI was assumed. The environmental impact of permanent waste storage in the disposal sites is considered to be outside the scope of this supplement and is the subject of a separate licensing action in connection with the site.

Some of the waste generated, especially from the basement, could exceed maximum Class C limits, in which case it could not be accepted by a licensed burial site. The licensee, however, has a unique agreement with the U.S. Department of Energy (DOE) that allows such wastes to be transferred to the DOE on a cost-reimbursement basis. It is under this agreement, known as the Memorandum of Understanding,[a] that the fuel is being transferred to the DOE Idaho Falls site.

The volume of wastes that would be generated (as summarized in Tables F.1 through F.4) was estimated on the basis of knowledge of the TMI-2 facility and assumptions that were made regarding the tasks to be performed for each alternative. Waste volume estimates for the licensee's proposal and five alternatives analyzed in this study were generated from the estimates for the individual phases listed below:

- preparation for PDMS
- PDMS activities
- 2-year engineering study
- preparation period prior to decommissioning
- cleanup activities.

A discussion on the methodology used to derive the waste volume estimates for each of the phases is presented in Sections F.1.1 through F.1.5.

F.1.1 Preparations for PDMS

This phase would last between 6 months and 1 year and would include modifying, deactivating, and preserving plant systems, as discussed in Section 3.1.1.2. Waste generation during this phase would be minimal, as indicated by the 100 to 200-cubic-foot (2.8 to 5.7-cubic-meter) estimate. Because major decontamination activities will not be taking place, the radioactive materials in the waste would likely be Class A or B waste. The estimated ratio of Class A to Class B waste would be approximately 20 to 1 based on current experience.

(a) *Memorandum of Understanding Between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy, Concerning the Removal and Disposition of Solid Nuclear Wastes from Cleanup of the Three Mile Island Unit 2 Nuclear Plant*, March 15, 1982.

F.1.2 PDMS Activities

As discussed in Section 3.2.4, maintenance of the facility in PDMS could generate waste consisting of high-efficiency particulate air (HEPA) filters and disposable protective clothing. Treatment of water and decontamination solutions would generate additional waste consisting of HEPA filters and disposable protective clothing. These wastes could be Class A, B, or C. Quantities of wastes are expected to be small, as indicated in Tables F.1 and F.2. The quantities of waste for 5 years and 33 years of PDMS were obtained by scaling the base case PDMS estimate (23 years of PDMS).

F.1.3 Two-Year Engineering Study

As discussed in Section 3.3.1, the purpose of the 2-year engineering study would be to perform studies to determine the most appropriate cleanup methods for the different plant locations during immediate cleanup. Waste volume estimates for this phase were assumed to be equivalent to the waste volume generated during 2 years of PDMS.

F.1.4 Preparation Period Before Decommissioning

This phase assumes the facility would be decommissioned without extensive additional cleanup before decommissioning, as discussed in Section 3.1.1 (Delayed Decommissioning) and Section 3.5.1 (Immediate Decommissioning). The preparation period was assumed to last 1 year for the delayed decommissioning alternative and 2 years for the immediate decommissioning alternative. The waste volumes generated during this period were assumed to be equivalent to waste volumes generated during equivalent time periods of PDMS.

F.1.5 Cleanup Activities

Cleanup activities include limited decontamination of the auxiliary and fuel-handling building (AFHB) and decontamination of the reactor coolant system, upper elevations of the reactor building (305-foot and 347-foot elevations), reactor building basement, and polar crane. Class A waste was estimated to account for approximately 70 percent of the waste volume generated during cleanup activities. The estimated volume of Class A waste for cleanup activities is equivalent to the annual waste volume generated during the past several years of reactor cleanup and defueling, multiplied by the projected 4-year period of cleanup.

Most of the Class C waste would be generated from the decontamination activities in the reactor building basement (i.e., robotic scabbling, removal of the stairwell and elevator shaft, and removal of insulation and equipment).

The volume of waste from scabbling the basement floor was estimated by modeling the reactor building basement floor as a circular area. For high volume estimates, it was assumed that 2 inches (5 centimeters) of floor surface would be removed. For low volume estimates, it was assumed that 1 inch (2.5 centimeters) of the surface would be removed. For both estimates, it was assumed that the waste volume would be three times the volume of the poured concrete floor to the removed depth.

Basement walls were assumed to consist of 400 to 500 lineal feet (122 to 153 meters) of wall that would be scabbled to a height of 8 feet (2.4 meters) on both sides. Although samples from the walls indicate that the initial 0.125 inch (0.32 centimeter) of concrete contains most of the activity, the staff assumed that 0.25 inch (0.64 centimeter) would be removed by scabbling. The volume was assumed to triple to give between 400 and 500 cubic feet (11.3 to 14.2 cubic meters) of waste. Assuming that the waste produced from scabbling contains 7000 curies of cesium-137 and 300 curies of strontium-90 (see Table 2.4), it would be Class C waste. The radiation exposure rate 6.6 feet (2 meters) from a cask of this waste would be less than 0.01 mR/h, as calculated using the computer code SIMPLE (Reece et al. 1987). This value was used to assess the transportation impacts as discussed in Section F.2.

The concrete block and other components from the stairwell and elevator shaft would also constitute a significant quantity of waste. The concrete block of this structure has an installed volume of approximately 1100 cubic feet (31 cubic meters). This is based on calculations used by Munson and Harty (1985), assuming that the entire 21 feet (6.4 meters) of stairwell would be removed. For the low estimates of waste volume, it was assumed that the volume would double when removed. For the high estimates, it was assumed that it would triple. Based on the curie estimates in Section 2.0, the concrete block waste would average not more than approximately 300 Ci/m^3 of cesium-137 and 14 Ci/m^3 of strontium-90 along with other radionuclides. This would constitute Class C waste. The radiation exposure rate 6.6 feet (2 meters) from a cask of this waste during shipment was calculated to be less than 0.004 mR/h using the computer code SIMPLE (Reece et al. 1987). This value was used to assess the transportation impacts discussed in Section F.2. The metal doors, trolley, loading platform, and other components would contribute an additional volume. A volume of 21 feet (6.4 meters) by 3 feet (0.9 meter) by 1 foot (0.3 meter) was assumed for the stairs, and the volume of the doors, trolley, etc., was assumed to equal that of the stairs. Although some of this waste might be Class A or B, it was conservatively assumed to be all Class C waste.

Estimates of waste volume resulting from reactor coolant system decontamination were taken directly from the PEIS. Decontamination of the reactor coolant system was anticipated in the PEIS to generate approximately 9230 cubic feet (261 cubic meters) of radioactive waste. Waste from decontamination is assumed to contain the great majority of the fuel debris identified in Table 2.3. It will also contain some of the activation products. The following maximum concentrations were calculated:

- 73 nCi/g of mixed alpha (density of 1.1 assumed)
- 670 nCi/g of plutonium-241
- 1.4 Ci/m^3 of strontium-90
- 1.6 Ci/m^3 of cesium-137.

This waste is expected to be Class C although verification would be required before shipment. The radiation exposure rate 6.6 feet (2 meters) from a cask of this waste was calculated using the computer code SIMPLE (Reece et al. 1987) to average 1.5 mR/h. This value was used in assessing the transportation impacts, as discussed in Section F.2.

The remainder of the Class C waste is expected to come from removal of insulation from the basement, the cleanup of the upper elevations, removal of control rod drives, and contaminated tools and equipment.

