NUREG-0683
Supplement No. 1
Final Report

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 Occupational Radiation Dose

GPU Nuclear, Inc.

U.S. Nuclear Regulatory Commission

TMI Program Office

October 1984

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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. Dr. Ronnie Lo is the Project Manager for this supplement. He may be contacted at the Three Mile Island Program Office, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or at 301-492-8335.

3. In accordance with the National Environmental Policy Act, the <u>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</u> has been supplemented. The supplement was required because current information indicates that cleanup may entail substantially more occupational radiation dose to the cleanup work force than originally anticipated. Cleanup was originally estimated to result in from 2000 to 8000 person-rem of occupational radiation dose. Although nearly 2000 person-rem have resulted from cleanup operations performed up to now, current estimates now indicate that between 13,000 and 46,000 person-rem are expected to be required. Alternative cleanup methods considered in the supplement either did not result in appreciable dose savings or were not known to be technically feasible.

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 by the U.S. Nuclear Regulatory Commission in March 1981. That document (referred to as the PEIS) stated that the most significant environmental impact of cleanup activities at Three Mile Island Unit 2 (TMI-2) would result from the radiation dose to the cleanup work force. The purpose of this supplement to the PEIS is to reevaluate the occupational radiation dose and resulting health effects from cleanup and to address additional alternative cleanup approaches using information gathered since the PEIS was prepared. As a supplement to the PEIS, this document should be considered part of the earlier PEIS. For completeness, reference to the PEIS should be made for all aspects of the NRC's National Environmental Policy Act review of the TMI-2 cleanup, other than the radiation exposures and resultant health effects which are the subject of this supplement.

When the PEIS was prepared, it was believed that 2000 to 8000 person-rem of occupational radiation dose would be incurred during the decontamination and defueling of TMI-2. Through May 1984,[a] about 2000 person-rem have been incurred in cleanup. When the PEIS was prepared, the reactor building had been entered only five times. Since then, it has been entered more than 366 times to collect data, conduct tests, perform decontamination tests and decontamination, refurbish the polar crane, remove trash and contaminated equipment, and prepare for reactor vessel head lift and fuel removal. These entries have resulted in increased knowledge of the actual conditions in the building and awareness of the penetration of contamination into surfaces and the extent of corrosion, which have greatly increased the difficulty of the cleanup task. The temperatures reached during the accident and the time between the accident and the initiation of cleanup are thought to be factors in the decreased effectiveness of cleanup procedures.

Based on additional information available, decontamination workers at the plant are expected to receive a total collective radiation dose estimated at between 13,000 and 46,000 person-rem for the whole cleanup program. Doses to individual workers are limited by the health and safety standards in federal regulations. The licensee has agreed to set administrative controls that are lower than the limits in federal regulations to make sure that exposures of individual workers will be below the federal limits. Estimates of potential health effects due to exposure of the workforce have been made assuming that individual worker exposures are within regulatory limits. In the analysis in this report, it has been conservatively assumed that any exposure to radiation has a finite probability of causing cancer in the exposed workforce, and a finite probability of causing genetic abnormalities in the offspring of the exposed workforce. Using the preceding range of collective dose estimates (i.e., 13,000 to 46,000 person-rem), the staff estimates that about 2 to 6 potential premature cancer deaths may occur in the total exposed workforce,

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(a) In order to prepare this supplement, a cutoff date of May 11, 1984, was established for data.

during the remaining lifetime of the workers. In addition, a total of about 1 to 3 potential additional genetic disorders may occur over all future generations of the exposed workforce. The staff has used a central value for health risk estimators in estimating these health effects. In addition to uncertainties in collective dose estimates, there are also uncertainties in the data base used to estimate health effects. Using the most widely accepted range of health risk estimators, the staff estimates that the range of potential cancer deaths extends from 0 to as high as 26 for the highest workforce exposure estimate. In a similar manner, the range of potential genetic disorders extends from less than 1 for the lowest workforce exposure estimate to 17 for the highest workforce exposure estimate. It is important to note that these potential cancer deaths and potential genetic effects, if they occur, would be added to the expected 2,000 cancer deaths among the workforce and 5,000 genetic effects in the first five generations of the workers from natural phenomena, assuming a workforce of 10,000. These potential cancer deaths and potential genetic effects, if they were to occur, would not be statistically discernable. That is, the number of health effects falls well within the statistical variations of the expected cases of cancer fatalities and genetic effects among the cleanup workers and their offspring from causes unrelated to radiation exposures during the cleanup.

In accordance with the requirements of the National Environmental Policy Act, both the current cleanup plan and several alternative approaches were examined for their impact on occupational dose. The current plan calls for a dose reduction effort prior to defueling of the reactor, with primary-system decontamination and final building cleanup to follow defueling. Only one of the three additional alternatives considered in the supplement would result in an appreciably lower occupational dose than that expected to result from the current plan, but significant disadvantages are associated with this alternative, as discussed below.

The first alternative considers using approximately the same task sequence as that considered the most likely approach when the PEIS was originally prepared, that is, extensive cleanup of the reactor building prior to defueling. The purpose of evaluating this alternative was to determine how changing the work sequence from that of the current plan affects the occupational radiation dose, given current information. In evaluating this alternative, it was determined that some reduction in dose, up to approximately 10%, might be expected; however, the dose reduction is not considered sufficient to justify the delays in fuel removal. Fuel removal delays are considered undesirable because the fuel continues to pose a potential risk to workers and the public and because information obtained from examining the fuel is expected to be useful in improving the safety of other nuclear power facilities.

The second alternative considers phased defueling followed by decontamination and building cleanup. Phased defueling would involve removing fuel debris through the reactor pressure vessel head before removing the head and plenum. This approach would minimize the possibility that fuel fines would contaminate equipment and result in personnel exposure during later operations. However, no net savings in dose to workers would result because of the need for additional work. This approach would delay fuel removal and all subsequent cleanup activities for a minimum of 18 months.

The third alternative parallels the current plan through fuel removal, but then considers putting the reactor building, and possibly some of the more highly contaminated portions of the auxiliary and fuel-handling building, into a monitored, interim storage until additional decontamination activities could be performed robotically. This alternative, if found to be technically feasible, is expected to result in the lowest worker dose. However, there are obstacles associated with this alternative, including uncertainty about when robotic technology will have evolved enough to be feasible for extensive use in completing cleanup; lack of information about the feasibility and safety of interim storage; and lack of assurance that funds will be available for ultimate cleanup. These obstacles preclude the immediate adoption of this alternative; however, it may warrant further consideration after defueling is completed. No decision is required on this alternative until after the fuel has been removed.

Although this supplement's estimate of the dose to the workers who perform cleanup and the possible resulting health effects are higher than those estimated in the PEIS, it is still the conclusion of the staff, as it was when the PEIS was completed, that cleanup should proceed as expeditiously as possible to reduce the potential for release of radioactive materials to the environment and to ensure that TMI-2 does not become a long-term radioactive waste disposal site. If the damaged fuel and radioactive wastes are not removed, the Island would, in effect, become a permanent waste disposal site. The location, geology, and hydrology of Three Mile Island are among the factors that do not meet current criteria for a safe long-term waste disposal facility. Removing the damaged fuel and radioactive waste to storage sites that do meet all of the relevant criteria is the only reliable means for eliminating the long-term risk of widespread uncontrolled contamination of the environment by the accident wastes.

FOREWORD

This supplement to the Programmatic Environmental Impact Statement on the decontamination and disposal of waste from Three Mile Island Unit 2 (the PEIS) was prepared by the U.S. Nuclear Regulatory Commission, TMI Program Office, Office of Nuclear Reactor Regulation (the 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.

In the policy statement, the Commission states that as the licensee proposes specific decontamination alternatives for each major cleanup activity, the staff will determine whether these proposals, and associated impacts that are predicted to occur, fall within the scope of those already assessed in the PEIS. The staff may act on each proposal if the proposed activity and associated environmental impacts fall within the scope of those assessed in the PEIS. If an activity and its impacts fall outside of the scope of those in the PEIS, the staff shall complete necessary reviews in accordance with NEPA.

One of the conclusions of the PEIS was that the most significant environmental impact associated with cleanup would result from the radiation doses received by the entire work force from cleanup activities. At the time the PEIS was prepared, it was estimated that the cleanup would require 2000 to 8000 person-rem of occupational radiation dose. Since the issuance of the PEIS (March 1981) and the Commission's Statement of Policy (April 1981), a substantial amount of new information about the conditions inside the reactor building has become available. Based on the new information and the apparent decrease in decontamination effectiveness due primarily to delays in initiating cleanup, the staff now believes that the total occupational dose to accomplish the entire cleanup could exceed the range predicted in the PEIS. (To date, nearly 2000 person-rem have been required.) Therefore, this supplement to the PEIS has been prepared in compliance with NEPA requirements.

Information for the 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 staff's Final Environmental Statement for the operating license (U.S. Nuclear Regulatory Commission 1976), from the staff's PEIS of March 1981, and from new information provided by the licensee 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 generally to ensure that the staff had a thorough understanding of the cleanup operations. 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 and other such activities or inquiries as were deemed useful and appropriate, the staff made an independent evaluation of the TMI-2 cleanup plans and operations and prepared a draft supplement to the PEIS. The draft supplement was circulated to federal, state, and local governmental agencies and to interested members of the public for comment. A summary notice of the availability of the draft supplement was published in the Federal Register. The information on which the supplement is based was made available to the public,[a] and all comments received were considered by the staff in preparing this final supplement. As a result of the comments received, specific changes were made in this final supplement, specifically in the estimation and presentation of health effects. In addition, the staff has agreed to reevaluate the environmental consequences of curtailing cleanup following fuel removal.

The draft supplement used information that was current to August 22, 1983. For this final supplement, a cutoff date of May 11, 1984 was used. Since that time, a major milestone in cleanup has been reached. The reactor vessel head has been removed and stored behind shielding on the head storage stand on the 347-ft elevation. The internals indexing fixture was placed on the reactor vessel, filled and covered. Both the doses to perform this work and dose rates in the building following these activities were at the low end of the expected range.

(a) NRC Public Document Room, 1717 H Street, Washington, DC 20555, and NRC TMI Program Office, 100 Brown Street, Middletown, PA 17057.

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1.0 INTRODUCTION

1.1. PURPOSE AND SCOPE

In March 1981, the 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 (NUREG-0683). That document, referred to here as "the PEIS," was intended to provide an overall evaluation of the environmental impacts that would result from cleanup activities at Three Mile Island Unit 2 (TMI-2), beginning when the plant conditions were stabilized after the accident and continuing through the completion of cleanup. The purpose of this supplement is to reevaluate the impact of the radiation dose to workers, based on current information. The objective of "cleanup," as the term is used in that document and this one, is decontaminating and defueling the plant. The affected environment and the impacts that are not discussed here remain substantially as represented in the PEIS. As a supplement, this is not a stand-alone document. For completeness, the reader should refer to the PEIS this document supplements.

Since the issuance of the PEIS, numerous activities (cleanup of accident-generated water, reactor and auxiliary building decontamination, reactor vessel underhead characterization, etc.) have been proposed by the licensee. These activities were evaluated by the NRC staff and determined to fall within the scope of the activities assessed in the impact statement. Completion of these activities has resulted in considerable progress toward completing the cleanup, along with obtaining new information about conditions in the reactor building and in the auxiliary and fuel-handling building and about the effectiveness of various decontamination activities. One conclusion of the PEIS was that the most significant environmental impact associated with the cleanup would result from the radiation dose received by the entire work force from cleanup activities. That collective dose was estimated in the PEIS to be in the range of 2000 to 8000 person-rem. Cleanup activities conducted through May 11, 1984, have resulted in approximately 2000 person-rem based on the results of self-reading dosimeters. Individual worker doses are based on the results of thermoluminescence dosimeters (TLDs), which are more accurate and somewhat lower. Although this occupational dose is still within the predicted range, there is substantial uncertainty about future occupational exposures, primarily because the most difficult work remains to be done and in certain areas dose rates have not declined as projected. Based on cleanup experience to date at TMI-2, it now appears that the entire cleanup could result in doses in excess of the 8000 person-rem previously estimated. Therefore, this supplement has been prepared to update the estimates of radiation dose and assess the associated environmental impacts. The doses for waste-related tasks that are used in this supplement have been taken directly from the PEIS. These doses are expected to make only a very small contribution to the total dose from cleanup.

This document, like the impact statement it supplements, is programmatic in nature. That is, the action being considered is the assessment of the cleanup, which is subject to NRC approval. In order to accurately predict the impact of the occupational radiation dose from cleanup, the most probable sequences and methods for cleanup are evaluated. The most likely course of action, presented here as "the current cleanup plan," differs in sequence from the most likely course of action at the time the PEIS was prepared. At that time, the licensee was planning to begin cleanup in the reactor building with an extensive decontamination of the building and equipment. Although progress has been made on building and equipment decontamination, a great deal of additional work still remains. Rather than complete building and equipment decontamination before reactor disassembly and defueling as originally planned, the licensee has indicated his intention to remove the damaged reactor fuel as soon as possible. Therefore, defueling prior to complete building cleanup is the predominant feature of the current cleanup plan, which is presented and evaluated in Section 2.2 of this document.

In accordance with the National Environmental Policy Act, alternative courses of action are considered in this document. These alternatives were selected to be consistent with the conclusion of the PEIS that the TMI site is not suitable as a permanent repository for the accident-generated radioactive waste. As discussed in Section 2.1.1 of the PEIS, a "no action" alternative, the option of not performing cleanup, would have the effect of converting the reactor to a permanent repository. Therefore, under all alternatives considered, wastes would be removed from the site. The alternatives were also selected to employ presently available technology, or, in one case, emerging robotic technology, to effect cleanup operations. Within these two limitations, a wide range of cleanup alternatives is not available. As a result, the alternatives considered here differ from each other and from the current cleanup plan primarily in individual task sequence and methodology.

The alternatives of permanent entombment or long-term storage following defueling, although rejected in the PEIS, will be reevaluated by the NRC prior to a major expenditure of dose for reactor building cleanup (see also Section 6.2.3).

1.2 HISTORY OF OCCUPATIONAL RADIATION DOSES RESULTING FROM CLEANUP ACTIVITIES

Cleanup of the TMI-2 reactor building could not begin until after the inventory of the noble gas, krypton-85, had been vented. Therefore, major work in the reactor building did not begin until the latter part of 1980. When the PEIS was being prepared, the reactor building had been entered only five times since the accident (at a total dose of about 13 person-rem), and little specific information was available on the conditions in the building. Dose estimates included in the PEIS were therefore based on limited data from the reactor building, some experience in the auxiliary and fuel-handling building, experience with previous reactor accidents, and certain necessary assumptions. In addition, the dose estimates were based on the licensee's cleanup schedule as of 1980, which was not constrained by funding. Since that time, major delays in cleanup have resulted from lack of funds and other causes. On the previous bases, cleanup was estimated to require between 2000 and 8000 person-rem of occupational dose. Since the PEIS was issued, the reactor building has been entered more than 366 times. Entries now typically take place several times each week and involve several workers performing a variety of tasks. These entries have provided a significant opportunity to gather information on the conditions in the building.

At the time the PEIS was prepared, it was estimated that "once the sump water has been removed, hot spots shielded, and general area decontamination completed, general area radiation levels should be reduced to 5 mR/hr or less" on the 347-ft elevation (PEIS Appendix I). This has not proved to be the case. The basement has been drained of highly radioactive water, and many hot spots in the building have been shielded. General-area decontamination was begun but was suspended when it was learned that little dose rate reduction was being achieved and that cleaned areas were becoming recontaminated. Workers on the 347-ft elevation currently average about 106 mrem/hr (Flanigan 1983). Estimates of the effectiveness of water draining, decontamination, and shielding in other areas of the building were likewise overly optimistic. Other factors are contributing to the diminished effectiveness of cleanup activities. As of the May 11, 1984 cut-off date for this Supplement, workers were still required to wear respiratory protection, which increases fatigue and decreases productivity.

The TMI experience has differed from past experience in the nuclear industry in that cleanup of the reactor building was not begun immediately. During the intervening time, the humidity in the reactor building was 100%, and it literally rained in containment. One result of the rain was that dose rates at initial entries were lower than expected because radionuclides had been rinsed downward. A second result was that radionuclides permeated into porous surfaces such as uncoated concrete, were incorporated into corrosion layers as iron surfaces rusted and were trapped in paint layers. The humidity in the reactor building is still high and contamination is still being spread through the air; thus, recleaning of cleaned areas is still required, with concomitant exposure of workers.

Doses from both periodic maintenance work and repairs of breakdowns have also been and continue to be adversely affected by delay. Certain tasks, such as the testing and replacement of fire extinguishers, must be done periodically whether or not any cleanup is in progress. Also, the longer cleanup activities are prolonged, the greater is the probability of failure of systems needed for cleanup, such as lighting and other electrical systems.

Experience with the cleanup thus far, coupled with the desirability of removing the damaged fuel as soon as possible, has led the licensee to reevaluate plans, strategies, and occupational doses. On March 30, 1983, the licensee transmitted to the NRC its first formal estimate of the dose needed to complete cleanup (Kanga 1983). This estimate, 16,000 to 28,000 person-rem, was based on defueling as soon as possible and on the assumptions that little, if any, difficulty would be experienced in plenum removal and that little, if any, concrete removal would be required.

Because the licensee's predicted doses were outside the range given in the PEIS and the assumptions did not appear overly conservative, the staff undertook to independently reassess the cleanup dose. This supplement presents the results of that reassessment.

The cleanup effort in the reactor building at TMI-2 has focused on the following activities to date:

- mapping of radiation levels, and air sampling
- acquisition of data
- decontamination of surfaces
- placement of shielding
- removal of sources of radiation exposure
- processing of the sump water
- refurbishment and testing of the polar crane
- assessment of the extent of core damage
- preparations for reactor vessel head removal.

Table 1.1 lists the occupational radiation doses received by workers since the accident. The doses are shown by activity and year, through 1983. As of May 1984, nearly 2000 person-rem had been received at TMI-2 from the cleanup operation. Figure 1.1 shows the doses at TMI-2 relative to doses at all commercial nuclear power reactors in the United States (Brooks 1983). (Throughout this document, doses are rounded to two significant digits, and current doses include those incurred up to May 11, 1984.)

Although worker activities at TMI-2 have been quite different than those at operating power plants, the accumulative doses at TMI-2 since the accident have been lower than the average doses experienced at operating reactors. In 1981, the most recent year for which figures are available, the average collective dose at U.S. pressurized-water reactors (PWRs) was 652 person-rem per reactor (Brooks 1982). The collective annual doses at TMI-2 since the accident were 490 person-rem in 1979 (some of this dose was incurred prior to the accident), 310 person-rem in 1980, 160 person-rem in 1981, 400 person-rem in 1982, 450 person-rem in 1983, and 180 person-rem in 1984 (to May 11). The average dose per worker was also lower. Workers who received measurable radiation exposure in U.S. PWRs received an average of 0.61 rem in 1981. At TMI Units 1 and 2, a comparable group of workers averaged 0.23 rem/person in 1979, 0.11 rem/person in 1980, 0.16 rem/person in 1981, 0.45 rem/person in 1982, and 0.89 rem/person in 1983. This data was readily available only for Units 1 and 2 together. (In each of these years except 1979, more dose was accumulated at Unit 1 than at Unit 2.)

Work on large-scale operations in the reactor building that are both labor-intensive and occupational-exposure-intensive is now beginning or is planned for the near future. The primary operations include:

- placement of radiation shields
- removal of the pressure vessel head
- removal of the plenum
- removal of fuel and fuel debris
- hands-on decontamination.

Because of the increasing amount of work being done in the reactor building, a major effort to reduce dose rates was initiated by the NRC and the licensee in late 1982. The objective was to identify and eliminate or shield as many sources of radiation exposure as possible. The dose reduction program initially focused on both the 305-ft and 347-ft elevations of the reactor building and is currently concentrated on the 347-ft elevation because this is

TABLE 1.1. Occupational Radiation Doses at TMI-2 from March 28, 1979, to May 11, 1984

	Dose (person-rem)[a]					
	1979	1980	1981	1982	1983	1984
Decontamination/Dose Reduction (b)						
Reactor Building	0.0	12	54	180	140	6.1
Auxiliary Fuel-Handling Building	97	88	2.6	14	27	26
Systems	0.5	1.8	3.1	4.9	2.2	1.9
Reactor Disassembly & Defueling (b)	0	0	4.3	120	130	100
Radioactive Waste Management (Onsite Activities)						
Solid Waste	14	23	8.9	7.6	15	1.4
Liquid Waste	30	11	18	12	16	3.8
Routine Operations & Surveillance						
Plant Operations	73	81	32	36	78	28
Plant Maintenance	82	31	31	20	38	8.4
Support Systems	95	33	9.5	4.1	4.4	2.8
Other	95	32	0.1	0.9	0.0	0.0
TOTALS	490	310	160	400	450	180
CUMULATIVE TOTALS	490	800	960	1400	1800	2000

(a) From self-reading personnel dosimeters; all doses are rounded to 2 significant figures.
(b) Several activities, such as polar crane cleanup and refurbishment, support both building cleanup and reactor disassembly and defueling.

where most of the defueling work will take place in the near future. This effort has shown some significant results, as can be seen in Figure 1.2 and as discussed further in Section 2.1.

1.3 REGULATORY AND ADMINISTRATIVE CONTROLS FOR LIMITING OCCUPATIONAL DOSE

Before any cleanup activity at TMI-2 is initiated, the NRC staff performs an extensive review of the licensee's technical evaluation report, written procedures, safety analyses, and other documentation governing the work to be performed. Permission for an activity to begin is granted only when the NRC staff has determined that the following conditions are met:

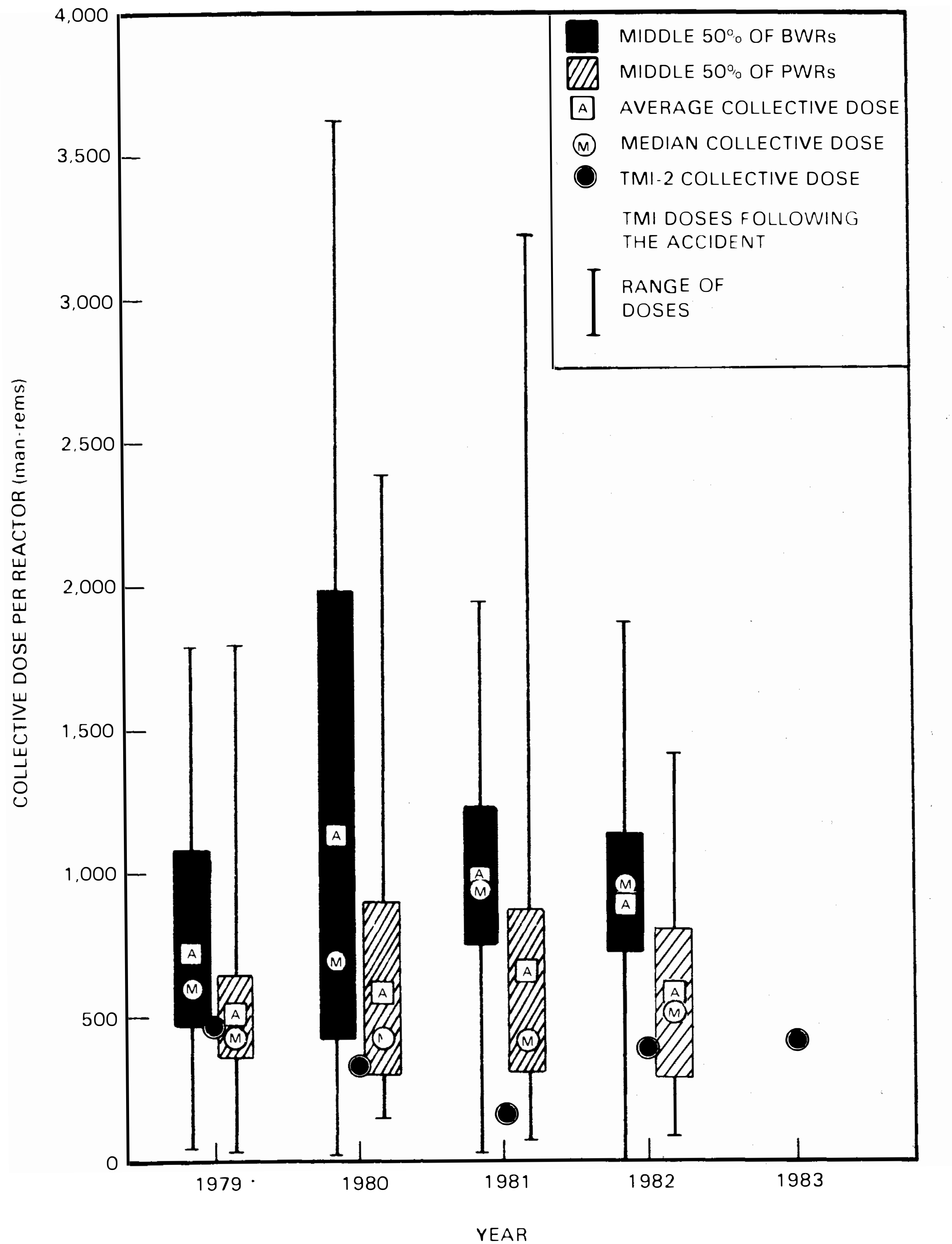

FIGURE 1.1. Doses at TMI-2 Compared with Doses Per Reactor at All Commercial Nuclear Plants in the United States

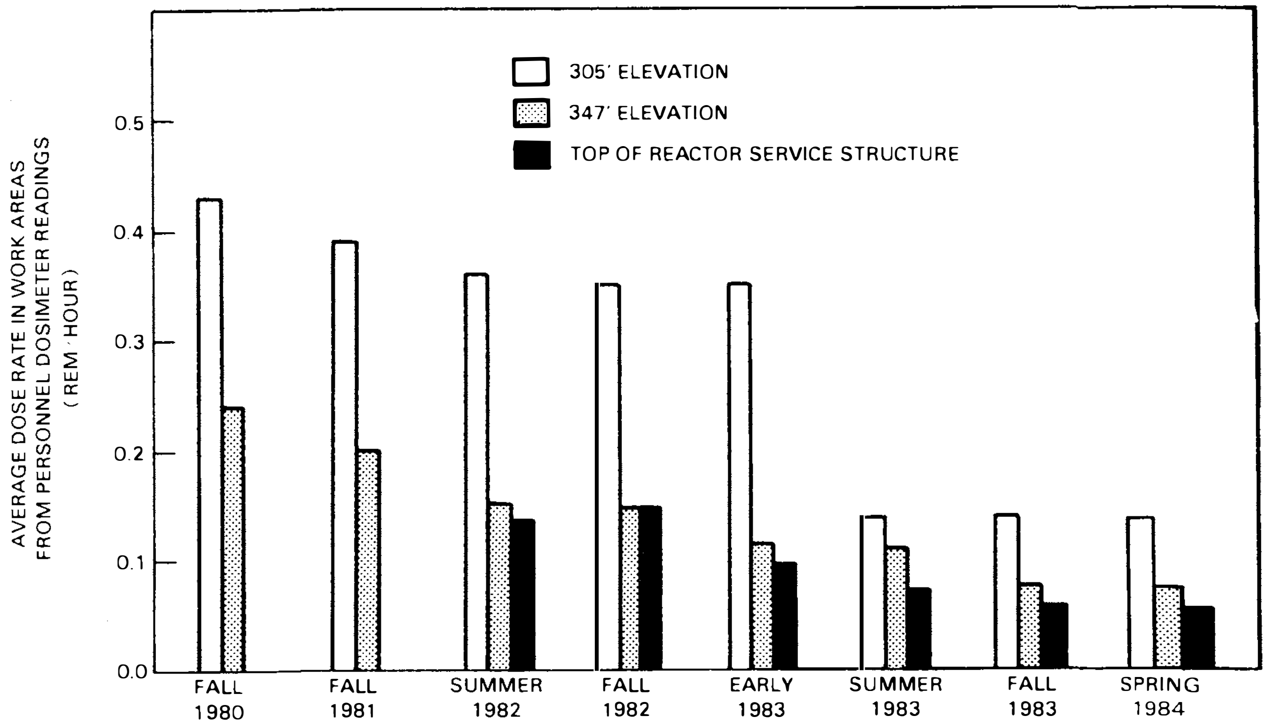

FIGURE 1.2. Average Dose Rates at Selected TMI-2 Locations

- safety standards are maintained
- the activity is consistent with the TMI-2 operating license and technical specifications
- the activity does not violate NRC radiation protection regulations, including the requirement to maintain radiation doses as low as is reasonably achievable (ALARA)
- the activity and associated impacts fall within the scope of the PEIS.

Regulations governing occupational exposure to radiation for all NRC licensees, including the TMI-2 licensee, are given in Title 10, Part 20, of the U.S. Code of Federal Regulations (10 CFR 20). Two types of requirements to protect workers against radiation are set forth in 10 CFR 20. The first requirement (10 CFR 20.101) sets numerical limits on the amount of radiation a worker may be exposed to in any calendar quarter. The limit for whole-body external radiation is 1.25 rem (special limits apply to extremities--see 10 CFR 20.101) in any one quarter unless certain requirements regarding individual lifetime dose limits and dose records are met, in which case the limit is 3 rem per calendar quarter. Exposure records are kept on all workers (licensee employees and subcontractors) and are reported to the workers at least annually. The NRC regularly audits the licensee's dose assessment and reporting activities.

The second requirement deals with the fundamental approach to radiation protection. The principle of maintaining radiation exposures ALARA has long been a basic goal of radiation protection programs, and 10 CFR 20.1(c) states that NRC licensees should follow this principle. The basic ALARA objective is to ensure that radiation exposures are kept to the lowest levels that are commensurate with sound economic and operating practices. The Nuclear Regulatory Commission's Regulatory Guide 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," (NRC 1978) expands on the elements of an effective ALARA program. These elements are reflected in the TMI-2 program, and include: 1) upper-level management responsibility and authority for the ALARA program; 2) appropriate training and instruction for those at all organizational levels who are involved in radiation work; 3) review of the design of new and modified equipment to ensure that the selection of equipment will minimize occupational radiation exposure; 4) control of access to radiation areas; 5) appropriate use of shielding; 6) extensive review of procedures, job preparation, and planning to minimize the dose required to perform specific tasks; and 7) adequate protective equipment and personnel-monitoring instrumentation.

To promote ALARA and comply with the dose limits, the licensee has established administrative radiation dose limits for workers. These administrative limits require management approval for all doses in excess of 1 rem/quarter. (Successively higher doses, up to the regulatory limits, require authorization from successively higher levels of management (GPU Nuclear 1983). These administrative limits are set below the regulatory limits to ensure that no worker will be exposed to radiation in excess of the regulations. Since the accident, the maximum annual radiation doses received by workers at TMI Units 1 and 2 (not necessarily the same person each year) have been 4.5 rem in 1979; 2.1 rem in 1980; 2.1 rem in 1981; 4.2 rem in 1982; and 2.7 in 1983. (See Figure 1.3 for the number of workers versus the yearly occupational dose at TMI from the time of the accident through 1983.) In addition, all operations planned at TMI-2 undergo review by the licensee's health physics and radiological engineering staff to ensure that each task is conducted in accordance with the ALARA principle. An important part of the NRC's review and approval of cleanup activities is to independently determine that the proposed work will be carried out following good ALARA practices.

The sections that follow deal with the work to be performed and alternative approaches to it (Section 2); the most important impact of cleanup, occupational radiation dose (Section 3); the conclusions reached in preparing this supplement (Section 4); and comments received on the draft supplement and responses to those comments are included in Section 6.

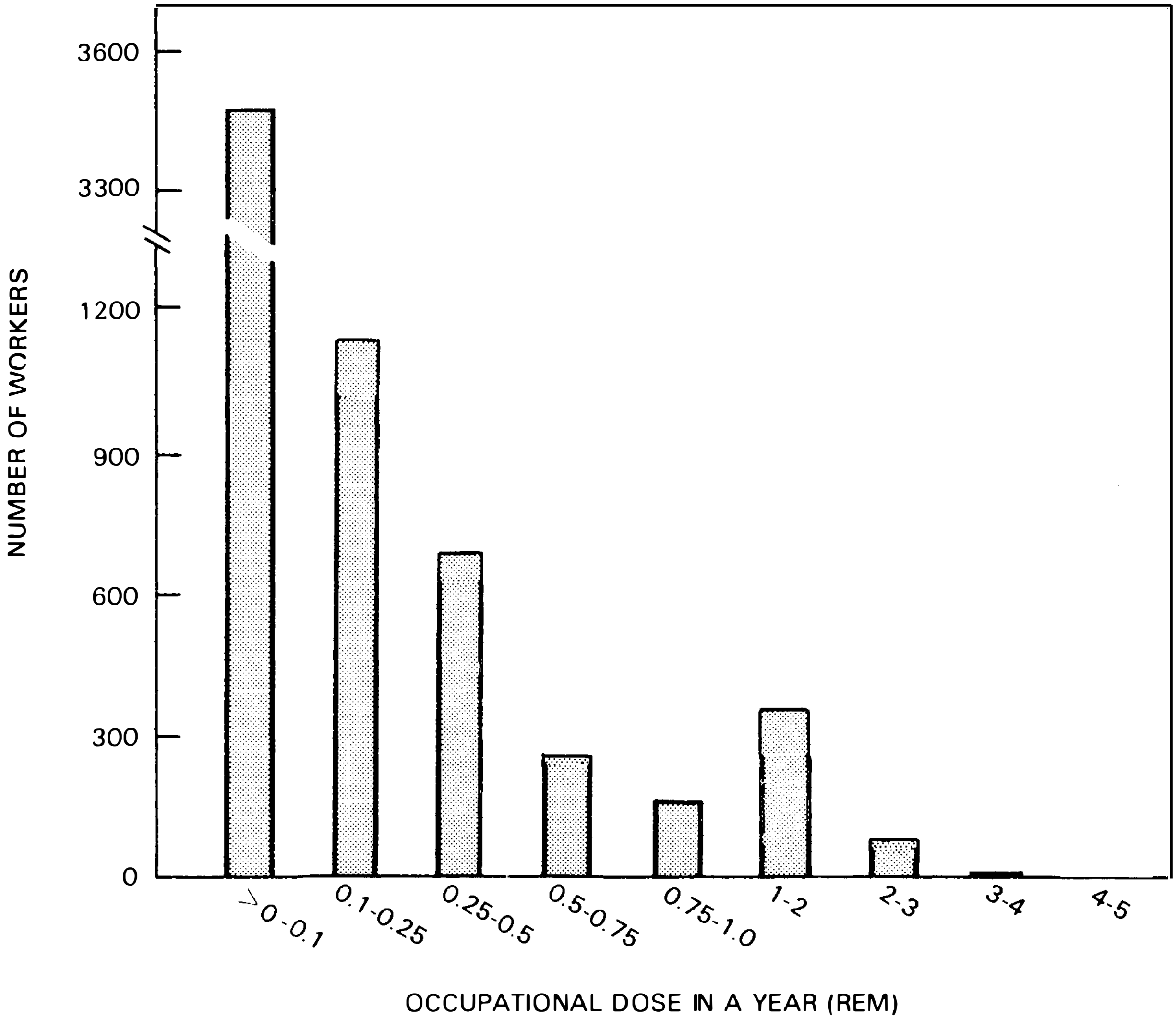

FIGURE 1.3. Number of Workers Versus Yearly Occupational Dose for TMI-2

2.0 CURRENT AND ALTERNATIVE PLANS FOR CLEANUP OF REACTOR AND AUXILIARY BUILDINGS

Chapters 5 and 6 of the PEIS address in some detail the tasks to be accomplished for cleanup of the reactor building and the auxiliary and fuel-handling building, disassembly and defueling of the reactor, and decontamination of the primary system. These tasks are briefly presented in Section 2.1 to provide an appropriate background for the descriptions of the plan and alternatives that follow. Section 2.1 also reflects current knowledge of the tasks to be performed and the methods available to carry them out. Section 2.2 presents the licensee's current plan for cleanup, which was evaluated in preparing this supplement. Three alternatives, developed by the NRC staff, are also presented. Alternative 1, discussed in Section 2.3, is an approach similar to that evaluated in the original PEIS, that is, cleaning the building to reduce the dose rate to 10 mrem/hr or less prior to defueling. Alternative 2, discussed in Section 2.4, is the removal of fuel fines and particles through the reactor pressure vessel head before head removal. Alternative 3, discussed in Section 2.5, involves putting the reactor into a monitored interim-care mode after defueling until the high-dose work of building cleanup can be performed robotically. The plan and alternatives are compared and evaluated in Section 2.6.

2.1 BACKGROUND INFORMATION ON CLEANUP WORK

Cleanup work to be performed in the reactor building can be subdivided into three principal endeavors: 1) cleanup of the reactor building and equipment; 2) disassembly and defueling of the reactor; and 3) decontamination of the primary system. The first two of these may be performed in any sequence or simultaneously. The third must follow defueling. It is the variation in sequence that is the primary difference between the current plan and the first alternative. The second and third alternatives utilize slightly different methods of performing the work. Cleanup of the auxiliary and fuel-handling building is already underway and, under the current plan and Alternatives 1 and 2, would be completed as resources are available. Under Alternative 3, those portions of the auxiliary and fuel-handling building cleanup that require the greatest dose might be postponed until additional technology is developed.

The physical and radiological conditions that affect these endeavors are discussed briefly below, followed by a description of the tasks involved in each phase of cleanup.