F.2 WASTE TRANSPORTATION IMPACTS

The transportation impacts estimated in this section include routine radiation doses, radiological accident risks, nonradiological accident risks, and transportation costs from the transport of cleanup wastes from TMI to licensed low-level waste (LLW) disposal facilities. The transportation impacts were examined for the licensee's proposal and the five alternatives. Table F.7 indicates which low-level waste disposal site or sites would be used for each alternative according to guidance presented in Section F.1.

The following sections discuss the routine radiological impacts, radiological accident impacts, nonradiological accident impacts, and transportation costs.

F.2.1 Routine Radiological Impacts

The routine radiation doses resulting from the transportation of waste during delayed decommissioning, delayed cleanup, immediate cleanup, immediate cleanup/reduced effort, immediate decommissioning, and incomplete defueling were estimated using the RADTRAN III computer code (Madsen, Wilmot, and Taylor 1983; Madsen et al. 1986). A brief description of the RADTRAN III computer code and the bases and assumptions used in this analysis are provided and the results of the routine radiological impact calculations are discussed.

In routine (i.e., incident-free) transport, the package of radioactive material arrives at its destination without releasing its contents. Routine radiation doses include the direct external radiation

TABLE F.7. Waste Disposal Sites Considered for Each Alternative

Alternative	Disposal Site: Richland, WA (U.S. Ecology)	Disposal Site: Regional Disposal Site
Delayed Decommissioning and Incomplete Defueling		
Preparations for PDMS	√	
PDMS	√(a)	√(b)
1-year preparation prior to decommissioning	√(a)	√(b)
Delayed Cleanup		
Preparations for PDMS	√	
PDMS	√(a)	√(b)
Cleanup	√(a)	√(b)
Immediate Cleanup		
2-year engineering study	√	
Cleanup	√	
Immediate Cleanup/Reduced Effort		
Cleanup	√	
Immediate Decommissioning		
2-year preparation prior to decommissioning	√	

(a) If disposal occurs before the year 2001.
(b) If disposal occurs during or after the year 2001.

dose emitted by the radioactive material package as the shipment passes by. Even though the shipping packages are provided with radiation shields, some radiation penetrates the package and exposes the nearby population to a low dose rate. After the shipment passes by, no further exposure occurs.

The population groups exposed to radiation include those exposed on an incidental basis and those exposed as a result of their occupation. Truck crew members are exposed as a result of their occupation. The general public may be exposed on an incidental basis. The general public includes bystanders at truck stops, persons living or working along the route, and nearby travelers (moving in the same and opposite directions).

For the assessment of population dose, the packaging is assumed to be a point source of external, penetrating radiation. The point-source approximation is acceptable for distances between the receptor and the radiation source of more than two source-characteristic lengths. Source-characteristic length is defined as the largest physical dimension (length, diameter, etc.) of the radiation source. At shorter distances, the point-source approximation is conservative; that is, the calculated doses tend to be higher than those likely to occur. Derivations of the various equations used for different population groups and transport modes are discussed in detail by Taylor and Daniel (1982) and Madsen et al. (1986). Some of the input data used in this analysis are listed in Table F.8. These data are RADTRAN III default values, except where indicated.

The transportation impacts are influenced by the population densities of the regions across which the shipments must travel. The percent of time that travel occurs in each of three population zones (i.e., rural, suburban, and urban) was taken from Cashwell et al. (1986). The values for shipments to the LLW site in Richland, Washington, are 78 percent in rural areas, 21 percent in suburban areas, and 1 percent in urban areas. For shipments to a regional LLW disposal facility, the values used are 63 percent for rural areas, 36 percent for suburban areas, and 1 percent for urban areas[a] and are believed to be representative of shipments from TMI to most locations within 250 miles (400 kilometers) of the site.

The calculated, routine, 50-year committed radiation doses are shown in Table F.9. The routine doses are given in units of person-rem accumulated during the entire shipping program. Doses to the truck crews, persons who live or work in the vicinity of the highway (off-highway), persons sharing the highway with the shipments (on-highway), and bystanders at truck stops are shown separately for each waste type. As shown, the truck crews will receive the largest portion of the routine dose, followed by persons at truck stops. On-highway and off-highway doses are small relative to truck crew and stop doses.

As shown in Table F.9, the immediate decommissioning and delayed decommissioning alternatives result in the lowest routine doses from transportation: approximately 0.3 to 0.5 person-rem for immediate decommissioning and 0.5 to 2.4 person-rem for delayed decommissioning. The impacts of these alternatives are so low because minimal cleanup activities would be performed. Doses for the immediate cleanup and immediate cleanup/reduced effort alternatives (91 to 170 person-rem)

(a) A 1-percent urban travel fraction is assumed even though Cashwell et al. (1986) indicate no travel in urban areas.

TABLE F.8. Input Data for Analysis of Routine Transportation Impacts[a]

Parameter	Value
Number in truck crew	2
Distance from source to crew, meters	5
Population densities, persons/km^2	
High-population zone (urban)	3861
Medium-population zone (suburban)	719
Low-population zone (rural)	6
Average speed of truck, km/h	
High-population zone (urban)	24
Medium-population zone (suburban)	40
Low-population zone (rural)	88
Traffic count, one-way vehicles/h	
High-population zone (urban)	2800
Medium-population zone (suburban)	780
Low-population zone (rural)	470
Average exposure distance while stopped, meters	20
Stop time, h/km	0.011
Number of persons exposed while vehicle stopped	50
One-way shipping distance, kilometers	
To Richland, WA, LLW disposal facility	4314[b]
To regional LLW disposal facility	402[c]

(a) Values are taken from Madsen, Wilmot, and Taylor (1983) except where otherwise indicated.
(b) Source: Cashwell et al. 1986.
(c) Assumed value used in this study.

TABLE F.9. Routine Radiological Doses for Transporting TMI-2 Cleanup Wastes to Offsite Disposal Facilities[a]

Alternative	Dose Ranges by Exposed Population, person-rem[b] Truck Crew	Off-Highway[c]	On-Highway[d]	Stops	Total[e]
Delayed Decommissioning and Incomplete Defueling					
23-year PDMS	0.3 to 1.6	0.009 to 0.04	0.01 to 0.05	0.1 to 0.7	0.5 to 2.4
5-year PDMS	0.2 to 0.8	0.006 to 0.02	0.008 to 0.03	0.1 to 0.3	0.3 to 1.2
33-year PDMS	0.3 to 1.7	0.01 to 0.05	0.01 to 0.06	0.1 to 0.8	0.5 to 2.6
Delayed Cleanup					
23-year PDMS	6.5 to 13	0.3 to 0.5	0.3 to 0.5	2.7 to 5.3	9.7 to 19
5-year PDMS	60 to 110	1.7 to 3.0	2.0 to 3.6	27 to 50	91 to 170
33-year PDMS	6.5 to 13	0.3 to 0.5	0.3 to 0.5	2.7 to 5.3	9.7 to 19
Immediate Cleanup and Immediate Cleanup/ Reduced Effort	60 to 110	1.7 to 3.0	2.0 to 3.6	27 to 49	91 to 170
Immediate Decommissioning	0.1 to 0.3	0.004 to 0.007	0.005 to 0.01	0.07 to 0.1	0.3 to 0.5

(a) Does not include dose from transportation during decommissioning or refurbishment.
(b) Dose range based on low and high waste volume estimate.
(c) "Off-highway" refers to exposures to persons residing or working along a highway.
(d) "On-highway" refers to persons sharing the highway with the waste shipment; includes persons traveling in the same and opposite directions.
(e) The totals may not be exact because of rounding.

are the greatest because all the cleanup waste would be shipped to the disposal site in Richland, Washington, while cleanup waste for the delayed cleanup alternative would be shipped to the regional disposal site in Pennsylvania. If only 5 years of PDMS is assumed for the delayed cleanup alternative, the dose results would be the same as those for the immediate cleanup alternative, because waste would be shipped to the Richland, Washington, disposal site.

F.2.2 Radiological Accident Risks

The accident analysis considers the potential release of radioactive material from the waste package and its contents. The RADTRAN III computer code was also used to calculate the transportation accident risks. For this study, risk is defined as the frequency of accidents involving radioactive material multiplied by the consequences of an accident. The consequences can be expressed in terms of the radiation dose resulting from a release of radionuclides from the packaging or the exposure of persons to radiation that could result from damaged package shielding.

The frequency of an accident is expressed in terms of the number of accidents per unit distance. The response of the shipping container, and thus the probability of a release or loss of shielding, is related to the severity of the accident. Accidents with severities that exceed the design standards for shipping packages (see 10 CFR 71 [CFR 1988a] and 49 CFR 173, Subpart I [CFR 1988b]) could potentially occur, but the probability is extremely small. Thus, there is a slight possibility that an accident accompanied by a release of radioactive material or reduction of shielding could occur. The accident rates used in this study, which are RADTRAN III default parameters, are given for three population density zones: rural (1.4×10^{-7} accidents/km), suburban (2.7×10^{-6} accidents/km), and urban (1.6×10^{-5} accidents/km). As expected, accident rates in urban areas are significantly higher (i.e., about 100 times higher) than accident rates in rural areas.

RADTRAN III uses four quantities (the release fraction, the severity fraction, the aerosol fraction, and the respirable fraction) to describe a release of radioactive material. These quantities are dependent upon the severity of the accident. The release fraction is the amount of radioactive material of all sizes that could escape from the package in an accident (given as the fraction of the total contents of the package). The release fraction varies with the severity category. Eight severity categories are used in RADTRAN III. Associated with each severity category is a severity fraction, that is, the fraction of accidents that occur that would be representative of the accident conditions described by each severity category. The overall accident frequency for each severity category can be obtained by multiplying the severity fraction by the overall accident rate. The aerosol fraction is defined as the fraction of material released that can be entrained in an aerosol (cloud of radioactive material). The respirable fraction accounts for the fraction of aerosolized material that is also respirable (i.e., can be inhaled into the lungs). The release fraction and the severity fractions are presented in Table F.10. The values used for the aerosol fraction and the respirable fraction for each waste type considered in this study are presented in Table F.11.

RADTRAN III evaluates the radiation dose resulting from four pathways: external exposure to radiation from a passing cloud of radioactive material, external exposure from radioactive materials deposited on the ground, inhalation (exposure to radiation from breathing in radioactive materials), and ingestion (exposure from food that has been contaminated as a result of an accidental release of radionuclides and then eaten). The accident dose pathways are illustrated in Figure F.1. RADTRAN III assumes that radioactive materials released from a package in an accident are dispersed according to a standard Gaussian diffusion model. The model predicts downwind airborne radionuclide concentrations and the amount of material deposited on the ground. Radiation doses to human organs are then determined using the calculated airborne and ground-deposited radionuclide concentrations and standard dosimetric conversion factors. A 50-year dose commitment from radioactive materials deposited on the ground for a single year is calculated for the public. The model assumes that

TABLE F.10. Release Fraction and Severity Fractions Used in RADTRAN III Accident Analysis

Severity Category	Release Fraction[a]	Severity Fraction for Truck Shipments: Rural	Suburban	Urban
1	0.0	4.6×10^{-1}	4.4×10^{-1}	5.8×10^{-1}
2	0.0	3.0×10^{-1}	2.9×10^{-1}	3.8×10^{-1}
3	1×10^{-6}	1.8×10^{-1}	2.2×10^{-1}	2.8×10^{-2}
4	1×10^{-5}	4.0×10^{-2}	5.1×10^{-2}	6.4×10^{-3}
5	1×10^{-4}	1.2×10^{-2}	6.6×10^{-3}	7.4×10^{-4}
6	1×10^{-3}	6.5×10^{-3}	1.7×10^{-3}	1.5×10^{-4}
7	1×10^{-2}	5.7×10^{-4}	6.7×10^{-5}	1.1×10^{-5}
8	1×10^{-1}	1.1×10^{-4}	5.9×10^{-6}	9.9×10^{-7}

(a) Given as the fraction of the cask contents that are released as a result of an accident. Source: JIO 1986.

TABLE F.11. Aerosol and Respirable Fractions Used in RADTRAN III Accident Analysis

Parameter	Class A Waste	Type of Waste: Class C, Reactor Coolant System Waste	Other Class C Waste
Aerosol fraction	0.05	0.1	0.05
Respirable fraction	0.05	0.05	0.05

after 1 year, the contaminated area will be cleaned up to acceptable residual levels if needed or, if the contamination is too great, it is assumed that the area will be fenced off and access prohibited. Radiation doses to emergency response and cleanup personnel are not included. Doses to the general population from ingestion of radioactive material are estimated with the use of radionuclide transfer fractions which relate the amount of radioactive material ingested to the amount deposited on the ground after a potential accident (Ostmeyer 1985).

Calculated transportation accident risks associated with TMI cleanup activities are presented in Table F.12. The results are given in units of population dose (total 50-year committed dose) for the entire shipping program. This can be viewed as the sum of frequencies of a particular accident times the consequence of that accident in person-rem.