2.1.1 Cleanup of the Reactor Building and Equipment

The reactor building is a cylindrical reinforced-concrete structure with a dome top, as illustrated in Figure 2.1. Levels within the building are referred to by elevation above sea level. The building is entered at the 305-ft elevation. When the building was first entered after the accident, radiation doses at this elevation averaged 430 mrem/man-hr. The placement of shielding, the removal of debris, and decontamination of the building have

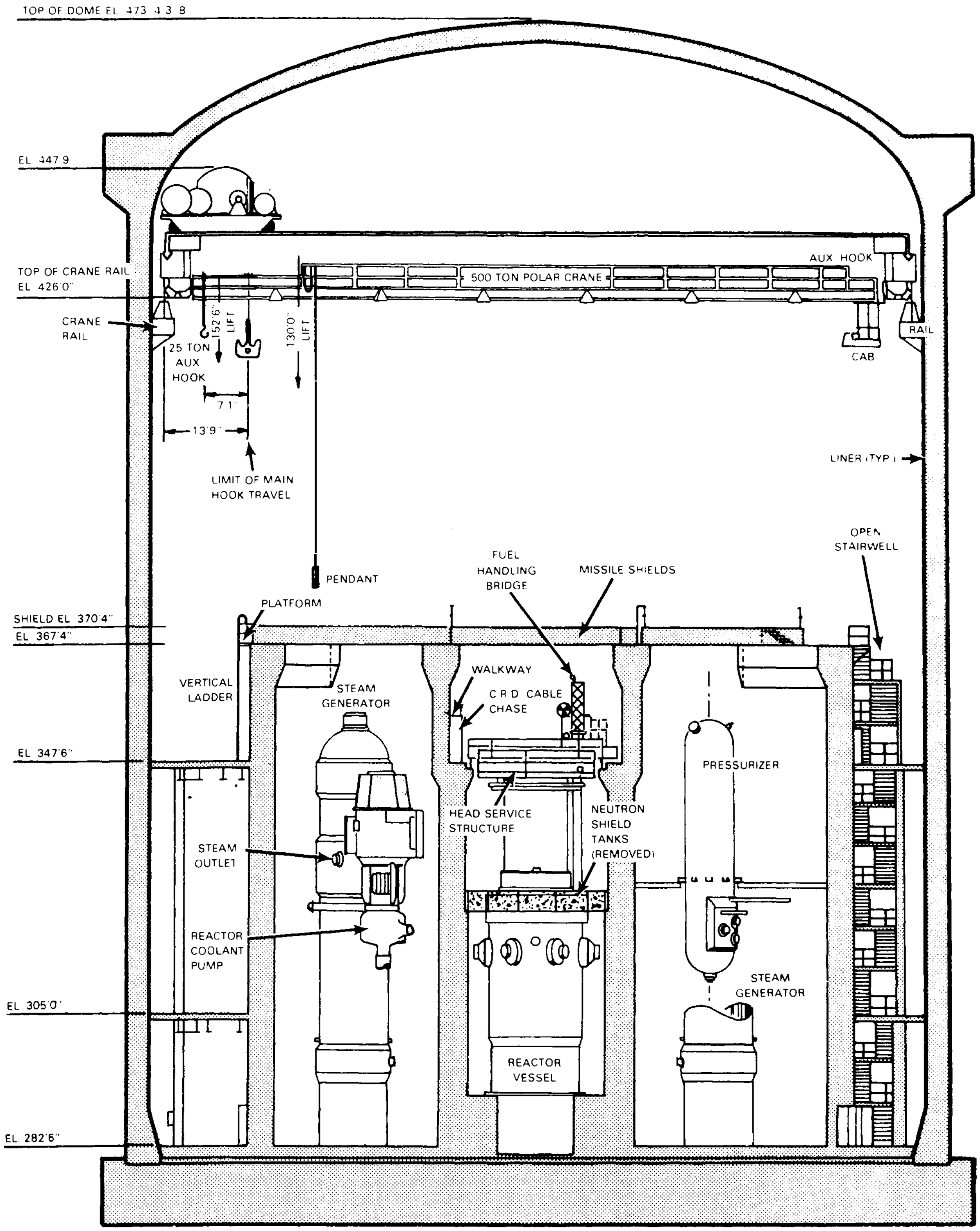

FIGURE 2.1. Reactor Building

reduced doses at this level to an average of approximately 140 mrem/man-hr in mid-1983. The dose rate for normal operation, and the target for the total cleanup effort, is on the order of 10 mrem/hr (Kanga 1983). Because radiation sources are distributed throughout the building and are difficult to remove, reducing the dose rate below the current level is expected to require greater effort than that required so far. A plan view of the 305-ft elevation is shown in Figure 2.2.

Above the 305-ft elevation is the 347-ft elevation (the operating floor), which is currently reached by an open stairway. (An elevator and an enclosed stairwell are also present; however, radiation dose rates resulting from the accident have prevented refurbishment of the elevator and minimized use of the stairwell.) The 347-ft elevation is used to gain access to the reactor vessel head and service structure, the fuel transfer canal, and other areas important for reactor disassembly and defueling. Doses at the 347-ft elevation averaged

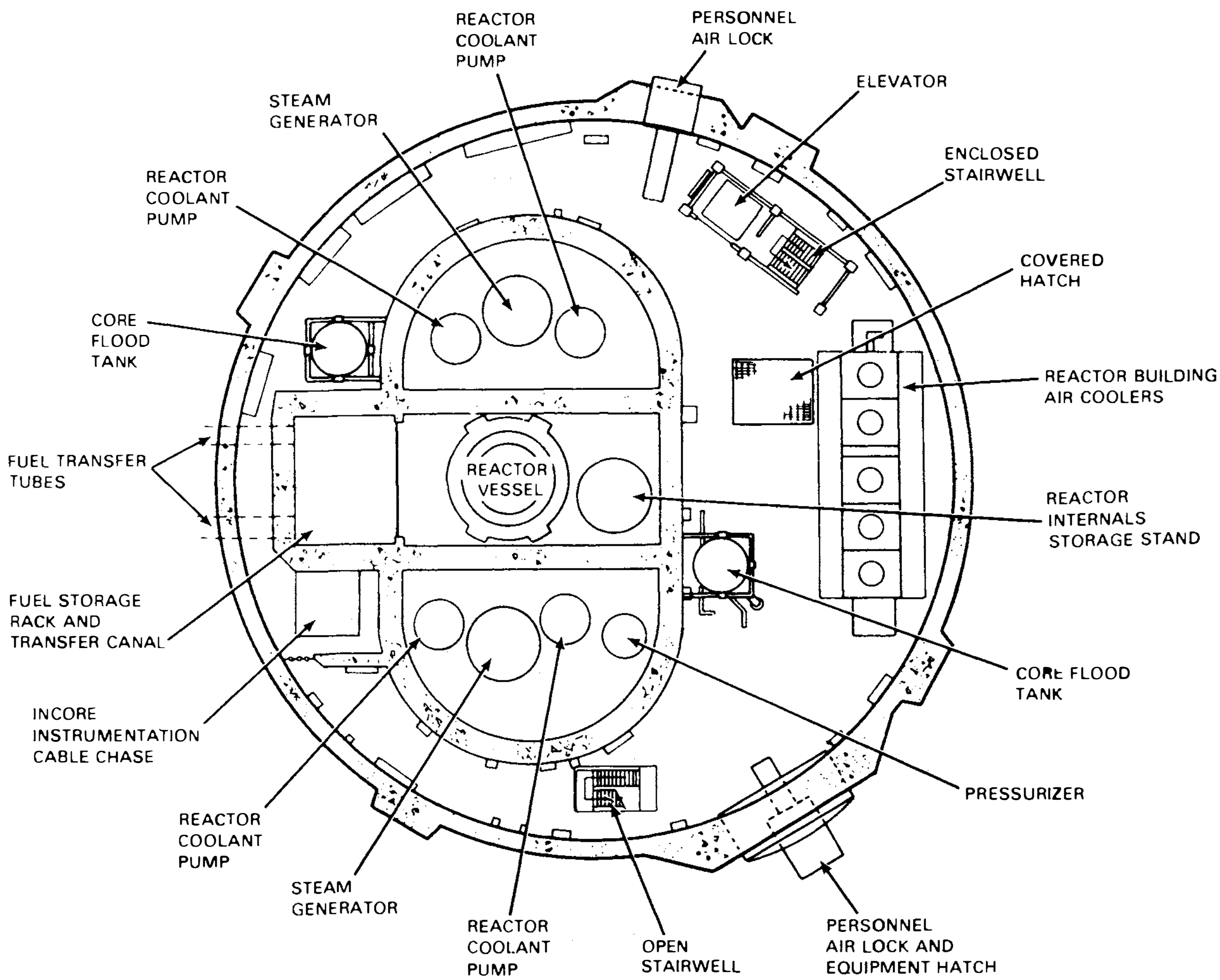

FIGURE 2.2. 305-ft Elevation

240 mrem/man-hr following the accident. Shielding, debris removal, and decontamination have reduced the average doses to approximately 110 mrem/man-hr in the summer of 1983. The target dose rate for cleanup of the 347-ft elevation is in the 10-mrem/hr range. A plan view of this elevation is shown in Figure 2.3.

The polar crane, located at the 426-ft elevation, is reached by ladder or hoist from the 347-ft elevation. (The elevation of the crane's cab is 418 ft, 6 in.) The polar crane, shown in Figure 2.1, is necessary for numerous activities in support of disassembly and defueling, and will also facilitate the transportation of decontamination equipment, directional radiation measuring devices, and shielding materials within the building. Worker doses at initial access to the polar crane averaged 120 mrem/hr, but through considerable work to decontaminate and prepare the crane for use, the doses have been reduced to about 80 mrem/man-hr. Doses on the reactor vessel service structure currently average 56 mrem/man-hr.

Below the 305-ft entry level elevation is the 282-ft elevation, or basement, shown in Figures 2.4 and 2.5. The 282-ft elevation contains large numbers of reactor control cables, various pumps and piping systems, the reactor coolant drain tank (in a shielded cubicle), and other equipment. This area contained accident-generated water to a depth of about 8 feet when the building was initially entered after the accident. Since that time, the water has been drained, processed, and recycled for use in decontamination. Water

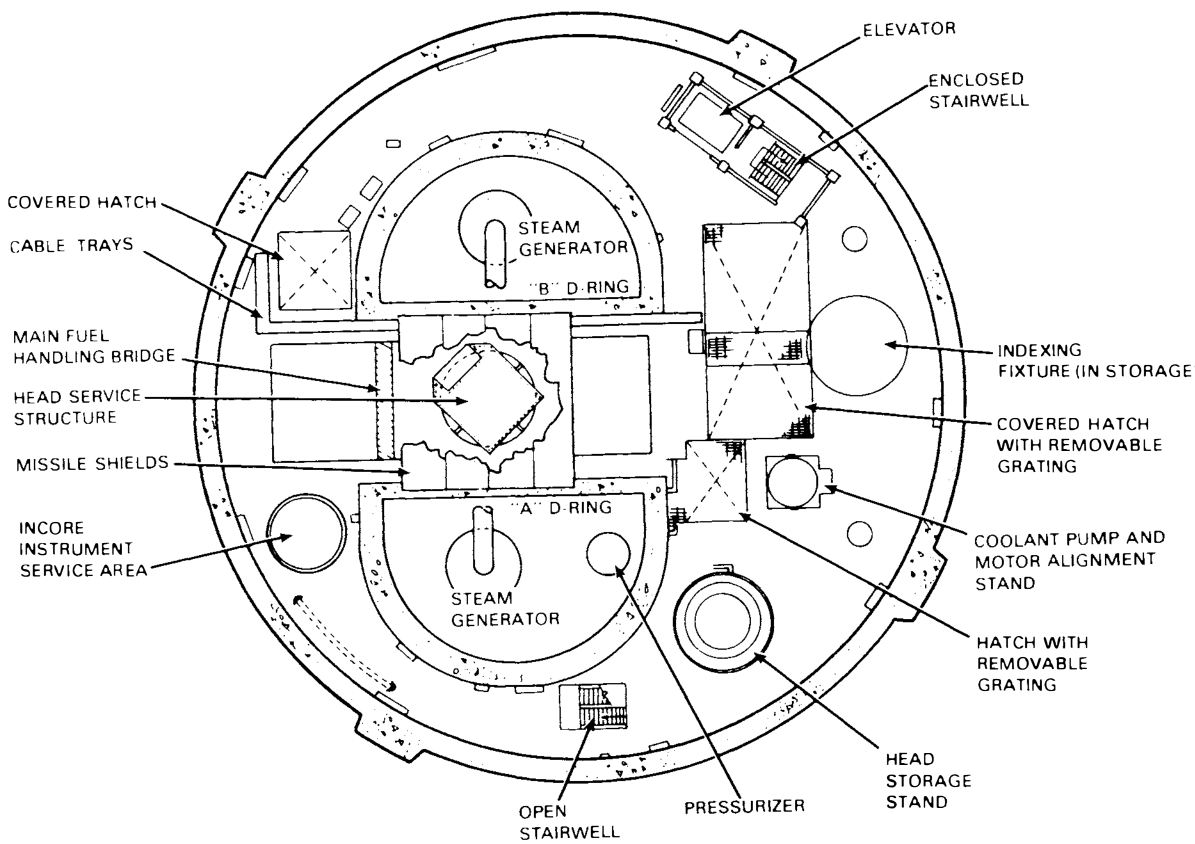

FIGURE 2.3. 347-Ft Elevation

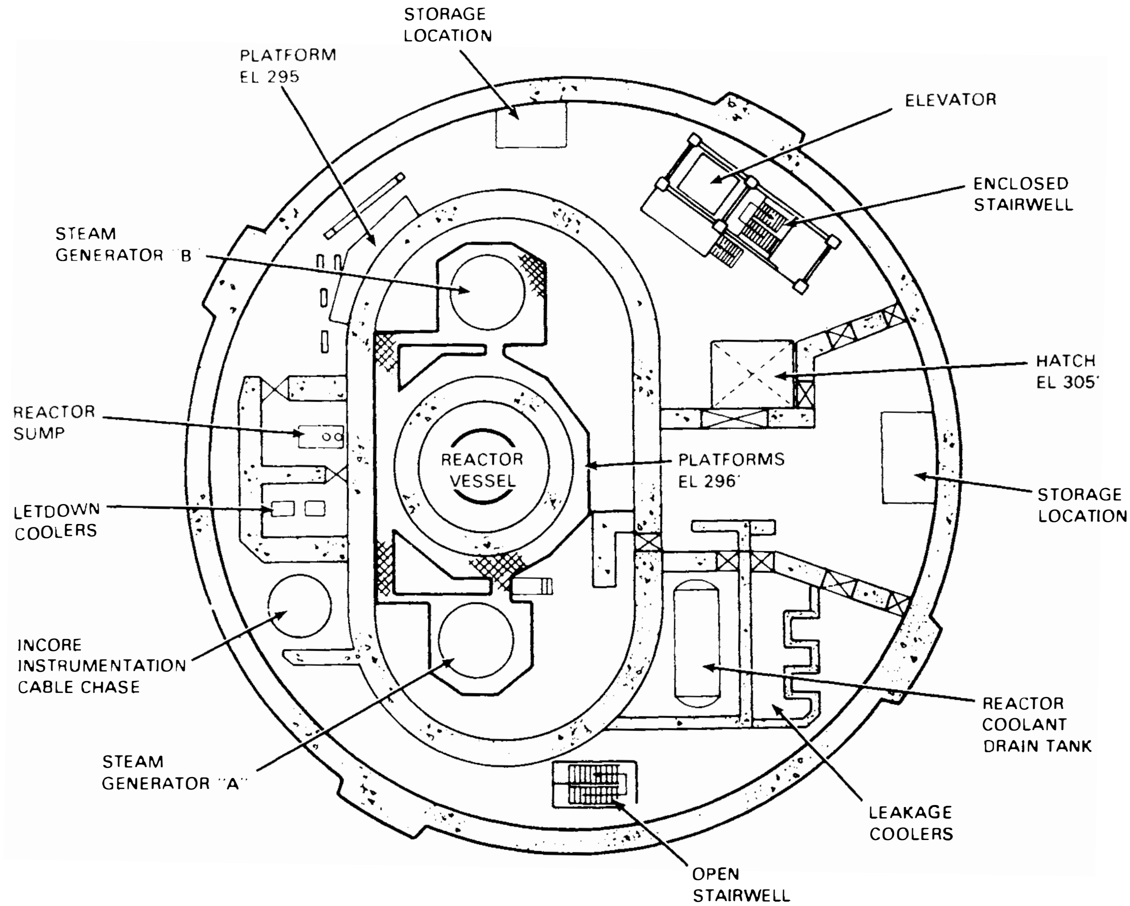

FIGURE 2.4. 282-ft Elevation

from decontamination efforts on the upper levels has flowed into the basement, dissolving additional contamination in the basement and then removing it as the water was pumped out. However, the numerous structures and pieces of equipment at this level (see Figure 2.4) make cleanup particularly difficult, and the area remains highly contaminated, with dose rates in the range of 1 to 1000 rem/hr, depending on location and distance from the floor. Although a sample was collected from the stairway, no other entries have been made. The basement is expected to be one of the most difficult areas in the building to clean.

The highest measured radiation levels at the 282-ft elevation are in the vicinity of the elevator shaft and enclosed stairwell. These structures, which are made of hollow concrete blocks, became saturated with the accident water and absorbed radionuclides from it. The bottom of the elevator shaft is an enclosed area that until recently contained highly radioactive water. Radiation from the contaminants in the elevator and enclosed-stairwell area of the 282-ft elevation have prevented use of the stairwell and elevator at upper levels as well.

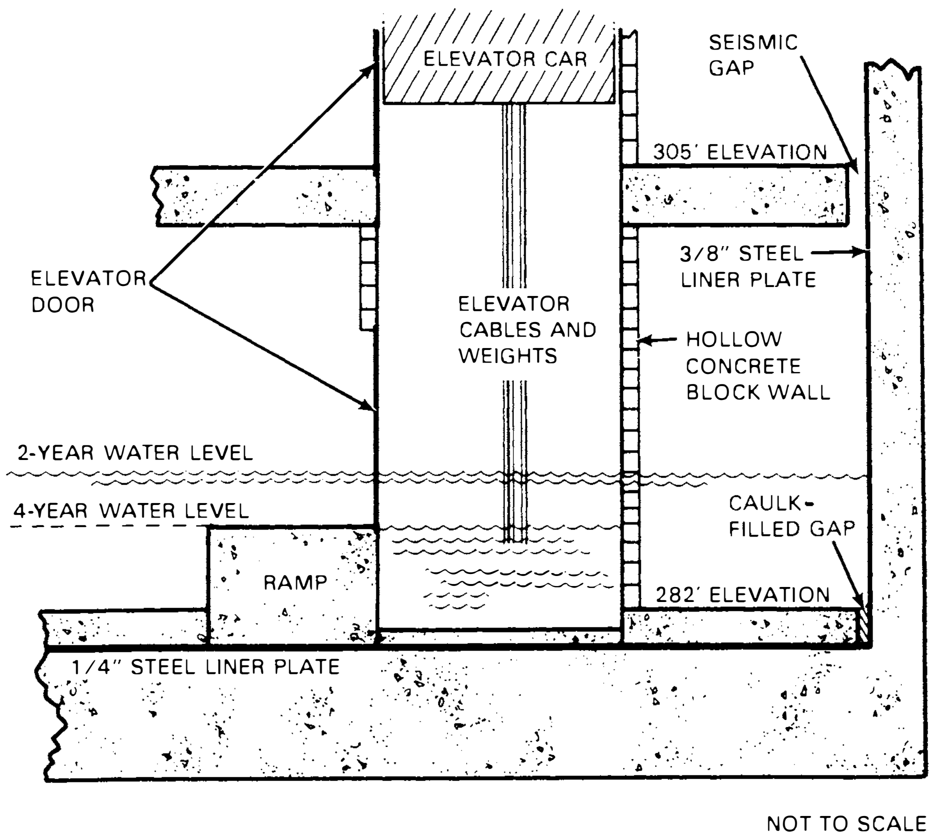

FIGURE 2.5. Cross Section of 282-ft Elevation Showing Elevator Shaft

Because the accident-generated water remained in the reactor building for several years, radionuclides concentrated on vertical surfaces at the water surface level. This phenomenon, commonly referred to as "the bathtub ring," continues to affect dose rates on the 282-ft elevation, and possibly in other locations as well. Efforts to remove the ring by spraying from above have not been successful in reducing general-area dose rates. Although some chemicals may have a positive effect, it is expected that decontamination of concrete areas will require removal of the surface coating and some of the concrete. There is a thin layer of sludge on the floor of the 282-ft elevation, which may contribute to dose rates, and the reactor building sump is also expected to be highly contaminated. The sump is inaccessible for dose rate measurement but has recently been sampled.

The cleanup of the reactor building will entail: the removal of miscellaneous equipment and debris that were in the building at the time of the accident (ladders, scaffolding, tools, etc.); the decontamination or removal of reactor-associated equipment (air coolers, cable trays, reactor piping, etc.); the decontamination of building surfaces (both metal and concrete); and various support activities to ensure the safety of workers performing these tasks and to measure the effectiveness of the cleanup activities. Cleanup activities in the reactor building have been underway for several years and are continuing. Considerable debris and equipment have been removed from the 305-ft and 347-ft elevations, and decontamination of the building and remaining equipment has been attempted on these elevations. Some remote flushing of the 282-ft elevation has been performed. Although decontamination using high- and low-pressure sprays of borated water has reduced the level of smearable contamination on equipment and building surfaces, these techniques have been of limited success in reducing general-area dose rates. Effective, although temporary, dose rate reduction has been achieved by the shielding of certain sources of high-level radiation, including the elevator shaft and stairwell on the 305-ft elevation and certain floor drains. (Shielding is considered only a temporary measure because final building cleanup will require the elimination of these sources.)

Most tasks involved in the reactor building decontamination, reactor disassembly and defueling, and primary-system decontamination can be performed without access to the 282-ft elevation; therefore, cleanup of this area will be left until the later stages of the cleanup operation in all options. However, the water being used for building decontamination is apparently continuing to leach radionuclides from sources on this elevation; hence, it is undergoing some continual decontamination. To the extent possible, preliminary decontamination of the 282-ft elevation will be performed remotely or semi-remotely from the 305-ft elevation. Tasks will include remote radiation surveys and video examination, water and/or chemical spraying from above through penetrations, and possibly the use of robots for cleaning and removing equipment. When dose rates permit, hands-on decontamination techniques such as those used in the remainder of the building will be employed. The ultimate cleanup objective for the 282-ft elevation is also in the range of 10 mrem/hr.

Since the accident, the level of airborne radioactive material has necessitated the wearing of respirators for all activities in the building. (Airborne-radionuclide concentrations during work in the building vary with the level of activity. They have averaged from 2 to 23 times the allowable concentration for a 40-hr/wk exposure without respiratory protection (Flanigan 1983 and 1984).) These respirators, while protecting the workers, tend to reduce productivity and hamper mobility. In addition, in some areas the airborne radioactive material has redeposited on cleaned surfaces, making decontamination only temporarily effective. Much general building decontamination has therefore been suspended temporarily. The problems of airborne contamination and redeposition appear to be, at least partially, the result of radioactive material associated with boric acid crystals in the air (Alvarez 1983). Boric acid comes from the primary coolant and, most importantly, from the decontamination solutions used in the building since the accident. (The solutions have been made from recycled accident-generated water that has been processed by a selective ion-exchange treatment that removes radionuclides but not boric acid.) The removal of boric acid from decontamination water is currently being investigated by the licensee.

The principal radionuclides that were identified in the PEIS (pp. 5-26, 27) and reconfirmed by subsequent measurements are cesium-137, cesium-134, and strontium-90. Cesium-137 has a 30-year half-life and is expected to be a major source of whole-body dose throughout cleanup. Cesium-134 has a 2.0-year half-life and has therefore diminished to about 25% of the accident inventory in the first 4 years following the accident. Its contribution to whole-body dose rates will continue to decrease. Strontium-90 has a 28-year half-life. Therefore, it has decayed very little since the accident. It is, however, a beta-emitting radionuclide, which means that protective clothing offers substantial worker protection. This mix of radionuclides is markedly different from that of other reactors, where these radionuclides are contained within the core. In those cases, cobalt-58 (71-day half-life) and cobalt-60 (5.3-year half-life) are the principal sources of worker dose, and the dose rate to which workers are exposed can be halved by waiting 5.3 years. At TMI, the same halving of dose rate requires 30 years.

2.1.2 Disassembly and Defueling of the Reactor

A cutaway view of a typical pressure vessel for a PWR is shown in Figure 6.1 of the PEIS. This drawing has been modified, as shown in Figure 2.6 of this report, to show the results of work in progress and what has been learned about the TMI-2 vessel and its contents by video camera examination and other exploratory techniques. Proceeding from top to bottom of the reactor pressure vessel, the conditions are as follows. Three of the lead screws that were previously attached to control rod drives have been uncoupled and removed to allow examination of the core and internals. A complete control rod drive assembly has been removed for further examination of the reactor vessel and internals and for characterization of the radiological conditions under the head. All of the remaining lead screws have been uncoupled. The upper plenum assembly, the device that positions the control rods in the core, appears to be relatively undamaged. Clearance between the pressure vessel and plenum is only 50 mils (50 thousandths of an inch), so the ease of plenum removal is still open to question as the plenum may be warped. There are portions of damaged fuel assemblies adhering to the underside of the plenum. Beneath the plenum is a 5-foot-deep void where fuel and control rods used to be. At the bottom of the void is a bed of loose rubble to a depth of at least 30 inches. The Debris Defueling Working Group (Runion 1983) has estimated, but not verified, that there are approximately 45,000 kg (100,000 pounds) of rubble and fines in the TMI-2 reactor core that are 25,000 μm (1 inch) or less in size. These estimates indicate that 5300 kg are 800 μm or less and 125 kg are 4 μm or less. The conditions below the rubble are not known. Material may be loose or may have been fused by melted nonfuel material. The lower support structures may be intact or warped. Fuel may have been deposited in the lower areas of the reactor vessel below the lower support structure.

The tasks for reactor disassembly and defueling include:

- visual and radiological characterization of the core and the reactor pressure vessel head
- preparation for head lift
- lifting and storage of the head and installation of the reactor internals indexing fixture

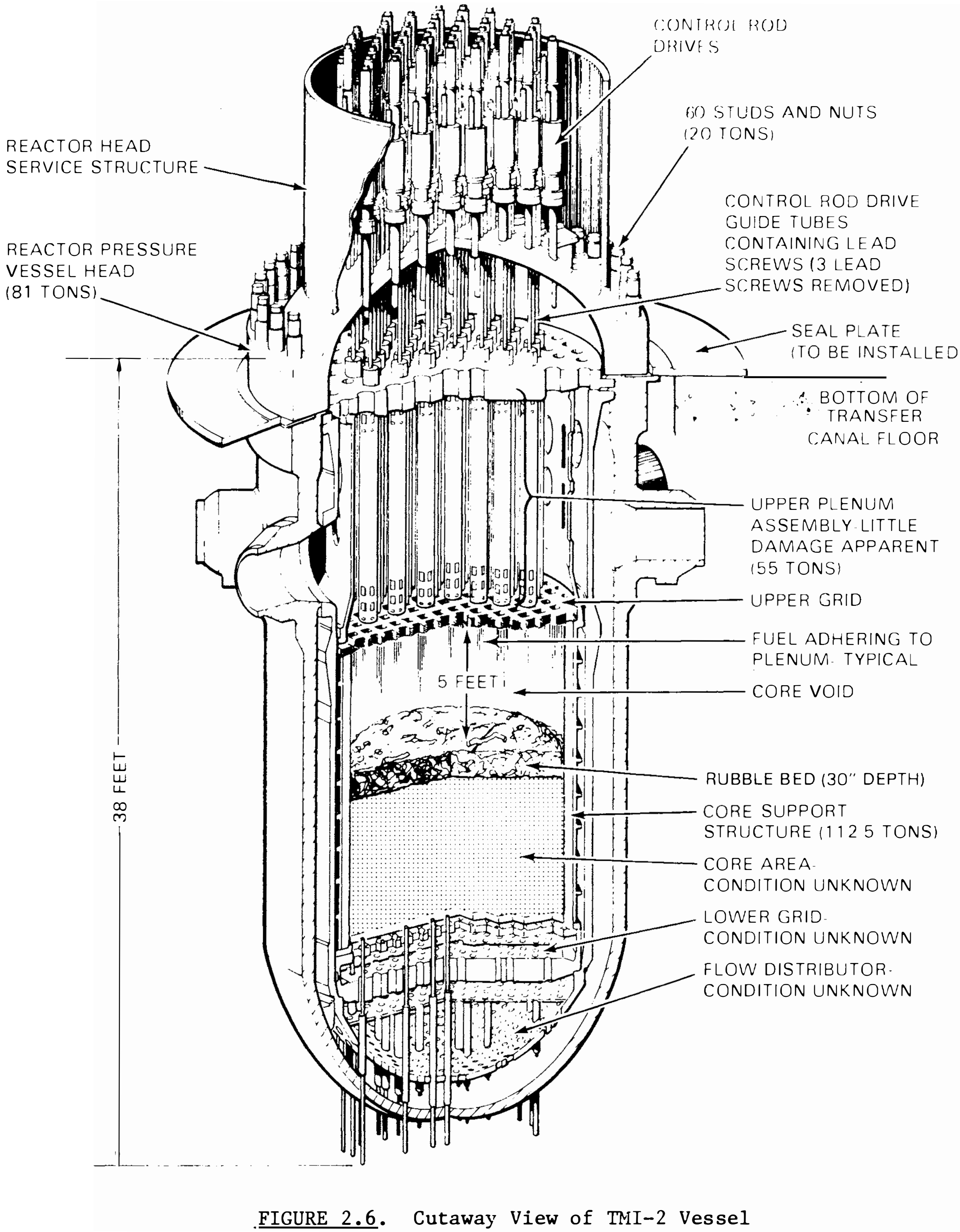

FIGURE 2.6. Cutaway View of TMI-2 Vessel

- installation of water cleanup systems for the reactor vessel and fuel transfer canal

- refurbishment and modification of the fuel-handling system

- removal of the plenum

- removal of the fuel

- removal of the core support structure and lower internals.

Initial visual and radiological characterizations of the reactor vessel and core have been accomplished. Additional underhead characterization, including dose rate measurements, visual inspection (using closed-circuit television), core topography, and water and debris sampling, is in progress.

Preparations for head lift are in progress. The uncoupling of the remaining 63 lead screws has been completed. Handling of the lead screws is important because experience with those removed so far indicates that they may be a significant source of radiation exposure to the workers. A test to measure the radiation contribution from parked lead screws has shown that the radiation from the lead screws will be reduced by the planned shielding during and after head lift. Other preparations necessary for head lift include disconnecting and removing cooling and electrical lines and overhead platforms (in progress), detensioning (complete) and removing head studs and nuts, refurbishing and installing the seal plate (in progress), and attaching the hoisting equipment. The head will be lifted and stored away from the work area. The head is highly contaminated, and plans have been made to shield it during storage. Once the head is removed, the condition of the plenum will be further assessed. Water shielding over the plenum will be provided by placing the internals indexing fixture over it.

One or more water cleanup systems will be installed to treat the reactor vessel and fuel canal water during defueling. These will be located in the fuel transfer canal to use canal water as shielding. Because of particulate and dissolved radionuclides in the primary coolant, cleanup of any water in contact with the reactor core will be important for dose reduction and the control of airborne contamination. Plans call for refurbishing and modifying the fuel-handling system to accept fuel canisters. The plenum will be removed intact or, if necessary, in pieces and stored underwater to provide radiation shielding.

Loose, particulate fuel debris will be removed, followed by larger fuel pieces. Fuel is normally handled underwater for radiation shielding. When the fuel is removed, it will probably be placed in canisters in the water-filled fuel transfer canal. These canisters will be tipped horizontally by the modified fuel transfer equipment and passed through the fuel transfer tube into a fuel storage pool in the auxiliary and fuel-handling building. Once most of the fuel has been removed, the core support structure and lower reactor internals will be removed (intact if possible, otherwise in pieces) and any remaining fuel particles will be removed.

It is not certain what effort, if any, will be made to mechanically remove fuel particles from the reactor piping system. Any particles that have been swept into the outlet nozzles of the reactor vessel may be accessible to defueling equipment through the reactor nozzles once the reactor internals are removed.

Once all the fuel accessible through the reactor vessel has been removed, defueling will be complete and the transfer canal will be drained and decontaminated. Then primary-system decontamination can begin.

2.1.3 Decontamination of the Primary System

Directional radiation surveys indicate that reactor fuel and/or fission products are dispersed throughout the primary piping system as finely divided particles and/or as plating on surfaces. This material must be removed as part of the cleanup. Section 6.5 of the PEIS contains a discussion of primary-system decontamination. Since the completion of the PEIS, the Electric Power Research Institute (EPRI) has funded research into the probable distribution of radionuclides in the primary system (Cunane and Nicolosi 1983 and Daniel et al. 1983) and into physical and chemical methods available for decontamination (Card 1983, Sejvar and Dawson 1983, Gardner et al. 1983, and Munson et al. 1983). Although information about the distribution and removal of contamination has thus been gained, there is little additional definitive information on which to base a task description for primary-system decontamination.

Decontamination solutions may transport radionculides from highly contaminated areas to less-contaminated ones. In some cases, plateout may occur in the decontaminated areas, resulting in increased dose rates. For this reason, the most highly contaminated portions of the system, such as the reactor vessel and piping to the pressurizer, may require mechanical decontamination by grit blasting or other methods before, or in place of, full-system chemical decontamination.

Whether chemical or mechanical methods are used and whether the system is decontaminated all at once or section by section, primary-system decontamination will entail most or all of the following in-containment activities: opening the reactor coolant system, making connections to the reactor piping, and introducing and removing decontamination agents or equipment.

2.1.4 Cleanup of the Auxiliary and Fuel-Handling Building

The auxiliary and fuel-handling building has two parts that are separated by a common wall. One part contains tanks, pumps, piping, and other equipment for the processing and storage of water for the reactor and primary cooling system and for the treatment of radioactive wastes. The other part contains fuel-handling and storage equipment and facilities. The general layout of the auxiliary and fuel-handling building is shown in Figures 2.7 and 2.8.

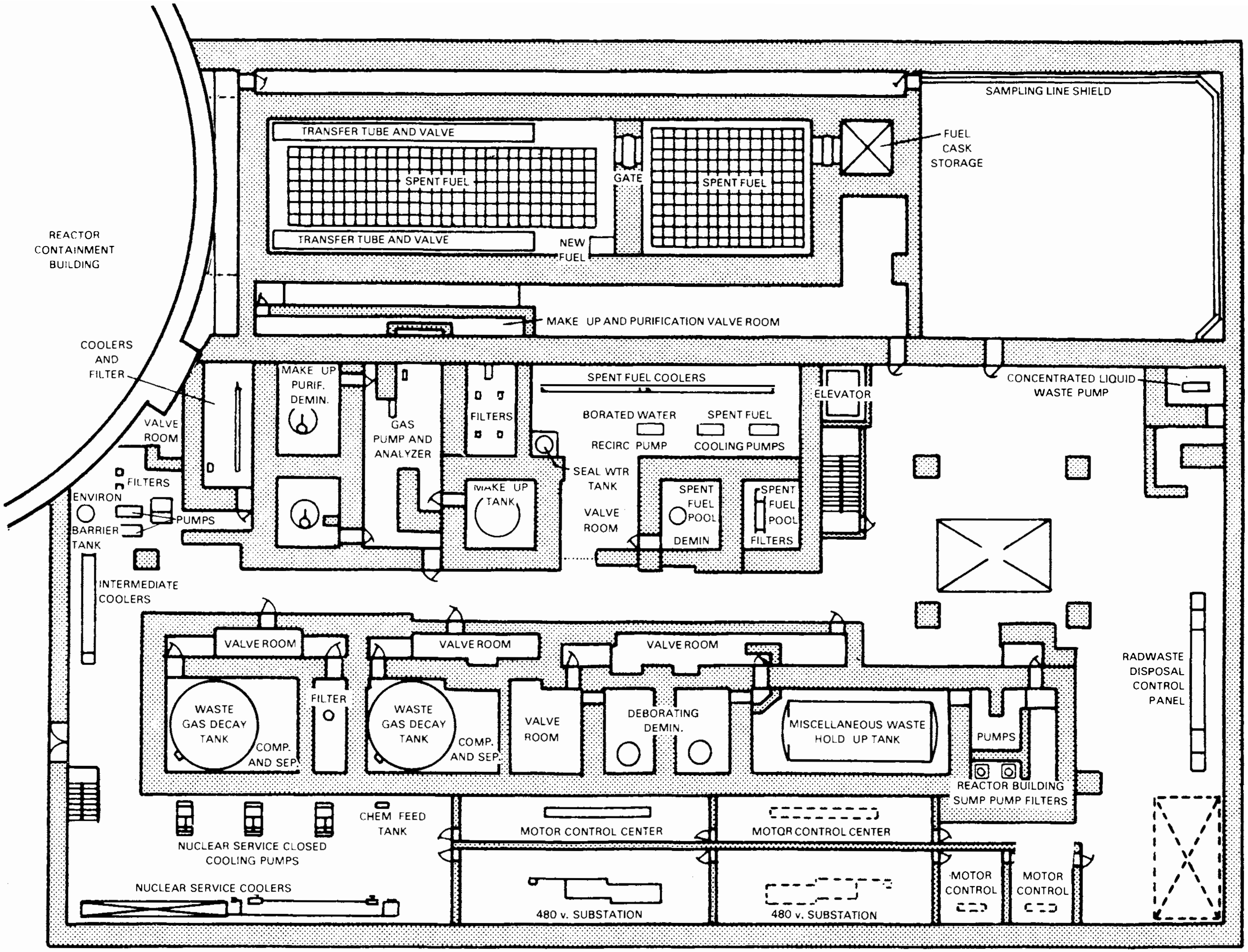

FIGURE 2.7. Plan View of Auxiliary and Fuel-Handling Building (305-ft elevation)

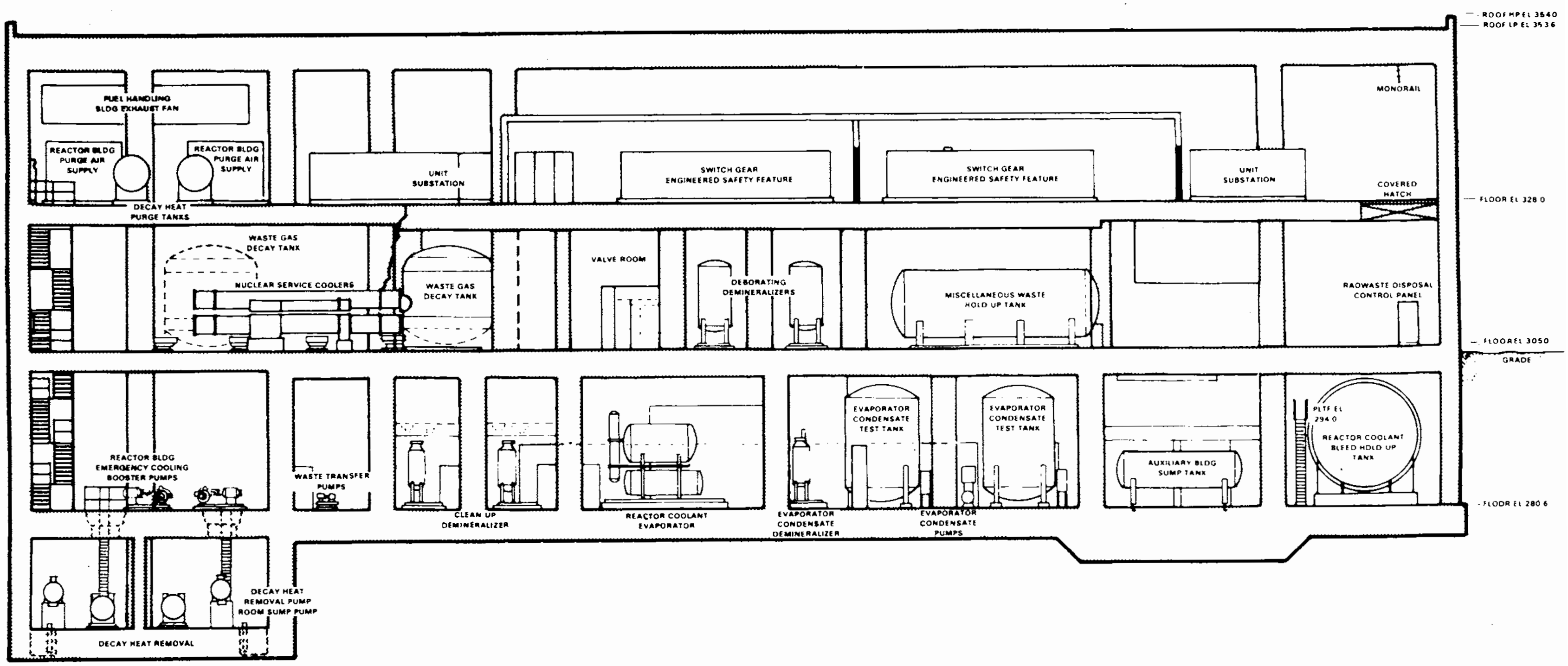

FIGURE 2.8. Cutaway View of Auxiliary and Fuel-Handling Building

The interior of the auxiliary and fuel-handling building was severely contaminated by radioactive material as a consequence of the accident. Piping systems that interface with the reactor coolant system were also highly contaminated. There are 26 such systems in the auxiliary and fuel-handling building. Some flushing has been done, but major decontamination efforts are still required. Cleanup of the building entails the following activity: the removal of miscellaneous equipment and debris that were in the facility at the time of the accident (ladders, tools, portable equipment, etc.); the decontamination or removal of installed equipment (piping systems, air conditioning and exhaust equipment, cable trays, electrical and lighting equipment, etc.); the decontamination of interior building surfaces (both metal and concrete); and the removal of contaminated sludge and resins. In addition, various support activities must be performed to ensure worker safety and to measure the effectiveness of the cleanup.