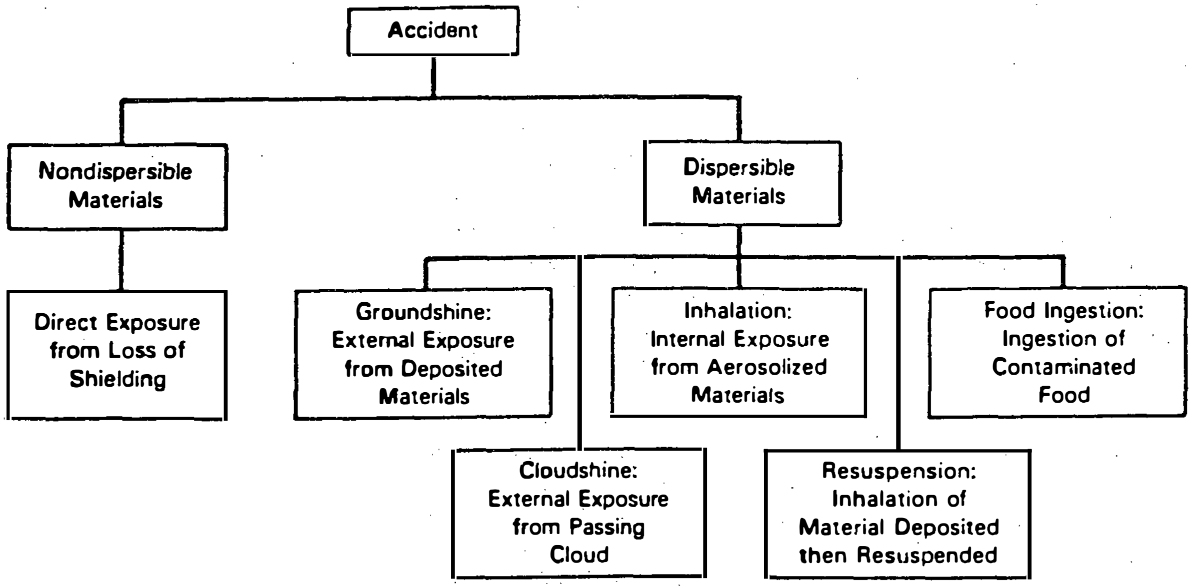

FIGURE F.1. Accident Dose Pathways Included in RADTRAN III

As shown in Table F.12, immediate decommissioning and delayed decommissioning alternatives result in the lowest accidental dose from transportation, approximately 0.00002 to 0.00003 person-rem and 0.00003 to 0.0002 person-rem, respectively. The impacts of these alternatives are low because it is assumed that minimal cleanup activities would be performed. Doses for the immediate cleanup and immediate cleanup/reduced effort alternatives (0.005 to 0.01 person-rem) are the greatest because all the cleanup waste would be shipped to the disposal site in Richland, Washington, while cleanup waste for the delayed cleanup alternative would be shipped to the regional disposal site in Pennsylvania. The longer distance results in a greater possibility of an accident. If only 5 years of PDMS is assumed for the delayed cleanup alternative, the dose results would be the same as those for the immediate cleanup alternative because it is assumed that waste would be shipped to the Richland, Washington, disposal site.

F.2.3 Nonradiological Accident Impacts

Nonradiological accident risks consist of injuries and fatalities that may result from traffic accidents involving the shipments of TMI-2 cleanup wastes. These risks are in no way related to the radioactive nature of the waste materials being transported. The number of estimated injuries and fatalities would be the same even if the cargo were not radioactive materials. In this section standard unit risk factors were used to estimate the nonradiological risks of transporting TMI cleanup wastes to offsite disposal facilities.

TABLE F.12. 50-Year Radiological Dose Commitment from Accidents During Transport of TMI-2 Cleanup Wastes to Offsite Disposal Facilities[a]

		Dose by Type of Waste, person-rem[b]		
Alternative	Exposed Population	Class A Waste	Class C Waste	Total[c]
Delayed Decommissioning and Incomplete Defueling				
23-year PDMS	Public	0.0000004 to 0.000001	0.00003 to 0.0002	0.00003 to 0.0002
5-year PDMS	Public	0.0000002 to 0.000008	0.00003 to 0.00008	0.00003 to 0.00008
33-year PDMS	Public	0.0000005 to 0.000001	0.00003 to 0.0002	0.00003 to 0.0002
Delayed Cleanup				
23-year PDMS	Public	0.00001 to 0.00002	0.0009 to 0.002	0.0009 to 0.002
5-year PDMS	Public	0.00008 to 0.0001	0.005 to 0.01	0.005 to 0.01
33-year PDMS	Public	0.00001 to 0.00002	0.0009 to 0.002	0.0009 to 0.002
Immediate Cleanup and Immediate Cleanup/ Reduced Effort	Public	0.00008 to 0.0001	0.005 to 0.01	0.005 to 0.01
Immediate Decommissioning	Public	0.0000001 to 0.0000003	0.00002 to 0.00003	0.00002 to 0.00003

(a) Does not include dose commitments from accidents during transport of wastes during decommissioning and refurbishment.
(b) Range of person-rem based on low and high waste-volume estimate.
(c) The totals may not be exact because of rounding.

The potential for accidents involving shipments of TMI cleanup wastes is assumed to be comparable to that of general truck transport in the United States. Cashwell et al. (1986) used statistics compiled by the U.S. Department of Transportation (DOT 1985) to develop nonradiological risk factors. These risk factors, in units of fatalities/kilometer and injuries/kilometer of travel, were multiplied by the total distance traveled for each type of waste shipment to calculate the expected number of nonradiological injuries and fatalities due to transportation of TMI cleanup wastes. These risk factors are shown in Table F.13. Accident fatality and injury data are available for both transport workers (truck crews) and the general public during travel in three population zones: rural, suburban, and urban (Cashwell et al. 1986). Therefore, the total number of fatalities (or injuries) over the entire shipping program is the sum of the products of the vehicle miles (kilometers) and the fatality or injury rates in each zone.

The total number of traffic accidents involving these shipments was also estimated using a similar approach. The number of accidents was estimated using the accident rates in rural, suburban, and urban areas that were given in Section F.2.2. These rates were multiplied by the total travel distances in these areas.

The estimated number of traffic accidents and the total estimated fatalities and injuries are shown in Table F.14 for the different alternatives. The total number of nonradiological fatalities was estimated to be less than 1.0 for all the alternatives. For the immediate cleanup and immediate cleanup/reduced effort alternatives,

TABLE F.13. Truck Transportation Accident Risk Factors for All Waste Types

Population Zone	Affected Group	Risk Factors: Fatalities/km	Risk Factors: Injuries/km
Rural	Truck crew	1.5×10^{-8}	2.8×10^{-8}
	Public	5.3×10^{-8}	8.0×10^{-7}
Suburban	Truck crew	3.7×10^{-9}	1.3×10^{-8}
	Public	1.3×10^{-8}	3.8×10^{-7}
Urban	Truck crew	2.1×10^{-9}	1.3×10^{-8}
	Public	7.5×10^{-9}	3.7×10^{-7}

Source: Cashwell et al. 1986.

TABLE F.14. Estimated Number of Traffic Accidents, Fatalities, and Injuries for Each Alternative[a]

Alternative	Total Number of Accidents[b]	Total Fatalities[b]		Total Injuries[b]	
		Truck Crew	Public	Truck Crew	Public
Delayed Decommissioning and Incomplete Defueling					
23-year PDMS	0.02 to 0.1	0.0003 to 0.001	0.001 to 0.005	0.0007 to 0.003	0.02 to 0.08
5-year PDMS	0.01 to 0.05	0.0002 to 0.0008	0.0008 to 0.003	0.0004 to 0.001	0.01 to 0.04
33-year PDMS	0.03 to 0.1	0.0004 to 0.002	0.001 to 0.005	0.0007 to 0.003	0.02 to 0.09
Delayed Cleanup					
23-year PDMS	0.6 to 1.1	0.006 to 0.01	0.02 to 0.04	0.01 to 0.02	0.3 to 0.6
5-year PDMS	4.5 to 7.2	0.07 to 0.1	0.2 to 0.4	0.1 to 0.2	3.8 to 6.1
33-year PDMS	0.6 to 1.1	0.006 to 0.01	0.02 to 0.04	0.01 to 0.02	0.3 to 0.6
Immediate Cleanup and Immediate Cleanup/ Reduced Effort	4.5 to 7.2	0.07 to 0.1	0.2 to 0.4	0.1 to 0.2	3.8 to 6.1
Immediate Decommissioning	0.007 to 0.02	0.0001 to 0.0003	0.0005 to 0.001	0.0003 to 0.0006	0.007 to 0.01

(a) Does not include accidents, fatalities, or injuries associated with decommissioning or refurbishment.
(b) Results are presented as a range based on low and high waste-volume estimates.

the number of injuries was estimated to be between 3.9 and 6.3. The estimated number of injuries for the delayed cleanup alternative (23 years of PDMS) are approximately one-tenth of those for the immediate cleanup alternative, and those for the delayed decommissioning, incomplete defueling, and immediate decommissioning alternatives are approximately one-hundredth of the immediate cleanup alternative. The immediate cleanup alternatives have the highest nonradiological impacts. This is because of the much longer shipping distances involved for the immediate cleanup alternative (i.e., shipment to Richland, Washington, during immediate cleanup and immediate cleanup/reduced effort versus a much closer regional LLW disposal facility during delayed cleanup following storage).