Cleanup activities in the auxiliary and fuel-handling building started shortly after the accident and are currently underway. Considerable debris and equipment have been removed, and decontamination of the building and remaining equipment has begun. Because most of the interior surfaces (walls, floors, etc.) are composed of uncoated concrete, radioactive materials have penetrated or leached into the surfaces to varying depths. The use of high- and low-pressure water sprays, wet vacuuming, concrete spalling, and manual wiping has reduced both the level of smearable contamination on building surfaces and the dose rates in halls and normally occupied areas. Some temporary dose rate reduction has also been achieved by shielding sources of high radiation (e.g., floor drains, the elevator shaft, and various valves, piping, and pipe dead legs). Internal decontamination of tanks and piping remains to be done, including the purification demineralizers, where contaminated resin has remained since the accident. Cleanup of several of the higher-dose-rate cubicles also remains.

Support activities in the auxiliary and fuel-handling building include: perform radiation surveys to measure the progress of the cleanup effort; identify the need for shielding and/or further decontamination; and provide lighting and utilities. Support activities are also required for the repair and maintenance of equipment used in the cleanup of the facility and for the repair of piping leaks to eliminate sources of additional contamination.

2.2 CURRENT CLEANUP PLAN: DOSE REDUCTION FOLLOWED BY DEFUELING AND DECONTAMINATION

The licensee's program for cleanup of the TMI-2 reactor building, as presented in Figure 1.4 of the PEIS, assumed extensive decontamination of the reactor building to significantly reduce the radiation levels prior to reactor disassembly and defueling. This sequence has been revised for several reasons. First, the reactor building decontamination to date has been less effective in reducing dose rates than was originally anticipated. Second, the presence of the damaged fuel in the reactor core constitutes some risk, primarily to workers in the reactor building (the risk results from uncertainties in the core configuration and the remote possibility of a boron dilution incident potentially leading to recriticality of the core). Third, the information that will be obtained from laboratory examination of the damaged core will be of value for the design of planned facilities and may also be of benefit to the continued safe operation of other nuclear power facilities. Therefore, to avoid further delaying the removal of the core, the licensee has adopted a revised approach to cleanup.

2.2.1 Tasks and Sequencing of the Current Cleanup Plan

The revised cleanup program entails the same milestones as the initial schedule, but the sequence of tasks has been altered as follows:

- dose reduction--presently underway and to continue during reactor disassembly
- reactor disassembly and defueling--to begin in the near future
- primary-system decontamination--to follow defueling
- reactor building and equipment cleanup--to proceed as resources allow, with completion following that of other activities
- cleanup of the auxiliary and fuel-handling building--presently underway and to continue, concurrently with reactor building work, until complete.

2.2.1.1 Dose Reduction

The purpose of the dose reduction program is to reduce the radiation dose rates in occupied portions of the reactor building before and during reactor disassembly and defueling. These activities, which include the installation of temporary shielding and the removal of certain equipment, are well along and have helped reduce from 40 mrem to 14 mrem the average transit dose for each worker entering the building on the 305-ft elevation and traveling to the 347-ft elevation and back. Future dose reduction plans call for the continued use of shielding, additional source identification, and the removal, decontamination, or shielding of floor surfaces, cable trays, air coolers, and other sources of exposure. Dose reduction activities should also reduce airborne radioactive contamination and the recontamination of cleaned surfaces.

2.2.1.2 Reactor Disassembly and Defueling

Early in Period 1 or 2 of the dose reduction program, the preparatory activities that are an essential part of reactor disassembly and defueling will begin. Disassembly and defueling work is expected to continue at least into Period 4 and possibly into Period 5.

The operations leading to and including the removal of the damaged core from the reactor vessel are listed and discussed below in approximate chronological order. Some will be done concurrently, and some resequencing may be necessary or advantageous as the cleanup effort progresses. Although planning is still underway, the licensee's current conceptual designs are briefly described below:

- removal of the reactor pressure vessel head
- installation of high-volume cleanup systems for the water in the reactor vessel and fuel transfer canal
- refurbishment of the fuel transfer canal in the reactor building and of a fuel storage pool in the auxiliary and fuel-handling building
- removal of the reactor vessel upper internals (plenum)
- removal of the reactor fuel, followed by its placement in containers and transfer to the fuel storage pool
- removal of the reactor vessel lower internals (core support assembly), followed by removal of remaining debris from the reactor pressure vessel and draindown and decontamination of the fuel transfer canal.

Removal of the Reactor Vessel Head. Preparations for the removal of the reactor pressure vessel (RPV) head are currently under way. Preparatory activities directly related to RPV head removal are expected to include: 1) controlling the level of the primary-system water; 2) decontaminating and inspecting support equipment and systems needed for head removal (mostly completed); 3) characterizing radiological conditions under the RPV head to ensure that the contamination and dose rates resulting from the head lift can be safely handled (completed); 4) removing the missile shields shown in Figure 2.1 (completed); 5) detensioning (in progress) and removing the RPV head studs; 6) refurbishing the reactor internals indexing fixture (in progress) and placing it on the vessel after the RPV head lift; and 7) fabricating a cover plate for placement on top of the installed indexing fixture (in progress). Also, as part of the underhead characterization, one control rod drive mechanism has been removed. All lead screws have already been uncoupled and will be parked in the RPV head service structure and removed later, if required.

When preparations are complete, the RPV head will be lifted with the polar crane to gain access to the reactor vessel internals and the fuel. It will be placed on the storage stand with shielding. If dose rates or contamination warrants, the transfer canal can be filled to facilitate head lift. The internals indexing fixture and a cover will then be installed on top of the reactor vessel to facilitate water shielding of the plenum and to provide a work platform for plenum inspection activities.

Installation of High-Volume Water Cleanup Systems. High-volume water treatment capabilities will be needed to clean particulate and dissolved radionuclides from water in the primary system and the fuel transfer canal both before and during the reactor disassembly and defueling. Although the submerged demineralizer system (SDS) currently in operation at the site is processing primary coolant, it does not have sufficient capacity to support defueling. Two separate systems are planned, each with a capacity of about 400 gal/min for filtration and 60 gal/min for ion exchange. Preliminary designs indicate that one of these systems will treat only reactor vessel water, and the other will treat water in the fuel transfer canal (Devine

1983). The filter for the system servicing the reactor vessel will be designed to fit in modified fuel canisters and will be located in the fuel transfer canal for shielding. The ion exchange columns are expected to be about 100-ft^3 cask liners of mixed-zeolite ion exchange media. The columns will be shielded underwater in the transfer canal pool, or placed in a shielded cask inside or outside of containment. The filter for the system servicing the fuel transfer canal will be like those used for the reactor vessel. This entire system, which will use the existing SDS (after modification) for cesium removal, will be submerged in spent-fuel pool "A" in the auxiliary and fuel-handling building.

Refurbishment of the Fuel Transfer Canal. The refurbishment of the fuel transfer canal will include the installation of the water cleanup system discussed above, the refurbishment and modification of the fuel transfer equipment to handle fuel canisters, and the installation of the seal plate to allow filling of the fuel transfer canal. Fuel storage racks for fuel pool "A" in the auxiliary and fuel-handling building will also be modified.

Plenum Removal. After head lift and the installation of the indexing fixture, and concurrently with refurbishment of the fuel pool and preparation and filling of the fuel transfer canal, the condition of the plenum will be evaluated. The clearance between the plenum and reactor vessel wall was very small prior to the accident. It is not known whether accident conditions damaged the plenum in a way that would make conventional plenum removal impossible.

Plenum removal will require the prior or concurrent removal of the damaged fuel assemblies adhering to the underside of the plenum. They may be dislodged remotely through openings in the plenum, or they may be removed with the plenum.

In an undamaged reactor, the removal and storage of the plenum is normally performed underwater in the fuel transfer canal so that the plenum does not contribute significantly to the occupational radiation dose. This is the current plan for TMI-2. However, if radiation levels permit, the plenum might be lifted before the modifications of the transfer canal are complete. In this case, the plenum would be lifted into air and subsequently stored under water in part of the transfer canal.

Plenum removal is not ordinarily a high-dose job; however, it may be at TMI-2, particularly if intact removal is not possible. Sectioning the plenum would require that workers spend considerable time over the reactor vessel attaching lifting devices to the plenum, aligning cutting equipment, etc. Workers cutting the plenum would receive radiation dose from sources in the reactor building and from the plenum and reactor coolant. However, the additional dose contribution from the plenum and reactor coolant could be fairly small, depending on the depth of water cover and the effectiveness of the water cleanup systems.

Fuel Removal. Once the plenum assembly has been removed, defueling equipment will be installed in the canal area and the fuel will be removed. The fuel removal plans have not yet been finalized because investigations of fuel conditions are still in progress.

The reactor vessel defueling sequence will involve removing only that fuel material within the reactor vessel--not material that may be lodged in other locations within the reactor primary system, such as in the coolant piping. The removal of fuel and particulates from other portions of the reactor primary system are discussed in Section 2.2.1.3.

The TMI-2 core contained 177 fuel assemblies. While their exact condition is uncertain, current information indicates that there are no intact fuel assemblies. The fuel is assumed to be in a combination of the following configurations:

- fused sections--portions of fuel assemblies fused to each other or to structural components in such a way that they will have to be mechanically separated

- core debris--includes relatively large pieces that can be mechanically handled, and smaller pieces that will have to be hydraulically vacuumed and filtered.

The initial step of defueling will be the removal of the core debris, to clear the working area in preparation for the removal of large pieces of fuel assemblies. The small debris will be removed first, followed by accessible loose debris that is larger than pellets but small enough to be placed in canisters. These canisters will be temporarily stored underwater in the transfer canal, then moved underwater through the transfer tube to the underwater spent-fuel storage racks in the fuel-handling building. This will provide space in the transfer canal for subsequent defueling operations. Large fuel pieces will then be removed using remote manipulators and/or long-handled tools. Adjacent pieces may need to be separated in order to be removed.

Removal of Lower Internals. The core support assembly is a large, basket-like component in the reactor vessel that supports the fuel elements and directs the entering reactor coolant towards the lower portion of the reactor core. Along with the removal of fuel from the reactor vessel, fuel particles will be removed from the lower internals. Then the core support structure will be removed using the internals lifting fixture and polar crane, if possible. If conditions require, it will be cut up for removal. As the core support assembly is removed, remaining fuel debris will also be removed and placed in transfer containers.

Although the fuel and reactor core material is highly radioactive, the depth of water over the core should shield workers from all but dissolved or very finely divided debris that becomes dispersed in the coolant. The reactor water cleanup system is expected to remove this material and provide cleaned coolant in the vicinity of defueling workers. Defueling will, however, require that workers spend considerable time in containment, during which they will receive radiation doses from numerous sources. Because of the time defueling requires, it will be a relatively large contributor to the radiation dose for cleanup.

After the reactor has been defueled, any remaining fuel canisters and particulate filters from the water treatment system will be transferred through the fuel transfer canal to the fuel storage pool. Defueling equipment will be removed and the transfer canal will be drained and decontaminated. This will complete reactor disassembly and defueling.

2.2.1.3 Primary-System Decontamination

Decontamination of the primary system will involve mechanically and/or chemically decontaminating the internal surfaces, as discussed in Section 2.1.3 of this report and Section 6 of the PEIS. At the completion of primary-system decontamination, the radionuclide concentrations in the primary piping system should approach those of operating reactors.

2.2.1.4 Reactor Building and Equipment Cleanup

The cleanup of the reactor building and equipment will be an extension of the dose reduction effort, with the purpose of reducing radionuclide concentrations and radiation dose rates to levels approaching those in operating plants.

Chemical and mechanical decontamination techniques will be used on equipment and on building surfaces. The removal of items such as cable trays, insulation, and portable equipment will reduce doses and facilitate cleanup operations. Some concrete removal is expected to be required, particularly on the 282-ft elevation. The hollow-concrete-block walls on this elevation will also need to be removed.

Reactor building cleanup will involve a continual sequence of identifying the most significant contributor to radiation dose and airborne contamination, decontaminating or otherwise removing that source, then identifying and decontaminating or removing the next most important source, and so on until dose rate objectives are met. This repeated process is necessary because of the extreme difficulty (with available instrumentation) of identifying minor contributors to radiation fields in the presence of major contributors.

Cleanup will be further complicated because, once a component is cleaned, it may become recontaminated by particulate radioactive material from the air or from equipment removal or decontamination activities in adjacent areas. For this reason, it will be important to protect cleaned areas with plastic, strippable coatings, or some other covering, and to determine a sequence for cleanup activities that will minimize recontamination.

Dose rates in the reactor building (from equipment and surfaces) will be a function of the effectiveness of the cleanup actions. It is expected that a relatively large number of person-hours will be required to complete the cleanup and that the dose rates will decrease ever more slowly as cleanup progresses, because removing a single large source has a much greater effect on dose rates (per worker hour expended) than removing numerous smaller sources.

2.2.1.5 Auxiliary and Fuel-Handling Building Cleanup

The overall objective of the cleanup effort in the auxiliary and fuel-handling building is to permit access to all portions of the building. Access has been limited because of surface and airborne contamination and radiation exposure from confined sources (radionuclides inside pipe runs, resin columns, dead legs, holding tanks, etc.).

Mechanical and chemical decontamination techniques will be used inside tanks and piping and on equipment and building surfaces. The removal of contaminated items that are still in the building, such as portable equipment, insulation, sludge, resins, and miscellaneous debris, will facilitate cleanup. Some concrete spalling has been done and more will be required, particularly on the concrete surfaces that were below the accident water level or were otherwise exposed to contaminated liquids. Hollow-concrete-block walls may have to be removed. The building will require some additional general cleanup, primarily of overhead areas and of cubicles and their contents. As in the reactor building, cleanup may be hampered by recontamination, and covering decontaminated areas with protective materials may be important.

The cubicle areas will be the most difficult to decontaminate because of the concentration of equipment (tanks, filters, piping, etc.), the crowded work space, the need for special shielding (e.g., lead blankets), and the high contamination and radiation levels. The makeup and purification demineralizer cubicles may be the most severely contaminated because of radionuclides that were deposited in the in-line filters and demineralizer resins during the accident.

The decontamination plan presented in the PEIS postulated complete decontamination of the auxiliary and fuel-handling building using conventional decontamination methods, including water flushing and hydroblasting (high-pressure water flushing). Experience has indicated that these methods are not effective in reducing dose rates and are not as rapid as originally anticipated.

2.2.2 Occupational Radiation Dose Associated with the Current Cleanup Plan

In order to determine the occupational radiation dose associated with the current cleanup plan, a team of nuclear-operations and decontamination specialists evaluated the work to be performed and the dose required for each task. Each task was evaluated assuming that the tasks would be performed in the sequence described and that occupational radiation doses would be maintained ALARA by the proper planning and execution of each task. A great deal of information and data required for accurate estimates will become available only during the progress of cleanup (e.g., conditions inside the reactor, characterization of contamination). Because of this, the radiation dose estimate is presented as a range. The upper and lower ends of the estimated range represent the corresponding extremes of conditions based on an evaluation of the information presently available.

Table 2.1 lists the estimated range of occupational radiation doses for cleanup performed according to the current plan. Doses for work performed to date and doses for waste management tasks (taken from the PEIS) are included. Observations regarding these estimated doses are presented in the following paragraphs.

The occupational dose incurred during performance of the dose reduction task will effectively reduce the radiation doses to workers performing subsequent tasks. Eliminating this task would effectively increase the doses for later tasks.

The range of estimated doses for completing reactor disassembly and defueling (2600 to 15,000 person-rem) is wide because of many uncertainties involving the removal of the reactor internals and fuel and the effectiveness of the water cleanup systems. The plenum may be removed intact, or an extensive effort may be needed to section and remove it. The time required to transfer the fuel to canisters is likewise uncertain. If the fuel is not fused, a lower number of person-hours and a lower dose would be expected. However, if much of the fuel is fused, the dose would be much higher. The transfer canal will contain myriad small particulate sources of radiation that will be removed by the water cleanup system during defueling. If these sources are kept well underwater and transferred to fuel canisters by the water cleanup system, dose rates will be low. However, if a significant portion of these particulates forms a film on the surface of the water in the transfer canal, the average dose rate for the workers could be much higher.

TABLE 2.1. Estimated Occupational Radiation Dose for the Current Cleanup Plan

Task	Person-rem
Dose Reduction Program	2,000-5,100
Reactor Disassembly and Defueling	2,600-15,000
Primary-System Decontamination	56-970
Reactor Building and Equipment Cleanup	5,900-21,000
Auxiliary and Fuel-Handling Building Cleanup	500-1,400
Utility and System Maintenance	100-200
Waste Management and Transportation[(a)]	97-485
Dose To Date	2000
	13,000-46,000

(a) From the PEIS.

The processes for primary-system decontamination have not yet been identified by the licensee. The occupational dose required will be a function of the number and type of dead legs (sample lines and other areas of restricted flow) that workers must flush, the number of repeat processes that must be performed, the occurrence of spills resulting from leaks in the system, and the waste-handling method used.

Cleanup of the reactor building and equipment will result in an estimated 5,900 to 21,000 person-rem of occupational radiation dose. As much as 80% of this dose is associated with cleanup of the 282-ft elevation. This estimate assumes that considerable decontamination of this elevation is performed from the 305-ft elevation through floor penetrations prior to entry into the 282-ft elevation. As an alternative, immersion decontamination, accomplished by filling the basement with water or other decontamination solutions and processing the water on either a batch or a continuous basis, is being considered but was not evaluated due to limited knowledge of its effectiveness. Extensive use of robotics on the 282-ft level would also reduce the dose to workers. The robotic option is explored further as Alternative 3.

Final cleanup of cubicals and systems in the auxiliary and fuel-handling building, including the processing of decontamination waste from system and tank cleanup, is estimated to require between 500 and 1400 person-rem.

The maintenance of utilities, communication systems, and other essential services during the cleanup is expected to require an additional 100 to 200 person-rem, depending on the frequency of breakdowns and the duration of the cleanup effort.

Approximately 2000 person-rem have already been incurred during cleanup operations through May 11, 1984. In the opinion of the staff, if cleanup goes well, it might be completed at the low estimate of 13,000 person-rem. However, even if additional problems continue to arise, cleanup should be completed at less than the high estimate of 46,000 person-rem.

2.3 ALTERNATIVE 1: EXTENSIVE CLEANUP FOLLOWED BY DEFUELING

As mentioned earlier, the initial cleanup plans discussed in the PEIS called for extensive decontamination of the reactor building and equipment prior to defueling. It was believed at the time the PEIS was prepared that such decontamination could be accomplished largely by water flushing and hydroblasting (high-pressure water flushing). Experience to date has indicated that these activities are less effective at reducing dose rates than had been anticipated, probably because contamination is embedded deeper in surfaces than was expected because of delays in beginning cleanup.

This alternative to the current cleanup plan calls for meeting the initial dose reduction goal of about 10 mrem/hr in occupied areas through a combination of aggressive decontamination, equipment removal, and shielding. Once this goal is met, the reactor would be disassembled and defueled and the primary system would be decontaminated. In this section, the procedures and work sequence for decontaminating the building and equipment, disassembling and defueling the reactor, and decontaminating the primary system are outlined, and the impact of this alternative on occupational dose is discussed.

2.3.1 Tasks and Sequencing of Alternative 1

Under this alternative, decontamination of the auxiliary and fuel-handling building would be as described in the discussion of the current cleanup plan. The sequence of decontamination operations in the reactor building would consist of first removing debris and heavy deposits, and then cleaning the exposed surfaces. Cleanup efforts would begin at upper levels and proceed downward to minimize recontamination. The majority of the building-cleaning effort would precede defueling; however, some final cleanup would be required following defueling and primary-system decontamination.

2.3.1.1 Reactor Building and Equipment Cleanup

Cable trays, overhead lighting, and electrical conduits are known to be significant sources of occupational radiation exposure. Water flushing and hydroblasting are not particularly effective at decontaminating these sources. Unless some alternative method of chemical decontamination, such as foam cleaning or freon cleaning, proves effective, the equipment would have to be removed to eliminate these sources. Removal of the equipment would require the identification and replacement of instrument and control cables required for safety, and the installation of temporary lighting and electrical outlets needed to operate decontamination and defueling equipment. Chemical decontamination or removal of the reactor building's air coolers would also be required. Floor drains would have to be chemically decontaminated, the surfaces of concrete floors and walls would have to be removed by spalling, and other aggressive decontamination actions would be required. Some shielding of primary piping and other sources would also be required to reach the dose rate objective.

Such an extensive cleanup program would require extensive planning, testing, and source identification as well as a substantial number of workers in containment. Large occupational doses would be incurred early in the cleanup effort. This approach would delay the start of fuel removal for at least 1-1/2 years and possibly considerably longer, depending on the difficulties encountered.

2.3.1.2 Reactor Disassembly and Defueling and Primary-System Decontamination

Under Alternative 1, disassembly and defueling of the reactor and decontamination of the primary system would involve essentially the same tasks as described for the current plan. The difference would be that these tasks would be performed in lower radiation fields, with only a small dose contribution from radiation sources associated with the building and equipment other than the reactor primary system. During building cleanup, the primary coolant would be processed in small batches through the SDS system, as is now being done. This additional processing beyond what has already been done is expected to have a negligible effect on the quantity of radioactive material handled during defueling, or on the dose rates from this material. Theoretically, the longer radioactive materials are in contact with reactor piping, the greater the extent of radionuclide migration into the oxide layer of the piping and the more difficult decontamination becomes. In view of the considerable time between the accident and decontamination of the primary system (under all options), the delay required under this alternative to allow for building cleanup would have little effect on the ease or effectivness of primary-system decontamination. Much of the dose received during primary-system decontamination is from material in the primary system rather than sources in the building. Therefore, the dose for primary-system decontamination in this alternative is only slightly less than the dose for the same task in the current plan.

Additional building decontamination would be required during and following both defueling and primary-system decontamination to maintain the dose rates achieved during the initial building and equipment cleanup phase. This recleaning would result in additional occupational radiation doses.

2.3.2 Occupational Radiation Dose Associated with Extensive Cleanup Followed by Defueling

The occupational radiation dose associated with this alternative was estimated in the same manner as was the dose for the current cleanup plan and is shown, broken down by tasks, in Table 2.2. The dose reduction task called for in the current plan does not appear in Table 2.2 because any of those activities required as part of Alternative 1 would be performed as part of the reactor building and equipment cleanup, not as a separate task.

It was assumed that considerable equipment would need to be removed in order to achieve the goals for this alternative. Because fuel remains in the reactor, certain safety systems are required. The preservation or replacement of these systems would require a very large number of man-hours in containment and a corresponding increase in worker doses.

TABLE 2.2. Estimated Occupational Radiation Dose for Extensive Cleanup Followed by Defueling

Task	Person-rem
Reactor Building and Equipment Cleanup	9,000-30,000
Reactor Disassembly and Defueling	820-6,500
Primary-System Decontamination	39-780
Reactor Building Recleaning	12-630
Auxiliary and Fuel-Handling Building Cleanup	500-1,400
Utility and System Maintenance	100-200
Waste Management and Transportation[a]	97-485
Dose to Date	2000
	13,000-42,000

(a) From the PEIS.

Even assuming release from some of these requirements, higher occupational doses were estimated for reactor building and equipment cleanup under this alternative than under the current cleanup plan, for the following reasons:

- Worker time in containment would be required to replace some control and utility cables to ensure that the reactor is maintained in a safe status prior to fuel removal.

- The lack of a dose reduction program preceding cleanup would result in the cleanup work being done at high dose rates and would require more worker hours for completion of this operation. (Under the current plan, some source removal is performed as part of the dose reduction program.)

Even with aggressive building decontamination, there is little assurance that the average 10-mrem/hr target for the reactor building could be met as long as fuel and fission product contamination remained in the primary system. The goal would certainly not be met inside the D-rings or near primary-system piping and components. An average working dose rate of 10 mrem/hr was, however, assumed as the low dose rate for most reactor disassembly and defueling tasks.

The occupational dose for primary-system decontamination was lower under this alternative than under the current plan because of the lower general-area dose rates. The average dose rate, however, was assumed to be somewhat above 10 mrem/hr because the workers would be close to the reactor coolant piping for much of this work.

The task of maintaining reactor building cleanliness during defueling and decontamination is new under this alternative. The level of effort that would be required is difficult to estimate because it would depend on the nature of the reactor core debris, the contamination control barriers provided, the work practices, the process used for primary-system decontamination, and the number and size of any leaks in the primary system. Because the dose rates for this task would be low, the total dose involved would be relatively small.

Cleanup of the auxiliary and fuel-handling building would result in the same dose under this alternative as under the current plan because it would be done in the same way.

Utility and system maintenance is estimated to require approximately the same dose under this alternative as under the current plan. The utilities would be needed for a longer time under this alternative; however, the dose rates involved in maintenance would decrease earlier in the cleanup operation. If cleanup were performed according to this alternative, fuel removal would not begin for several years.

2.4 ALTERNATIVE 2: PHASED DEFUELING FOLLOWED BY REACTOR BUILDING CLEANUP

Alternative 2 differs from the current plan and the other alternatives in that a large portion of the fuel debris would be removed as a slurry before the reactor vessel head was lifted. Although there are currently no plans to do any defueling before the head lift, this alternative is included because it would minimize the potential for fuel fines to contaminate equipment and result in exposure to personnel during later operations. Also, there may be safety advantages to having the reactor vessel head in place as long as possible because it would provide shielding to the workers performing initial defueling tasks. Drawbacks to this alternative include delays resulting from the design, fabrication, and testing of equipment for phased fuel removal, and additional equipment costs.

2.4.1 Tasks and Sequencing of Alternative 2

Phased defueling would be accomplished by altering the sequence of tasks for reactor defueling. The major tasks and their general sequence for phased defueling are:

- implementation of the dose reduction program, as described for the current plan (this program would continue throughout reactor defueling)
- installation of water vacuum and support equipment for removing the fuel fines, and removal of the fines through a control rod drive mechanism (CRDM) nozzle in the head
- preparation for reactor vessel head removal, and removal of the head, plenum, fuel, and reactor vessel internals, as described for the current plan
- decontamination of the primary system, as described for the current plan
- completion of the auxiliary and fuel-handling building cleanup and the reactor building and equipment cleanup, as described for the current plan.

2.4.1.1 Fines Removal Prior to Head Lift

Under this alternative, a fuel debris removal system would be installed before the reactor vessel head was lifted. This system would have some of the features of the planned system for reactor water cleanup system except that canisters would be provided for the collection of relatively large quantities of fuel debris, and a system would be required for observing and manipulating the vacuum nozzle within the reactor vessel. The time required for the design and fabrication of this system would delay fuel removal and all subsequent cleanup efforts for at least 18 months, perhaps longer.

The debris removal system would include a water vacuum probe inserted through a CRDM nozzle (the CRDM was previously removed for the underhead characterization work). The vacuum would be used to remove accessible fines and small rubble. Debris removal would be observed by closed-circuit TV (CCTV) inserted in one of the two vacant CRDM lead screw holes (the lead screws were removed for quick-scan and quick-look operations). The debris removal nozzle would be controlled by a cable system similar to that used for control of the CCTV cameras. Clarified borated water would be returned to the reactor vessel using a third CRDM lead-screw opening. Actual debris removal would take only a few months unless nozzle plugging and visibility problems were severe, in which case it could take much longer. A substantial portion of the estimated 100,000 lb of rubble 1 inch or less in diameter might be removed in this way.

The fuel canisters would require considerable shielding, either by storage underwater (which might be accomplished by filling the fuel transfer canal) or by the use of massive shielding casks. Filling the fuel transfer canal for shielding in the near future could impede the necessary refurbishment of the canal. The availability of adequately shielded casks has not been investigated.

2.4.1.2 Reactor Disassembly and Defueling

After the modification and refurbishment of the fuel transfer equipment and the removal of accessible fines from the reactor vessel, reactor disassembly and defueling would proceed as described for the current plan, with the exceptions noted below. Under the current plan, every effort will be made to perform a dry head lift because refurbishment of the transfer canal will not be complete. If the head lift was delayed until the transfer canal refurbishment was complete, as it would be under this alternative, the incentives for dry head lift would diminish. A wet head lift is expected to require less occupational dose.

Once the head was lifted, there would be much less particulate radioactivity in the reactor coolant and therefore a diminished probability of rapid releases of dissolved cesium from the core contents as it is disturbed. This would lead to lower dose rates. Defueling after head removal would also involve fewer filter changes and fewer worker hours because so much material would have been removed before head lift. Later defueling activities would be identical to those for the current plan, except that under this alternative, the effort required to decontaminate the transfer canal following defueling could be somewhat lessened because of lower contaminant levels in the water.

2.4.1.3 Primary-System Decontamination, Auxiliary and Fuel-Handling Building Cleanup, and Reactor Building and Equipment Cleanup

These activities would be unaffected by the defueling method; hence, for these activities, all aspects of Alternative 2 and the current plan are identical.

2.4.2 Occupational Radiation Dose Associated with Phased Defueling Followed by Reactor Building Cleanup

The occupational radiation dose required to perform phased defueling followed by reactor building cleanup was estimated in the same manner as the dose for the current plan. The total estimate and the breakdown by task are given in Table 2.3. The occupational dose needed to accomplish the dose reduction program was unchanged from that of the current plan.

TABLE 2.3. Estimated Occupational Radiation Dose for Phased Defueling Followed by Reactor Building Cleanup

Task	Person-rem
Dose Reduction Program	2,000-5,100
Defueling Operation Prior to Head Lift	140-540
Reactor Disassembly and Defueling	2,600-14,000
Primary-System Decontamination	56-970
Reactor Building and Equipment Cleanup	5,900-21,000
Auxiliary and Fuel-Handling Building Cleanup	500-1,400
Utility and System Maintenance	140-280
Waste Management and Transportation[a]	97-485
Dose To Date	2000
	13,000-46,000

(a) From the PEIS.

The dose range for removing the fuel fines prior to head lift was estimated assuming that either water or solid material would be used as shielding to diminish the dose contribution from the fuel fines.

The doses for reactor disassembly and defueling would be only slightly lower under this alternative than under the current plan, because the time that would be required for vacuuming the fines represents only a small portion of the time needed for fuel removal, and the dose rates in the building would remain approximately the same. The greatest advantage of early fuel removal would be the subsequent decrease in the quantity of particulates that could contribute to worker dose. This decrease results in the lowering of the upper bound assumed for the dose rates for the balance of defueling. The early removal of fines might also simplify cleanup of the transfer canal, and this benefit is reflected in the dose estimate.

The doses for primary-system decontamination, reactor building and equipment cleanup, and auxiliary and fuel-handling building cleanup would be the same under this alternative as under the current cleanup plan; they would not be affected by the fuel removal procedure considered under this alternative. The dose required for utility and system maintenance would increase over that of the current plan to account for the additional time that this alternative would prolong the cleanup. (This additional time would be needed to allow for the design, development, construction, and testing of the equipment needed for phased fuel removal.)

2.5 ALTERNATIVE 3: DEFUELING FOLLOWED BY DELAYED CLEANUP USING ROBOTICS

A third alternative for cleaning up TMI-2 would be to clean up most or all of the auxiliary and fuel-handling building and to reduce the dose rates in and defuel the reactor, as described in the current plan; then to place the reactor and containment building in interim, monitored storage, and to perform final building cleanup using robotics sometime in the future, when appropriate technology and devices become available.

While timely removal of the damaged fuel is considered essential, the option of delaying further cleanup was considered worthy of evaluation. Robotics is a rapidly emerging technology with the potential for eliminating considerable occupational radiation exposure. Robotics is already being applied to a limited degree in the auxiliary and fuel-handling building, and applications in the reactor building are being evaluated. 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.

Although maximizing the use of available robotic devices for high-dose work would be consistent with the ALARA principle, certain assurances would be required before this alternative could be adopted. The safety of the interim-care phase would require additional study and assessment. There would need to be better assurance that the robotic technology needed to accomplish cleanup would become available. In addition, provisions for financing future cleanup would need to be made.

2.5.1 Tasks and Sequencing of Alternative 3

This alternative would include the phases of cleanup discussed for the reactor building in the current cleanup plan and would incorporate an interim-storage phase as well. These are discussed below.

2.5.1.1. Reactor Disassembly and Defueling

The auxiliary and fuel-handling building cleanup, dose reduction program, and reactor disassembly and defueling would proceed concurrently, essentially as described in the current plan. The areas of the auxiliary and fuel-handling building with the highest dose rates might be left untouched. In the dose reduction program, slightly greater emphasis might be placed on shielding rather than decontamination, and only locations that must be occupied for reactor disassembly and defueling would be subject to dose reduction efforts. The 282-ft elevation, for example, would probably be left totally untouched to reduce the occupational radiation dose.

Because the safety of the monitored interim storage period has not been evaluated, it is difficult to predict how much radioactive material, particularly fuel, might be allowed to remain during this phase. Although it is clear that fuel inventories should be reduced to a level where criticality is inconceivable, such a criterion would require only that about half the fuel be removed. The actual quantity permitted to remain during interim storage, if interim storage were allowed, would probably be much less.

Under this alternative, defueling might stop prior to final cleanup of the transfer canal, or some selected mechanical or chemical decontamination might required for those portions of the primary system that contain fuel particles.

2.5.1.2 Interim Storage of the Defueled Reactor

Upon the completion of reactor defueling, the auxiliary and fuel-handling building and the containment building would be placed in an interim, monitored storage mode until robotic technology was available to perform the remaining decontamination of cubicles in the auxiliary and fuel-handling building and of the primary system and the reactor building and equipment. Interim storage would involve the maintenance of essential services (e.g., security and radiological surveillance, utilities, ventilation systems, and planning and administration), but no active program of building or equipment decontamination would be conducted except as remote or robotic technology became available. During interim storage, occupational radiation exposures would be restricted to those necessary to maintain the facilities in a safe and secure condition. Tasks such as repairing the ventilation systems and changing filters would account for most of the dose received.

2.5.1.3 Primary-System Decontamination

Except for those activities necessary for the reactor to be considered safe for interim monitored storage, any primary-system decontamination would be done by robotics. Decontamination performed by plant workers before interim storage might include localized chemical or mechanical cleaning, but would involve only a small fraction of the occupational radiation dose incurred for complete primary-system decontamination under the current plan.

Further primary-system decontamination might or might not be undertaken following interim storage of the reactor, depending on the anticipated future use of the reactor, waste disposal limitations in effect at that time, the capabilities of available robotic devices, and other factors. If decontamination were undertaken by robotics, the only occupational radiation dose incurred would be from decontaminating and maintaining the robots, and possibly from handling and transporting the waste generated; however, some of these tasks might also be done by robotics.

2.5.1.4 Robotic Cleanup of the Reactor Building and Equipment

It is somewhat premature to envision in detail what tasks might be involved in robotic cleanup of the TMI-2 reactor building because most present-generation robots are severely limited in mobility, dexterity, strength, or logic. The tasks of equipment removal, building and equipment decontamination, shielding removal, and decontamination and building survey would have to be performed to complete the cleanup. The principal difference between this alternative and the current plan is that these tasks would be performed without workers routinely being in the reactor building.

Occupational doses incurred during robotic cleanup of the reactor building, like those incurred during primary-system decontamination using robotics, would primarily be those from decontaminating and servicing robots and from waste-packaging, waste-handling, and waste transportation activities that were not done robotically.

2.5.2 Occupational Radiation Dose Associated with Defueling Followed by Delayed Cleanup Using Robotics

The occupational radiation dose associated with this alternative was estimated in the same manner as the dose for the cleanup plan and the other alternatives. The total and task-breakdown estimates are presented in Table 2.4.

The dose reduction program and reactor disassembly and defueling would be performed in the same way and require the same dose as under the current plan.

The primary-system cleaning performed by plant workers before interim storage would consist only of the localized cleaning required for the plant to be considered defueled. The extent of this activity was arbitrarily chosen

TABLE 2.4. Estimated Occupational Radiation Dose for Defueling Followed by Delayed Cleanup Using Robotics

Task	Person-rem
Dose Reduction Program	2,000-5,100
Reactor Disassembly and Defueling	2,600-15,000
Primary-System Cleaning	11-190
Utility and System Maintenance	80-160
Interim Care of Reactor Building and Auxiliary and Fuel-Handling Building (1.7-31 person-rem per year)	0-620[a]
Auxiliary and Fuel-Handling Building Cleanup	97-1,400
Robotic Primary-System Decontamination, Reactor Building and Equipment Decontamination, and Final Auxiliary and Fuel-Handling Building Cleanup	300-3,500
Waste Management and Transportation[b]	97-485
Dose To Date	2000
	7,200-28,000

(a) Based on 0 to 20 years of interim care.
(b) From the PEIS.

because the criteria for interim storage have not been established. A dose of 20% of that required for the full-system decontamination considered in the current plan was used. In reality, any value between zero and the maximum dose of 970 person-rem under the current plan might be possible.

Utility and system maintenance would be required only until defueling, including any primary-system decontamination, was complete; therefore, doses associated with this task are lower under this alternative than under the current plan. However, a new task, interim care during the storage period, would be required. The dose incurred in maintaining the reactor building during this time would be 1.6 to 30 person-rem per year. This interim-care period might not be required, or it could continue for as long as 20 years. It is this difference that accounts for the wide range of doses presented.

Cleanup of the auxiliary and fuel-handling building would be much the same under this alternative as it is under the current plan, except that areas where there are high dose rates (e.g., the insides of tanks and piping systems) might remain untouched until robotic technology was available. The elimination of a few high-dose jobs involving a relatively large uncertainty accounts for the difference between the low end of the dose range estimated for this alternative and that presented for the current plan. The high end of the dose range was estimated assuming the same treatment as under the current plan. The dose incurred for interim care of the auxiliary and fuel-handling building is estimated to be 0.1 to 1.0 person-rem per year.

Primary-system decontamination, reactor building and equipment decontamination, and cleanup of remaining hot spots in the auxiliary and fuel-handling building would all be done robotically under this alternative. Robotic activities are, however, expected to result in some radiation dose to workers maintaining the robots and performing other activities. This dose was assumed to be between 5% of the low dose and 15% of the high dose from manual performance of the activities.

2.6 ANALYSIS OF THE CURRENT CLEANUP PLAN AND ALTERNATIVES

Sections 2.2 through 2.5 described four approaches to accident cleanup at TMI-2 and presented estimates of the occupational radiation dose associated with each approach. The approaches that were selected would use available or emerging technology and would be consistent with the conclusion of the PEIS that the TMI-2 site is not suitable as a permanent repository for the accident-generated waste. This section is intended to summarize the strengths and weakness of the current cleanup plan and the three alternatives and to provide an additional basis for the environmental impact discussed in Section 3.

The criteria against which the licensee's current plan and each alternative were evaluated include:

- public safety
- occupational radiation dose
- time schedule for fuel removal and completion of cleanup
- technical feasibility.

In the following discussion, the four cleanup options are compared using these four criteria.

2.6.1 Analysis of Public Safety

The safety concerns of the TMI-2 reactor are presented in the PEIS and have not changed. Therefore, they are not discussed here. However, the safety concerns will be substantially reduced when the fuel is removed. The current plan and Alternative 3 (defueling followed by delayed cleanup using robotics) are therefore preferable according to this criterion. Alternative 2 (phased defueling followed by reactor building cleanup) was evaluated because it appeared to have some advantages for the safety of the public and the workers. The staff now feels that any advantages of Alternative 2 are offset by the fact that it would delay defueling by at least 1-1/2 years.

The public safety of the monitored, interim-storage phase that is envisioned as part of Alternative 3 would require additional evaluation. Although the possible release modes and affected environment are well known, the radionuclide inventories that will remain after defueling, the type of care that would be provided, and the duration of the care period are unknown. An evaluation of the safety of this phase would therefore be premature at this time.

2.6.2 Analysis of Occupational Radiation Dose

As illustrated in Figure 2.9, the estimated dose associated with cleanup of the TMI-2 site under the current plan is considerably higher than the dose associated with cleanup under Alternative 3 (defueling followed by delayed cleanup using robotics), and slightly higher than that for Alternative 1 (extensive cleanup followed by defueling). The estimated dose for the current plan is equivalent to that for Alternative 2 (phased defueling followed by reactor building cleanup).

Although the lowest occupational radiation dose is associated with Alternative 3, the tasks that would be performed under this alternative, through the reactor disassembly and defueling phase, are the same as those under the current plan. Therefore, it is not necessary to make a decision for or against Alternative 3 on the basis of radiation dose at the present time.

The second lowest dose is estimated for Alternative 1, extensive decontamination followed by defueling. The implementation of Alternative 1 would preclude the use of robotics to perform the high-exposure job of reactor building cleanup because the building would be decontaminated in the very near future, before adequate robotic technology became available.

On the basis of occupational dose, Alternative 2 (phased defueling followed by reactor building cleanup) is essentially equivalent to the current plan.

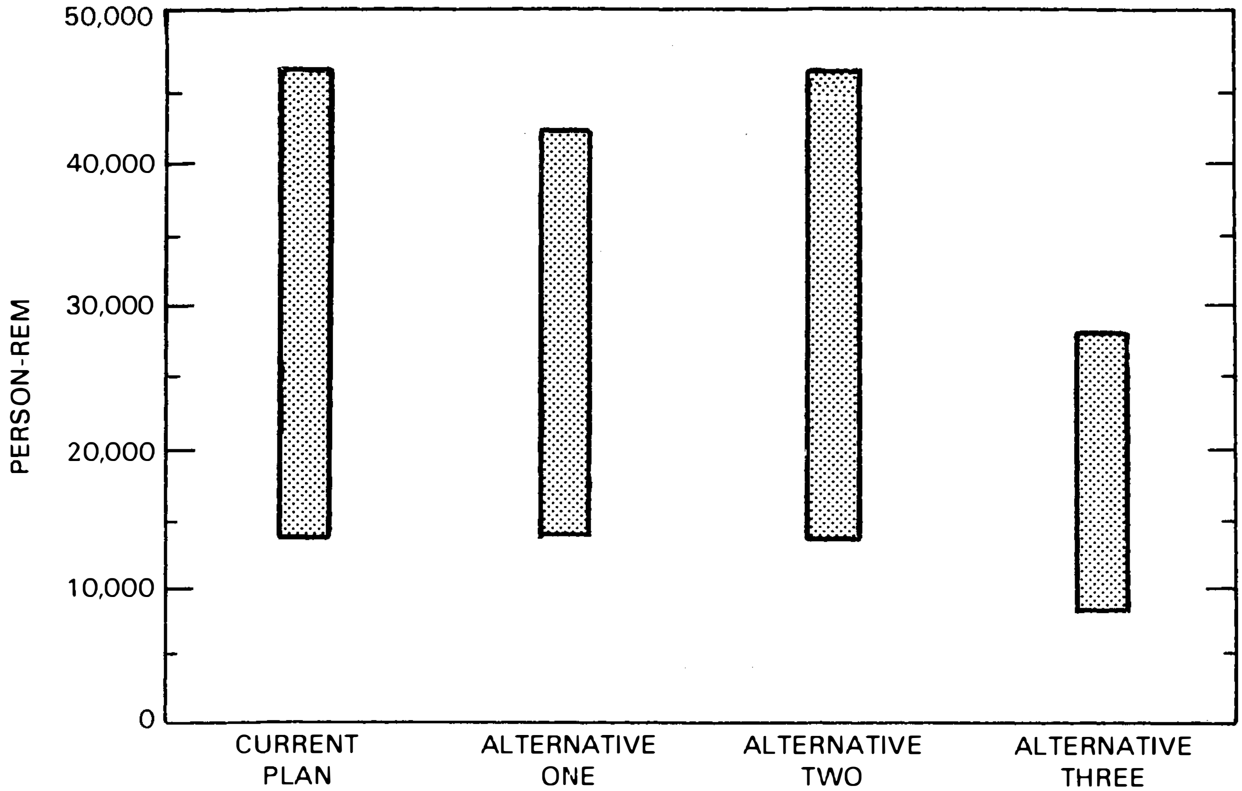

FIGURE 2.9. Occupational Radiation Dose to Complete Cleanup

2.6.3 Analysis of Time Schedule

The prompt removal of fuel and cleanup of the reactor building affects worker dose, both directly because of routine maintenance and indirectly because of ease of cleanup. An attempt was therefore made to determine the relative effect of the current plan and the alternatives on the timing of fuel removal and the completion of cleanup. To do this, four schedules (presented as Figures 2.10, 2.11, 2.12, and 2.13) were prepared to reflect the plan and the alternatives. These schedules are presented in time intervals rather than years. The intervals used here correspond roughly to the periods used by the licensee in estimating radiation dose (Kanga 1983). If resources were unlimited, an interval could correspond to 6 to 9 months. Under the best conditions of available resources, it probably represents 1 year; under less favorable conditions, 2 years. These schedules show the earliest probable start time and the latest start time for each activity. Because of the unique nature of many of the cleanup tasks to be performed, there is an amount of uncertainty for the duration of those cleanup tasks. Also, because of the sequential nature of many of the cleanup tasks (e.g., under the present plan, fuel removal is preceded by reactor head removal and subsequent plenum removal), the starting and finishing date of many cleanup tasks will have a cascading effect on the starting dates of subsequent tasks. Each of the

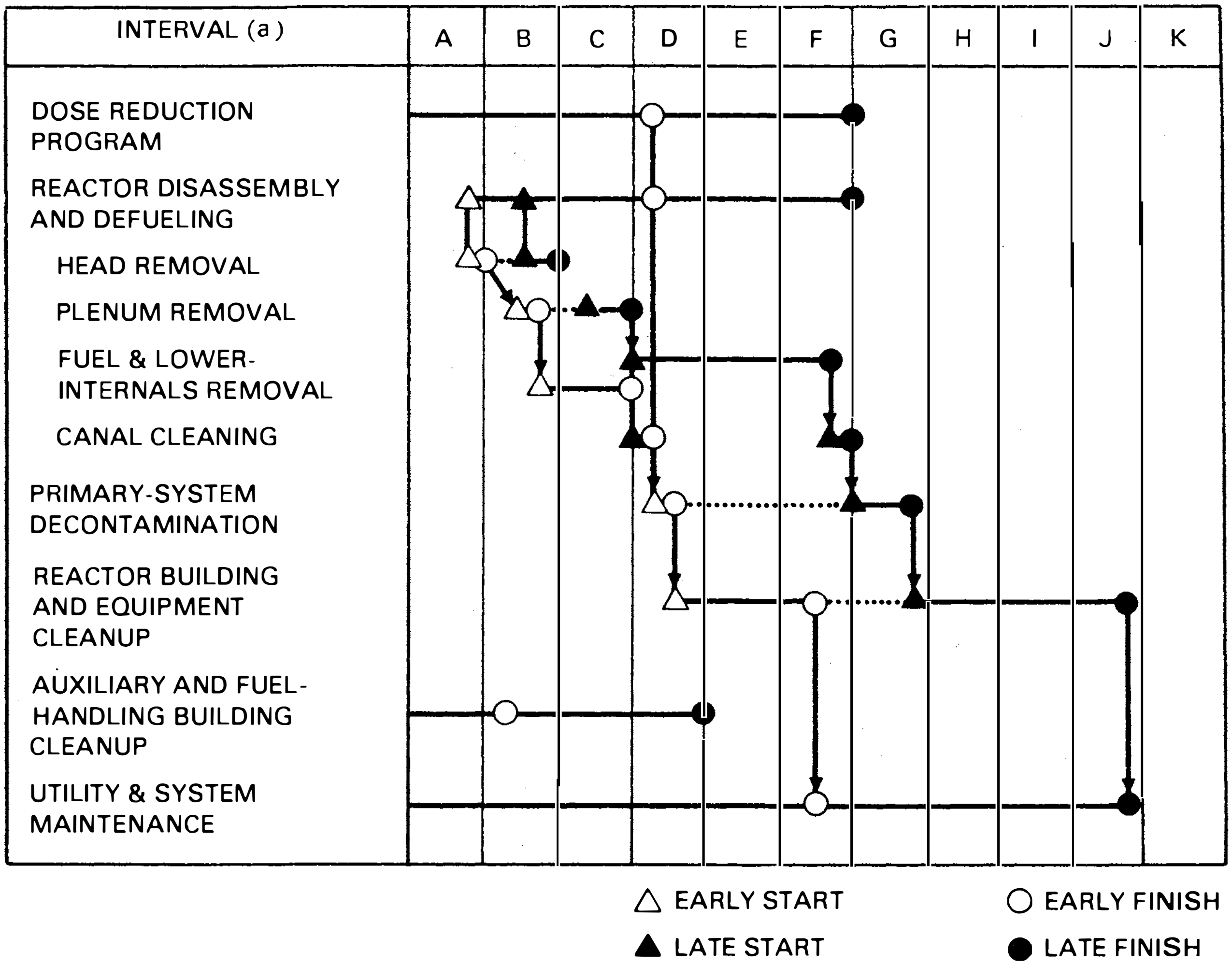

FIGURE 2.10. Conceptual Schedule for the Current Plan
(a) an interval represents a time period of 6 months to 2 years - see Section 2.6.3.

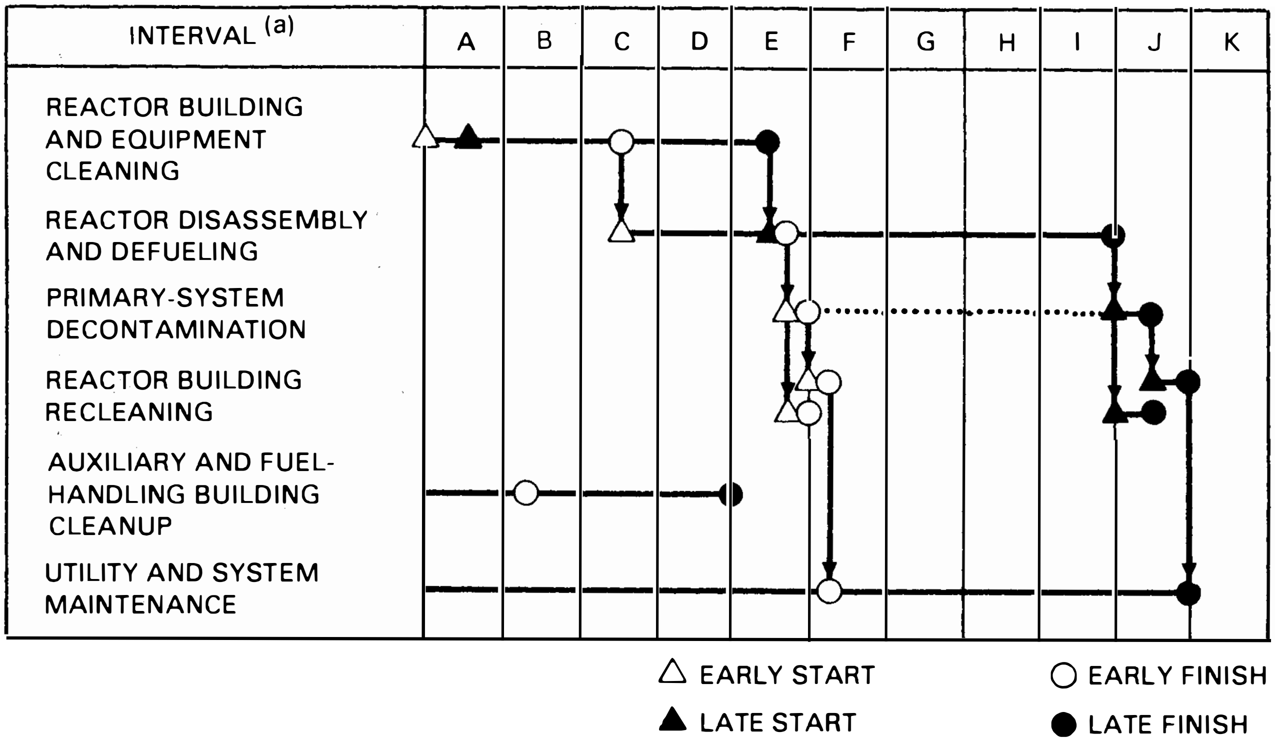

FIGURE 2.11. Conceptual Schedule for Alternative 1
(a) an interval represents a time period of 6 months to 2 years - see Section 2.6.3.

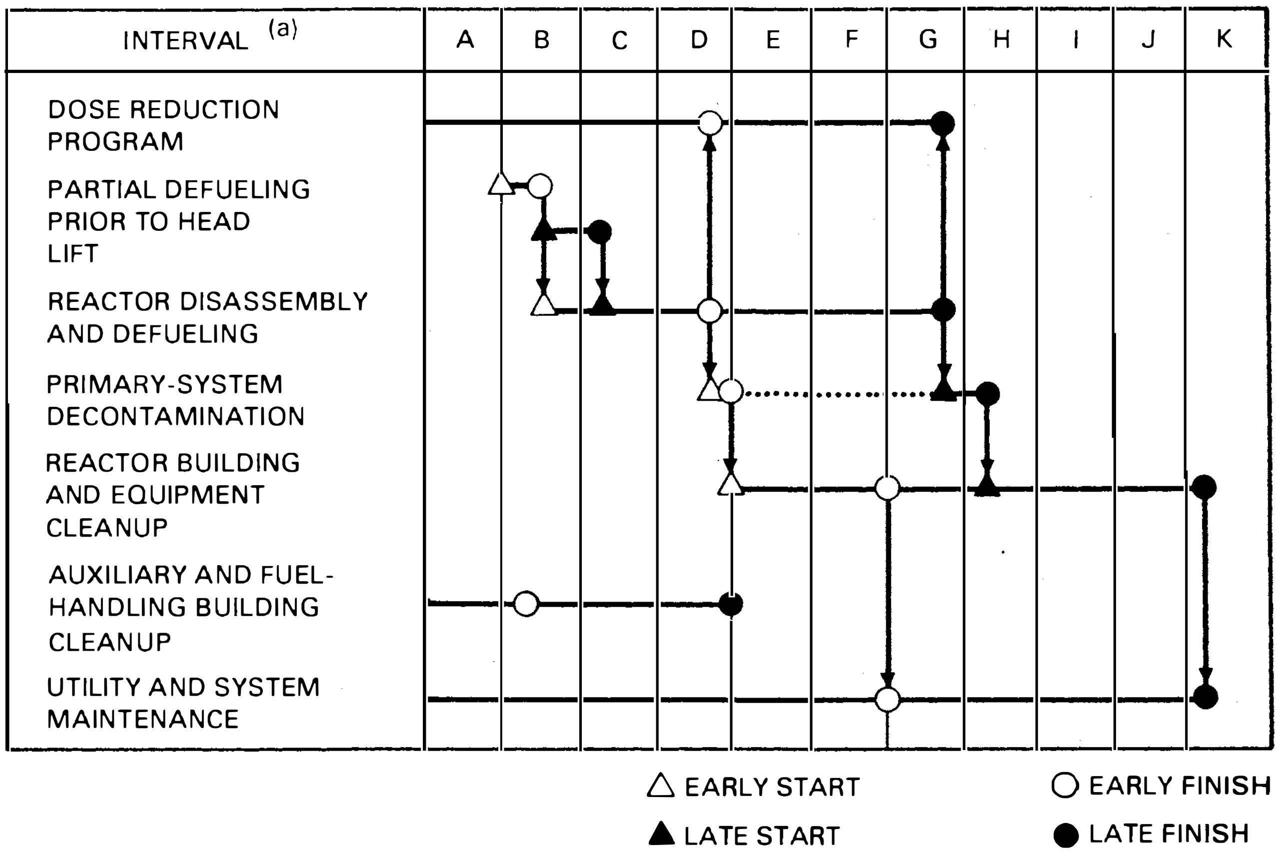

FIGURE 2.12. Conceptual Schedule for Alternative 2
(a) an interval represents a time period of 6 months to 2 years - see Section 2.6.3.

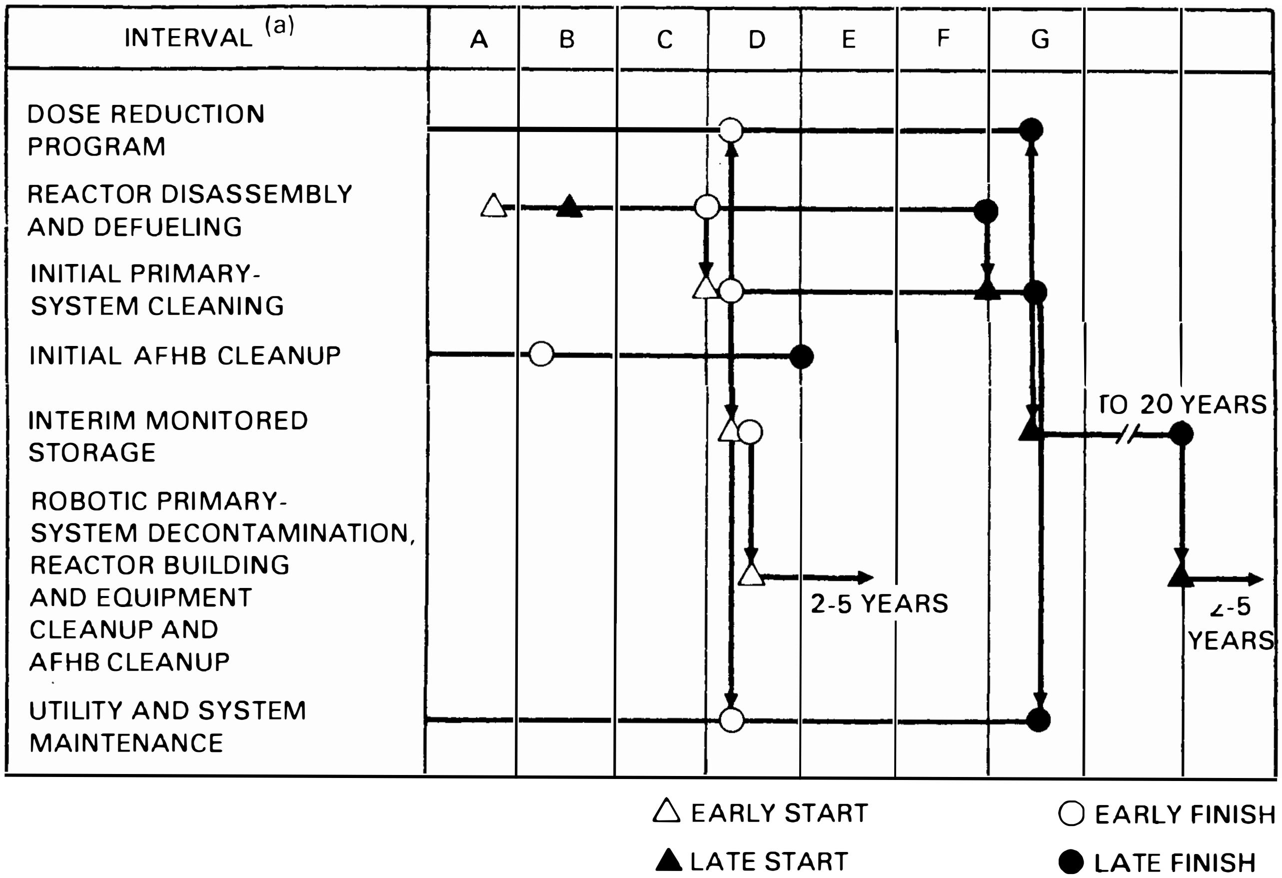

FIGURE 2.13. Conceptual Schedule for Alternative 3
(a) an interval represents a time period of 6 months to 2 years - see Section 2.6.3.

schedules presented in Figures 2.10 through 2.13 show an early start and early finsih sequence along with a more pessimistic late start and late finish sequence. However, the two sequences should not be completely decoupled. For example, one could have an early start and finish for one task followed by a more lengthly period necessary to complete the subsequent task. In that case, the subsequent task would have an early start date, however, the duration of the task will correspond to the late start and late finish interval. The actual completion date for the subsequent task would then fall between the early finish and late finish dates as illustrated in those schedules. The duration of major tasks in the various approaches to cleanup is discussed below.

Under all options, reactor disassembly and defueling must await the requalification of the polar crane. Under Alternative 1 (extensive cleanup followed by defueling), disassembly and defueling must also await the completion of reactor building cleanup. Under Alternative 2 (phased defueling followed by reactor building cleanup), disassembly and the completion of defueling must await the design, fabrication, and operation of a system to remove fines through the reactor head. For all approaches, disassembly and defueling (from head removal through transfer canal cleanup) was estimated to require a minimum of 2-1/4 intervals and a maximum of 4-1/2 intervals, illustrated in detail in Figure 2.10.

Reactor building cleanup was estimated to require between 2 and 3 intervals under the current plan and Alternative 2 (phased defueling followed by reactor building cleanup). Under Alternative 1, when building cleanup would precede defueling, it was estimated to require between 2-1/2 and 4 intervals because of the need to maintain some safety systems in operable condition. In addition, under Alternative 1, the reactor building would require some additional cleaning following both defueling and primary-system decontamination.

Primary-system decontamination was estimated to require 1/4 to 1/2 interval following defueling for all cases in which it would be performed. Cleanup of the auxiliary and fuel-handling building was estimated to require from 1-1/4 intervals to 4 intervals, and utility and system maintenance is required under all options for as long as work is going on.

As shown in Figures 2.10 and 2.13, the current plan and Alternative 3 (defueling followed by delayed cleanup using robotics) provide for the earliest defueling, completed in 3-1/4 to 6 intervals. Alternative 2 (phased defueling followed by reactor building cleanup) would delay the completion of defueling to 4 to 6-1/2 intervals. Alternative 1 (extensive cleanup followed by defueling) would have the greatest impact, delaying the completion of defueling to between 4-1/2 and 8-1/2 intervals.

The completion of cleanup also varies with the alternatives. The current plan and Alternative 1 are comparable in this area, with cleanup completed between 5-3/4 and 9-3/4 intervals. Alternative 2 (phased defueling followed by reactor building cleanup) would extend the cleanup time to between 6-1/2 and 10-1/4 intervals. Under Alternative 3 (defueling followed by delayed cleanup using robotics), final cleanup might not be completed for more than 30 years.

2.6.4 Analysis of Technical Feasibility

The technical feasibility of the various alternatives was also evaluated. Alternative 3, involving delayed cleanup by robotics, would clearly have some drawbacks in this area. Current models have suffered from reliability problems. In addition, there is no assurance that robotic technology will progress to the point at which robots could perform all phases of cleanup. However, current models are capable of some cleanup tasks, and the development of more versatile models appears to be progressing rapidly. Under Alternative 1, the ability of the licensee to meet the goals set for building and equipment decontamination prior to defueling is subject to some doubt. Fuel in the primary system might preclude meeting these goals. The current plan and Alternative 2 (phased defueling followed by reactor building cleanup) were both judged to be technically feasible.

2.6.5 Summary Analysis

The staff has determined that, in terms of the nature of the activities involved, the current cleanup plan, Alternative 1, and Alternative 2 all fall within the scope of the PEIS. The interim-storage phase of Alternative 3 does not. All of the options have advantages and drawbacks (summarized in Table 2.5), and all would involve an occupational radiation dose beyond that estimated in the PEIS.

TABLE 2.5. Summary Evaluation of Cleanup Alternatives

Criterion	Current Plan	Alternative 1	Alternative 2	Alternative 3
Public Safety	No change[a]	No change[a]	No change[a]	Safety of interim storage not evaluated
Occupational Dose	Equivalent[b]	Equivalent[b]	Equivalent[b]	Lower
Time for Fuel Removal	Early	Latest	Later	Early
Time for Cleanup Completion	Early	Early	Later	Not completed in a defined time
Technical Feasibility	Feasible	Feasible with some reservations	Feasible	Feasibility not assured

(a) No significant change from that assessed in the PEIS.
(b) The current plan and Alternatives 1 and 2 were assessed to be equivalent in terms of occupational dose.

The current plan is equal or superior to the alternatives with respect to all criteria except occupational dose; Alternative 3 would result in a lower occupational dose, but currently the technical feasibility of Alternative 3 is not assured.

Alternative 1 (extensive decontamination followed by defueling) has the drawback of delaying fuel removal. There is also some question regarding the feasibility of meeting the 10-mrem/hour decontamination goal prior to defueling and primary-system decontamination. Alternative 2 (phased defueling followed by reactor building cleanup) is equivalent to the current plan with respect to public safety and technical feasibility. It has the drawback of delaying both fuel removal and final building cleanup.

Alternative 3 (defueling followed by delayed cleanup using robotics) is expected to be superior to the current plan with respect to occupational dose and equivalent with respect to the time for fuel removal. It would, however, result in an undefined, but possibly very long, delay in the time required to complete cleanup. The safety of the monitored, interim-storage phase could not be evaluated at the present time, but some increased risk to the public is expected to result from delaying final cleanup. The major difficulty in assessing Alternative 3 was in regard to technical feasibility. There is little doubt that the majority of building cleanup could not reasonably be accomplished using robotic technology at the present time. One can only speculate on what the state of robotic technology will be in the 0 to 20 years following defueling. The staff prefers to present Alternative 3 as an alternative that may warrant further consideration after defueling is complete, but cannot be considered feasible at the present time.

3.0 REVISED ENVIRONMENTAL IMPACTS

The most significant environmental impact defined in the PEIS was the radiation dose to workers during cleanup operations: it was determined in the PEIS that offsite dose is not going to be significant. The revision of the estimated occupational dose was calculated for this supplement to the PEIS, based on new information regarding the difficulty of cleaning up the reactor building and the auxiliary and fuel-handling building.

In Section 2 of this document, various alternatives for the cleanup of TMI-2 were described. Occupational radiation doses were estimated for reactor building cleanup, auxiliary and fuel-handling building cleanup, primary-system decontamination, reactor disassembly and defueling, and dose reduction efforts. In all cases, a range of values was given for the occupational dose, representing the uncertainty of the estimates. This section of the supplement discusses the revised occupational-dose estimates and resulting health effects. The discussion is divided into three sections. Section 3.1 discusses the population that would receive the occupational dose from the cleanup. Section 3.2 summarizes the estimated occupational doses that would result from cleanup. Section 3.3 discusses the potential health effects associated with those estimated occupational doses.

3.1 AFFECTED POPULATION

The only population group considered in this supplement is composed of members of the workforce who enter radiation zones at TMI-2 while conducting cleanup operations. These workers are over 18 years old (average age is 42), in good health, and primarily male. They are employed by the licensee and the licensee's subcontractors, the Department of Energy and its subcontractors, and the Nuclear Regulatory Commission and its subcontractors.

3.2 REVISED OCCUPATIONAL-DOSE ESTIMATES

The cumulative occupational radiation dose to complete cleanup of TMI-2 is presented in Table 3.1 for each of the four cleanup options. As discussed in Section 2.6, the current plan and Alternatives 1 and 2 are considered acceptable at this time. Of these, the current plan represents the most probable course of action for the licensee. Regardless of which option is chosen, three operations are responsible for 90% or more of the total occupational dose associated with cleanup. These three operations are:

- reactor building and equipment cleanup
- reactor disassembly and defueling
- dose reduction.

The highest percentage of the total dose will result from reactor building and equipment cleanup. This operation is necessary to meet the cleanup objectives.

TABLE 3.1. Cumulative Occupational Radiation Dose Associated with Each Cleanup Option (person-rem)

	Current Cleanup Plan	Alternative 1	Alternative 2	Alternative 3
Reactor Building and Equipment Cleanup	5,900-21,000	9,000-30,000	5,900-21,000	300-3,500[a]
Reactor Disassembly and Defueling	2,600-15,000	820-6,500	2,600-14,000	2,600-15,000
Primary-System Decontamination	56-970	39-780	56-970	11-190
Dose Reduction	2,000-5,100	-0-	2,000-5,100	2,000-5,100
Auxiliary and Fuel-Handling Building Cleanup	500-1,400	500-1,400	500-1,400	97-1,400
Utility and System Maintenance	100-200	100-200	140-280	80-160
Radioactive Waste Management and Transportation[b]	97-485	97-485	97-485	97-485
Other	-	12-630[c]	140-540[d]	0-620[e]
Dose Received To Date in Cleanup	2000	2000	2000	2000
	13,000-46,000	13,000-42,000	13,000-46,000	7,200-28,000

(a) Includes dose to robotically complete primary-system decontamination and to complete cleanup of the auxiliary and fuel-handling building.
(b) Based on information from the PEIS.
(c) For recleaning of the reactor building.
(d) For defueling operation prior to head lift.
(e) For interim care of reactor building and auxiliary and fuel-handling building for up to 20 years.

Reactor disassembly and defueling will lead to the next largest portion of the total dose. This operation is essential to the cleanup effort because it assures public safety and provides for removal of the largest quantity of radioactive material from the site.

The dose reduction program is associated with approximately 10% of the total occupational dose for the current cleanup plan and Alternative 2. There is no separate dose reduction program under Alternative 1 because any dose reduction work done as part of this option would be included in reactor building and equipment cleanup. For the current plan and Alternative 2, the dose reduction program will result in lower total occupational dose for cleanup than if the program were not carried out. The dose reduction program is part of the licensee's effort to maintain occupational radiation doses ALARA.

3.3 POTENTIAL HEALTH EFFECTS

Occupational radiation exposure of the workers involved in the cleanup of TMI-2 is limited by the requirements of federal regulations 10 CFR 20. Nevertheless, even individual radiation doses less than the limit of 3 rem per quarter may have the potential for inducing health effects in the exposed workers or in their offspring. A great deal of data on the biological (health) effects of radiation has been accumulated on a worldwide basis over the past several decades. These data have been analyzed by international and national organizations responsible for radiation protection, i.e., the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1977), the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiations (BEIR 1980), the National Council on Radiation Protection and Measurements (NCRP 1975), and the International Commission on Radiological Protection (ICRP 1977). The findings of these organizations, in particular the findings of the Committee on the Biological Effects of Ionizing Radiation (the BEIR Committee), are the basis for estimating radiation-related human health effects in this document.

The radiation doses which a worker involved in the TMI-2 cleanup will experience in the course of that effort may result in somatic effects (effects to the body of that worker) and genetic effects (effects to the worker's yet-to-be conceived children and more remote descendents). The somatic effect typically of greatest concern is the possibility of inducing a fatal cancer; the genetic effects include a variety of inheritable changes that may result in deficiencies or health problems in future generations.

Published estimates of risk factors for both somatic and genetic effects are scattered over a wide range. The staff has chosen to use the following factors:

- 131 fatal cancers in the exposed workers per one million person-rem (BEIR I 1972).

- 220 genetic effects among the offspring of the workforce per one million person-rem (BEIR III 1980).

The work force for the TMI-2 cleanup will be exposed predominantly to penetrating radiation distributed over the whole body, so that any consequences will not be restricted to a particular area or organ of the body. More detailed information on the health effect risk estimators used by the staff is contained in Appendix Z of the PEIS (Volume 2).

It should be stressed that these risks, or probabilities, are increments above or additions to those risks to which the entire population currently is exposed. Current public health statistics show that, for the entire U.S. population, there is a 1 in 5 probability that death will be due to some form of cancer. The normal occurrence of hereditary deficiencies and ill health in the offspring of the present U.S. population is about 1 in 9. The occupational dose to the work force cleaning up TMI-2 may increase the workers' risk of death from cancer, but, as discussed below, this added risk is relatively small in comparison with the existing risk. In addition, the risk of genetic effects among the offspring of the work force may increase, but this increment is also very small compared to the natural occurrence of hereditary deficiencies and ill health.

Potential health effects from occupational exposure to radiation were calculated for the work force on the basis of radiation doses ranging between 13,000 and 46,000 person-rem. For the minimum-collective-dose case (13,000 person-rem), 2 additional fatal cancers may occur. For the maximum-dose case (46,000 person-rem), 6 additional cancer fatalities may occur. These 2 to 6 cancer fatalities would be in addition to the approximately 2000 deaths from cancer that would occur naturally in a work-force of 10,000 without this occupational exposure. These 2 to 6 potential cancer fatalities would not be statistically discernable. That is, this number falls well within the statistical variations of the approximate 2,000 deaths from cancer from natural cancer such that no statistically significant cases of cancer deaths among the cleanup workers would likely be attributable to radiation exposures from the cleanup.

The total number of potential additional cancers, both fatal and nonfatal, from the occupational exposure would be approximately 1.5 to 2 times the number of potential fatal cancers, according to the 1980 BEIR report. Although it is possible to compute a range of probabilities for cancer induction among average individual workers based on the above figures, the results of such a calculation may not bear a close relationship to actual risks since the work force size and collective dose associated with the various tasks can differ by large factors, rendering inapplicable the concept of an average individual worker.

The licensee applies administrative controls for doses to its employees in order to ensure compliance with the regulations given in 10 CFR 20. These controls result in keeping most doses to less than 1 rem/quarter (see Figure 1.3). Most of the workers involved in the cleanup can be expected to be in this category. The regulations of 10 CFR 20 limit the highest quarterly dose that an individual worker may received to 3 rem/quarter. Individuals are not allowed to receive exposures in excess of 1 rem/quarter unless there are special circumstances. For example, a complex task that would normally be done by a single worker might require several workers if the 1-rem/quarter administrative control were imposed. In such situations, the total exposure to the work force can often be reduced if one worker is allowed to exceed 1 rem/quarter (but not the 10 CFR 20 limits) in order to complete the task.

For an individual worker who gets 1 rem/quarter throughout an assumed 9-year cleanup period, the total dose would be 36 rem. For a person of age 30, the probability of dying of cancer from normal causes is, as discussed above, about be 1 in 5. The added probability of a premature death from cancer as a result of receiving a radiation dose of 36 rem would be 1 in 210. Thus, for the decontamination workers, the overall probability of death from cancer would be 1 in 4.9. The equivalent decrease in life expectancy from a 36-rem dose would be about 23 days. The risk for a younger worker would be greater, and for an older worker it would be less.

The number of potential additional genetic effects totalled over all future generations of the offspring of the workforce is estimated to be 1 for the minimum-collective-dose case, assuming that about one-third of the collective dose is a genetically-significant dose (according to ICRP Publication 26, paragraph 80, 1977, it is assumed that about one-third of the occupational radiation dose is received by workers who have offspring subsequent to the radiation exposure). For the maximum-collective-dose case, the number would be 3. The potential number in the workers' children (i.e., the first generation of offspring) would be one-third to one-sixth of the total number of genetic effects over all generations. The normal (exclusive of occupational dose) incidence of genetic disorder in 10,000 offspring would be about 1100. BEIR III indicates that the mean persistence of the two major types of genetic disorders is about 5 generations and 10 generations.

In the discussion above, the staff has treated the selected risk estimators (131 fatal cancers, 220 genetic effects per one million person-rem) as if they were unique, accurate values. The purpose was to make the discussion understandable to the general public. Some commenters have proposed risk estimators which differ greatly (see Appendix A, comment letter #20 from Drs. Pisello and Piccioni and its enclosure). However, the values that the staff considers are the most reliable values are those provided by the ICRP, UNSCEAR, and the BEIR Committee in their publications of the past dozen years, and these values fall within a relatively small range. For the range of annual individual doses reported for the TMI-2 cleanup through 1983, i.e. less than 5 rem per year, the values fall between zero and 568 fatal cancers per million person-rem for somatic effects. The staff believes that the somatic effects risk estimator may be considered with confidence to be in the range of zero to about four times the value used in this document. The staff does not consider any of the estimates to deserve representation by more than one significant figure; the use of 3 figures here only helps identify the particular value and relate it to its derivation.

Table 3.2 (adapted from Table 2.10 of Appendix Z of the PEIS) shows the assortment of values for the cancer fatality risk estimator published by the BEIR Committee and by UNSCEAR since 1971. The values range from about one half that used by the staff to about four times as large. Furthermore, for collective doses consisting of exposures amounting to at most a few hundreds

TABLE 3.2. Comparison of Fatal Cancer Risk Estimators

Source	Cancer Mortality Estimators (deaths/10^6 person-rem)
NRC staff (PEIS)	135[a]
BEIR, 1980[b]	67-169
BEIR, 1972[c]	115-568
UNSCEAR, 1977[d,e]	75-175

(a) Risk estimator used for members of the public. For workers, a risk estimator of 131 deaths/10^6 person-rem was used. This value accounts for worker age-specific (20-70) radiosensitivity.
(b) Linear-quadratic dose-response model for absolute and relative projection models. These values represent the BEIR committee's stated best estimate. However, the committee also pointed out that there are arguments that also favor the linear and pure quadratic effects models. Corresponding estimator values for the linear model are 158-403. The pure quadratic model provides estimates lower than the linear and linear-quadratic models, but values were not calculated for this case.
(c) Values obtained from Table V-4, BEIR, 1980, are an update of values obtainable in Table 3-3 and 3-4 of BEIR, 1972. Range attributable to differences between absolute and relative projection models.
(d) Range of estimates for low-dose, low-LET radiation (UNSCEAR 1977).
(e) UNSCEAR chose to not publish any revised somatic effect risk estimators in its 1982 report due to the then unresolved proposed revision of the estimates of doses received by the populations of Hiroshima and Nagasaki.

of millirem to an individual per year in addition to background, the BEIR Committee stated that the possibility of zero is not excluded by the data. The largest estimator from Table 3.2, 568 fatal cancers per million person-rem, indicates 7 to 26 potential fatal cancers for 13,000 to 46,000 person-rem. The smallest, 67, indicates 1 to 3 potential fatal cancers.