F.2.4 Transportation Costs

Transportation costs are estimated assuming that all transportation services would be provided by commercial companies. It is assumed that a sufficient supply of the shipping containers would be available when needed. This means that capital costs for construction of additional shipping containers would not be necessary. Thus, transportation costs consist of shipping charges and shipping container leasing fees.

Shipping costs are the costs charged by commercial carrier companies for moving waste shipments from TMI to a destination facility and returning the empty container to TMI. Data used to determine shipping costs were taken from McNair et al. (1986). These data are based on published tariffs and include such items as freight rates and detention of drivers and vehicles while shipping containers are being loaded or unloaded. Because of the deregulation of the transportation industry, actual shipping costs cannot be determined until a contract is negotiated between the shippers and carrier companies.

Because shipping containers are owned by commercial companies, a lease is required for the shipper to use the shipping containers. Based on telephone conversations with owners of shipping containers, it is assumed for this study that the lease fee for the representative shipping containers amounts to $200/day. This rate is multiplied by the number of days the shipping containers are estimated to be used. The number of days was estimated by dividing the shipping distances through rural, suburban, and urban population zones by the average speed in these zones (see Table F.8), summing over all three zones, and then adding time spent at truck stops. Stop time was estimated using a factor of 0.011 hour of stop time per kilometer of travel (see Table F.8). Two days were added to each trip to account for loading (1 day) and unloading (1 day) of shipping containers. Assuming that a two-person driving team travels round-the-clock, shipments from TMI to Richland, Washington, and back to TMI would take approximately 11 days. Shipments from TMI to a regional LLW disposal facility and back again are estimated to require about 3 days.

Results of the transportation cost calculations for shipment of TMI cleanup wastes to disposal facilities are shown in Table F.15. The total number of shipments for each waste type and total costs are shown in the table. Although total costs are based on the best available information and are believed to be representative approximations, they are intended for comparison purposes only.

TABLE F.15. Total Transportation Costs[a]

Alternative	Waste Type, Number of Shipments[b] Class A Waste	Class C Waste	Total Cost, $ Millions[c]
Delayed Decommissioning and Incomplete Defueling			
23-year PDMS	4 to 12	2 to 14	0.025 to 0.11
5-year PDMS	1 to 4	1 to 3	0.014 to 0.047
33-year PDMS	5 to 17	2 to 20	0.027 to 0.12
Delayed Cleanup			
23-year PDMS	425 to 570	203 to 450	1.1 to 1.8
5-year PDMS	422 to 561	202 to 439	4.2 to 6.8
33-year PDMS	426 to 574	203 to 456	1.1 to 1.8
Immediate Cleanup and Immediate Cleanup/ Reduced Effort	421 to 559	201 to 438	4.2 to 6.7
Immediate Decommissioning	0 to 1	1 to 2	0.009 to 0.018

(a) Does not include transportation costs for decommissioning or refurbishment.
(b) Results are presented as a range based on low and high waste-volume estimates.
(c) Costs are given in 1988 dollars.

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APPENDIX G

CALCULATION OF SOCIOECONOMIC IMPACTS

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The direct socioeconomic impacts of the licensee's proposal and the U.S. Nuclear Regulatory Commission (NRC) staff-identified alternatives were evaluated. The socioeconomic impact of the post-defueling operations depends on the size of the work force that would perform the work. Employment at TMI is considered to be "export-base" employment because it involves the sale of products or services outside the economy. The useful rule of thumb for local Pennsylvania economies is that export-base employment sustains 0.5 or more local offsite support-sector jobs for every 1 direct "export-base" job. Thus, the implicit offsite employment multiplier is about 0.5 (0.5 offsite job for each onsite job) and the total employment multiplier is about 1.5 (1.5 total jobs, onsite and offsite, for each job onsite).[a] Similarly, a reasonable local offsite income multiplier is about 1.0 and the total local income multiplier is about 2.0.

For the delayed decommissioning, delayed cleanup, and incomplete defueling alternatives, the licensee estimates that the level of direct employment for the PDMS program would be about 100 to 125 personnel during the transition year following the completion of current defueling activities and about 70 to 75 personnel thereafter until preparations for decommissioning or continued cleanup begin. In comparison, approximately 1150 personnel were involved in defueling and decontamination activities during 1987-1988.[b] According to the same source, transition-year direct payrolls would be about $6.2 million, and subsequent annual payrolls for the monitoring and maintenance work force would be about $3.8 million. Assuming total employment and income impact multipliers of 1.5 and 2.0, respectively, the total local economic impact in the transition year could be about 150 to 200 jobs and $12 million to $13 million in local income, and from 100 to 120 jobs and about $7 million to $8 million in annual local income thereafter. These amounts are extremely small in relation to the local economy and cannot be considered significant socioeconomic impacts.

(a) The total employment multiplier can be somewhat higher than 1.5 (0.5 offsite plus 1.0 direct jobs) if the export sector jobs are highly paid. (Personal contact with Stan Duobinis, Econometrics Department, Wharton School of Finance and Commerce, University of Pennsylvania, Philadelphia, Pennsylvania, September 22, 1987.)

(b) Letter from F. R. Standerfer, Director, TMI-2, GPU Nuclear Corporation to W. D. Travers, Director, TMI-2 Cleanup Project Directorate, NRC, November 5, 1987. Subject: Post-Defueling Monitored Storage Environmental Evaluation, NRC Comment Response.

The socioeconomic impact of incomplete defueling would be the same as that for delayed decommissioning. The impact from immediate decommissioning was estimated by the NRC staff to be twice that of delayed decommissioning for a 2-year period, based on a level of employment of 200 to 250 personnel during the first year and 140 to 150 personnel during the final year.

In response to NRC staff inquiries, the licensee has indicated that although detailed planning for immediate cleanup has not been completed, it can be assumed for the purpose of evaluating the socioeconomic impact of delayed cleanup that the level of employment during immediate cleanup would not be greater than the 1987-1988 level of approximately 1150 personnel involved in defueling and decontamination. In all likelihood, the required work force would be much smaller.[a] Based on the potential occupational exposure levels and activity requirements for immediate cleanup described in Section 3.3, it is assumed for the purpose of the socioeconomic analysis that immediate cleanup would require approximately 3 to 4 years with a maximum of 1150 workers.[b] The licensee estimates that the payroll cost of the immediate cleanup scenario would be about $57.5 million per year at the employment level of 1150 workers. According to data supplied by the licensee, approximately 70 percent of the current TMI work force resides in the Harrisburg-Lebanon-Carlisle labor market area, which consists of Cumberland, Dauphin, Lebanon, and Perry Counties. (About 50 percent reside in Dauphin County.) It can be expected that this labor market area would benefit the most from the continued employment of workers, followed by Lancaster County (with 25 percent of the TMI work force) and York labor market area (consisting of Adams and York Counties and having 5 percent of the TMI labor force).