The values for the genetic effects risk estimators published by the BEIR Committee in their 1972 and 1980 reports, by UNSCEAR in their 1977 and 1982 reports, and a result from an ICRP Task Group, together with the estimator used by the NRC staff are all within the range of 60 to 1500 per million liveborn offspring due to 1 rad exposure to each parent. If the largest of the estimators in BEIR, 1980, (i.e., 1100) were applied to the collective dose range of 13,000 to 46,000 person-rem and assuming one-third of the dose is genetically significant, the corresponding range of number of potential additional genetic effects for all following generations is estimated to be 5 to 17. Use of the smallest estimator, 60, produces estimates of one or less than one.

4.0 CONCLUSIONS

In this supplement to the Programmatic Environmental Impact Statement, the NRC staff has reevaluated the occupational radiation dose and the health effects associated with the proposed cleanup of Three Mile Island Unit 2. As a result of this evaluation, the staff has reached the following conclusions:

- All options for the TMI-2 cleanup evaluated in this supplement involve occupational radiation doses higher than those predicted more than 3 years ago in the PEIS. The basis for these revised estimates is increased knowledge of the conditions inside the reactor building and of the effectiveness of decontamination and dose reduction efforts.

- The costs of the cleanup, in terms of environmental impacts, are in the radiation exposures and potential health effects among the cleanup workers. Despite the possible increase in radiation exposures to the workers, the benefits of cleanup, especially reactor disassembly and defueling, still exceed the drawbacks. The major benefit of the cleanup will be the elimination of the continuing risk of potential uncontrolled releases of radioactivity to the environment from damaged fuel or from the radioactive contamination which is distributed throughout the primary system, the reactor building, and the auxiliary and fuel-handling building. It is the staff's judgment that the conclusion of the PEIS that "cleanup of the TMI-2 facilities should proceed as expeditiously as reasonably possible to reduce the potential for uncontrolled releases of radioactive materials to the environment" remains valid, at least through the defueling stage.

- Another benefit of cleanup is the additional knowledge that would be useful for reducing the risks and consequences of possible future accidents at nuclear power plants. This earlier PEIS conclusion remains valid. While considerable information has already been obtained in the cleanup to date, much more data remains to be obtained as the focus of the cleanup is directed towards reactor disassembly and defueling. The information to be obtained increases the understanding of fission product behavior resulting from severe accidents, the metal-water reaction and the corresponding generation of hydrogen, the management of very highly contaminated liquid and solid radioactive waste, the management of gaseous radioactive waste, decontamination methodology and techniques, radiological and physical protection of workers in highly contaminated areas, and radiation and environmental effects on materials and equipment. This information could be applied to current and planned nuclear power facilities in a variety of areas including plant and equipment layout and design, accident mitigation system design, instrument location and design, radioactive waste processing system design, surface coatings for contamination control and mitigation of fission product releases from severe accidents.

- The only means identified in this supplement for substantially reducing the occupational dose is the extensive use of robotic technology. Under any cleanup plan that makes use of this technology, the feasibility of completing the cleanup will depend on developments in robotics, which are uncertain at this time. Because the highest dose is associated with reactor building and equipment cleanup, adoptation of this approach can be reconsidered following defueling or when there are sufficient developments in robotic technology.

- Decontamination workers at the plant will receive a total collective radiation dose estimated at between 13,000 and 46,000 person-rem for the whole cleanup program. These ranges are broad because of uncertainties about the plant conditions and about the amount of work that will be needed to decontaminate the reactor building and its contents.

  Doses to individual workers are limited by the health and safety standards in federal regulations. The licensee has agreed to set administrative controls that are lower than the limits in federal regulations to make sure that exposures of individual workers will be below the federal limits. Estimates of potential health effects due to exposure of the workforce have been made assuming that individual worker exposures are within regulatory limits. In the analysis in this report, it has been conservatively assumed that any exposure to radiation has a finite probability of causing cancer in the exposed workforce, and a finite probability of causing genetic abnormalities in the offspring of the exposed workforce. Using the preceding range of collective dose estimates (i.e., 13,000 to 46,000 person-rem), the staff estimates that about 2 to 6 potential permature cancer deaths may occur in the total exposed workforce, during the remaining lifetime of the workers. In addition, a total of about 1 to 3 potential additional genetic disorders may occur over all future generations of offspring of the exposed workforce. The staff has used a central value for health risk estimators in estimating these health effects. In addition to uncertainties in collective dose estimates, there are also uncertainties in the data base used to estimate health effects. Using the most widely accepted range of health risk estimators, the staff estimates that the range of potential cancer deaths extends from 0 to as high as 26 for the highest workforce exposure estimate. In a similar manner, the range of potential genetic disorders extends from less than 1 for the lowest workforce exposure estimate to 17 for the highest workforce exposure estimate. It is important to note that these potential cancer deaths and potential genetic effects, if they occur, would be adeed to the expected 2,000 cancer deaths among the workforce and 5,000 genetic effects in the first five generations of the workers from natural phenomena, assuming a workforce of 10,000. These potential cancer deaths and potential genetic effects, if they were to occur, would not be statistically discernable. That is, the number of health effects falls well within the statistical varitions of the expected cases of cancer fatalities and genetic effects among the cleanup workers and their offspring from causes unrelated to radiation exposures during the cleanup.

- The occupational radiation dose to an individual worker will be limited to less than 3 rem/quarter in accordance with 10 CFR 20. Based on current experience and the licensee's more stringent limits, most workers will receive radiation doses substantially below that limit.

- The most dose-intensive task is reactor building and equipment cleanup, unless this task is done using robotic technology. An early decision to use robotics is not necessary as long as the licensee defuels the reactor before reactor building cleanup.

- The current plan provides the most likely path for early fuel removal. Extensive building cleanup before defueling, or the modification of defueling methods, would cause substantial, unwarranted delays in fuel removal, with attendant risks.

- The dose reduction program has substantial potential for lowering the total radiation dose to workers during the cleanup. ALARA considerations dictate that a significant commitment of funds and managerial emphasis should continue to be placed on this effort.

- Reactor building cleanup concurrent with defueling can also be expected to reduce the occupational dose by removing sources of radiation exposure from the work place.

Other conclusions of the PEIS that do not pertain to occupational radiation dose remain valid. The staff concludes that the cleanup should proceed as expeditiously as possible while ensuring the health and safety of the workers and the public. All work performed as part of the cleanup should be done in a manner that keeps occupational doses as low as is reasonably achievable.

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6.0 DISCUSSION OF COMMENTS ON THE DRAFT SUPPLEMENT

Pursuant to 10 CFR Part 51, the Programmatic Environmental Impact Statement (PEIS) 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, Draft Supplement 1, was transmitted in January 1984 with a request for comments to the following federal, state, and local government agencies:

U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Labor
U.S. Department of Interior
U.S. Department of Interior, Geological Survey
U.S. Department of Transportation
U.S. Nuclear Regulatory Commission, Advisory Panel on TMI Cleanup
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 State Clearing House.

In addition, a notice requesting comments from interested members of the public was published in the Federal Register on January 5, 1984, and about 300 copies were subsequently distributed to individuals and organizations at their request. The staff had two formal meetings with interested members of the public to discuss the draft supplement and to receive comments. Those two meetings took place in Middletown, Pennsylvania on Feburary 15, 1984 and before the Commission's Advisory Panel on TMI-2 Cleanup on April 12, 1984. The comments received from letters to the staff and from transcripts of the two formal public meetings are reproduced in Appendix A of this final supplement, which is reserved solely for them.

The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by revisions in the pertinent sections of this PEIS and in part by the following discussions. Where data corrections suggested in the comments have been adopted by the staff, these changes have usually been made without discussion here. The organization of this section corresponds generally to the ordering of the chapters of the supplement; however, the discussions of comments on similar topics are grouped together. The comment letters to which these discussions apply are referenced by the numbers following the title of each response; these numbers are keyed to the Table of Contents in Appendix A.

6.1 PURPOSE AND SCOPE OF THE SUPPLEMENT

6.1.1 History of Occupational Radiation Doses and Update of Doses to Date (23, 33, 35)

To the extent possible, the staff has grouped past doses and estimates of future doses into general categories that facilitate the understanding of cleanup activities. It is not the intent of this supplement to take the place of the detailed task-by-task record keeping required of the licensee, nor to establish occupational radiation exposure goals for various phases of the cleanup operation. Such activities are best done by the licensee with NRC surveillance and by the NRC regulatory staff onsite, who have available the most current information.

6.1.2 The Financing of Cleanup (3, 35)

The question of the financing of the cleanup is important; however, it is largely outside of the scope of this supplement, except for the proviso that the supplement assumes more-or-less-continuous cleanup progress.

Past delays in processing the water and in re-entering the reactor building are thought to have contributed to the radiation dose, but those delays were not directly funding related. Any future contamination of concrete, rusting of metal, etc. because of delays are not expected to affect doses appreciably as long as cleanup is progressing continuously. The dose that might be incurred in correcting the effects of deterioration over an interim storage period of tens of years has not been evaluated.

6.1.3 GPU Conduct of the Cleanup Operations (14, 28, 32)

The ability of GPU Nuclear and their subcontractors to safely conduct the cleanup operations is under continuous scrutiny by both the NRC staff and, because of the importance of the TMI-2 cleanup, the NRC commissioners.

On September 29, 1980, the NRC issued a Statement of Policy with regard to the requirement of the licensee to proceed with the cleanup. It states that "The Commission will not excuse Met Ed from compliance with any order, regulation or other requirement imposed by this Commission for purposes of protecting public health and safety or the environment." Although the license has been transferred to GPU Nuclear, the successor to Met Ed. as licensee, the commission policy still applies. Should the licensee fail to meet its obligation, the NRC has, under existing laws, the authority to act to ensure that the cleanup proceeds in a timely manner.

6.1.4 Restart of Unit 1 and Upgrade of the Water Polisher at Unit 1 (13, 16, 28)

Issues concerning the restart of TMI-1 are not addressed in this supplement. The staff considers the restart of TMI-1, if authorized, to be wholly independent of the TMI-2 decontamination process.

6.1.5 Use of Hollow Concrete Blocks and Unpainted Concrete (14)

When TMI was being built, an accident such as the one that took place was considered to have a low probability of occurring. Postaccident safety and environmental considerations were concentrated on mitigating the offsite consequences of an accident by methods such as terminating the accident and containing releases to the environment. The use of hollow concrete blocks and unpainted concrete has been found since the accident to contribute to the difficulties of decontamination and will result in a higher occupational dose for cleanup. In hindsight, the use of different materials would have reduced the radiation dose for cleanup and promoted the ALARA principle.

6.1.6 The Pace of Cleanup Activities (8)

The NRC remains committed to the prompt cleanup of the TMI-2 reactor. The staff is constantly monitoring cleanup progress to ensure that public health and safety are safeguarded.

6.2 CURRENT AND ALTERNATIVE PLANS FOR CLEANUP OF REACTOR AND AUXILIARY BUILDINGS

6.2.1 Background Information on Cleanup Work (8, 35)

Although more is being learned about the reactor building and the sources of dose, there are still significant unknowns regarding the occupational dose to complete the cleanup. These relate to the condition of the plenum and reactor internals, the effort that will be required to remove fuel and to decontaminate or remove equipment, and the work that will be needed at the reactor building's 282-ft elevation. The high estimate was formulated taking a very pessimistic view of these tasks, to cover all contingencies. The low estimate was formulated taking a much more optimistic view of the effort and the initial success that it would bring in lowering dose rates. The dose estimates cover all the work to be done, independent of who performs it.

6.2.2 Cleanup Progress and Doses to Date

6.2.2.1 Update of Data (33)

Several of the licensee's comments were designed to update the supplement to December 31, 1983. However, because the comment period was extended several times due to unforeseen circumstances, the December 31 cutoff date appeared inappropriate, and a date of May 11, 1984, was adopted as the cutoff date for incorporating data into the final supplement.

The polar crane has been decontaminated by water spraying and hand wiping. The 347-ft elevation has been decontaminated by water spraying, and the floor surfaces were subsequently coated with a strippable coating that would protect the area from recontamination. Some concrete spalling is planned for this area in the near future. The 305-ft elevation has received less decontamination effort, although some work has been done. Decontamination of this area is not considered an immediate priority because it will be a low-occupancy area during defueling.

The control rod drive mechanism lead screws that were removed were removed at a dose between 3 and 5 person-rem each. This would be a maximum value for future lead screws because they can be handled by crane now that the missile shields have been moved. However, present plans are to shield the lead screws and leave them in the head to avoid this dose.

6.2.2.2 Criticality (35)

Criticality is the name given to the nuclear chain reaction that is used to generate power in operating reactors. It occurs when neutrons from fissionable isotopes (either uranium-235 or plutonium-239) are produced in sufficient quantity to promote additional fissions, which then release more neutrons, creating a self-sustaining chain reaction. Criticality, in addition to generating neutrons, generates heat and a variety of radioactive materials, many of which decay with a very short half-life.

There has not been a criticality in the TMI-2 core since the reactor was shut down at the very beginning of the accident. The risk of a recriticality occurring now is extremely small but is not zero. Criticality is relatively difficult to achieve because many materials that are present in the reactor core (fission products, boron in the reactor coolant, and control rod materials) absorb neutrons and thereby tend to prevent a chain reaction. However, a chain of events involving the dilution of the boron and the physical segregation of fuel and control rod debris could conceivably result in criticality. A criticality in the core at the present time would be dangerous for workers in the building, and could seriously hamper cleanup beyond that anticipated in the draft supplement. There could be some release, but this would be fairly small because the reactor building was designed to contain such a release.

There is a vanishingly small probability of criticality in the near term, but even that low probability coupled with the hazard of extremely long-lived transuranic isotopes leads the staff to reject, as untenable, reactor disposition schemes that would fix the core in place for tens, hundreds, or thousands of years.

6.2.2.3 Other Estimates (29)

Shortly after the publication of the draft supplement, GPU, in a notice to workers, published a chronology of their past estimates of the dose to perform cleanup. Those early estimates were GPU's internal estimates for planning purposes and had no effect on the NRC's estimate of dose to perform cleanup or the NRC's decision to prepare a supplement to the PEIS. The current GPU estimates did influence the NRC in the decision to prepare a supplement.

6.2.3 Other Alternatives

6.2.3.1 Permanent Fixation of Fuel In Place (5, 11, 34, 35)

In the opinion of the NRC staff, there is currently no technology for the safe, permanent fixation of the TMI-2 fuel in place. The question of the need to remove the fuel has been dealt with several times, including in the original PEIS. The unacceptability of in-place fixation is not materially altered by the revised occupational dose estimates.

6.2.3.2 Permanent Entombment of the Reactor Building Following Fuel Removal (14, 35)

Following fuel removal, the major source of threat to public health and safety will have been eliminated. Radiation level in the reactor building, especially in the basement level, will remain high. This alternative suggests that current waste immobilization technology might conceivably be adapted to permanently entomb the remaining contamination (mainly ^{137}Cs with half-life of about 30 years) at the Three Mile Island site. However, under the proposed decommissioning rules currently being prepared by NRC, entombment of a facility would only be allowable if the residual radioactivity will have decayed to a level permitting unrestricted use of the property within a period of approximately 100 years. Therefore, the ENTOMB option is not an acceptable decommissioning alternative for TMI-2, because the long-lived radionuclides resulting from the accident will still be a significant radiation source for much longer than 100 years, the time period assumed for the assured continuance of necessary institutional controls. The staff, therefore, does not consider this to be a viable alternative.

6.2.3.3 Alternatives of Curtailing Cleanup Efforts Following Fuel Removal and Gross Decontamination of Reactor Building and the Reactor Coolant System (31)

In the response to the previous comment, we have said that an alternative that would result in the permanent entombment of radioactive wastes on the site is not acceptable. However, there are other alternatives which do not involve the immediate completion of the cleanup of the reactor building and equipment after fuel removal that merit consideration. Examples of these alternatives are: 1) the alternative involving completion of cleanup robotically after an interim storage period during which the licensee actively developes the necessary technology; 2) to place the facility into a monitored storage phase until substantial decay of the contamination has taken place. Both of these alternatives have the advantage of significantly reducing radiation exposures to the cleanup workers. However, these alternatives would also require the interim storage of the facility in its contaminated condition. The staff will evaluate the environmental consequences of the alternatives of curtailing cleanup efforts following fuel removal. This evaluation will be completed prior to any decision on the licensee's proposed plan of activities following fuel removal. Because the defueling and supporting cleanup activities would be much the same, an early decision on the alternatives of curtailing cleanup efforts following defueling at this time is not necessary.

6.2.3.4 Decommissioning (35)

Even if the decision were already made to decommission the reactor, the next step would be the removal of the fuel, and it would be done in virtually the same way as it will be done under the current cleanup plan. For this reason, an early decision to decommission is not necessary at the present time. Likewise, the initial steps in reactor building cleanup would be the same whether the plan is to refurbish or to decommission. Thus, a decision on decommissioning is not necessary before the irradiated fuel has been removed from TMI-2.

6.2.4 Realism of Alternative 3 (13, 33, 35)

Alternative 3 (defueling following by delayed dismantling) may or may not be a real possibility. Twenty-five years ago, predictions regarding the inexpensive computers available today were not considered realistic by many people, and technology appears to be advancing faster now than it was then. We do not know whether the robots necessary to perform Alternative 3 will be available; however, it is not necessary or desirable to determine at the present time whether Alternative 3 should be pursued. The NRC plans to study Alternative 3, along with other options prior to allowing the licensee to proceed with a significant commitment of occupational dose for building cleanup following the defueling operations.

6.2.5 Dose Estimates for Current Cleanup Plan (8)

The scenarios given in the draft supplement were developed to include the full range of postulated reactor and building conditions. In determining the value of the low-range dose estimates, a reasonably optimistic view was taken regarding reactor building conditions and decontamination success. There is, however, a possibility that individual tasks or subtasks might require less dose than anticipated.

To arrive at the upper-range estimates, an exceedingly pessimistic view was used in assessing the work to be done, the dose rates involved, and the decontamination and shielding success likely to be achieved. It was, however, assumed that there would be more-or-less-continuous cleanup progress and that doses would be kept ALARA. There is, even in the high dose estimates, a possibility that a particular task or subtask might exceed the estimate given, particularly because the doses attributed to individual tasks are affected by bookkeeping practices; for example, the dose to clean the transfer canal following defueling might logically be considered part of the dose to clean the reactor building, the dose associated with defueling, or the dose required to prepare the primary system for decontamination.

The NRC believes, however, that the dose for the entire cleanup will fall in the range given, barring unforeseen improvements such as the extensive use of robotics, or unforeseen difficulties such as criticality during cleanup.

6.2.6 The Term "Defueling" (8)

Defueling means the removal of fuel. It will be the next major step in the cleanup of TMI-2. The use of the term is in no way intended to be euphemistic or to imply that the process at TMI-2 will in any way resemble a normal refueling at an undamaged reactor.

6.2.7 End Point of Cleanup (35)

The stated end point of cleanup is to reduce the dose rates to a level that would be typical of operating plants. The figure of 10 mrem/hr has been used as typical. However, it may not be beneficial to expend sufficient worker dose to reduce dose rates to that level. Before the end of cleanup, the final disposition of the facility will have been decided upon, and the end point can be evaluated in the light of that information. If incurring worker doses to make the building cleaner is not cost beneficial, then the NRC, with appropriate environmental review, would consider alternative end points based on risk-benefit analysis and the state of technology at that time. Because the defueling and cleanup activities planned for the next few years would be much the same regardless of the final dose rate, an early decision on this point is not required.

6.3 ENVIRONMENTAL EFFECTS

6.3.1 Number of Workers Involved in Cleanup (35)

The precise number of workers that will be involved in cleanup is not known. If cleanup ends up requiring only the 13,000 person-rem envisioned in the low estimate and if each worker averaged 4 rem/yr, 3250 person-years would be required. For the high estimate of 46,000 person-rem, 11,500 person-years would be required. Realistically, a large number of workers who are involved in cleanup and receive some dose receive much less than 4 rem/yr, so the actual number of worker years will be greater than the values given above. (These "low-dose" workers are usually involved in preparing procedures, training workers, processing waste, etc.)

The total number of workers will also be a function of the turnover rate of personnel on the job. Some workers will leave for other jobs, some will retire, and others will be contractor employees who are brought onsite as temporary workers to do a specific job (concrete coring, chemical decontamination, etc.). The estimate of 10,000 workers given in the supplement is as good a value as is currently available, but it may be off by a large percentage in either direction. The number of health effects estimated is independent of the number of workers assumed.

6.3.2 Information to the Workers (35)

All licensees of the NRC are required to train their workers in the adverse effects of radiation and in the principles and practices of radiation protection. The risk information to be included in this training is described in Regulatory Guide 8.29, "Instructions Concerning the Risks from Occupational Radiation Exposure." The NRC has met with representatives of the bargaining unit employees at TMI on two occasions. The licensee has likewise held two open meetings for workers and their families. In addition, workers with complaints are free to contact the NRC at any time and are protected from adverse actions by the licensee.

6.3.3 Distinction Between Worker Dose and Public Dose (14)

Although the NRC is fully aware that radiation workers are also part of the general public, radiation protection regulations have historically made a distinction between those who are exposed to radiation of their own volition and those who are not. (A parallel situation exists in the occupational exposure limits for workers under OSHA regulations and the environmental release limits permitted by the EPA.) Radiation limits are different for workers because radiation workers are trained in the principles of radiation protection and are closely monitored to ensure that the regulatory limits are not exceeded.

6.3.4 How Health Effect Estimates Can Be Made When the Mechanism of Cancer Induction Is Unknown (27)

The staff has provided in Section 3.3 conservative estimates of the number of cancer fatalities that may occur due to the occupational radiation exposures during the cleanup. A range of estimates is also provided. For more detailed information on the bases for these estimates, see the referenced reports by the major radiation protection organizations, e.g., BEIR 1980 Chapter II.

6.3.5 Synergistic Effects of Radiation and Decontamination Chemicals (27)

With a few exceptions (e.g, uranium miners who smoked), there is no reliable evidence for synergistic effects (see UNSCEAR 1982, Appendix L). Present estimates do not include the "synergistic effect of chemicals" except for the fact that they do take into account the best available data on radiation workers, and these workers were, in the main, also exposed to a variety of industrial chemicals, in some cases probably to a greater extent than the TMI-2 cleanup workers.

6.3.6 "Natural" Radiation (27)

Webster's New Work Dictionary of the American Language, Second College Edition (William Collins+World Publishing Co., Inc. 1976) defines "natural" as "1. of or arising from nature; in accordance with what is found or expected in nature. 2. produced or existing in nature; not artificial or manufactured...." By either of these two definitions, there is most definitely "natural radiation." The amount of radiation issuing from the earth's crust is diminishing, and has been since the beginning of time, although the rate of decrease is so small that it is hardly discernable during human lifetimes. The amount we receive from space is, as far as we know, not varying according to any trend other than the sunspot cycle.

The level of the natural background radiation varies widely over different locations, with no apparent health effects to the indigenous populations. For instance, in some areas of India where people have lived for thousands of years, each individual receives about 1000 mrem/yr. This radiation is 100% natural and is in addition to the approximately 1 mrem/yr received from man-made sources. It results in no apparent adverse health effects or increased incidences of cancer. However, it is very difficult to study this population relative to a suitable control population because of differences in culture, diet, exposure to disease, etc.

6.3.7 Give the Full Range of Health Effects (20, 31)

The text of Section 3.3 has been revised to show the range of health effects more clearly. Drs. Pisello and Piccioni enclosed with their comment letter (Appendix A, letter #20) a table listing a wider range of fatal cancer risk estimators. However, as stated in response to comment 6.3.25, the NRC has based its risk estimates on reports prepared by the major radiation protection agencies.

6.3.8 What Type of Genetic Damage Might Occur? (35)

The staff's genetic effects risk estimates include only those effects which would have a significant health impact sometime during the person's lifetime. Irradiation has been found to cause in animals the same types of genetic ill health and deficiencies found in the populations not exposed to additional irradiation. In humans, these may include such effects as short-limbed dwarfism, muscular dystrophy, sickle cell anemia, cystic fibrosis, hemophilia, and color blindness. Gross deformities are quite rare because such severe genetic abnormalities are commonly eliminated by miscarriages and similar processes.

6.3.9 Do Other Occupations Involve a Genetic Risk? (35)

Exposure to certain chemicals is known to cause genetic effects.

6.3.10 The Effect on the Aging Process Must Also be Considered (27)

No effect of irradiation at permitted occupational levels on the aging process in people has been firmly established, other than the apparent aging resulting from the effects of cancer. The 1980 BEIR report says, "There is no firm evidence that exposure to ionizing radiation causes premature aging in man or that the associated increased incidence of carcinogenesis is due to a general acceleration of aging." Similar views are given in ICRP Publication 26 and the 1977 UNSCEAR report.

6.3.11 Projected Health Effects Should be Compared With the Natural Incidence (18)

Comparisons of this type have been revised and expanded for clarity.

6.3.12 Use First Generation Risk Estimators to Calculate Genetic Effects on Progeny (33)

BEIR 1980, in its concluding discussion to its chapter on genetic effects, shows the two methods they used to provide roughly equivalent estimates for both first generation and equilibrium effects. Nowhere do they suggest that only first generation estimates should be used and subsequent generations ignored.

6.3.13 The NRC Staff Should Recognize That Occupational Exposure Levels in the Range of Natural Background Radiation are Considered to Represent Negligible Risks to Individual Workers (19, 33)

The text has been revised to indicate that such risks may be small.

6.3.14 A Linear Model is/Is Not Overly Conservative (7, 19, 20, 29, 33)

The revised text explains that the risk estimator used was selected primarily because it suitably represents the range of estimators published by authoritative organizations in the field; it was not selected primarily for its linearity, or lack thereof.

6.3.15 The Risk Estimates Based on the Linear Model Assume No Repair of Injury in the Human Body (19, 33)

The 1980 BEIR report says "Reductions in dose rate may decrease the observed radiation effect per unit dose, particularly for large doses of low-LET radiation, but not for doses in the linear portion of the linear-quadratic dose response model." The TMI-2 cleanup occupational exposures are not such large doses that repair of injury plays a significant role. The risk estimators of Table 3.2 were developed for low-dose, low-dose-rate, low-LET irradiation, and thus are applicable to the TMI-2 cleanup circumstances.

6.3.16 The Potential Cancer Deaths Should be Stated as a Range from Zero to Some Number (7, 19, 33)

Revisions to the text indicate that zero effects are a possibility.

6.3.17 Will the Health Effects of Workers (or Specific Groups of Workers Such as pregnant Women) Be Studied? (35)

Such studies might be performed if it appears that there will be enough data to produce meaningful results. However, a study performed for the NRC, "The Feasibility of Epidemiologic Investigations of the Health Effects of Low-Level Ionizing Radiation," NUREG/CR-1728 (November 1980) indicates that it is unlikely that there would be enough data.

6.3.18 The Risks of Health Effects From the TMI-2 Cleanup Occupational Radiation Exposures Should be Compared with Other Risks (18, 19, 35)

In the commercial nuclear electric generating industry, with an industry-wide average annual individual radiation dose of about 0.8 rem to the whole body, the average risk to the worker (including both the radiation-related risk and the non-radiation related risk) is about equal to the occupational risk in the other public utilities and in transportation, and is less than the risk in the area of agriculture, forestry and fisheries and in the area of contract construction. The occupational radiation exposures in the TMI-2 cleanup are expected to remain comparable to others in the commercial nuclear electric generating industry.

6.3.19 Public Safety Must be Considered as Well as the Safety of the Workers (14, 35)

A primary objective of the defueling and cleanup of TMI-2 is to assure the public safety. The potential for accidental releases of radioactive materials has been evaluated in the PEIS for the cleanup.

6.3.20 Would an Exposure to 3 rems in a Relatively Short Period of Time Increase the Chances of Cancer? (35)

A dose of 3 rems of low-LET (e.g. gamma) radiation is sufficiently small that the risk estimators given in Tables 3.2 and 3.3 are applicable even if the exposure occurred in a very short time.

6.3.21 "No Worker May Average More Than 5 rem per Year for Each Year Past age 18." Five rem seems high. (35)

The limits of 5 rem per year and 3 rem per quarter together with the ALARA requirement, have been effective in keeping occupational exposures at low levels for the vast majority of workers. Thus there does not appear to be a basis for reducing these limits.

6.3.22 Risk Estimates Should be Made Giving Credence to the Works of Those Who Propose Significantly Larger Risk Estimators (1, 5, 8, 29, 34)

The staff has chosen to base its risk estimators on those proposed by the major radiation protection organizations such as the UNSCEAR, the ICRP, the NCRP, and the BEIR Committee. These organizations, in preparing their recommended estimators, review and give due consideration to hundreds of related scientific papers, including the works of those who propose significantly larger risk estimators.

6.3.23 Use More Recent Information on Health Effects of Irradiation (29, 34)

Appendix Z of the PEIS shows that information as authoritative and recent as the 1980 report of the BEIR Committee was indeed considered. Section 3.3 has been revised to show more clearly why risk estimators derived from the 1972 BEIR report were considered suitable. Information from the 1982 UNSCEAR report serves to further support this judgment.

6.3.24 The Uncertainties in the Risk Estimates Should be Prominently Presented (31)

Additional information on the uncertainties has been included in the text.

6.3.25 Both the Range in Potential Cancer Incidence (Morbidity) and Fatalities (Mortality) Should be Reported (31, 35)

Information on the potential cancer incidence has been added to the revised text.

6.3.26 The Range of Consequences Due to the Occupational Doses Projected In the Draft Supplement are Greater Than Indicated Therein (29, 35)

The text has been revised to show the potential range of consequences indicated by the differences in authoritative estimators.

6.4 GENERAL COMMENTS

6.4.1 "Why Haven't Public Comments Been Used?" (16)

One of the NRC's main purposes in issuing the PEIS and the supplement is to allow public review of and comment on the environmental issues of cleanup. Public comments are taken into consideration when the staff evaluates the licensee's proposed actions and when the commission makes policy decisions. Comments that are beneficial have resulted in specific staff actions. For example, comments from representatives of the bargaining unit have resulted in reviews of the communications channel by which workers can suggest improvements in cleanup actions. The modifications in communications channels that resulted from the staff review will ultimately be beneficial in keeping exposures ALARA.

6.5 WASTE MANAGEMENT

(35) The Department of Energy has agreed to take accident-generated waste that it can use for research purposes, at no cost to the utility, and to accept other accident-generated waste for which the utility will reimburse DOE for the handling and disposal costs. Because of this arrangement, the interstate compacts for the handling of waste will probably affect TMI less than they will other reactors.

(35) The dose to those who will perform research on or otherwise handle the waste from TMI is not discussed because it is covered in the environmental and occupational exposure evaluations of the facilities where the waste will be dealt with. (Exposures at these facilities are also required to be as low as is reasonably achievable considering the state of technology and the economics of the situation.)

(35) The transportation of the reactor vessel, steam generators, and other components that would need to be disposed of if the reactor were decommissioned is not addressed because this topic goes beyond the scope of cleanup. If decommissioning were proposed, the evaluation of the waste transportation and disposal would be reviewed at that time.

(35) The Three Mile Island site has never been evaluated as a permanent repository for radioactive waste because there has never been an intent to make it one. At the time TMI-2 was granted a construction permit, it was understood that all radioactive materials would ultimately be removed from the site. Although the complexity of moving those materials has changed since then, this understanding has not been altered.

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

This table lists the sources of the comment letters in the following order: federal government agencies; state government agencies; local government agencies; citizen groups and businesses; individual citizens, listed in alphabetical order. Also shown in the table are the identification numbers which were assigned to individual letters and the page numbers of this appendix where the first page of each letter appears. The letter numbers are used in Chapter 6 (Discussion of Comments on the Draft Supplement) in responding to the comments.

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(a) Excerpts from transcripts of public meeting.

BRYN MAWR COLLEGE
BRYN MAWR, PENNSYLVANIA 19010

DEPARTMENT OF BIOLOGY
BIOLOGY BUILDING
(215) 645-5097

6 January 1984

Mr. Bernard Snyder
TMI Program Office
Office of Nuclear Reactor Regulations
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Worker risk during TMI-2 cleanup

Dear Mr. Snyder,

I have just read the account of your news conference yesterday concerning worker risk at TMI-2 in which it was announced that estimates of total worker exposure during the cleanup operation have been increased from 2,000 - 8,000 person-rems to 13,000 - 46,000 person-rems. If these increased exposure estimates exist in some written report, I would very much appreciate a copy.

The public has been invited to comment on these increased estimates of worker exposure during TMI-2 cleanup. I would like to do so here and to attend NRC meetings in the Harrisburg area. Please send me announcements regarding time and place of these meetings.

Based upon BEIR-III, the new worker exposure levels have been estimated to increase the lethal cancer burden from one to 2 - 6 fatalities and genetic abnormalities in future generations from a maximum of two to 3 - 12. As you know, however, there is considerable disagreement among the scientific community regarding carcinogenic and mutagenic risks inherent in person-rems. Some of this scientific uncertainty is adequately aired in the BEIR-III report itself and its appendices. Much more variation in risk assessment to radiation exposure is seen if one departs from official documentation of the National Academy of Sciences and the NRC.

For the record, and perhaps erring on the side of human health concerns, certainly presenting a conservative extreme in radiation risk assessment, I would like to interpret new worker exposure levels in terms of cancer fatalities and subsequent birth defects according to John Gofman's estimates (Radiation and Human Health, Sierra Club, 1981). If we apply Dr. Gofman's estimates to the TMI-2 worker community, we can expect 48 - 172 additional cancer fatalities and approximately

100 - 350 additional birth defects in worker's children. In the face of uncertainty among the scientific community regarding radiation risk assessment, I feel it is prudent to err on the side of caution.

An additional caveat must be expressed concerning worker safety during the TMI-2 cleanup operation. This past year it has become evident that GPU Nuclear Corporation has economized the cleanup operation by sacrificing certain worker safety precautions to which they had acceded earlier. Hence, in addition to higher radiation levels than earlier appreciated within the TMI-2 containment facility, workers are being subjected to higher radiation exposures than they might had GPU adhered to their original plan.

Again, please send me any published information or reports on reassessment of worker radiation exposure during the TMI-2 cleanup operation and notice of upcoming public meetings on the topic in Harrisburg.

Yours sincerely,

Bruce Molholt, Ph. D.
Lecturer

TELEPHONE 232.7093
AREA CODE 717

MEETS FIRST MONDAY AT 7:30 P.M.
AT 1501 REVERE STREET

INTERNATIONAL
BROTHERHOOD OF ELECTRICAL WORKERS
LOCAL UNION NO. 143

1501 REVERE STREET
HARRISBURG, PENNA. 17104

January 10, 1984

Mr. Lake H. Barrett
Deputy Program Director
TMI Program Office

Dear Mr. Barrett:

I want to thank you for providing me with a copy of the recent draft Environmental Impact Statement supplement dealing with expected occupational radiation exposures during the clean up of Three Mile Island Unit 2. I also appreciate your willingness to meet with the Harrisburg and Central Pennsylvania Building and Construction Trades Council to provide a better understanding and answer questions on your revised estimates and potential health consequences.

I want to state that this Union continues to be concerned that the safety and health of our members, and the general public, will be the primary consideration during any future clean up operation. Having read the P.E.I.S. supplement I understand the need for increasing the original number of persons-rem required for clean up of TMI 2 is based on information obtained during subsequent entries into containment of TMI 2. I also understand and acknowledge that the level of doses that clean up workers have received at TMI 2 are lower than doses received by workers at the majority of NRC licensed reactors. I am convinced that those low exposure rates are due in part to the incredibly slow pace of the clean up operation, and even though increased clean up activities will also mean increased risk of exposure to our members, that clean up <u>must</u> proceed at a faster pace in the future because the TMI site <u>is</u> not suitable as a permanent, or extended, temporary repository for radioactive wastes generated by the accident.

Our acknowledgement that the need for more expeditious clean up of TMI will also increase the risk of exposure to our members should not be interpreted to mean that we have no fear or concern regarding the risk involved. My position remains that ALARA programs must <u>ensure</u> that an individual's risk from occupational exposure is small <u>and is</u> kept as low as is reasonably achievable. I look to both GPUN and the NRC for assurances that increased clean up activities will not proceed beyond the ability to assure ALARA (e.g. proper coordination of activities to assure that one clean up operation

does not impact on other workers in the same area, and also that the clean up procedure never becomes more important than the individuals performing the clean up.

The members of this Local Union and the Building Trades Council have participated in the construction of Unit 2, as well as the clean up work since the accident March 28, 1979. Their knowledge of the facilities and systems in Unit 2, and their experiences to date, working on the clean up, should be considered to be a vital source of information during the planning and engineering phases. Full utilization of this knowledge at this stage will result in fewer changes to "ECM's" and elimination of unnecessary and/or duplicated entries into containment which would increase exposure.

In summary, this Local Union is convinced that the clean up of Unit 2 has been delayed too long. We are ready to proceed with the task at hand. We want the safety and health of our members, and the public, to be the <u>primary</u> consideration during clean up, and we seek a procedure that would <u>require</u> our participation to the extent that we are able, toward the elimination of unnecessary exposure.

Thank you for this opportunity to comment.

Sincerely,

Glenn A. Schaeffer
Business Manager
Local Union No. 143, IBEW

GAS:mp

Eric J. Epstein
352½ W. Orange St.
Lancaster, PA 17603
January 11, 1984

Dr. Bernard J. Snyder, Program Director
Three Mile Island Program Office
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Snyder:

After reading "Answers to Questions About Updated Estimates of Occupational Radiation Doses at Three Mile Island, Unit 2", a few questions have arisen in my mind and I hope you can answer them.

Question 1, (p. 4-Q. 18),: The report maintained a link between a lack of funds and worker safety. However, in a meeting on May 11, 1983 with yourself, Joseph Fouchard and Commissioner John Ahearne, Commissioner Ahearne assured me that, "Lack of money has never been a problem." He also stated that he did not forsee a problem resulting from lack of funds. There is a lack of funds, and all the while GPU continues to use ratepayer money for nuclear promotions and advertisements. Do you feel a diversion of GPU's funds from nuclear promotion would facilitate the cleanup? If not, what other pressure can the NRC exert on GPU and the nuclear industry to raise funds for the cleanup of Unit 2?

Question 2, (P. 5-Q. 21),: The report states that, "The TMI site is not suitable as a permanent repository for radioactive wastes generated by the accident." I agree. However, there are new federal laws concerning interstate transportation, interstate compacts have arisen, and states which once welcomed wastes are having serious reservations. How can the NRC assure the public that these new developments will not result in a long and costly delay in transporting radioactive waste from Three Mile Island?

Question 3, (p. 7-Q. 27),: The report states, "A radiation worker may receive no more than 3 rem of radiation dose in any three-month period. No worker may average more than 5 rem per year for each year past age 18." In 1934 the government said that 50 rem a year was a "safe dose", by 1956 the government had reduced the "safe dose" level to 5 rem. Do you feel that in the last 28 years technology has increased in the nuclear field far enough to warrant a reduction in the "safe dose"? 5 rem seems very high since workers will be exposed to background radiation an other "unexpected" radioactive releases from Three Mile Island. Also would an exposure to 3 rems in a relatively short period of time* increase the chances of cancer?

*By short time I mean any time span within the three month period.