Assuming that the multipliers discussed above apply and that offsite employment and income impacts are distributed geographically in the areas where the TMI workers reside, total employment and income in nearby local economies temporarily could be higher than they otherwise would be by the amounts shown in Table G.1. As can also be seen from the table, the impact in each labor market area is significant but relatively small (less than 0.5 percent) in comparison to the total local economy. Table G.1 shows maximum annual impacts.

(a) Letter from F. R. Standerfer, Director, TMI-2, GPU Nuclear Corporation, to W. D. Travers, Director, TMI-2 Cleanup Project Directorate, NRC, November 5, 1987. Subject: Post-Defueling Monitored Storage Environmental Evaluation, NRC Comment Response (4410-87-L-0165/0209P).

(b) The cleanup was assumed to follow a 2-year period of engineering study. During this 2-year period, the current work force would increase to the 1987 level (or somewhat less) of 1150 workers.

TABLE G.1. Annual Local Economic Impact of TMI-2 Employment for Immediate Cleanup[a]

Labor Market Area	Direct Jobs	Total Local Jobs	Direct Payrolls, $ million 1987	Local Income, $ million 1987	Total Local Jobs Impact as a Percentage of Current Employment[b]
Harrisburg-Lebanon-Carlisle[c]	1150	1550	57.5	80	0.5
Lancaster[d]	0	145	0	28	0.1
York[e]	0	30	0	6	0.01
Total	1150	1725	57.5	114	0.2

(a) Jobs and direct payroll are reported on a place-of-work basis; local income is reported on a place-of-residence basis. The 0.5 offsite job for each direct job and $1 of offsite income per dollar of onsite income are assumed to be generated at the areas where TMI workers reside.
(b) Based on second-quarter 1987 employment as reported in Pennsylvania State University College of Business Administration, Pennsylvania Business Survey, August 1987.
(c) Includes Cumberland, Dauphin, Lebanon, and Perry Counties, as residences of 70 percent of TMI workers.
(d) Lancaster County only, as residence of 25 percent of TMI workers.
(e) Includes Adams and York Counties as residence of 5 percent of TMI workers.

If the cleanup work force were significantly smaller, the economic impact would also be significantly smaller. The NRC staff estimated that the number of workers needed to complete cleanup for the immediate cleanup/reduced effort alternative would be 50 to 75 percent of the number estimated for immediate cleanup. Thus, the maximum annual socioeconomic impact of this alternative could be approximately 50 to 75 percent of that shown in Table G.1.

The only socioeconomic impact associated with the delayed decommissioning, delayed cleanup, and immediate decommissioning alternatives is the early transition from the 1987-1988 level of project employment of about 1150 to the much lower levels discussed above. Immediate cleanup or immediate cleanup/reduced effort would temporarily sustain the portion of local jobs and income (or in the case of immediate cleanup/reduced effort, a fraction of the local jobs and income) dependent on current defueling activities at the reactor. Although the differences between the alternatives are significant, the employment difference is temporary and amounts to less than 0.2 percent of the local baseline employment in 1987.

APPENDIX H

OCCUPATIONAL RADIATION DOSE ESTIMATES

APPENDIX H

OCCUPATIONAL RADIATION DOSE ESTIMATES

Occupational dose estimates for Draft Supplement 3 were developed using the estimates in Final Supplement 1 as a starting point. Tasks were added that had not been previously considered, tasks were deleted that had already been performed, and job-hours were adjusted for tasks that were partially complete. After the licensee issued the post-defueling monitored storage (PDMS) safety analysis report (GPU 1988), the dose estimates in Appendix 1A of the safety analysis report were compared with the occupational radiation dose estimates in Draft Supplement 3. Although the exposure rate estimates were similar in Draft Supplement 3 and Appendix 1A of the safety analysis report, the task and the job-hour estimates varied. Each of the occupational dose evaluations contained tasks that the other evaluations did not. The job-hours estimated in Draft Supplement 3 were considerably lower than those estimated for Appendix 1A of the safety analysis report, partly because of an assumption that the decontamination methods to complete cleanup in the most expeditious manner would be mostly destructive. In many cases the job-hour estimates in Appendix 1A of the safety analysis report seemed unrealistically high and resulted in high occupational dose estimates. In several cases, tasks were considered that in Draft Supplement 3, were assumed to be largely finished. Thus, doses in the Final Supplement 3 are based on the U.S. Nuclear Regulatory Commission (NRC) staff's re-evaluation of the work to be accomplished and the additional information in Appendix 1A of the safety analysis report.

Table H.1 lists the individual tasks that were analyzed for occupational radiation doses and the estimated doses associated with the licensee's proposal for delayed decommissioning and the five NRC staff-identified alternatives that were evaluated quantitatively. The tasks are discussed under the following headings:

- preparation for storage and storage activities
- auxiliary and fuel-handling building (AFHB) activities
- reactor building activities
- support activities
- miscellaneous activities

The occupational dose estimates for delayed decommissioning, delayed cleanup, and incomplete defueling in Table H.1 are based on a PDMS period of 23 years. Dose estimates for the 33-year PDMS were obtained by scaling to the 23-year base case estimates in Table H.1. Dose estimates for the 5-year PDMS were obtained by scaling to the immediate cleanup estimates in Table H.1. Immediate cleanup estimates were used because the state of robotic development at the end of 5 years of PDMS would likely be more equivalent to conditions during

TABLE H.1. Occupational Radiation Dose Estimates in Person-Rem for Various Alternatives[a]

Task Description	Delayed Decommissioning[b]	Delayed Cleanup[b]	Immediate Cleanup	Immediate Cleanup/Reduced Effort	Immediate Decommissioning	Incomplete Defueling[b]
Preparation for Storage and Storage Activities						
Pre-PDMS preparation	2.0 to 20	2.0 to 20	--	--	--	2.0 to 20
PDMS mode	74 to 190	74 to 190	--	--	--	74 to 190
2-year engineering study	---	---	16 to 40	---	---	---
1-year preparation period before decommissioning activities	4.6 to 12	---	---	---	---	4.6 to 12
2-year preparation period before decommissioning activities	---	---	---	---	16 to 40	---
AFHB Activities						
AFHB cleanup	---	12 to 30	65 to 140	65 to 140	---	---
Reactor Building Activities						
Reactor coolant system decontamination	---	16 to 410	53 to 920	53 to 920	---	---
Basement general cleanup	---	310 to 680	670 to 1500	670 to 1500	---	---
Cubicle cleanup	---	250 to 560	650 to 1400	650 to 1400	---	---
Blockwall removal	---	11 to 230	77 to 610	77 to 610	---	---
D-ring dose reduction	---	110 to 230	360 to 780	360 to 780	---	---
D-ring final decontamination	---	170 to 360	370 to 820	370 to 820	---	---
Dome and polar crane decontamination	---	3.0 to 5.9	10 to 20	10 to 20	---	---
Reactor building 347-foot elevation cleanup	---	53 to 120	190 to 410	190 to 410	---	---
Reactor building 305-foot elevation cleanup	---	83 to 180	290 to 630	290 to 630	---	---
Support Activities						
Engineering support	---	24 to 59	60 to 130	60 to 130	---	---
Health physics support[c]	---	200 to 570	550 to 1400	550 to 1400	---	---
Radioactive waste handling	5.3 to 8.3	210 to 330	360 to 550	360 to 550	0.7 to 1.1	5.3 to 8.3
Miscellaneous Activities						
Post-cleanup monitored storage	---	---	10 to 17[d]	8.3 to 14[e]	---	---
Total[f]	86 to 230	1500 to 4000	3700 to 9400	3700 to 9300	17 to 41	86 to 230

(a) Estimates do not include dose from decommissioning or refurbishment.
(b) Occupational radiation dose estimates are for the base case, assuming a 23-year PDMS period. Impacts for 5-year and 33-year PDMS periods can be found in Section 3.1.3 (delayed decommissioning) and Section 3.2.3 (delayed cleanup).
(c) Dose is equal to 20 percent of dose received under "Reactor Building Activities."
(d) Estimated occupational radiation dose associated with a 18-year period of storage following cleanup. This dose was not included in the total.
(e) Estimated occupational radiation dose associated with a 14-year period of storage following cleanup. This dose was not included in the total.
(f) The totals may not be exact because of rounding.

immediate cleanup than to conditions at the end of 23 years of PDMS. Occupational doses for immediate cleanup/reduced effort are essentially the same as those for the immediate cleanup, with the exception of the doses incurred during the 2-year engineering study, which is unique to the immediate cleanup alternative (see Section H.1).

H.1 PREPARATION FOR STORAGE, STORAGE PERIOD, PREPARATION FOR DECOMMISSIONING, AND ENGINEERING STUDY

This section discusses the occupational radiation doses incurred during pre-PDMS activities, PDMS activities, the 2-year engineering study before immediate cleanup, the 1-year preparation period before decommissioning for the licensee's proposed alternative (delayed decommissioning), and the 2-year preparation period before decommissioning for the immediate decommissioning alternative. These occupational doses are in addition to the occupational radiation dose) already received and that required to complete defueling.

Pre-PDMS activities would last between 6 months and 1 year and include modifying, deactivating, and preserving plant systems. Such activities would be performed for the delayed decommissioning, delayed cleanup, and incomplete defueling alternatives and involve minimal dose (2 to 20 person-rem) compared with the cumulative doses for these alternatives.

The PDMS activities would include doses incurred during surveillance and maintenance activities. The PDMS doses are applicable only for the delayed decommissioning, delayed cleanup, and incomplete defueling alternatives (see Table H.1). Doses during PDMS were estimated by the staff assuming 10 entries into the reactor building and the AFHB per year, six persons per entry, and entry durations of 2 hours in the reactor building and 3 hours in the AFHB. As discussed in Section 3.1.1.3 during the start of PDMS, entries will be made monthly. Entry frequency would be expected to decrease if data accumulated from previous entries show no unexpected or adverse changes in building conditions or radiation levels. Therefore, an average of 10 entries per year was assumed for the duration of PDMS. Exposure rates during entries were assumed to average 25 to 75 mR/h in the reactor building and 5 mR/h in the AFHB.

The 2-year period for engineering study (discussed in Section 3.3.1) is applicable only to the immediate cleanup alternative. The staff assumed that the occupational dose incurred during this planning phase would be twice the dose received annually during PDMS activities to account for the additional work force onsite. Occupational doses for the 1-year preparation period before decommissioning in the delayed decommissioning alternative and the 2-year preparation period before decommissioning in the immediate decommissioning alternative were also considered to be twice the dose received annually during PDMS activities.

H.2 AFHB CLEANUP

The AFHB cleanup activities are described in Section 3.3.1.2. Occupational dose related to AFHB cleanup is applicable for the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives. The licensee's estimates in Appendix 1A of the safety analysis report formed the basis for the dose estimates. However, the staff independently estimated the effort required to complete the cleanup and consequently used substantially less labor time than the licensee had estimated. The AFHB cleanup activities were not considered for the delayed decommissioning, immediate decommissioning, and incomplete defueling alternatives.

H.3 REACTOR BUILDING CLEANUP

Reactor building cleanup encompasses the following tasks listed in Table H.1: reactor coolant system decontamination, basement general cleanup, cubicle cleanup, blockwall removal, D-ring dose reduction, D-ring final decontamination, dome and polar crane decontamination, 347-foot elevation cleanup, and 305-foot elevation cleanup.

The staff calculated an estimate for the reactor coolant system decontamination task by breaking the task into subtasks and estimating high and low job-hours and exposure rates for each subtask, as shown in Tables H.2 and H.3 for delayed cleanup and immediate cleanup, respectively. The estimate of 53 to 920 person-rem for immediate cleanup is very close to the 56 to 970 person-rem estimated in Supplement 1 of the PEIS. For the delayed decommissioning, immediate decommissioning, and incomplete defueling alternatives, the staff assumed that the reactor coolant system decontamination would not be performed.

Dose estimates for basement general cleanup, cubicle cleanup, D-ring dose reduction, and D-ring final decontamination were calculated on the basis of the licensee's estimates in Appendix 1A of the safety analysis report. The staff confirmed the licensee's estimates of radiation dose rates used in the safety analysis report calculations but independently estimated the manpower to complete the cleanup and, consequently, used substantially less labor time than the licensee had estimated. For the delayed decommissioning, immediate decommissioning, and incomplete defueling alternatives, the staff assumed that the above tasks would not be performed.

The staff's estimate for the removal of the blockwall was generated by breaking the task into subtasks and estimating high and low job-hours and exposure rates for each task, as shown in Tables H.4 and H.5 for delayed cleanup and immediate cleanup, respectively. The estimate of 11 to 230 person-rem for delayed cleanup and 77 to 610 person-rem for immediate cleanup can be compared to the 56 to

TABLE H.2. Occupational Dose Estimate[a] for Reactor Coolant System Decontamination - Delayed Cleanup[b]

Task Description	Exposure Rate Range, mR/h	Job-Hour Range	Occupational Dose Range, person-rem
Preparation of Reactor Coolant System			
Isolate and decontaminate vessel	5 to 10	160 to 200	0.8 to 2.0
Mechanically decontaminate steam generators and replace manways	15 to 105	40 to 240	0.6 to 25.2
Install reactor head or cover	5 to 25	40 to 80	0.2 to 2.0
Verify valve lineup	10 to 50	40 to 120	0.4 to 6.0
Decontamination of Reactor Coolant System			
Run water leak check	7.5 to 25	0 to 120	0 to 3.0
Control leaks	5 to 50	8 to 120	0.04 to 6.0
Rinse, remove, store, and treat solutions	2.5 to 25	0 to 240	0 to 6.0
Process water from mock run	1 to 10	40 to 240	0.04 to 2.4
Preparation and recovery of AFHB	7.5 to 20	600 to 1000	4.5 to 20
Resurvey	10 to 50	8 to 80	0.08 to 4.0
Repeat decontamination	5 to 25	0 to 500	0 to 12.5
Flush dead legs	25 to 50	40 to 400	1 to 20
Clean up spills	10 to 50	40 to 800	0.4 to 40
Decontamination of Tanks in Reactor Building			
Reactor coolant drain tank, cooler, and pump	25 to 125	80 to 400	2 to 50
Core flood tanks	50 to 75	40 to 200	2 to 15
Reactor building sump	100 to 250	50 to 500	5 to 125
Steam generator pedestals	10 to 250	20 to 400	0.2 to 100
Total[c]			17 to 440

(a) This calculation was performed for Draft Supplement 3, which assumed a 20-year PDMS period. This value was adjusted for radioactive decay to obtain the estimate in Table H.1 for a 23-year PDMS period.
(b) Estimates do not include dose from decommissioning or refurbishment.
(c) The totals may not be exact because of rounding.