Question 4, (p. 10-Q. 43),: The NRC seems satisfied the GPU is taking every preventative measure to protect woman of child bearing age. Has the NRC ever done a report concerning the percentage of women who work at TMI and have had miscarriages, stillborn babies or deformed babies?

I know your schedule is busy but I would greatly appreciate a prompt reply.

Sincerely,

Eric J. Epstein
352½ W. Orange St.
Lancaster, PA 17603

Dear Mr. Snyder, 1/23/84

My family and I do not support increases in radiation exposures of workers involved in the clean up of TMI Unit 2.

We insist on regulations which [illegible] control [illegible] of radioactive material from TMI Unit 2. We want the surrounding environment to be free from [illegible] this plant has created.

We will continue to watch carefully to see if the human and environment welfare are given top priority.

Sincerely
[illegible]

BIOMEDICAL METATECHNOLOGY, INC.

109 MAYNARD DR., EGGERTSVILLE, NY 14226
(716)-832-4200

January 24, 1984

Dr. Bernard J. Snyder
Tlhree Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

The enclosed letter to the New York Times is a commentary on the mismanagement by NRC that needlessly endangers the health and safety of residents and workers at TMI. If NRC took the trouble to use current risk estimates, it would see the futility of its present clean-up plan and would leave the rods where they belong, in TMI-2.

If NRC would read my DIRECT ESTIMATES OF LOW-LEVEL RADIATION RISKS OF LUNG CANCER AT TWO NRC-COMPLIANT NUCLEAR INSTALLATIONS: WHY ARE THE NEW RISK ESTIMATES 20 TO 200 TIMES THE OLD OFFICIAL ESTIMATES? (my Yale paper (54,1981.,317-328, Yale Journal of Biology and Medicine) it would find more than 30 papers listed where there are positive health hazards from low-level radiation. It is impossible that there would be so many independent scientific reports of hazard unless the actual risks are about 100 times greater than those used by NRC in its decision-making.

Very sincerely yours,

Irwin D. Bross, Ph.D.
President
Biomedical Metatechnology, Inc.

BIOMEDICAL METATECHNOLOGY, INC.

109 MAYNARD DR., EGGERTSVILLE, NY 14226
(716)-832-4200

January 24, 1984

New York Times
229 W.43rd Street
New York City, NY 10036

To the Editor:

Coming as it does almost 5 years after the TMI-2 accident, the Times editorial on management failures in the nuclear industry (Jan.22,1984) shows how long it has taken for the lessons of that accident to sink in. One point is still missed: The reason nuclear management is so difficult is that the health hazards of low-level ionizing radiation are so serious. This is why a minor leak at a conventional power plant may be repaired in a few days while the same leak at a nuclear plant can result in a prolonged shutdown. The health hazards leave little margin for error: Any management mistake can be a fatal mistake.

People in management are no different from other human beings: Not only do they make mistakes but, to make matters worse, they don't like to admit it. This is why the clean-up at TMI-2 could be more dangerous for workers and residents than the original accident. The Nuclear Regulatory Commission plan underestimated the radiation esposures by a factor of at least 10 and the health effects by a factor of 100. Although the clean-up has barely started, NUREG-1050 admits that worker exposure passed 1700 person-rem although the lower limit for the entire clean up was originally estimated at 2000. At that time, I said the estimates were ridiculously low and the NRC's new upper limit has been raised to 46000 person-rem, from 8000.

However because NRC continues to underestimate health risks by a factor of 100, it persists with its original clean-up plan. But even the NRC acknowledges that the risks to workers and residents could be virtually eliminated by an option called "entombment" which would keep the fuel rods on site. This option would cut both the risks and the costs by 90% but would require changes in NRC regulations. For ideological reasons the regulations are sacrosant but sensible nuclear management would change them to save human lives and hundreds of millions of dollars.

If NRC used the risk estimates of normal science instead of those of "official science", cost-benefit analysis would favor entombment. In a class action suit, a Three Mile Island Public Health Fund was set up to do studies of low-level radiation hazards. If the $3,000,000 would be used for the benefit of the residents, it could provide definitive evidence of higher health risks within 2 years and avert the risk to TMI residents from the clean-up. However this is unlikely to happen because the Committee running the fund is dominated by the ideology of "official science" that "low-level radiation is harmless". It has just issued an RFP that virtually precludes research that could settle the issue.

It is gross injustice for the money is to be used to fund "official science" studies by the very persons who have been the adversaries in court of litigants seeking compensation for radiation injuries (as is likely at TMI in the future) instead for the protection of the workers amd residents at TMI.

While the Times editorial deplores "management by ideology", this is hard to change because it benefits the ideologists in the nuclear area. What is now happening at TMI shows how this hurts the public--the TMI residents, the ratepayers, and the taxpayers are all going to pay dearly for the NRC refusal to admit its mistake.

Very sincerely yours,

Irwin D.Bross

Irwin D.Bross, Ph.D.
President
Biomedical Metatechnology, Inc.

P.S.: Metatechnology is the technology for the safe, effective, and economical use of our powerful new technologies.

MARYLAND

DEPARTMENT OF STATE PLANNING

301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201-2365

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

January 24, 1984

Dr. Ronnie Lo
Project Manager
Three Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Reply Due: February 23, 1984

State Identification Number: 84-1-294

State Clearinghouse Contact: Samuel Baker

RE: Draft Supplement Dealing with Occupational Radiation Dose - Three Mile Island Nuclear Station, Unit 2

Dear Dr. Lo:

This is to acknowledge receipt of the referenced subject. We have initiated the Maryland intergovernmental review and coordination process as of this date. You can expect to receive review comments and recommendations on or before the reply date indicated. If you have any questions concerning this review, please contact the staff member noted above.

The State Identification Number must be placed on any financial assistance application form and used in future correspondence.

We are interested in the referenced subject and will make every effort to ensure a prompt review. Thank you for your cooperation.

Sincerely,

Guy W. Hager
Director, Maryland State Clearinghouse
for Intergovernmental Assistance

GWH/cw

TELEPHONE: 301-383-7875
OFFICE OF STATE CLEARINGHOUSE

Oak Ridge Associated Universities
FTS: 576-3171
Post Office Box 117
Oak Ridge, Tennessee 37830

Institute for Energy Analysis

February 7, 1984

Dr. Fred Bernthal
Commissioner
U.S. Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, D.C. 20555

Dear Fred:

I note that NRC has modified its estimate of the number of cancers that will be incurred among the 10,000 workers cleaning up TMI-2. According to the newspaper account, the integrated exposure is now set at between 13,000 and 43,000 man-rems, and the new estimate of cancers is between 2 and 6. The latter figure is obtained by assuming the linear hypothesis with 7,000 man-rems per cancer.

In making this estimate, NRC is ignoring the uncertainty in the cancer dose-response at low dose. According to the BEIR-III report, one cannot exclude a lower limit for cancer induction of zero at the low individual doses (1.3 to 4.3 rems) encountered here. A more accurate and scientifically justified statement by NRC would have been "the estimated number of additional cancers lies between zero and six," not between "two and six." Of course, the actual difference between a lower limit of 2 and 0 is hardly significant—but the psychological impact could be much greater than this. A newspaper reader who learns that there may be no extra cancers I should think would be less apprehensive than he would be were the NRC to state, categorically, that there would certainly be at least 2 cancers.

All of this is by way of urging NRC to re-examine its own position on the linear hypothesis: I cannot object to NRC giving an upper limit to number of cancers per man-rem; I object strongly to NRC, or anyone else, giving a lower limit different from zero when the individual exposures are no greater than 4 rems!

Best wishes for a Happy New Year!

Sincerely,

Alvin

Alvin M. Weinberg
Director
Institute for Energy Analysis

AMW:bc

A.9

BRYN MAWR COLLEGE
BRYN MAWR, PENNSYLVANIA 19010

DEPARTMENT OF BIOLOGY
BIOLOGY BUILDING
(215) 645-5097

8 February 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Comments to Draft Supplement 1 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. Snyder,

Enclosed you will please find my comments to the draft supplement PEIS for TMI-2 cleanup.

Although NRC staff has increased worker radiation exposure expectations six-fold for the duration of cleanup, these maximized expectations still fall short of potential worker exposures due to vast uncertainties in status of TMI-2 plenum, lower core and reactor vessel core support structures. Dissection of fused fuel assemblies, plenum and core support structures will continuously contaminate primary coolant with particulates and fines which must be filtered prior to chemical decontamination via the submerged demineralizer system. Worst case scenarios for worker and environmental exposures have not been taken into account in the draft supplement PEIS for TMI-2 cleanup.

In addition, newer estimates of carcinogenic and mutagenic risks from radiation exposure have not been taken into account since issuance of the earlier PEIS March 1981. Finally, the draft PEIS insists on the euphemism "defueling" for the most hazardous phase of TMI-2 cleanup, the delicate removal of 100 tons of destroyed core and fuel debris.

Yours sincerely,

Bruce Molholt

Bruce Molholt, Ph. D.

D019 1/1

Enclosure

Comment to

DRAFT SUPPLEMENT
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
Supplement No. 1

8 February 1984

Bruce Molholt, Ph.D.
Department of Biology
Bryn Mawr College
Bryn Mawr, PA 19010

Introduction

Due to increased estimates of radiation risks to workers during cleanup of Three Mile Island Nuclear Station, Unit 2 (TMI-2) the U.S. Nuclear Regulatory Commission has been required by the National Environmental Policy Act to issue a supplement to its original Programmatic Environmental Impact Statement dealing with the TMI-2 cleanup. Increased doses to workers are now estimated at 13,000 - 46,000 person-rems, up from the original estimates of 2,000 - 8,000 person-rems.

In my comments to the draft supplement PEIS, I will consider the following issues:

1) Are human risk estimates valid for increased exposures of 13,000 - 46,000 person-rems?

2) Is the upper limit of 46,000 person-rems realistic?

3) What do increased risks to workers mean when translated to nonworkers residing near TMI-2?

4) Can the most critical phase of TMI-2 core cleanup accurately be called "defueling"?

5) Are core decontamination procedures developed such that worker and environmental exposure risks are minimal?

6) What are the risks inherent in delayed TMI-2 core cleanup?

Although worker risk estimates have been increased in the draft supplement PEIS, there is every reason to believe that these estimates are still minimal. Risks

to persons residing near TMI-2 are not included in the supplement draft PEIS and were inadequately addressed in the original final PEIS of March 1981. Unless the TMI-2 core is in danger of assuming re-criticality, there is no reason from the standpoint of worker or public health considerations to push ahead with any of the three alternatives outlined in the draft supplement PEIS.

<u>Are human risk estimates valid for increased exposures of 13,000 - 46,000 person-rems?</u>

Despite the fact that revised health risk estimates exist, for example from the BEIR-III report (Biological Effects of Ionizing Radiation, U.S. National Academy of Sciences, 1980), the draft supplement PEIS continues to rely upon outdated health risk estimates for human exposure to ionizing radiation. In Appendix B, page B.1, the staff relies upon risk estimates from the 1972 BEIR report and its own flawed statistical analysis of 1975, WASH-1400, which also concluded that a TMI-2 type accident should happen once every 20,000 reactor-years.

Various risk estimates for human genotoxic effects from exposure to ionizing radiation have been developed. Despite NRC staff's insistence that their health effect risk estimators are "internationally accepted" (p. iii), many internationally recognized physicians and health physicists would disagree. For example, John Gofman, M.D., former Director of Lawrence Livermore Laboratories, in his authoritative <u>Radiation and Human Health</u> (Sierra Club, 1981) applies a risk estimator of one cancer per 268 person-rems which would translate as 170 cancer deaths from 46,000 person-rem exposure rather than the 6 deaths calculated in the draft supplement PEIS. In addition, Gofman's risk estimates would indicate 340 additional genetic defects among worker offspring at 46,000 person-rem exposure rather than 12 as in the draft supplement PEIS.

Is the upper limit of 46,000 person-rem worker exposure realistic?

The NRC was forced to issue its draft supplement PEIS because data accumulated from hundreds of entries into the TMI-2 containment building since 1980 have indicated that worker exposures were estimated six times too low in the original PEIS. Much of this increased worker exposure estimate comes from realization that the TMI-2 reactor core is largely melted, crumbled and fused, such that workers in core removal will be exposed to prolonged periods of radiation which were underestimated in March 1981. Yet, much uncertainty exists as to the state of the TMI-2 core, as admitted in the draft supplement PEIS:

1) Below the upper plenum there is a core void of about 5 feet where fuel assemblies have been completely destroyed. Under this there is a rubble bed at least 14 inches in depth. "The conditions below the rubble are not known." (p. 2.8)

2) Figure 2.6, a cutaway view of the TMI-2 reactor vessel, shows this uncertainty as to the condition of the lower reactor vessel more explicitly in describing the three lowest levels of the vessel:

a) CORE AREA - CONDITION UNKNOWN

b) LOWER GRID - CONDITION UNKNOWN

c) FLOW DISTRIBUTION - CONDITION UNKNOWN (p. 2.9)

(Emphases mine).

3) Decontamination of the primary coolant may require grit blasting of the reactor vessel and piping before chemical decontamination: "... the most highly contaminated portions of the system, such as the reactor vessel and piping to the pressurizer, may require mechanical decontamination by grit blasting or other methods before, or in place of, full-system chemical decontamination." (p. 2.11, Emphasis mine).

4) Uncertainty exists as to plenum integrity: "Clearance between the pressure vessel and the plenum is only 50 mils (50 thousandths of an inch), so the ease of plenum removal is still open to question as the plenum may be warped." (p. 2.8, Emphasis mine). If the plenum is warped, it will have to be cut up, which would be a potentially "high-dose job." (p. 2.19)

5) Considerable uncertainty exists about decontamination of the primary coolant by the submerged demineralizer system (SDS). This system is easily blocked by particulates, which are planned to be removed by filtration prior to ion exchange adsorption. Yet each step of fuel removal requires extensive cutting and mechanical separation which will reflood the

primary coolant with fines and other particulates. "The fuel removal plans have not yet been finalized because investigations of fuel conditions are still in progress." (p. 2.19) Continual contamination and decontamination of primary coolant by released fines and other particulates during fuel removal could lead to considerably higher worker exposures during this critical phase of reactor vessel cleanup.

6) The mechanics of actual fuel removal are very poorly articulated in the draft supplement PEIS. None of the original 177 fuel assemblies is intact, but the exact extent of fuel pellet fusion, crumbling or the size of debris to be encountered in the bottom of the reactor vessel remain unknown:

a) "The fuel is assumed to be in a combination of the following configurations:

- fused sections--
- core debris--" (p. 2.19, Emphasis mine)

b) "Adjacent pieces may need to be separated in order to be removed." (p. 2.19, Emphasis mine)

7) Finally, there is considerable uncertainty as to worker exposure doses which will result from removal of lower internals at the core support assembly. "If conditions require, it will be cut up for removal." (p. 2.20, Emphasis mine).

The draft supplement PEIS increases potential worker exposure from 2,000 - 8,000 person-rems to 13,000 - 46,000

person-rems as a result of decontamination of the TMI-2 reactor containment vessel and core. Upper and lower estimates of dose differ by a factor of 3.5. Yet, as outlined above, for key sections of reactor vessel and core cleanup, especially in the arena now refered to as "defueling," considerable uncertainty exists as to what impediments to cleanup will be encountered once the reactor vessel is breached. Hence, it is not known whether sensitive segments of the cleanup operation will take weeks, months or even years. These uncertainties make a risk range estimate of 13,000 - 46,000 person-rems, a 3.5-fold range, highly unlikely. Realistically, the upper extreme of this range should be increased according to the worst case scenario which might obtain during TMI-2 reactor vessel and core cleanup.

What do increased risks to workers mean when translated to non-workers residing near TMI-2?

The population residing near Three Mile Island has been persistently exposed to radionuclide releases and accompanying psychological stress as a result of the TMI-2 accident. Upon various occasions since 28 March 1979 this population has been exposed to 20 million curies xenon-133, at least 26 curies iodine-131, 200 curies tritium, 43,000 curies krypton-85 and other radionuclides in their water and air. The present core inventory of radionuclides has a potential health threat far in excess of any previous radionuclide exposures from the accident and its aftermath at TMI-2. In the radionuclide inventory are actinides, including 150,000 curies of plutonium-241, strontium-89/90, cesium-137, cobalt-60 and at least 150 other radionuclide species, all of which are dangerous to human health.

Considerable uncertainty exists as the the state of the plenum, lower core and lower internals of the core support assembly which will determine the difficulty of decontamination and extent of worker radiation exposure (see previous section, pp. 3-6). This same uncertainty translates as potential increased non-worker exposures in residents living near Three Mile Island. There are two potential sources of increased radiation exposures to persons residing near TMI-2 as a result of further stages of the cleanup operation:

1) From unforeseen mechanical failure to heavy equipment during delicate stages of plenum, core or core-support removal. These mechanical failures could include unpredictable lodgings or droppings of large sections of the fused core during attempted removal which would have high potential for both worker and environmental contamination and cause semi-permanent breach of the containment vessel.

2) From underestimated levels of potential environmental contamination even in the absence of accidents due to the uncertainties of plenum, core and core-support configurations.

Release of revised worker exposure estimates in draft supplement 1 of the PEIS has already exacerbated psychological

A.13

stress of residents in the TMI-2 community. There would be irreparable harm, both to the psychological health of the population residing near TMI-2 and to the regard this population has for the U.S. Nuclear Regulatory Commission if, two years hence, a second draft supplement to the PEIS were issued according to NEPA mandate, because, upon entering the core, worst case scenario calculations presented worker exposures well in excess of 46,000 person-rems.

<u>Can the most critical phase of TMI-2 core cleanup accurately be called "defueling"?</u>

Normally operating nuclear power reactors are defueled approximately annually and generally involve the replacement of about one-third of the spent fuel assemblies with fresh fuel rods. The operation is conducted entirely by remote control through a fuel canal adjacent to the reactor vessel and spent fuel rods are then stored still submerged in pools adjoining the reactor.

This is far from the scenario at present at TMI-2. The fuel canal cannot be used for "defueling" since none of the fuel assemblies which normally pass through this canal are intact. Instead, cranes, grappling hooks, saws, torches and other separation and removal devices for the entirely decomposed core must be applied from above through lifting of a potentially warped plenum after reactor head removal. It is euphemistic at best, fraudulent at worst and certainly misleading to refer to this most hazardous phase of the TMI-2 cleanup operation as <u>defueling</u>. Perhaps <u>removal of fuel debris</u> more accurately conveys the real situation.

A.14

Are core decontamination procedures developed such that worker and environmental exposure risks are minimal?

In the face of overwhelming ignorance concerning the integrities of TMI-2 plenum, core and core-support, prudence dictates proceeding cautiously such that worker and environmental contaminations are kept to a minimum. This is not the tenor of the draft supplement PEIS:

1) " ... it is still the conclusion of the staff, as it was when the PEIS was completed, that cleanup should proceed as expeditiously as possible to reduce the potential for release of radioactive materials to the environment and to ensure that TMI-2 does not become a long-term radioactive waste disposal site." (pp. iv-v, Emphases mine).

Neither reason expressed supports the staff's conclusion. "Expeditious" cleanup may well release more radionuclides to the environment than cautious cleanup, for the reasons outlined previously in these comments. Cautious cleanup by no means argues for establishment of TMI-2 as a permanent repository for high level radioactive wastes any more than storage of spent fuel assemblies on-site at many other nuclear reactors renders them long-term radioactive waste disposal sites. In succumbing to this reasoning, NRC staff is guilty of a simplistic "now or never" approach, which, in the face of considerable uncertainty seems imprudent at best.

2) "Fuel removal delays are considered undesirable because the fuel continues to pose a potential risk to workers and the public and because information obtained

from examing the fuel is expected to be useful in improving the safety of other nuclear power facilities." (p. iv).

Here again NRC staff's reasoning for expeditious cleanup seems flawed. Of course fuel in the destroyed core is a potential risk to workers and to the public, but that potential is all the more realized upon core decontamination and removal of highly hazardous high level radwastes. If hastily or imprudently approached, this "potential risk" becomes real risk and, hence, does not justify removal.* As to the usefulness of the highly melted and crumbled core for didactic purposes in improving the safety of other nuclear power facilities, this may be a useful argument for obtaining Japanese investment in core cleanup, but it is hardly an argument that expeditious cleanup is least risky, which is the subject of this draft supplement to the PEIS.

What are the risks inherent in delayed TMI-2 core cleanup?

Implied throughout the draft supplement PEIS are the dangers of delaying core cleanup above and beyond the explicit reason stated. Is there a danger of re-criticality in the core at TMI-2? When this same question was posed during commentary to the initial PEIS, the possibility was strongly denied. If, now, this is a real danger, or if the NRC staff assesses it may become a danger in the near future, this danger of re-criticality of the TMI-2 core should be realistically included in the final supplement PEIS.

*This same ploy was used by NRC staff to justify krypton-85 venting in June-July 1980, to protect the public from accidental krypton-85 releases!

Conclusions

Despite the fact that worker dose estimates have increased six-fold since the original PEIS on TMI-2 cleanup, the NRC staff in its draft supplement retains its original conclusion that cleanup proceed as expeditiously as possible. The NRC staff's reasons for retention of its earlier conclusion appear invalid. The potential for release of radioactive materials into the environment is exacerbated by core cleanup rather than decreased, unless the core is in danger of re-criticality, a potential danger not addressed in the draft supplement PEIS. An alternative cautious cleanup procedure which maximizes worker protection would not enhance the chances that TMI-2 becomes a long-term radioactive waste disposal site.

Furthermore, new genotoxic human dose assessments have been made since the last PEIS which were not taken into account in the draft supplement (Gofman, 1981). These risk assessments when applied to 46,000 person-rems translate at 170 additional cancer deaths and 340 additional genetic defects among children of the 10,000 TMI-2 cleanup workers. Similar higher risk assessments must be applied to the environment and to the risk for already aggrieved residents living near TMI-2.

In its final supplement PEIS, it is recommended that the NRC staff substitute the misleading "defueling" with "removal of fuel debris" and seriously consider phased plenum, core and core-support removal strategies which maximize worker and nearby resident safety.

CATHERINE I. RILEY
34TH LEGISLATIVE DISTRICT
HARFORD COUNTY

COMMITTEES:
BUDGET AND TAXATION
SUB-COMMITTEE:
EDUCATION, HEALTH AND HUMAN RESOURCES
CHAIRMAN:
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February 13, 1984

Dr. Ronnie Lo
Three Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Lo:

I am in receipt of the TMI EIS draft supplement regarding occupational radiation doses. Clearly I am supportive of utilizing any methodlogy that provides for the lowest possible person-rem doses.

However, as the representative of a large number of people directly down the Susquehanna from TMI, I believe the ultimate goal at the TMI clean-up is to accomplish the clean-up in as safe and quick a manner as feasible. The people of Pennsylvania, as well as those of us downstream, must be vitally concerned that delay in the clean-up process continues to force us toward eventualities that none of us want to see. First, the structural integrity of Unit 2 continues to deteriorate as time passes. Secondly, failure to clean-up expeditiously, brings us closer to the time when, financially, utilizing the TMI site as a long-term disposal site will appear more attractive. This must not be allowed to occur.

Thus, I would urge the NRC to approve the safest methodology possible, while not jeopardizing the clean-up process.

Thank you for your consideration.

Sincerely,

Catherine I. Riley
Senator

sck

THE JOHNS HOPKINS MEDICAL INSTITUTIONS

DIVISIONS OF NUCLEAR MEDICINE AND RADIATION HEALTH SCIENCES

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BALTIMORE, MARYLAND 21205-2179

Telephone 301: 955-335

February 13, 1984

The Honorable Arthur E. Morris
Mayor, City of Lancaster
120 N. Duke Street, P.O. Box 1559
Lancaster, Pennsylvania 17603

Dear Art:

Anticipating our meeting last night at Harrisburg, the Maryland Governor's Committee on TMI met on February 6, 1984 with officials of the Department of Natural Resources of the State of Maryland and approved unanimously the draft response of the State of Maryland to the Supplement to the Programmatic Environmental Impact Statement (NUREG 0683). A copy of the Maryland opinion is attached.

Despite the fact that the meeting in Harrisburg lasted 5 hours, I was unable to present this written opinion to the Panel. Therefore, I would be most grateful to you if you could attach the Maryland response to the recorded transcription of the Harrisburg meeting.

The Maryland response is a draft in that the Governor of Maryland has not yet had the opportunity to review the actions of his advisory committee which I chair.

Since I will not be able to attend the visit to TMI on March 8, 1984 (our Maryland group has inspected Unit II five times over the past four years and found the visits to be most instructive), I would appreciate your reading the Maryland response to the Advisory Panel on March 8, 1984 as I had planned to do last night if I had been given the opportunity.

I hope that in the future a more balanced discussion of the issues will be possible.

Sincerely yours,

Henry N. Wagner, Jr., M.D.
Professor of Medicine, Radiology
and Environmental Health Sciences;
Director, Divisions of Nuclear Medicine
and Radiation Health Sciences

kc

cc: Dr. Nunzio J. Palladino
Dr. Bernard J. Snyder

February 6, 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

RE: 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-Draft Supplement Dealing with Occupational Radiation Dose (NUREG - 0683, Supplement 1)

Dear Dr. Snyder:

This letter is to forward the State of Maryland's comments on the Supplement to the Programmatic Environmental Impact Statement. As lead agency for the State of Maryland for review of cleanup activities at Three Mile Island, the Power Plant Siting Program has coordinated State review of the Supplement.

Maryland's principal concern continues tobe the hazard posed to its population and resources by the presence of high level wastes, including spent fuel, at Three Mile Island. Maryland's position has been that the "cleanup should proceed as expeditiously as reasonably possible to reduce the potential for uncontrolled releases of radioactive materials to the environment" (PEIS, 1981). That position has not changed.

The evidence presented in the Supplement indicates that the total radiation exposure to the work force during the cleanup will be higher than originally estimated. While we in Maryland are concerned about worker exposure and advocate strict adherence to the ALARA principle, we note that the doses to the individual workers will be within the limits of 10 CFR 20, that is, no worker will receive more than 3 rem/quarter or 5 rem/year.

Maryland is also concerned that the selection of the cleanup plan could delay the cleanup process. We have reviewed the analysis of the current plan as well as the three alternatives. Alternatives 1 and 2 would result in a delay of fuel removal while resulting in no significant savings in occupational exposure. Because of this delay, and the fact that little or no dose savings would be achieved, Maryland considers both of these alternatives unacceptable. Alternative 3 is more attractive because of the projected reduction in occupational exposure without delaying fuel removal. It does, however, signifi-

RL

RE: 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 Draft Supplement Dealing with Occupational Radiation Dose (NUREG - 0683, Supplement 1)

cantly delay the overall cleanup while relying on the speculation that robotic cleanup technology will be available at some time in the future. Maryland is opposed to delaying even post-fuel removal elements of the cleanup, and therefore considers this alternative unacceptable. For these reasons, the State of Maryland is opposed to the three alternatives presented, and strongly favors the current cleanup plan.

We appreciate the opportunity to provide these comments and hope you find them useful.

Sincerely,

Thomas E. Magette, Administrator
Nuclear Evaluations

dml

615 Dewey avenue
Bridgeville, Pa. 15017
February 19, 1984

Dr. Bernard Snyder
U.S. Nuclear Regulatory Comm
Washington, D.C. 20555

Dear Dr. Snyder:

Re: To find the most feasible line of action to handle the TMI 2 radioactivity

After evaluating the options and study of the facts necessary to make a decision, and speaking as a lay person – why not a fourth option?

This could read as follows: take measures to fortify against any possible chain reaction from the remaining fuel (per Q. + A. 75), encapsulate and seal the reactor and buildings forever.

It follows that this option could pave the way for the acquisition of Three Mile Island by the U.S. Government and that payment could be made to those now living there so that they could move elsewhere.

Yours sincerely,

Viola Fisher

H. G. C. S.
Henry H. Grimm
Consulting Scientist

32 Valley Drive, RD3,
Annville, PA, 17003.

February 21, 1984.

Dr. Bernard J. Snyder, Program Director,
Three Mile Island Program Office,
U.S. Nuclear Regulatory Commission,
Washington, D.C. 20555.

This comment letter is being written in response to the invitations given in NUREG-1060 and in NUREG-0683. It seems to me that an important aspect of the Three Mile Island accident on March 28, 1979, is being overlooked, or is being supressed by the political ramifications of the problem. One of the concerns, exacerbated by those who want to ban the nuclear alternative for generating electric power, was the fear that a large fraction of the nuclear charge could transmute to radioactive elements which would be widely distributed as a gas, elemental of molecular.

Is it not true that TMI-2 demonstrated this does not occur in an accident of this type? I would like to see some quantitative estimates of what fraction did get distributed. It seems to me that this type of information will be available when a complete inventory of the damaged contents is available. Is a careful inventory of the contents being taken? If it is taken, it may indicate whether there is any validity to the enormous death toll estimates the anti-nuclear people like to make. Any radiocactive material that is still in the containment structure was not available to kill anyone, except TMI workers.

A.18

At one time I read some of the literature accompanying the dispute about the discharge of radioactive material in an accident of this sort. As I remember it, the New York Times published material from a Brookhaven report. In this report a calculation was made to assess the effect of distributing half the radioactive atoms in the containment area, or their transmuted products, by wind-borne distribution, over a large area. The person who wrote this part of the document wrote a letter of protest to Physics Today, I believe. One of his complaints was the very fact that he believed this distribution of half the radioactive load would not and probably could not happen. TMI demonstrated that his belief was correct. The general public does not understand that physical science calculations can be made for completely erroneous assumptions, and that the results of such calculations represent physically unrealisable events.

About a year ago I attended a symposium at Capital Campus of PSU. This same question was under discussion. In a private conversation with one of the other participants, an anti-nuclear individual, I asked him how he thought the heavy uranium atoms could become airborne. His reply was, by transmutation to radioactive noble gasses and to iodine atoms. I presume, from all the discussion about krypton, that we now have some estimate about how much material was transmuted and transported in these ways. We should also know a lot about the transmutation and transport of iodine. This question should be addressed. Is the observed residue in the containment structure consistent with a prediction of deaths by the 10,000? If not, how much should this estimate be reduced?

From the TMI experience, can we point to physical phenomena which will keep almost all of the radioactive atoms in the containment structure, even if much more severe high temperature conditions are encountered? Can chemical activity, smaller atomic concentrations, and improved passive heat dissipation all work together to guarantee the containment of the nuclear charge? For example, radioactive iodine could be reacted with some other element to insure the immobility of the iodine.

The TMI experience is unfortunate. However, we should learn as much from it as we

H. G. C. S.
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Consulting Scientist

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can. It has already suggested that the worst of the predicted phenomena do not occur. Can we go on to prove that all the phenomena that can occur are manageable? Answers to some of these questions could even be worth a billion or even several billion dollars in effort.

People in this area should be looking for more signs that the rest of the world is willing to help sustain the TMI-2 clean-up effort. We would have been well advised, right after the accident, to try to sell opportunities to do some vital research in a unique situation. Nowhere else in the world is there an equal opportunity to study some pertinent large scale problems. All those going to learn from it, and to use the results, should help sustain the effort.

Classified scientific literature is not available to me. It seems to me that the government agencies in charge of nuclear electric power development should have had and should now have a substantial development program to prove that severe accidents can be contained. I hope that such programs exist that are not known to me. Clearly it has been shown that the general population can be stampeded into policies that can have disasterous long time results. It is also clear that a group of people exist whose primary objective is to deny the people of this country the benefits of nuclear generated electric power. We should be showing the world that energy independence is possible for a nation which has inadequate hydocarbon and carbon fuel resources. Instead we grovel in fear, demanding zero risk processes, which are physically unrealizable. In our demands, we frequently reach the state where we cause deaths and economic hardship rather than releaving them. Political pressure cannot change the laws of the physical universe. In fact, what we do know says that the physical world cannot even sense, much less react to, our political pressures.

The TMI-2 cleanup delays are giving more time for the processes of diffusion and corrosion to take hold in the containment building. If we are ever going to clean-up the accident residue, delay can cause the loss of some TMI-2 worker's life, because the processes of diffusion and corrosion are inexorable and go right on at the same pace no matter what political processes are doing. Those claiming to be protecting lives by continuing delay can, and probably are, causing the loss of life right now. The whole clean-up process requires the best competence that can be obtained, to achieve a minimum expenditure of lives and effort. Certainly that competence is not going to be assembled using only decisions made by a crowd mindful only of political considerations.

It is my impression that the NRC is charged with the regulation of the nuclear electric power industry. It is supposed to maintain this industrial function as one of the options available for the generation of electric power, for the citizens of this country. Any NRC members who are not willing to work toward these types of objectives should be requested to resign and forced to do so if necessary. Many of the delays that have occurred are really nothing less than sabotage, aimed directly at the people of this nation and their opportunities. Let's get the TMI-2 clean-up job done.

There is one fundamental objection to the way the risk results are reported in both NUREG-0683 and-1060. The use of calculated death risks, made in the marginal form of 2 to 6 additional deaths, due to TMI-2 clean-up activity, implies that selecting the option of no more clean-up activity will remove this risk. This does not follow at all. These marginal risk figures should be given with a table for marginal risks which presents the important options available to us. When we select a course of action that forces the use of some fuel, all deaths which could be avoided by some

H. G. C. S.
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Consulting Scientist

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Annville, PA, 17003.

other plan of action, should be charged to the use of the fuel chosen. For example, if we elect to replace nuclear with coal, the differential marginal deaths should be charged to coal. A small marginal increment in deaths can be generated covering the main alternatives. This table need not be large, because the worthwhile alternatives are few in number now. Future events may constrain them even further, events such as another middle-east oil cut-off.

Such a marginal death rate matrix needs to include all of the dominant death risks associated with each method of electric power generation. The entire process needs to be described by the main contributors to deaths among electricity customers and the suppliers. Three contributors that would surely be needed would be mining the fuel, processing it for use in the convertor, and converting it to electric energy. Perhaps these would provide all the significant contributors and would be enough to adequately represent the situation as far as deaths and safety are concerned.

The present method of presenting the situation is completely inadequate, primarily because it encourages the presumption that avoiding the one activity under discussion will have the net result of zero marginal deaths. Another choice among the options available may lead to negative marginal deaths, that is, the saving of lives.

Probablistic Risk Assessment can generate marginal risk matrices which can help us to assess the relative safety of our methods for generating electric power. It is certainly possible that there is enough safety data now available to make better judgements. Deaths that have already been occurring over an extended period should not be permitted to be brushed aside because some policy advocate does not like them. All of the main competitors have a more than trivial history now. We may need to keep knowing about all of the alternatives. We should certainly be very careful about allowing any of the main ones to be discarded, particularly if those wanting to discard it are ignoring some dominant physical constraint.

A.19

This country needs to require advocates of specific policies in connection with safety debates to have marginal death matrices generated. It should be required that these rest on established data in the case of all existing processes. They must also have some well defined completeness properties. Processes and data that are obviously incomplete should be barred. Entirely new processes would be more difficult to handle. They should not be arbitrarily thrown among established processes. For the moment, it would be enough to try to handle established processes in the ways outlined above. I understand that some tentative moves have been made toward originating legalities to be applied to our contentions about safety. Such procedures should be given a lot of new attention. A method needs to be legally defined requiring a regulating agency to reject processes that are inferior to some reference risk maximum and to accept those better than some other reference risk. Guaranteed zero risks in all situations, or even in any situation, is not any citizen's birthright.

Contentions about safety must be resolved. They could kill this nation. The NRC and other agencies must hang in there.

Sincerely yours,

Henry H. Grimm

Henry H. Grimm

TRI-COUNTY REGIONAL PLANNING COMMISSION
(CUMBERLAND, DAUPHIN, and PERRY COUNTIES)
2001 NORTH FRONT STREET
BLDG. #2 SUITE 221
HARRISBURG, PENNSYLVANIA 17102
Staff Telephone 234-2639

February 23, 1984

REFER:File# 1984-12

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Three Mile Island Program Office
Washington, D.C. 20555
Attn: Dr. Bernard J. Snyder
Program Director

RE: Review/Comment TMI Unit #2, PEIS: Supplement #1

Dear Dr. Snyder:

At their February 23, 1984 meeting, the Tri-County Regional Planning Commission reviewed the above noted supplement and offers the following comments:

- The proposed refocusing on reactor disassembly and defueling as soon as possible appears to be in the best interests of long term occupational and public safety;
- Concurs that the monitored interim storage, as proposed in Alternative 3, is unacceptable due to the unreliability of robotic technological advancements in the forseeable future, the increase of total decontamination difficulties resulting from delays, and potential health and safety hazards;
- The TMI site is not suitable as long-term repository for the accident generated radioactive waste. The Commission therefore concurs with NRC staff conclusion that decontamination activities should "proceed as expeditiously as possible while ensuring the health and safety of the workers and the public."

Very truly yours,

James R. Zeiters

James R. Zeiters, AICP
Executive Director

cc: Dauphin County Commissioners
PA Intergovernmental Council

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February 23, 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Snyder:

Please consider and respond to the following comments on the draft supplement 1 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):

1. Why should the general public accept draft Supplement 1 as valid when Supplement 1 is an open admission by the N.R.C. Staff that they can only estimate the radiation doses the public will be exposed to, and that their estimates are (1) too low (2) little more than mathematical hypotheses (3) not based upon any actual experience (4) a continuation of the errors, poor policies, lack of understanding, poor supervision, mistakes, and continuous underestimation of the serious radiation hazzards to which the general public is being exposed?

2. How can you justify the intentional radiation exposure of 10,000 plus workers under ALARA requirements by selecting any decontaminating method other than Alternate three: defueling followed by delayed cleanup using robotics.

3. Why didn't the NRC forsee the incredible decontamination difficulties created by and compounded by failure by the licensee to seal all exposed concrete surfaces and to require that the seal be renewed as required?

4. Why did the NRC allow hollow-concrete-block walls within any building subject to contaminated liquid exposure when decontamination is impossible?

5. Inasmuch as nearly five years have passed since the TMI "accident," and the NRC is only in the discussion and

"estimating" stage of radioactive decontamination, (which has already proved incorrect) why wouldn't robotic cleanup provide the necessary time to proceed in safety with due care to minimize human radiation exposure?

6. How can the NRC gain the public confidence and rectify all of its past mistakes, many of which caused the TMI incident, when krypton-85 was regularly released into the atmosphere during "normal" operation and purposely vented into the atmosphere after the TMI incident?

7. Public safety must necessarily concern the radiation exposure of any human whether voluntary (occupational) or involuntary (non-occupational) - the public safety cannot be divorced from employee safety. All employees are part of the public and must be considered as such in any radiation dose measurement.

8. The consistent inability of the NRC to oversee, supervise, forsee, plan or execute Nuclear plant construction, operation, or decontamination casts serious doubt upon its ability in those areas. The NRC has to date (1) disregarded public safety resulting in the 1979 TMI incident (2) underestimated substantially the <u>theorectical</u> radiation exposure of employees (3) failed to establish any decontamination schedule five years after the TMI incident (4) been unable to supply the technical skills or knowledge necessary to decontaminate the failed nuclear reactor although that possibility existed long before the construction of TMI was begun. Wouldn't it be far more useful to have an independent group of nuclear scientists study the TMI problem and release their findings for public scrutiny and comment?

9. Inasmuch as the TMI reactor was constructed to be a source of radiation exposure to the public for at least 40 years and inasmuch as the five-year delay in beginning any significant decontamination by the NRC has maximized the extent of total contamination at this point in time, the only item left that can be minimized is public radiation exposure (including employees). Alternate three is the only alternate proposed by the NRC (although there may be others) which considers this item and therefore is the only alternative worthy of any serious consideration.

10. GPU Nuclear licensee decontamination proposals should not be considered, reviewed or approved in any respect by the NRC. Many of the problems that caused the TMI incident can be traced to the NRC approval of GPU proposals without adequate evaluation or follow-up as a matter of record. Only independent studies and evaluations made by independent nuclear scientists

Dr. Bernard J. Snyder 3 February 23, 1984

skilled in their areas and who are willing to put their professional reputations on the line should be utilized by the NRC.

I trust that you will give my comments full and careful consideration and that your response will so demonstrate. Thank you.

Very truly yours,

Louis M. Busch
1610 Cherry Lane
Macungie, PA 18062

February 25, 1984

RE: NUREG 0683

To the NRC Commissioners:

Mr. Derrick, in the enclosed reprint, has expressed our feelings better than we could, but would like to add a few thoughts of our own.

Lincoln freed the slaves many years ago. Who will free us from a government whose protection agency does not protect and whose regulatory body does not regulate?

What happens when the lid is lifted, providing the crane works as it should and there is no snafu? To what exposure will the workers be subjected today? In five more years? Will workers families evacuate?

When will a cancer study up-date be done? Why will this not include all workers, including "sponges" of TMI?

The ostrich syndrome does not eliminate any problem. After 5 years the People of TMI are still here, asking why you would consider restarting Unit 1 before the original accident is cleaned up. Neither restarting Unit 1 in 1984 nor removing the fuel and entombing Unit 2 will be effective in alleviating the fears of the People of Three Mile Island. Either alternative would be just another evasion of responsibility. Where would the financial support for monitoring Unit 2 be found, especially since GPUN does not have the funds for a "normal" clean-up of Unit 2? Clean it and close it -- then worry about starting Unit 1.

Sincerely,

Charles & Genevieve E. Emerick, Sr.
489 Willow St.
Highspire, PA 17034
(717) 939-9037

MY VIEW one reader's opinion

SCOTT S. DERRICK

A native of the Goldsboro area, Scott S. Derrick currently is writing a dissertation in American Literature and teaching composition at the University of Pennsylvania.

Officials must speak for people on TMI

RECENT EVENTS indicate that the Three Mile Island nuclear facility may open under the worst possible conditions: with questions of the integrity and reliability of plant operators left unresolved. Certainly, there was no reason for the recent NRC vote if the plan isn't to reopen TMI reactor 1. As a result, it is absolutely essential that state public officials speak with a clear, strong voice in safeguarding the interests of the people of Pennsylvania.

The issue is no longer just the initial nuclear accident in 1979. Had the response of government and industry to that accident been sufficient, had the clean-up of TMI reactor 2 been as efficient as the people of Pennsylvania had a right to expect, the accident would now be a fading memory. Central Pennsylvanians would have the assurance of knowing that the nuclear reactor in their midst was in the hands of safety-conscious, reliable management and that behind this management stood government regulators whose chief concern was public welfare. Public anxiety would have been eased to the point that undamaged unit reactor 1 could be safely restarted.

NEEDLESS to say, however, the ensuing five years have been anything but reassuring.

We have learned that individuals with grave public responsibilities have been guilty of lies and negligence.

We have been faced with a Nuclear Regulatory Commission which often seems most anxious to sweep important questions under some bureaucratic rug, a commission so deeply divided that members charge each other with negligence!

We have watched as problems at other plants convince us that our own accident was not some horrible aberration, but something which could well happen again if the plant is not operated with real care and dedication.

We have learned that we are expected to recommit Three Mile Island to the same careless hands, as if after repeated violations, public trust can be regained by simply asking for it.

We have learned that we are expected to display a patience which we would find ludicrous if we were dealing with, say, a drunk driver who repents after every offense.

We have seen the folly of faith in private industry and the federal government because, five years after the accident, a workable plan has still not been constructed to eliminate this dangerous health problem in our midst.

While radiation seeps into containment building walls, we have learned that risk to workers has been significantly underestimated.

What about the risk to ourselves? To our children and families? Psychologically, most of the damage has been done to us not during, but since, the 1979 accident.

ALL OF these things, I am convinced, have left scars in the hearts and minds of Pennsylvanians which won't heal for many years. Most of us, after the initial accident, assumed that the restart of Three Mile Island was inevitable. We made ourselves be calm, believing that irrational panic and hysteria would only make a bad situation worse.

I now believe, however, that public anxiety is nearly as bad as it can get, and that nothing can be gained by pretending a matter-of-factness we do not feel. If a referendum were held in Pennsylvania, the populace would overwhelmingly, statewide, vote against the restart of the Three Mile Island reactor under any conditions. To restart under current conditions is really unthinkable. Yet, we are told, the opinions of Pennsylvanians count for nothing, and even our leaders seem to shake their heads helplessly when confronted by the power of the NRC.

We were initially hospitable hosts to the nuclear industry in our midst. Our hospitality has been abused. We now are victims of an outrage all too common in recent years: industry and government failing to safeguard the interests of private citizens.

We must be victims no more; now is the time for all who love Pennsylvania to come to her defense. The people of Pennsylvania must speak with a unified voice, with postcards and letters to their public officials. What they must say, to Governor Thornburgh, Senators Specter and Heinz, congressmen, state senators and legislators is this: we want you to defend us with a unified, bipartisan voice, from the organized power of the nuclear industry and the federal government, who seem to care so little for our welfare. If need be, you must come up with plans of your own to resolve this dreadful state of affairs: for too long, we have placed our safety in the hands of those who seem to hold it lightly. You must give voice to our fear and anger: if you do not represent us now, why are you in office? Now is the time to act.

R. D. #5
York, PA 17403
February 24, 1984

FEB 28 1984

Bernard J. Snyder, Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

In re: NUREG-0683, Supplement No. 1
Docket No. 50-320

Dear Mr. Snyder:

Dose reduction in the Environmental Impact Statement is once again almost exclusively concerned with occupational dose. While it is understandable that you are very concerned about worker exposure, you must put forth more effort on the matter of reducing radiation exposure to the general public. Since many of your previous decisions have been based on "cheap and fast" solutions (admitted by both the NRC and GPU), it is past time that you put the utmost emphasis on protection of the public at this critical stage of the cleanup.

The practice of "exception to regulation" whenever you encounter a difficult problem at TMI must be discontinued.

You profess to have mastered this technology, yet your favorite solution to problems encountered is to "vent" and proclaim no health hazard.

All the possible dangerous scenarios are classified as highly unlikely, but many of your previous projections and calculations have been proven inaccurate and much in need of revision. When you talk of limited amounts, stringent controls, and pyrophoric explosions, do not forget your inability to comprehend a scenario such as that which caused the original accident.

You use "lack of funding" as a crutch in the slow pace of the cleanup. All money spent on Unit 1 should have been used for the cleanup of Unit 2. You and GPU have your priorities mixed up. The safety of the workers and the public must take precedence over GPU profits.

Bernard J. Snyder, Program Director
February 24, 1984
Page 2.

It is known that Unit 1 will leak radiation into the environment due to "leak <u>limiting</u>" rather than "leak free" steam generator tube repairs. That, along with reactor vessel embrittlement, corrosion of critical parts, and unresolved emergency feedwater system problems sets the scenario for a far more serious accident at TMI. Are you ready for <u>another</u> major cleanup at TMI? You will then have completed a full cycle with "No Lessons Learned".

I would like you to let me know of one suggestion from the general public that has been incorporated into your cleanup effort.

I know of none.

Sincerely,

Alice A. Herman

Alice A. Herman

cc: Hon. Richard Thornburgh
cc: Hon. H. John Heinz, III
cc: Hon. Arlen Specter
cc: William F. Goodling

332 Valley Road
Etters, Pennsylvania 17319
February 27, 1984

Dr. Bernard Snyder
Program Director, TMI Program Office
U.S. N.R.C., Washington, D.C. 20555

Dear Dr. Snyder,

When members of the tribe threw fellow members off the cliff or down the steps of the temple, the rationale was that that act would please or appease some god and therefore benefit the whole society.

Your rationale for sacrificing fellow members of our society to death from radiation exposure so that the society may use nuclear-generated electricity cannot be excused on any grounds.

To people for whom intentional radiation exposure is

2

synonymous with mom and apple pie, it is no doubt hard to understand that others consider such intentional exposure to be utterly unconscionable and totally immoral.

You have condemned innocents to a cruel waiting time. Who will be the unfortunate victim? Who will receive the cancer diagnosis? The cancer diagnosis which you know full well must be in the future for far too many, is the first step on a long path for the victim and for all those who share and exchange affection and amity with the victim. Surgery, if possible, recovery, if recovery is the fortunate result, and treatment, (if treatment is possible with all the risks and side effects; these are the next steps on the

3

sorrowful path. A life that will never be the same, if it continues. Sometimes the remaining time is little more than and agonized wait for the end. All of this because a minority has ordained that we must accept nuclear power plants in our communities.

Would a scientific treatise, submitted as a comment on the Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident - Three Mile Island Nuclear Station Unit 2, be given more careful consideration than my comments? I doubt it.

As usual, the NRC does as it and the nuclear industry pleases, and the health and safety of the public be damned.

Sincerely yours,
Helen M. Hocker

WILLIAM H. HAMILTON

4601 BAYARD STREET, APT. 307
PITTSBURGH, PENNSYLVANIA 15213
TELEPHONE: 412-683-8826

February 27, 1984

Dr. Bernard J. Snyder, Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Snyder:

The Technical Advisory Group has reviewed the Nuclear Regulatory Commission's draft Supplement 1 to NUREG-0683, Programmatic Environmental Impact Statement (PEIS) on the Three Mile Island cleanup activities.

Our concerns are centered on the Section 3/3 discussion of health effects. We consider the draft section somewhat misleading and recommend the specific changes discussed below to provide a more realistic and comprehendible focus:

1. NRC's estimate for cumulative occupational radiation doses associated with the Current Cleanup Plan is 13,000 to 46,000 person-rem (Table 3.1).

   To provide some perspective on this cleanup dose, which is expected to occur over a five to ten year period, we recommend that the text include a comparison with several examples of common radiation releases in the area. For instance, (1) persons living in the vicinity of TMI receive approximately 24,000 person-rem each year of additional exposure through the use of natural gas in their homes (Reference 1); and (2) the total exposure to area residents due to potassium-40 in the blood and tissues of their bodies is approximately 43,000 person-rem/year (References 2 through 6). These doses assume a population of approximately 2.16 million within a 50 mile radius of the site. Hence, the annual exposure due to the cleanup will be about an order of magnitude less than the local radiation exposure due to these common sources.

2. In Section 3.3, the fourth paragraph states:

   "...For the minimum-collective-dose case (13,000 person-rem) it is expected that 2 additional fatal cancers would be caused. For the

   maximum-dose case (46,000 person-rem), 6 additional cancer fatalities would result. Although it is possible to compute a range of probabilities for cancer induction among average individual workers based on the above figures, the results of such a calculation may not bear a close relationship to actual risks since the work force size and collective dose associated with the various tasks can differ by large factors, rendering inapplicable the concept of an average individual worker."

   These mortality figures were derived based on a factor of 131 fatal cancers in the exposed workers per one million person-rem.

   We recommend the deletion of this discussion. Without considering such factors as the work force size and the collective dose associated with individual tasks, statements such as "6 additional cancer deaths would result" are meaningless. Discussions of licensee administrative controls and the risks to individuals associated with the maximum allowable doses during given time periods (as provided in subsequent paragraphs) present a much clearer picture.

3. In the last paragraph of Section 3.3, the probability of genetic effects among the offspring of the work force should be expressed in terms of increased risk to the individual worker, rather than as a flat number based on 260 genetic effects per one million person-rem.

We appreciate this opportunity to review on the draft Supplement to the PEIS and trust that our comments will be properly considered in the final document.

Sincerely,

William H. Hamilton
ep

William H. Hamilton
Chairman
Technical Assistance and Advisory Group

WHH/ep

cc: Mr. Bahman K. Kanga, Director
General Public Utilities Nuclear/Bechtel TMI-2

Mr. Harold M. Burton, Manager
EG&G Idaho, Inc.

Mr. Adrian Roberts
Electric Power Research Institute

References:
(1) EPA Report EPA-520/1/73-004, pages 29 through 31.
(2) Page 57 of "The Fight over Nuclear Power" by Drs. Bodansky and Schmidt.
(3) EPA 520/1-77-009, Pages 29 and 34.
(4) Dr. Edward Teller, Wall Street Journal, July 31, 1979.
(5) J. M. Smith, Jr., GE, "Natural Background Radiation and the Significance of Radiation Exposure".
(6) National Council on Radiation Protection and Measurement Report Nos. 45 and 56.

February 27, 1984

Dr. Bernard J. Snyder
Program Director, Three Mile Island
Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Snyder:

The Safety Advisory Board of TMI-2, which was constituted early in 1980 to provide expert scientific, engineering, and medical advice for guidance for the safe clean up and recovery of the damaged nuclear power plant, has had the opportunity to review the December 1983 draft of Supplement No. 1 to the Programmatic Environmental Impact Statement (NUREG 0683). The Safety Advisory Board of TMI-2 (SAB) wishes to submit the following comments concerning the Report in general, and Supplement No. 1 in particular.

1. The SAB is in full agreement with the NRC Staff recommendation that there should be an increase in the estimate of the collective dose equivalent for workers expected to occur in the course of the TMI-2 recovery operations. The new range of the Supplement of 13,000 to 46,000 person-rem appears to represent a far more realistic assessment than the estimates proposed in the original PEIS, particularly since so much more valuable data on the status of the damaged plant are now available.

2. The SAB believes that as the clean up progresses, the ranges of uncertainties will narrow depending on the engineering technologies developed and applied to the tasks, and as additional data becomes available to define subsequent tasks. With careful planning as these procedures are carried through, the results will impact on the proposed collective dose equivalent assigned to each subsequent or concurrent major activity. Thus, while the present values proposed reflect the current status, it may be necessary to revise or at best narrow the range of estimates as the clean up of the plant progresses safely to completion.

3. The SAB agrees that the conservative estimates of potential delayed health effects as carried through by the NRC Staff appear to be in accord with current scientific and medical knowledge, and are consonant with the methods of risk assessment used by the International Commission on Radiological Protection, the United Nations Scientific Committee on the Effects of Atomic Radiation, the National Council on Radiation Protection and Measurements, and the National Academy of Sciences-National Research Council. The Board recognizes that the NRC Staff estimates are statistically derived numerical values and are intentionally conservative within the prudent philosophy of radiological protection of the workers and the general public. The Board's assessment of the estimates as calculated compels the scientific conclusion that based on current radiobiological knowledge and theory the numerical values could be considered as an upper bound, and that the uncertainties associated with such risk estimates, derived as they are using linear extrapolation from the epidemiologic data at high doses, embrace the statistical probability that no delayed health effects could occur.

4. Given the NRC Staff estimates for carcinogenic and genetic risks, the question arises as to how this information can be used as a basis for radiation protection guidance in the very unique situation of the TMI-2 clean up. Logically the guidance or standard should be related to risk. Whether the magnitude of the risk should be considered acceptable or not depends largely on how avoidable it is, and to the extent not avoidable, how it compares with the risks of alternative options and those normally accepted by the individual or by society in everyday lift.

Accordingly, the SAB embraces the philosophy that evaluation of the adequacy of an occupational health standard, regulation, or guidelines must consider whether the potential incremental risk imposed is regarded as acceptable to the worker, both in the workplace and in his way of life. While we recognize such judgments are necessarily subjective, we believe that the currently proposed estimates of collective dose equivalent impose potential health risks to the workforce that should be acceptable to them, and to society in general, since the risks, in perspective, are extremely small in comparison to other risks that are now readily accepted. The SAB is pleased that the NRC Staff has carefully explained the relationship of these comparisons in the PEIS supplement.

5. In this regard, the SAB wishes to draw attention to recently available radiological protection data for the clean up, 1979 - 1983. During the five-year period since the accident, approximately 16,750 worker-years have been involved in the clean up process resulting in a collective dose equivalent of less than 1700 person-rem. Of the 16,750 worker-years, two-thirds recorded no measurable radiation exposure, and 85% involved doses of less than 0.1 rem per year, that is, less than the average annual whole-body dose received by all persons from natural sources of ionizing radiation. Moreover, a dose rate of 0.1 rem per year is considerably <u>less</u> than that received from all sources (including natural background radiation, medical and dental radiation, commercial air travel, etc.) other than occupational exposure.

The SAB urges that the NRC Staff recognize that occupational exposure levels in the range of natural background radiation are considered to represent negligible risks to individual workers. For example, a dose rate of 0.1 rem per year is only one-fiftieth of the annual maximum permissible dose for occupational exposure recommended by national and international standard-setting bodies (including the NRC). The Board recommends that the NRC take cognizance that the annual collective dose equivalent to the workers consists primarily of values considerably less than 0.1 rem. The risk of developing a delayed health effect, such as cancer, from a dose of 0.1 rem is considered to be about 1 in 100,000 (or about 10^{-4} per rem) and that this order of risk is generally considered by society as a negligible incremental risk to the individual.

The recorded data also demonstrate that approximately 96% of all TMI-2 workers have received less than 0.5 rem per year, or less than 10% of the annual permissible dose. Of the remaining 4% of the worker-years of exposure, no worker received more than the maximum permissible dose. The SAB recognizes this achievement as a particularly excellent record considering the immense engineering problems encountered and the unique nature of the work involved in the cleanup process.

6. The SAB wishes to draw to the attention of the workers and of the public that the NRC PEIS Supplement has determined that the revised estimates of worker exposure necessary for the clean up process (range 13,000 to 46,000 person-rem for a population of some 10,000 workers) will result in "from 2

to 6 additional deaths among these workers due to cancer and from 3 to 12 additonal genetic defects among their offspring". The SAB believes there is reason to expect that over the entire period of the clean up process, the dose commitments associated with the recovery will be no greater than those stated, and that the numerical values for potential health risks estimated most likely represent an upper bound, and will be less. The statistically-derived values presented by the NRC Staff may denote a level of precision that is not warranted; it should emphasize, preferably, the nature and reasons that, while the estimates are conservative, they are also extremely small. Furthermore, these figures must not be taken to represent more than crude estimates of risk, based on the incomplete nature of the data at present available. Several factors, not taken into account in the calculation of these estimates, exist which compound the uncertainty of these numbers. First, the scientific evidence indicates that some experimental and human data, as well as theoretical considerations, suggest that for exposure to low-LET radiation at low doses, the linear model probably leads to overestimates of the risk of most cancers, but can be used to define the upper limits of risk. Second, in these calculations, no allowance has been made for the likelihood that the carcinogenic or mutagenic effectiveness of low-LET radiation is reduced at low dose rates through the action of biological repair processes. Third, the individual cancer risks used in the derivation of these numbers may rise or fall as the follow up of the epidemiological study groups is extended to longer periods. Fourth, the risks have been derived for the most part at high total doses (which may have been sufficient to inactivate potentially susceptible cells from which a cancer might result), and linear extrapolation could tend to overestimate risk of low-LET radiation. Fifth, the numerical values of the risk estimates derived from radioepidemiological surveys are themselves crude and uncertain and often have wide statistical confidence limits. These uncertainties are made even wider by uncertainty about the dose-response relationship and the risk projection model.

However, the uncertainties tend in the main to emphasize the conservatism of the risk estimates as presented by the NRC Staff. This is clearly the situation where the linear hypothesis is applied and no allowance is made for biological repair processes; where age-distribution relative to potential reproductive performance is not considered; and where upper-level uncertainties derived from high-dose and high-dose rate data and extrapolated

to the region of low doses and low dose-rates tend to a miltiplicative effect in the calculation of risk estimates. These overestimates may serve to offset any calculations that argue that these numbers reflect cancer deaths, and do not therefore represent the number of individuals affected, or that they are based on absolute risk projection models rather than relative risk projection models for predicting future risks to an exposed worker population. If expressed in terms of cancer incidence, including non-fatal cancers, estimates of risk could be higher by a factor of roughly 1.5 considering the predominance of men in the workforce. And whereas within a particular homogenous population the projection of future risk may probably best be done on a relative risk basis, as yet no firm conclusions can be drawn at the present as to the appropriateness of either model for projection forward in time without further years of observation of irradiated populations. However, the current evidence indicates that estimates of lifetime excess cancer risk may vary only by a factor of 2 or 3, depending on which projection model is chosen.

7. The Safety Advisory Board is aware that differing viewpoints may be submitted to the NRC which oppose the current NRC PEIS Supplement in an effort to challenge the range of the calculated estimates of the worker collective dose equivalents or the potential delayed health effects that could occur. These positions are not unique to the clean up of TMI-2, but rather tend to apply to many of the societal activities involving the use of ionizing radiation. The Board recognizes that frequently these viewpoints are not predicated on sound scientific evidence, but rather on controversial or incomplete reports or personal statements. Several such reports have been published, some recently, seeming to claim degrees of carcinogenic radiation effects at low doses in humans that would be incompatible with the linear hypothesis being conservative, and may even underestimate the effects at low doses and dose-rates. Many of these studies are limited due to incomplete data bases, inadequate dosimetry, confounding factors, unconventional statistical methods, or unconfirmed results. The situations individually or collectively are not convincing enough to argue against the conservatism associated with the linear hypothesis nor do they provide evidence that the risk of cancer from low dose radiation is greater than indicated by conventional estimates. The Safety Advisory Board strongly endorses the view that these claims compel no scientific reason for national and international standard-setting

groups to abandon the body of epidemiologic evidence on radiation-induced cancer that, although based on greater exposures, yields consistent and statistically stable risk estimates.

8. The SAB concurs with the NRC Staff observations that extended delay in the cleanup can lead to both increased costs and increased collective dose equivalent. Further, the effects of increased costs can exacerbate delays which can increase risks of further collective dose equivalent, including that to the public. Therefore, the SAB believes that the more expeditiously the clean up can be completed, within current safety standards, the less the long term risks to both the workers and the public.

Sincerely,

James C. Fletcher, Chairman
Safety Advisory Board

JCF/jf

Board Members

Dr. John A. Auxier
Dr. Merril Eisenbud
Dr. Jacob I. Fabrikant
Dr. Robert S. Friedman
Dr. Bruce T. Lundin
Prof. Howard Raiffa
Prof. Norman Rasmussen
Mr. Lombard Squires
Dr. William R. Stratton

A.29

Accord Research and Educational Associates, Inc.

314 West 91st Street New York, N.Y. 10024

Phone: (212) 580-3889

28 February, 1984

Dr. Bernard J. Snyder
Program Director, Three Mile Island Program Office
Office of Nuclear Regulation
U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Dear Dr. Snyder:

In NUREG-0683, Supplement No. 1, Draft Report, cancer deaths resulting from whole-body exposure are calculated using values of 131 and 135 deaths per million person-rem exposure of workers and the general population, respectively. Table I (enclosed) presents a spectrum of such values from the recent scientific literature. In each case, the methodology recommended by each author was used for calculation of excess cancer deaths, assuming doses in the range 0 to 50 rads.

The wide discrepancy in the values for the number of fatal radiation-induced cancers results in large part from adoption or rejection of a linear dose/response relation in the exposure range considered. It is a viewpoint shared by a large portion of the scientific community that linearity of response down to very low doses is the only model consistent with epidemiological results in humans (see references below). Uncertainty in the slope of the dose/response curve in the low-dose range has been widely discussed, with highly divergent opinions having been reached by the authors of the references cited in Table I.

Translated into the expected effects from the updated estimates of 13,000 to 46,000 person-rem (which we do not endorse) the range of estimates of numbers of fatal cancers ranges from less than one to 270.

Because of this broad range of possible consequences, the staff should report all estimates of the number of fatal cancers per unit of population radiation exposure including those which differ from estimates established by the NRC or other organizations and individuals with demonstrable affiliation with the nuclear industry.

Rotblat, J., "The risks for radiation workers", Bull. Atom. Sci., 34 (1978) 41-44.

Radford, E.P. "Human Health Effects of Low Doses of Ionizing Radiation: The BEIR III Controversy", Radiation Research, 84 (1980) 369-394.

Brown, J. Martin, "Linearity vs. non-linearity of dose response for radiation carcinogenesis," Health Physics, 34 (1976) 231-245.

Respectfully,

Dr. Daniel Pisello, Ph.D.
Director of Research
A.R.E.A.

Dr. Richard Piccioni, Ph.D.
Senior Staff Scientist
A.R.E.A.

Assistant Professor
Department of Biological Sciences
Hunter College
695 Park Avenue
New York, NY 10021

Enclosure (1)

TABLE I. ESTIMATES OF WHOLE-BODY CANCER DOSE OF LOW-LET RADIATION FOR POPULATIONS OF MIXED AGES.

Source	Fatal Cancers per Million Person-rems
RSS(1975) Dose rates below 1 rem/day; central estimate of cancer risk.(a)	45
BEIR(1980) 75 yr exposure at 1 rad/yr; linear quadratic model; absolute risk projection; 4,751 cancer deaths per million persons irradiated.(b)	62
ICRP(1977)(c)	100
RSS(1975) Upper estimate of cancer risk.(d)	122
BEIR(1980) 75 yr exposure at 1 rad/yr; linear model; absolute risk protection; 11,250 cancer deaths per million persons irradiated.(b)	150
BEIR(1980) 75 yr exposure at 1 rad/yr linear-quadratic model; relative risk projection; 11,970 cancer deaths per million persons irradiated.(b)	160
Radford(1980) Lower estimate of cancer incidence (260 and 550 per million person rads for males and females, repsectively) averaged and converted to mortality (approximately one-half incidence).(e)	179
BEIR(1980) 75 yr exposure at 1 rad/yr; linear model; relative risk projection; 28,690 excess cancer deaths per million persons irradiated.(b)	385
Radford(1980) Upper estimate of cancer incidence risk (880 and 1620 per million person rads for males and females, respectively) averaged and converted to mortality (approximetely one-half incidence).(e)	588
Morgan(1981) Two-fold increase in BEIR (1980) risk (linear model, relative risk projection) due to revision of shielding factors in Hiroshima and Nagasaki.(f)	770
Rotblat(1978)(g)	800
Gofman(1981) Central estimate of cancer dose.(h)	3730
Kneale et al.(1978) Doubling dose for cancer mortality estimated as 33.7 rads for males divided by spontaneous cancer death rate of 0.198.(i)	5880

FOOTNOTES TO TABLE I

a. Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, WASH-1400 (NUREG-74-014), United States Nuclear Regulatory Commission, Appendix VI, page 9-33, Table VI 9-7, October 1975.

b. National Research Council, Advisory Committee on the Biological Effects of Ionizing Radiations. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. page 146, Table V-3, Washington, D.C.: National Academy of Sciences, 1980.

c. Internation Commission on Radiological Protection. Recommendations. ICRP Publication 25. Oxford: Pergamon Press, 1977.

d. Reactor Safety Study, Appendix VI, page 9-34, Table 9-4.

e. Radford, E.P. "Human Health Effects of Low Doses of Ionizing Radiation: The BEIR II Controversy", Radiation Research, 84 (1980) 369-394.

f. Morgan, K.Z., Letter to Science, 213, (1981) 604.

g. Rotblat, J., "The risks for radiation workers", Bull. Atom. Sci., 34 (1978) page 44.

h. Gofman, J.W., Radiation and Human Health. Sierra Club Books, San Francisco, 1981, page 294.

i. Kneale, G.W., Stewart, A. and Mancuso, T.H., "Reanalysis of data relating to the Hanford study of cancer risk to radiation", in Proceedings of the Internation Atomic Energy Agency meeting on Late Biological Effects of Ionizing Radiation, Vienna, 1978, 387-411, IAE-SM-224/510, page 404.

MARYLAND
DEPARTMENT OF STATE PLANNING
301 W. PRESTON STREET
BALTIMORE, MARYLAND 21201-2365

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

February 29, 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

SUBJECT: REVIEW AND RECOMMENDATION

State Identification Number: MD 84-1-294

Applicant: U.S. Nuclear Regulatory Commission

Approving Authority: Same

Description: Draft Supplement Dealing with Occupational Radiation Dose - Three Mile Island Nuclear Station, Unit 2

Recommendation: Endorsement with Comments

Dear Dr. Snyder:

The State Clearinghouse has coordinated the intergovernmental review of the referenced subject. Acting under Article 88C of the Annotated Code of Maryland and Code of Maryland Regulations 16.02.03, the State Clearinghouse received the following comments:

Cecil County, Regional Planning Council and its member jurisdictions, Department of Transportation, Department of Economic and Community Development including their Maryland Historical Trust section, Department of Natural Resources, Office of Environmental Programs, and the Department of State Planning indicated that the statement appears to adequately cover those areas of interest to their agencies.

Regional Planning Council noted (copy attached) that the current clean-up procedures should continue as expeditiously as possible. They indicated that the alternatives described in the report would further delay the removal of radioactive materials from the island and would not significantly reduce the occupational exposure. The Council also noted support for the recent IRS decision to allow tax deductions for utility contributions to the clean-up fund.

The Environmental Office advised (copy attached) that this response is a coordinated one generated by their office and the Department of Natural Resources. The Office further noted that both agencies (DHMH and DNR) support the current clean-up plan; however, there are reservations about the various alternatives outlined in the draft.

TELEPHONE: 301-383-7875
OFFICE OF STATE CLEARINGHOUSE

Dr. Bernard J. Snyder
Page 2
February 29, 1984

Department of Natural Resources letter of February 17, 1984 (copy attached) indicated that Maryland's principal concern continues to be the hazard posed to its population and resources by the presence of high level wastes, including spent fuel at Three Mile Island. The Department noted that Maryland's position has been that the "clean-up should proceed expeditiously as reasonably as possible to reduce the potential for uncontrolled releases of radioactive materials to the environment". That position has not changed. The Department indicated that Maryland is also concerned that the selection of a clean-up plan could delay the clean up. They have reviewed the analysis of the current clean-up plan as well as the 3 alternatives. Maryland considered alternatives 1 and 2 unacceptable as they would result in a delay of fuel removal and show no significant savings in occupational exposure. Alternative 3 seems to be more attractive due to the reduction in occupational exposure without delaying fuel removal. Their agency concluded that Maryland favors the current clean-up plan.

In response to the review request, this letter with attachments constitutes the State process recommendation. The comments and recommendations made in this review should be considered and addressed in the development of the final statement.

The State Clearinghouse should be kept informed of any decisions made with regard to this subject. The Clearinghouse recommendation is valid for a period of three years from the date of this letter. If a decision regarding the subject has not been made within that time period, information should be submitted to the Clearinghouse requesting a review update.

We appreciate your attention to the intergovernmental review process and look forward to continued cooperation.

Sincerely,

Guy W. Hager
Director, Maryland State Clearinghouse
for Intergovernmental Assistance

GWH/cw

Attachments

cc: Herbert Sachs
Clyde Pyers
Lowell Frederick
Max Eisenberg
Wilson Horst (84-024)
Scrib Sheafor
Michael Pugh

A.32

Date: February 28, 1984

Director
Maryland State Clearinghouse
for Intergovernmental Assistance
301 West Preston Street
Baltimore, MD 21201-2365

SUBJECT: REVIEW COMMENT AND RECOMMENDATION

State Identification Number: 84-1-294 (See 81-8-158)

Applicant: U.S. Nuclear Regulatory Commission

Description: Draft Supplement Dealing with Occupational Radiation Dose - Three Mile Island Nuclear Station, Unit 2

Responses must be returned to the State Clearinghouse on or before 2/22/84.

Based on a review of the notification information provided, we have determined that:

Check One:

____ 1) It is consistent with our plans, programs, and objectives (and when applicable, with the Coastal Zone Management Program and Historic Preservation Standards).

XXXXXX 2) It is generally consistent with our plans, programs, and objectives, but the qualifying comment below is submitted for consideration.

____ 3) It raises problems concerning compatibility with our plans, programs, or objectivea, or it may duplicate existing program activities, as indicated in the comment below. If a meeting with the applicant is requested, please check here ____.

____ 4) Additional information is required to complete the review. The information needed is identified below. If an extension of the review period is requested, please check here ____.

____ 5) It does not require our comments.

COMMENTS: See Attachments

(Additional comments may be placed on the back or on separate sheets of paper)

cc: Dr. Max Eisenberg

Signature: Wm M. Eichbaum

Name: William M. Eichbaum

Organization: Office of Environmen al Programs

Address: 201 West Preston Street
Baltimore, Maryland 21201

STATE OF MARYLAND • DEPARTMENT OF HEALTH AND MENTAL HYGIENE

MEMORANDUM

Copies

TO Dr. Max Eisenberg From David L. Resh, Jr. Date 2/28/84

Subject Draft Supplement Dealing with Occupational Radiation Dose - Three Mile Island Nuclear Station, Unit 2

The Environmental Impact Statement related to decontamination and disposal of radioactive waste resulting from the accident at the Three Mile Island Nuclear Station, Unit 2, has been reviewed by this Program's Division of Radiation Control, Power Plant Siting Program. The attached represents a coordinated response generated by both programs to the Nuclear Regulatory Commission. It should be noted that both agencies support the current clean-up plan; however, there are reservations about the various alternatives outlined in the draft.

DLR:cat

Attachment

A.33

TORREY C. BROWN, M.D.
SECRETARY

JOHN R. GRIFFIN
DEPUTY SECRETARY

RECEIVED
FEB 27 1984
DIVISION OF RADIATION CONTROL

STATE OF MARYLAND
DEPARTMENT OF NATURAL RESOURCES
ENERGY ADMINISTRATION
POWER PLANT SITING PROGRAM
TAWES STATE OFFICE BUILDING
ANNAPOLIS 21401
(301) 269-2261

RECEIVED
FEB 23 1984
COMMUNITY HEALTH MANAGEMENT PROGRAM

February 17, 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: 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 Draft Supplement Dealing with Occupational Radiation Dose (NUREG - 0683, Supplement 1)

Dear Dr. Snyder:

This letter is to forward the State of Maryland's comments on the Supplement to the Programmatic Environmental Impact Statement. As lead agency for the State of Maryland for review of cleanup activities at Three Mile Island, the Power Plant Siting Progam has coordinated State review of the Supplement.

Maryland's principal concern continues to be the hazard posed to its population and resources by the presence of high level wastes, including spent fuel, at Three Mile Island. Maryland's position has been that the "cleanup should proceed as expeditiously as reasonably possible to reduce the potential for uncontrolled releases of radioactive materials to the environment" (PEIS, 1981). That position has not changed.

The evidence presented in the Supplement indicates that the total radiation exposure to the work force involved in the TMI cleanup will be higher than originally estimated. While we are concerned that the principle of keeping the dose to these workers as low as reasonably achievable be strictly adhered to, and the dose reduction program be properly emphasized, we note that the doses to the workers will continue to be within the federally allowed limits of 10 CFR 20, that is no individual worker will receive a dose in excess of 3 rem per quarter or 5 rem per year.

Mr. Snyder -2- February 17, 1984

Maryland is also concerned that the selection of a cleanup plan could delay the cleanup. We have reviewed the analysis of the current cleanup plan as well as the three alternatives. Alternatives 1 and 2 would result in a delay of fuel removal while resulting in no significant savings in occupational exposure. Because of this delay, and the fact that little or no dose savings would be achieved, Maryland considers both of these alternatives unacceptable. Alternative 3 may seem more attractive because of the projected reduction in occupational exposure without delaying fuel removal. It does, however, significantly delay the overall cleanup while relying on the uncertain possibility that robotic cleanup technology may become available at some time in the future. Maryland is opposed to delaying even post-fuel removal portions of the cleanup on the basis of mere speculation. For these reasons, the State of Maryland favors the current cleanup plan.

Sincerely,

Thomas E. Magette, Administrator
Nuclear Evaluations

TEM:emp

cc: Richard McLean
Randy Roig
Henry Wagner
David L. Bush
Samuel Baker, DSP

Regional Planning Council
2225 North Charles Street Baltimore, Maryland 21218-5767 (301) 383-5838
J. Hugh Nichols, *Chairman* Walter J. Kowalczyk, Jr., *Executive Director*

Date: February 17, 1984

Department of State Planning
301 W. Preston Street
Baltimore, Maryland 21201

RE: Metropolitan Clearinghouse Review and Referral Memorandum, Project: 84-024 Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2

State Clearinghouse # 84-1-294

Dear Mr. Hager:

The attached review and referral memorandum is certification that the above referenced project has undergone review and comment by the Regional Planning Council and a recommended action has been determined based on the Council's findings.

Comments on this project were requested from: Anne Arundel County, Baltimore City, Baltimore County, Carroll County, Howard County, Harford County.

Comments from the following jurisdictions are included with the Clearinghouse review: Baltimore City, Anne Arundel County, Carroll County, Howard County.

We appreciate your attention to Metropolitan Clearinghouse procedures. If you have any questions, please contact us at 383-7110.

Sincerely,

W. Wilson Horat, Coordinator
Metropolitan Clearinghouse

Attachment

REGIONAL PLANNING COUNCIL
2225 North Charles Street
Baltimore, Maryland 21218

RPC Meeting February 17, 1984

REVIEW AND REFERRAL MEMORANDUM

Project: 84-024 Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2. The EIS Related to Decontamination and Disposal of Radioactive Waste for the 1979 Accident at Three Mile Island Nuclear Station Unit 2 has been supplemented. Information indicates that cleanup will entail more occupational radiation dose to the clean-up work force than anticipated.. Only one of three additional alternatives considered in the supplement would result in an appreciably lower occupational dose, but significant disadvantages are associated with this alternative.

Referral Source; Department of State Planning

COMMENT

The current clean-up procedure should continue as expeditiously as possible. The alternatives described in this report would further delay the removal of radioactive materials from the island, and would not significantly reduce the occupational exposure. Any and all additional funding should be pursued to ensure the removal of contaminated materials and damaged fuel. The recent IRS decision to allow tax deductions for utility contributions to the clean-up fund is a step in the right direction.

Recommendation: ENDORSEMENT IS RECOMMENDED SUBJECT TO THE ABOVE COMMENTS.

I HEREBY CERTIFY that at its 234th meeting, held February 17, 1984 the Regional Planning Council concurred in this Review and Referral Memorandum and incorporated it into the minutes of that meeting.

February 17, 1984
DATE

WALTER J. KOWALCZYK, JR.
Walter Kowalczyk
Executive Director

A. 35

FROM: Mr. Larry Reich, Director
Dept. of Planning
222 E. Saratoga Street
Baltimore, Maryland 21202

DATE: January 25, 1984

R P C Meeting: February 17, 1984

☐ Joint RPC/CHHSA Review Cycle (up to 60 days)

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

~~Applicant:~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuchlear Station, Unit 2

R & R File Number: 84-024

Comments should be returned by: 2/10/84

This project has been forwarded to the following local departments or agencies (Check appropriate blanks and attach comments from the reviewing agencies):

✓ Planning
___ Public Works
___ Environmental Protection
___ Human Relations
✓ Others (Specify) Baltimore City Health Department

JURISDICTION'S COMMENTS

Check One

✓ This jurisdiction has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises problems concerning compatibility with local plans, or intergovernmental, environmental or civil rights issues and a meeting with the applicant is requested.

___ This project raises problems concerning compatibility with local plans, or intergovernmental, environmental or civil rights issues; however, a meeting with the applicant is not requested.