TABLE H.3. Occupational Dose Estimate for Reactor Coolant System Decontamination - Immediate Cleanup[a]

Task Description	Exposure Rate Range, mR/h	Job-Hour Range	Occupational Dose Range, person-rem
Preparation of Reactor Coolant System			
Isolate and decontaminate vessel	10 to 20	160 to 200	1.6 to 4.0
Mechanically decontaminate steam generators and replace manways	30 to 210	16 to 240	0.48 to 50.4
Install reactor head or cover	10 to 50	40 to 80	0.4 to 4.0
Verify valve lineup	20 to 100	40 to 80	0.8 to 8.0
Decontamination of Reactor Coolant System			
Run water leak check	15 to 50	40 to 120	0.6 to 6.0
Control leaks	10 to 100	8 to 120	0.08 to 12
Rinse, remove, store, and treat solutions	5 to 50	120 to 240	0.6 to 12
Process water from mock run	2 to 20	120 to 240	0.24 to 4.8
Preparation and recovery of AFHB	15 to 40	400 to 1000	6 to 40
Resurvey	20 to 100	16 to 80	0.32 to 8
Repeat decontamination	10 to 50	0 to 500	0 to 25
Flush dead legs	50 to 100	120 to 400	6 to 40
Clean up spills	20 to 100	80 to 800	1.6 to 80
Decontamination of Tanks in Reactor Building			
Reactor coolant drain tank, cooler, and pump	50 to 250	160 to 600	8 to 150
Core flood tanks	100 to 150	50 to 200	5 to 30
Reactor building sump	200 to 500	100 to 500	20 to 250
Steam generator pedestals	20 to 500	40 to 400	0.8 to 200
Total[b]			53 to 920

(a) Estimates do not include dose from decommissioning or refurbishment.
(b) The totals may not be exact because of rounding.

TABLE H.4. Occupational Dose Estimate[a] for Removal of the Blockwall - Delayed Cleanup[b]

Task Description	Exposure Rate Range, mR/h	Job-Hour Range	Occupational Dose Range, person-rem
Install equipment	5 to 7	120 to 200	0.6 to 15
Perform demolition	5 to 10	1200 to 2000	6 to 20
Robot round trip	400 to 4000[c]	5 to 25[d]	2 to 100
Robot repair and modifications	10 to 40	80 to 400	0.8 to 16
Remove waste	5 to 50	500 to 2000	2.5 to 100
Remove equipment	5 to 10	40 to 100	0.2 to 1
Total[e]			12 to 250

(a) This estimate was based on the estimate given in Draft Supplement 3 which assumed a 20-year PDMS period. Draft Supplement 3 values were adjusted for radioactive decay to obtain the estimate in Table H.1 for a 23-year PDMS period.
(b) Estimates do not include dose from decommissioning or refurbishment.
(c) Units are person-millirem received by workers per robot round trip.
(d) Units are number of trips.
(e) The totals may not be exact because of rounding.

TABLE H.5. Occupational Dose Estimate for Removal of the Blockwall - Immediate Cleanup[a]

Task Description	Exposure Rate Range, mR/h	Job-Hour Range	Occupational Dose Range, person-rem
Install equipment	10 to 80	120 to 400	1.2 to 32
Perform demolition	20 to 50	1200 to 2000	24 to 100
Robot round trip	4000 to 8000[b]	10 to 30[c]	40 to 240
Robot repair and modifications	10 to 40	160 to 800	1.6 to 32
Remove waste	20 to 100	500 to 2000	10 to 200
Remove equipment	10 to 20	40 to 100	0.4 to 2
Total[d]			77 to 610

(a) Estimates do not include dose from decommissioning or refurbishment.
(b) Units are person-millirem received by workers per robot round trip.
(c) Units are number of trips.
(d) The totals may not be exact because of rounding.

970 person-rem estimated in Supplement 1 of the PEIS. The range in this supplement is lower than that in Draft Supplement 1 because the role of robotics has been and is expected to be greater during basement cleanup operations. For the delayed decommissioning, immediate decommissioning, and incomplete defueling alternatives, the staff assumed that the blockwall would not be removed.

Dome and polar crane decontamination and cleanup on the 305-foot and 347-foot elevations were assumed to be performed for the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives, as shown in Table H.1. The licensee's occupational dose estimates were used as a basis for those tasks. However, the staff again independently estimated the job-hours to perform the work, which resulted in less labor time than estimated by the licensee.

H.4 SUPPORT ACTIVITIES

As listed in Table H.1, support activities include engineering support, health physics support, and radioactive waste handling. The occupational dose estimates for these activities were based on methodology used by the licensee in Appendix 1A of the safety analysis report. Dose estimates for engineering support activities were taken directly from Appendix 1A. Health physics dose estimates were obtained by taking 20 percent of the doses involved with reactor building cleanup (Section H.3). The licensee's experience during past work indicated that during decontamination and defueling activities, occupational dose to health physics personnel accounted for approximately 20 percent of the total dose.

The licensee's dose estimates for radioactive waste handling were used for the delayed cleanup, immediate cleanup, and immediate cleanup/reduced effort alternatives. Occupational dose estimates for the delayed decommissioning, immediate decommissioning, and incomplete defueling alternatives were calculated by scaling to immediate cleanup or delayed cleanup doses based on waste volumes.

H.5 MISCELLANEOUS ACTIVITIES

Post-cleanup monitored storage (as described in Sections 3.3.1.3 and 3.4.1 for the immediate cleanup and immediate cleanup/reduced effort alternatives, respectively) could possibly occur if the licensee decides not to immediately decommission or refurbish the facility following completion of cleanup. Occupational doses during this post-cleanup monitored storage period were calculated using the same methodology as for PDMS. Doses were estimated assuming 4 entries into the reactor building and the AFHB per year, six persons per entry, and entry durations of 2 hours in the reactor building and 3 hours in the AFHB. Exposure rates during entries were assumed to be 10 to 15 mR/h (general area exposure rates) in the reactor building and 2.5 to

5 mR/h in the AFHB. The exposure rates used were somewhat lower than those used for PDMS calculations, since reactor cleanup would have been completed, resulting in lower background dose rates in the reactor building and the AFHB.

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General Public Utilities Nuclear Corporation (GPU). 1988. Post-Defueling Monitored Storage, Safety Analysis Report. Docket No. 50-320. GPU Nuclear Corporation, Middletown, Pennsylvania.

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In accordance with the National Environmental Policy Act, the Commission's implementing regulations, and its April 27, 1981, Statement of Policy, the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident Three Mile Island Nuclear Station, Unit 2, NUREG-0683 (PEIS) has been supplemented. This supplement provides an environmental evaluation of the licensee's proposal to complete the current cleanup effort and place the facility into monitored storage, and a number of alternative courses of action from the end of the current defueling effort to the beginning of decommissioning or refurbishing.

The NRC staff has concluded that the licensee's proposal to place the facility in monitored storage will not significantly affect the quality of the human environment. Further, any impacts associated with this action are outweighed by its benefits. The benefit of this action is the ultimate elimination of the small but continuing risk associated with the conditions of the facility resulting from the March 28, 1979 accident.

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