___ This project is generally consistent with local plans, but qualifying comments are necessary (attach comments).

RETURN TO:

Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Signature L Reich

Title ___

Agency ___

Date ___

TO: Mr. Larry Reich, Director
Department of Planning
222 E. Saratoga Street
Baltimore, Maryland 21202

Date: January 25, 1984

SUBJECT: PROJECT REVIEW FORM

Applicant: Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Isalnd Nuclear Station, Unit 2

R&R File Number: 84-024

Comments should be returned by: 2/10/84

Check One

X This agency has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises issues concerning compatibility with local plans or intergovernmental problems and a meeting with the applicant is requested. (Explain below)

___ This project raises issues concerning compatibility with local plans or intergovernmental problems; however, a meeting with the applicant is not requested. (Explain below)

___ This project is generally consistent with local plans, but qualifying comments are necessary. (Explain below)

Comments ___

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature Murray Conroy

Title Director, Planning and Research

Agency Baltimore City Health Department

A.36

FROM: Celia Wilson
Anne Arundel County
Office of Planning and Zoning
Arundel Center
Annapolis, MD 21401

DATE: January 25, 1984

R P C Meeting: February 17, 1984

☐ Joint RPC/CMHSA Review Cycle (up to 60 days)

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

~~Applicant~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mila Island Nuclear Station, Unit 2

R & R File Number: 84-024

Comments should be returned by: 2/10/84

This project has been forwarded to the following local departments or agencies (Check appropriate blanks and attach comments from the reviewing agencies):

✓ Planning

___ Public Works

___ Environmental Protection

___ Human Relations

___ Others (Specify) ___

JURISDICTION'S COMMENTS

Check One

___ This jurisdiction has no comments on this proposal.

✓ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objettives.

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RETURN TO:

Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Signature Celia Wilson

Title Referral Coordinator

Agency Office of Planning & Zoning

Date 2/7/84

A.37

FROM: Mr. Edmund Cueman
Director, Planning Commission
County Office Building
Westminster, Maryland 21157

DATE: January 25, 1984

R P C Meeting: February 17, 1984

☐ Joint RPC/CHHSA Review Cycle (up to 60 days

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

~~Applicant~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2

R & R File Number: 84-024

Comments should be returned by: 2/10/84

This project has been forwarded to the following local departments or agencies (Check appropriate blanks and attach comments from the reviewing agencies):

___ Planning ___ Public Works

___ Environmental Protection ___ Human Relations

___ Others (Specify) __________

JURISDICTION'S COMMENTS

Check One

✓ This jurisdiction has no comments on this proposal.

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RETURN TO:

Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Signature [signature]

Title Director

Agency Department of Planning

Date February 6, 1984

FROM: Mr. Thomas G. Harris, Jr.
Director of Planning
3430 Court House Drive
Ellicott City, Maryland 21043

DATE: January 25, 1984

R P C Meeting: February 17, 1984

☐ Joint RPC/CHHSA Review Cycle (up to 60 days)

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

~~Applicant~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuchlear Station, Unit 2

R & R File Number: 84-024

Comments should be returned by: 2/10/84

This project has been forwarded to the following local departments or agencies (Check appropriate blanks and attach comments from the reviewing agencies):

___ Planning ✓ Public Works

___ Environmental Protection ___ Human Relations

___ Others (Specify) __________

JURISDICTION'S COMMENTS

Check One

✓ This jurisdiction has no comments on this proposal.

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RETURN TO:

Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Signature Thomas G. Harris Jr.

Title Referral Coordinator

Agency Howard County

Date 2-8-84

TO: Mr. Thomas G. Harris, Jr.
Director of Planning
3430 Court House Drive
Ellicott City, Maryland 21043

Date: January 25, 1984

SUBJECT: PROJECT REVIEW FORM

~~Applicant:~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occuaptional Radiation Dose, Three Mile Island Nuclear Station, Unit 2

R&R File Number: 84-024

Comments should be returned by: 2/10/84

Check One

X This agency has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises issues concerning compatibility with local plans or intergovernmental problems and a meeting with the applicant is requested. (Explain below)

___ This project raises issues concerning compatibility with local plans or intergovernmental problems; however, a meeting with the applicant is not requested. (Explain below)

___ This project is generally consistent with local plans, but qualifying comments are necessary. (Explain below)

Comments ___

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature George F. Neimeyer 2-1-84
George F. Neimeyer

Title Director

Agency Department of Public Works

A.38

FROM: Mr. Robert S. Lynch
Director of Planning
45 South Main Street
Bel Air, Maryland 21043

DATE: January 25, 1984

R P C Meeting: February 12, 1984

☐ Joint RPC/CHHSA Review Cycle (up to 60 days)

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

~~Applicant~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2

REGIONAL PLANNING COUNCIL
FEB 21 1984
BALTIMORE, MARYLAND

R & R File Number: 84-024

Comments should be returned by: 2/10/84

This project has been forwarded to the following local departments or agencies (Check appropriate blanks and attach comments from the reviewing agencies):

X Planning ___ Public Works

___ Environmental Protection ___ Human Relations

___ Others (Specify) ___

JURISDICTION'S COMMENTS

Check One

X This jurisdiction has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises problems concerning compatibility with local plans, or intergovernmental, environmental or civil rights issues and a meeting with the applicant is requested.

___ This project raises problems concerning compatibility with local plans, or intergovernmental, environmental or civil rights issues; however, a meeting with the applicant is not requested.

___ This project is generally consistent with local plans, but qualifying comments are necessary (attach comments).

RETURN TO:

Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 North Charles Street
Baltimore, Maryland 21218

Signature [signature] Act Dir

Title Robert S. Lynch Director

Agency Planning & Zoning

Date 2/14/84

TO: Mr. Robert S. Lynch
Director of Planning
45 South Main Street
Bel Air, Maryland 21043

Date: January 25, 1984

REGIONAL PLANNING COUNCIL
FEB 21 1984
BALTIMORE, MARYLAND

SUBJECT: PROJECT REVIEW FORM

~~Applicant:~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2

R&R File Number: 84-024

Comments should be returned by: 2/10/84

Check One

X This agency has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises issues concerning compatibility with local plans or inter-governmental problems and a meeting with the applicant is requested. (Explain below)

___ This project raises issuee concerning compatibility with local plans or inter-governmental problems; however, a meeting with the applicant is not requested. (Explain below)

___ This project is generally consistent with local plans, but qualifying comments are necessary. (Explain below)

Comments ___

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature Pieter de Jong
Title Planner
Agency Harford County

A.39

TO: Mr. James Hoswell
Office of Planning & Zoning
County Courts Building
401 Bosley Avenue
Towson, Maryland 21204

Date: January 25, 1984

FEB 22

REGIONAL PLANNING COUNCIL
FEB 21 1984
BALTIMORE, MARYLAND

SUBJECT: PROJECT REVIEW FORM

~~Applicant:~~ Referral Source: Department of State Planning

Project: Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Isalnd Nuclear Station, Unit 2

R&R File Number: 84-024

Comments should be returned by: 2/10/84

Check One

X This agency has no comments on this proposal.

___ This project is consistent with or contributes to the fulfillment of local comprehensive plans, goals and objectives.

___ This project raises issues concerning compatibility with local plans or inter-governmental problems and a meeting with the applicant is requested. (Explain below)

___ This project raises issues concerning compatibility with local plans or inter-governmental problems; however, a meeting with the applicant is not requested. (Explain below)

___ This project is generally consistent with local plans, but qualifying comments are necessary. (Explain below)

Comments Insufficient time to review. When personnel is available impact statement will be read and comments made. Hopefully this can be done within the next 30 days.

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature Colin K. Kinekon
Director
Title Waste & Water Quality Management
Agency Health Department

cc: Mr. Ian J. Forrest
Mr. J. James Dieter

Harford County Howard County State of Maryland

TORREY C. BROWN, M.D.
SECRETARY

STATE OF MARYLAND

DEPARTMENT OF NATURAL RESOURCES

ENERGY ADMINISTRATION
POWER PLANT SITING PROGRAM
TAWES STATE OFFICE BUILDING
ANNAPOLIS 21401
(301) 269-2261

JOHN R. GRIFFIN
DEPUTY SECRETARY

RECEIVED
FEB 27 1984
DIVISION OF
RADIATION CONTROL

RECEIVED
FEB 23 1984
COMMUNITY HEALTH
MANAGEMENT PROGRAM

February 17, 1984

Dr. Bernard J. Snyder
Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: 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 Draft Supplement Dealing with Occupational Radiation Dose (NUREG - 0683, Supplement 1)

Dear Dr. Snyder:

This letter is to forward the State of Maryland's comments on the Supplement to the Programmatic Environmental Impact Statement. As lead agency for the State of Maryland for review of cleanup activities at Three Mile Island, the Power Plant Siting Progam has coordinated State review of the Supplement.

Maryland's principal concern continues to be the hazard posed to its population and resources by the presence of high level wastes, including spent fuel, at Three Mile Island. Maryland's position has been that the "cleanup should proceed as expeditiously as reasonably possible to reduce the potential for uncontrolled releases of radioactive materials to the environment" (PEIS, 1981). That position has not changed.

The evidence presented in the Supplement indicates that the total radiation exposure to the work force involved in the TMI cleanup will be higher than originally estimated. While we are concerned that the principle of keeping the dose to these workers as low as reasonably achievable be strictly adhered to, and the dose reduction program be properly emphasized, we note that the doses to the workers will continue to be within the federally allowed limits of 10 CFR 20, that is no individual worker will receive a dose in excess of 3 rem per quarter or 5 rem per year.

Maryland is also concerned that the selection of a cleanup plan could delay the cleanup. We have reviewed the analysis of the current cleanup plan as well as the three alternatives. Alternatives 1 and 2 would result in a delay of fuel removal while resulting in no significant savings in occupational exposure. Because of this delay, and the fact that little or no dose savings would be achieved, Maryland considers both of these alternatives unacceptable. Alternative 3 may seem more attractive because of the projected reduction in occupational exposure without delaying fuel removal. It does, however, significantly delay the overall cleanup while relying on the uncertain possibility that robotic cleanup technology may become available at some time in the future. Maryland is opposed to delaying even post-fuel removal portions of the cleanup on the basis of mere speculation. For these reasons, the State of Maryland favors the current cleanup plan.

Sincerely,

Thomas E. Magette, Administrator
Nuclear Evaluations

TEM:emp

cc: Richard McLean
Randy Roig
Henry Wagner
David L. Resh
Samuel Baker, DSP

TTY for Deaf - Annapolis 269-2609, Washington Metro 565-0450

Regional Planning Council
2225 North Charles Street Baltimore, Maryland 21218-5767 (301) 383-5838
J. Hugh Nichols, *Chairman* Walter J. Kowalczyk, Jr., *Executive Director*

Date: February 17, 1984

Department of State Planning
301 W. Preston Street
Baltimore, Maryland 21201

RE: Metropolitan Clearinghouse Review and Referral Memorandum, Project: 84-024 Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2

State Clearinghouse # 84-1-294

Dear Mr. Hager:

A.41 The attached review and referral memorandum is certification that the above referenced project has undergone review and comment by the Regional Planning Council and a recommended action has been determined based on the Council's findings.

Comments on this project were requested from: Anne Arundel County, Baltimore City, Baltimore County, Carroll County, Howard County, Harford County.

Comments from the following jurisdictions are included with the Clearinghouse review: Baltimore City, Anne Arundel County, Carroll County, Howard County.

We appreciate your attention to Metropolitan Clearinghouse procedures. If you have any questions, please contact us at 383-7110.

Sincerely,

W. Wilson Hurst, Coordinator
Metropolitan Clearinghouse

Attachment

REGIONAL PLANNING COUNCIL
2225 North Charles Street
Baltimore, Maryland 21218

RPC Meeting February 17, 1984

REVIEW AND REFERRAL MEMORANDUM

Project: 84-024 Draft Supplement to EIS-Occupational Radiation Dose, Three Mile Island Nuclear Station, Unit 2. The EIS Related to Decontamination and Disposal of Radioactive Waste for the 1979 Accident at Three Mile Island Nuclear Station Unit 2 has been supplemented. Information indicates that cleanup will entail more occupational radiation dose to the clean-up work force than anticipated.. Only one of three additional alternatives considered in the supplement would result in an appreciably lower occupational dose, but significant disadvantages are associated with this alternative.

Referral Source: Department of State Planning

COMMENT

The current clean-up procedure should continue as expeditiously as possible. The alternatives described in this report would further delay the removal of radioactive materials from the island, and would not significantly reduce the occupational exposure. Any and all additional funding should be pursued to ensure the removal of contaminated materials and damaged fuel. The recent IRS decision to allow tax deductions for utility contributions to the clean-up fund is a step in the right direction.

Recommendation: ENDORSEMENT IS RECOMMENDED SUBJECT TO THE ABOVE COMMENTS.

I HEREBY CERTIFY that at its 234th meeting, held February 17, 1984 the Regional Planning Council concurred in this Review and Referral Memorandum and incorporated it into the minutes of that meeting.

February 17, 1984
DATE

WALTER J. KOWALCZYK, JR.
Walter Kowalczyk
Executive Director

Bechtel National, Inc.
Engineers – Constructors

Oak Ridge Office
Jackson Plaza Tower
800 Oak Ridge Turnpike
Oak Ridge, Tennessee
Mail Address P O Box 350 Oak Ridge TN 37830

February 29, 1984

Dr. Bernard J. Synder
Program Director, TMI Program Office
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Synder:

Please review the following comments on NUREG 0683, Supplement No. 1 Draft Report.

ITEM 1

In my collection of data and information for this EIS supplement, I commented on the original numbers that were published regarding Auxiliary and Fuel Handling Building cleanup. Some were corrected, however, data on Page 1.4 Table 1.1, I believe is in error.

As Site Manager for VIKEM, I was very conscious of personnel radiation exposure and maintained daily status for equal distribution of work and radiation exposure. Totals were constantly maintained, weekly summaries calculated and posted bi-weekly as Met-Ed crews had two week assignments at TMI.

Please peruse the attached exposure sheets and you will note they far exceed the published figure. For your information, they do not include exposure for CNSI and Health Physics personnel who monitored the cleanup.

My records indicated as follows:

	1979	1980	
VIKEM	28.161	52.588	Person-Rem
MET-ED	36.285	33.146	" "
CATALYTIC	5.371		

ITEM 2

Page 2.21 Section 2.21.5 Last paragraph

I cannot agree with the statement concluding high pressure hydro-blasting is not effective in reducing dose rates. Instances in

AFHB where dose rates were in the 5-10 R/Hr range were reduced to low mR/Hr by rapid dispersion and flushing of highly contaminated dirt from floor, walls, pump bases, etc.

A particular example would be Auxiliary Sump Room where accumulations of dirt resulted in contact floor reading of 10-20 R/Hr with waist high level general area of 5 R/Hr. The area was hydroblasted twice in succession and project completed in less than one hour. Total exposure for four men blasting, crew removing high rad debris, pad and support crew was $<$ 1 person rem. Resultant room dose rate was waist high of 100-200 mR/Hr and floor contact of 3-5 R/Hr.

These high readings are attributed to the sludge buildup in the sump approximately 3 feet below.

There are many other examples of such hydroblasting. Included are:

FHB - 281 El Annulus
Bleed Tank Cubicles
Makeup Pump Cubicles A, B, and C
Decon Heat Vaults
Containment Spray Vaults

I cannot comment on the procedure and technique utilized in the containment; however, I believe this statement should be clarified.

Should you have any comments and/or questions, please do not hesitate to contact me at your convenience.

Sincerely,

Val Bouchard

Valmore F. Bouchard

VFB:cdw

Attachment

AUXILLARY & FUEL HANDLING BUILDING EXPOSURE FOR DECON

VIKEM	EXP. (mr)		PERSONNEL	AVG. EXP.
April 27 - June 30	13,424		37	362 Man mRem
July 1 - Sept. 30	6,985		28	249 Man mRem
Oct. 1 - Dec. 31	7,752	28,161	15	517 Man mRem
Jan. 1 - Feb. 26	6,901		17	409 Man mRem
Feb. 26 - March 16	976		17	57 Man mRem
March 17 - March 30	2,610		21	124 Man mRem
March 31 - April 13	2,059		21	98 Man mRem
April 14 - April 27	1,560		20	78 Man mRem
April 28 - May 11	2,072		16	130 Man mRem
May 12 - May 25	1,655		15	110 Man mRem
May 26 - June 16	1,407		17	83 Man mRem
June 16 - June 30	1,299		17	77 Man mRem
July 1 - Aug. 10	3,378		17	198 Man mRem
Aug. 11 - Sept. 7	5,695		18	316 Man mRem
Sept. 8 - Sept. 15	642		16	40 Man mRem
Sept. 16 - Sept. 28	1,419		12	118 Man mRem
Sept. 29 - Oct. 13	1,473	33,146	13	113 Mam mRem

AUXILIARY & FUEL HANDLING BUILDING EXPOSURE FOR DECON

MET-ED	EXP. (mr)		PERSONNEL	AVG. EXP.
May 30 - June 30	9,919		118	84 Man mRem
July 1 - Sept. 30	12,982		164	79 Man mRem
Oct. 1 - Dec. 31	13,384	36,285	159	84 Man mRem
Jan. 1 - Feb. 26	7,988		65	122 Man mRem
Feb. 27 - March 3	831		31	27 Man mRem
March 4 - March 16	3,376		36	94 Man mRem
March 17 - March 30	3,207		32	100 Man mRem
March 31 - April 7	1,592		31	51 Man mRem
April 14 - April 27	2,765		32	86 Man mRem
April 28 - May	3,420		31	110 Man mRem
May 12 - May 25	2,890		31	93 Man mRem
May 26 - June 8	1,302		30	44 Man mRem
June 9 - June 22	3,605		28	129 Man mRem
June 23 - July 5	1,562		29	54 Man mRem
July 7 - July 20	2,666		32	83 Man mRem
July 21 - August 3	2,515		28	90 Man mRem
August 4 - Aug. 18	2,203		31	72 Man mRem
August 19 - August 31	3,559		27	131 Man mRem
Sept. 1 - Sept. 14	5,324		32	166 Man mRem
Sept . 15 - Sept. 28	1 ,201		24	50 Man mRem
Sept. 29 - Oct. 12	2,582	52,588	21	122 Man mRem

AUXILLARY & FUEL HANDLING BUILDING EXPOSURE FOR DECON

CATALYTIC	EXP. (mr)	PERSONNEL	AVG. EXP.
APRIL 27 - MAY 17	5,371	28	192 Man mRem

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 84/45

'984

Bernard J. Snyder, Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Snyder:

We have reviewed the draft supplement to the programmatic environmental impact statement related to decontamination and disposal of radioactive wastes resulting from the accident on March 28, 1979 at the Three Mile Island Nuclear Station, Dauphin County, Pennsylvania, and have the following concern.

In the booklet entitled "Answers to questions about updated estimates of occupational radiation doses at Three Mile Island, Unit 2" there is a brief reference to "a small chance that the fuel could begin a self-sustaining chain reaction" in the answer to Question 56 (p. 13). However, there are no follow-up questions on that important concern. The possibility of recriticality of the core is also mentioned in the draft supplement (p. 2.14, last line), but only briefly and parenthetically. This concern should be more fully addressed in the final supplement.

We hope this comment will be helpful to you.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

D019
1/0

8403020277 840301
PDR ADOCK 05000320
P PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

March 21, 1984

Mr. William J. Dircks
Executive Director for Operations
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Dircks:

SUBJECT: REVIEW OF GPU NUCLEAR CORPORATION'S CLEANUP PLAN FOR TMI-2 AND THE NRC STAFF'S DRAFT SUPPLEMENT TO THE CLEANUP PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

During its 287th meeting, March 15-17, 1984, the ACRS considered the recommendations of its Subcommittee on Reactor Radiological Effects regarding the TMI-2 cleanup. The Subcommittee had the benefit of the presentations by the NRC's TMI Program Office and by GPU Nuclear Corporation personnel during meetings on January 24 and February 24, 1984, respectively.

The ACRS approved forwarding the Subcommittee comments to you for your consideration.

Sincerely,

Jesse C. Ebersole
Chairman

Enclosure:
Feb. 24, 1984 Subcommittee Comments on TMI-2
Cleanup and Related Issues

Reference:
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 (Draft Supplement Dealing with Occupational Radiation Dose) NUREG-0683, Supp. No. 1, Draft Report, 12/83

cc: B. Snyder, TMIPO
L. Barrett, TMIPO
H. Denton, NRR
R. Minogue, RES

COMMENTS ON
GPU NUCLEAR CORPORATION'S CLEANUP PLAN FOR TMI-2 AND
ON THE NRC STAFF'S DRAFT SUPPLEMENT TO THE CLEANUP
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (PEIS)

ACRS SUBCOMMITTEE ON REACTOR RADIOLOGICAL EFFECTS
FEBRUARY 24, 1984

During a meeting on January 24, 1984, the Subcommittee heard presentations by representatives of the NRC's TMI Program Office on the Staff's draft supplement to the Programmatic Environmental Impact Statement (PEIS) Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979 Accident, Three Mile Island Nuclear Station, Unit 2. This supplement was issued for comment in December, 1983 and deals with occupational radiation doses associated with the cleanup effort. On February 24, 1984, the Subcommittee met again and was briefed by GPU Nuclear Corporation on its detailed cleanup plan for TMI-2. Based on the above, we offer the following comments:

1. The TMI-2 GPU Recovery Staff appeared to be professional in their approach, and they were thorough in their presentations. However, they do not appear to have on their staff (or serving as consultants to them) an adequate number of people who have had previous direct experience in nuclear facility cleanup operations. The Subcommittee believes that the provision of such expertise would be helpful.

2. The discussions of the cleanup at TMI-2 clearly indicated that Cs-137 accounts for a major part of the external exposures that are occurring, and those that are projected in terms of the collective occupational doses for the total cleanup operation.

   Accordingly, the Subcommitee urges that GPU obtain the services of professional personnel expert in the chemical behavior of cesium so that they can effectively address the problems represented by this radionuclide. They apparently do not now have such expertise.

3. There appear to be several aspects of the recovery operations wherein a better understanding of the radiation protection problems and a better knowledge of more effective control measures would be helpful. These aspects include:

   a. Nature of Airborne Radionuclides

      In connection with potential internal exposures of workers within TMI-2 containment, there is a need to specify the radionuclide composition of the various airborne particulates according to particle size. This has not apparently been done, yet it is essential to the assessment of the accompanying potential health hazard. The Subcommittee believes that studies should be undertaken to more clearly delineate the nature of the airborne radionuclides.

b. Internal Versus External Exposures

Workers entering containment for decontamination and recovery operations are currently required to wear full-scale protective equipment, including respirators. Closer examination of the increased external exposures, because of the impediments caused by the utilization of protective equipment, might show that it would be better to alter this approach (such as working faster without protective equipment). This needs further evaluation.

March 24,1984

Dr. Bernard J. Snyder,Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. NRC
Washington,D.C. 20555

RE:PEIS related to decontamination and disposal of radioactive wastes resulting fromMarch 28,1979 accident at TMI Unit 2 occupational radiation dose revisions NUREG1060

Dear Sir:

It is stated in NUREG 1060 that revised, increased, dose estimates "slightly raise the chances of cancer for the group(workers exposed to radiation in TMI Unit 2 clean-up) as a whole".

COMMENT: How can the NRC claim "slight raises the chances of cancer" when NO ONE Knows what the initiating mechanism of cancer is? The American Cancer "society" is only now starting a survey to attempt to find out if diet, work or other exposure to chemicals and/or forms of radiation, heredity, etc., etc. could possibly be the trigger for the 1 in 5 cancers our"developed" society can expect. IF, afterall these years of collecting money to fight cancer and/or "to wipe out cancer in our lifetime", the medical experts still do not know WHAT causes cancer, it seems beyond the scope of the expertise of the NRC to claim that the rise in cancer rate will be slight. If the same number of workers are exposed to the new estimated exposure, the cancer to be expected will rise proportionately. If more numbers are exposed at this higher estimated radiation exposure, more cancers can be expected. Either way, there will be more cancer(s). Certainly the medical experts that now claim not to know what triggers cancer will be VERY reluctant to admit that radiation(ionizing) causes cancer, since they have been promoting radiation "treatment" for cancer for decades. Unfortunately no onetells the patient, enveloped as they are in pain, emotional torment, and financial crisis, that that "treatment" of radiation will increase their chances by 27 of developing a secondary cancer as a result of that "treatment".

COMMENT: The increased radiation exposure, be it assessed to the estimated number of workers or an increased number of workers to cut individual exposure levels, must also take into account the synergistic effects of chemicals used in this clean-up.

COMMENT: The increased radiation exposure is considered only in light of increased cancer. The aging processes must also be considered that give rise to increased kidney disease, diabetes, and all the age-related diseases. Simply, the processes that cause reactor embrittlement must be transposed to human embrittlement.

IN CONCLUSION: The assumption that there is a "natural" radiation is false.

Dr. Bernard J. Snyder, Program Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. NRC
Washington, D. C. 20555

March 24, 1984

RE: PEIS -elated to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident at TMI Unit 2 occupational -adiation dose revisions NUREG 1060

The EPA "natural radiation" is based on measurements and/or models and/or assumptions that holds no value in real life. The NATURAL radiation of the earth has been decaying, with the exception of added radiation from cosmic sources, UNTIL the advent of the "atomic age". The MAN-MADE radiation that has been accumulating in the environment since then is NOT "natural", but man-created, so the EPA "natural radiation" is incorrect. The only NATURAL radiation basis should be a declining factor in earth's envionment. But that ceased when man first began to extensively use coal and then accelerated when man started "creating" transplutonium elements more or less forty years ago. That fact may well be the reason for the escalating cancers and birth defects, in spite of our "advanced" civilization. With thirteen man-made isotopes now recognized, we are adding a human (but not humane) factor to the "natural" radiation that has not been recognized for what it is-added radiation that is not "natural", but is counted as such in assessing risk/benefit of nuclear activities. Unfortunately the risk is assigned by those in power, and that risk is assumed for future generations, while the "benefit" is a self-interested factor of short term duration, to either fulfill the "scientific" curiosity of a few individuals or sustain the jobs of those involved in "managing" nuclear activities.

ANNA E. W[illegible]CH, CHMN.
N.Y. FEDERATION FOR SAFE ENERGY
BOX 2303 W. SAUGERTIES RD.
SAUGERTIES, N.Y. 12477

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501 Vine Street
Middletown, PA 17057
April 1, 1984

Dr. Bernard Snyder
Program Director, TMIPO
Office of Nuclear Reactor
Regulation
U.S. Nuclear Regulatory
Commission
Washington, DC 20555

Dear Dr. Snyder:

I attended the February 15, 1984, NRC meeting at Middletown High School to comment on the Draft Supplement related to TMI #2 decon/defueling.

My comments appear on pages 77 to 94 of the transcripts. In reviewing my notes it appears there is an omission of the text of my presentation.

I asked Bernard Snyder why the licensee is not submitting the previously publicized plan for evaluating the possibility of stopping decon work after the fuel is removed in hopes that robotics technology will be available, in the future.

Mr. Snyder said he could not answer my question.

I find it very interesting that the State of Pennsylvania would submit such a plan when for the past 5 years the licensee has submitted these types of recommendations to the NRC.

I believe GPU and the NRC should be concentrating on one item--the complete decontamination and defueling of TMI #2. Any thought of operating TMI #1 would be a serious distraction in terms of personnel and funding.

I am very confused as to why the state of Pennsylvania will be submitting the proposal alluded to earlier and not GPU.

For the record I feel it is necessary this be added to my comments and unfortunate the question was omitted from the transcript.

Sincerely,

Donald E. Hossler

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 2 1984

OFFICE OF
EXTERNAL AFFAIRS

Dr. Bernard J. Snyder, Director
Three Mile Island Program Office
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Snyder:

In accordance with Section 309 of the Clean Air Act, as amended, the U.S. Environmental Protection Agency has reviewed the draft Supplement No. 1 to the Programmatic Environmental Impact Statement related to the decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident, Three Mile Island Nuclear Station, Unit 2 (NUREG-0683, Supplement No. 1). This draft supplement addresses new estimates for occupational radiation doses during the decontamination of the damaged unit.

The draft supplement does not consider the report of the 1980 National Academy of Sciences Biological Effects of Ionizing Radiation Committee (BEIR-3). EPA has used that report in our review to compare the NRC health risk estimates to those derived from the BEIR-3 work. EPA suggests that NRC incorporate the BEIR-3 work into the final EIS supplement. This comparison and other comments are presented in the attached detailed comments. In keeping with EPA's procedures, we have rated this draft supplement LO-2.

Should you have any questions please call Dr. W. Alexander Williams (382-5909) of my staff.

Sincerely,

Allan Hirsch

Allan Hirsch, Director
Office of Federal Activities

Detailed Comments of the Environmental Protection Agency
on the U.S. Nuclear Regulatory Commission's Draft Supplement No. 1
to the 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
(NUREG-0683, Supplement No. 1)

1. Projected collective doses to workers were estimated in 1981 as being in a range of 2,000 to 8,000 person-rem. The current projection increases the projected exposure to between 13,000 and 46,000 rem. In the Programmatic Environmental Impact Statement the risk of fatal cancer from the projected doses was estimated on the basis of risk estimates using an absolute risk projection provided in the 1972 NAS BEIR report. Risk estimates in the EIS Supplement are also based on these 1972 risk estimates.

In 1980, the National Academy of Sciences (NAS) published new risk estimates in the NAS BEIR-3 report. Unlike their 1972 report, the 1980 Biological Effects of Ionizing Radiation (BEIR) Committee discontinued advocacy of 30 years as the duration of expression for radiogenic solid cancers, as used in the Supplement. The Environmental Protection Agency (EPA) has prepared Table 1, below, which compares 1980 BEIR Committee estimates of the risk of fatal cancer due to occupational exposure with those used by NRC in the EIS Supplement. The BEIR-3 estimates in Table 1 are for ages 18 to 65. We note that the NRC estimate uses a mixed male and female population. Like BEIR-3, we have considered each sex spearately. In fact, over 95 percent of the workers at Three Mile Island are male.

Like NRC estimates, the BEIR-3 risk shown in Table 1 is based on a linear response model, designated L, L in the 1980 NAS report. The EPA believes that a linear model is appropriate and not overly conservative for evaluating risks at these exposure levels. From Table 1, it is seen that the NRC risk estimates are close to those obtained using the absolute risk projection model for males, but substantially below those obtained on the basis of a relative risk projection.

Table 2, below, compares NRC estimates of fatal concer due to a projected collective dose of 13,000 and 46,000 persons-rem with those for males based on the linear model in the 1980 NAS BEIR report. EPA therefore believes the range of consequences due to the occupational doses projected in the draft supplement are greater than indicated therein.

TABLE 1

Occupational Workforce - Linear Response Models
Estimated Fatal Cancers per 10^6 person-rem

Model	Single coefficient	
NRC	131	
BEIR-3 Absolute	163 Male	194 Average both sexes
BEIR-3 Absolute	225 Female	
BEIR-3 Relative[a]	311 Male	359 Average both sexes
BEIR-3 Relative[a]	407 Female	

(a) Leukemia and bone-absolute risk; all other-relative risk.

(b) This table shows the estimated number of fatal cancers per million rem exposure to a population for the indicated dose to response models for the indicated population.

Table 2

Estimates of Fatal Radiogenic Cancer Among Make TMI Workers[a]
for Exposures of 13,000 and 46,000 person-rem

Model	Total Cancer Fatalities 13,000 person-rem	46,000 person-rem
NRC	1.7	6.0
BEIR-3 Absolute Risk	2.2 (2.5)	7.5 (8.9)
BEIR-3 Relative Risk	4.0 (4.7)	14.3 (16.5)

(a) Averages for both sexes, as in the NRC analysis, are shown in parenthesis.

(b) This table multiplies the response estimates in table 1 by the NRC estimated exposures to give risk estimates with the more recent models.

2. On page 1.1 we recommend the typographical errors at the end of the first paragraph be corrected.

3. GPU Nuclear issued a report in January, 1984 which indicated projected occupational doses as follows:

Date of estimate	Estimated occupational for decontamination
1980	10,000-40,000 person-rem
1981	9,000-24,000 person-rem
1983	16,000-28,000 person-rem

EPA recommends that the fourth paragraph on page 1.3 be changed to reflect all of these estimates.

Bernard J. Snyder.

Program Director

TMIPO

U.S.N.R.C.

Dear Sir;

Please accept this letter as my comments upon the Draft Supplement to the TMI#2 Programmatic EIS. I submitted comments to the PEIS. Included in those comments were my doubts about the low exposures presumed by the PEIS. My doubts have shown to be closer to the truth than the optimistic "reality" assumed by the NRC staff. There is no reason to believe that these new exposures are still not optimistic, and unrealistic.

I am enclosing two items that the staff refuses to assess realistically.

1. zirconium fire'

2. upgrading of the polisher.

The chance of a zirconium fire increases the potential for exposures astronomically. If there is azirconium fire, much radioactive material can be loosed from the containment. The NRC has not looked at the possibility of a zirconium fire in an adequate manner.

If there si a zirconium fire and subsequent high exposures , not only will this draft EIS be in error ;but also, lives will be endangered.

This is only one area that is deficient. Because of these concerns, I respectfully request that the draft be taken back and work be temporarily stopped until adequate protection for workers is in place.

Respectfully submitted,

M. I. Lewis 4.10.84

M. I. LEWIS
6504 BRADFORD TERR.
PHILA., PA. 19149

Chairman Pallidino

Commissioners Gilinsky, Roberts, Asselstineand Bernthal,

Sirs:

Please accept this letter as my petition for APPEAL OF THE NRR DIRECTOR'S DECISION of 2-17-84 denying my request to postpone the headlift of TMI#2 for good cause. The Director of NRR recently issued a denial of Marvin Lewis' Request to Postpone the Headlift of TMI#2(DD 84-4 2-17-84) Due to deficiencies in the Director's Decision Petitioner asserts his right to appeal for good cause.

Petititioner asserts that a headlift at TMI#2 can result in a fire whcih endangers workers and the public with radioactive releases /. Further the work done by the NRC staff and used as the basis for the Director's decision and denial ignores obvious dangers and allows a dangerous headlift without sufficient assurance for the health and safety of the public and workers. The staff's research and experimental techniques demonstrat incompetence, ignorance of zirconium properties, and purposeful obsfucations.

Basis of Petitioner's Request to Stop Headlift:

Petitioner based his request to stop headlift upon three major deficiencies in the staff's evaluation of the pyrophoricity of the zirconium present in the TMI#2 reactor.

A. Zircolloy has gone thru an unknown temperature, time and hydrodynamic stress pattern that could easily have harmed a normally present non-pyrophorific oxide film.

B. The presence of hydrogen during the accident could have produced pyrophorific properties.

C. Contamination present in the accident could have increased pyrophoricity.

The Director's Decision mentions the above petitioner's concerns , but does not lay them to rest. In fact the data that is used to answer the petitioners concerns increases the petitioner's concern as the arguments are very flawed and deficient.

Deficiencies and errors in the Director's Denial:

The most obvious deficiency is the slowness of the Director's Denial. Petitioner sent his letter in September 83. The Denial was issued on 3-2-84, over 6 months later. Under the rules of the NRC , the issue of pyrophoricity was in limbo until the Director's Denial , not allowing Petitioner to bring any further action until the Director's Denial. This delay could very well have proven fatal both legally and actually if a fire had broken out at TMI#2 due to uncovering the core.

The Director states that the "issue of pyrophoricity was addressed by the licensee as part of its underhead charaaterization study" and "extensively evaluated by the NRC staff..." Although these studies were done , they did not answer this petitioner's specific concerns. (See A, B, and C above.)

A-51

In answer to the Petitioners concern A that "Zirconium could have gone thru unknown temperature , time and hydrodymamic stress patterns that could have easily harmed a normally present non-pyrophorific oxide film" , the Director states"(@2) the primary system flow dynamics during the TMI#2 accident would not likely have transportdd large quantities of pyrophoric material, if formed , to the top of the plenum."

The deficiencies in the director's answer here include

a. the flow characteristics during the TMI#2 accident are still an unknown; therefore, any conjecture about where and what the flow could have been during the TMI#2 accident is just that ,conjecture. The "flow characteristics" during the accident determined by the staff and repeated by the Director in his Denial is pure conjecture and should be given no weight .

b. The concern that the accident conditions could have harmed the normally present oxide film is not explored at all in the Director's Denial. This concern is not answered or even discussed. At a minimum , the Petitioner's concern about the damage to the normally present oxide film should be discussed in the Director's Denial.

c. The Director states that"large quantities of pyrophorific material" would not have been transported to the top of the plenum. However no evaluation is forthcoming as to what amount of material would be needed to start or propagate a fire to the zirconium below the water line. Once afire starts , it could propogate on its own to the zirconium below the water line. Zirconium not only burns under water but does so very well, once started out of water. This information is very necessary and the Commission should order that the amount of zirconium above the water line needed to start a propogation of the fire to the zirconium below the water line be determined as part of the pyrophoricity study at TMI#2.

The Director also states ,"(2) The presence of steam(i.e. , an oxidizing agent) would make it unlikely that significant quantities of zirconium hydride in a pyrophorific condition were produced during the accident." However The presence of hydrogen (Hartman Allegations) , a reducing agent, could easily have produced conditions favorable for the formation of zirconium hydride. The presence of hydrogen in the RPV during the accident is not discussed in the Director's Denial. This is truly unfair and a major deficiency to overlook obvious and continuing dangers.

Also the Director stated, "Mix(ing) with core debris ... would prevent the development of pyrophorific conditions." The petitioner has pointed out and the letters from Dr Gulbransen have pointed out that zirconium hydride often becomes more dangerous when contaminated. The Director's statement on the contamination to prevent pyrophorific development ignores the empirical and commercial history of zirconium. Contamination is used in the fireworks industry to produce zirconium time delay fuses.

.ne sampling technique to determine pyrophoricity is so devoid of basis that critique can easily sound like a harangue. Why only six samples from the core? How were these determined to be representative? Why only two "scrappings" fron the plemum surface? Why are these representative? Was the problem of a fire starting above the water line and propogating to zirconium below the water explored at all either in expediment or thru research? How did "chemical analysis" of filter solids and scrappings determine lack of pyrophorific materials? What did the chemical anlysis determine? Composition? Then give the compositb n that was found. How are the above tests representative and what are they representative of?

Dr Gulbransen's letter of March 2, 1984, to Marvin Lewis points out many deficiencies in the experimental technique. At aminimum, Dr Gulbransen's critique should be answered. I would also add that timing is very important in assessing the pyrophoricity of zirconium. Zirconium left in aircan increase or decrease its ability to ignite. This depends on conditions such as time , temperature and contaminants. Some mention of the handling techniques for experimental samples is indicated and not mentioned. These are all deficiencies in the Director's Denial.

A.52

Appeal:

Due to the deficiencies cited in the Director's Decision and denial of this Petitioners Request , Petitioner appeals his request and the Director's Denial to the Commission. This is a dire emergency as the waterline has been lowered at TMI#2 and a fire is a present and likely possibility.

Respectfully submitted,

Marvin Lewis. 3/1/84.

M. I. LEWIS
6504 BRADFORD TERR.
PHILA., PA. 19149

ENCLOSURE LETTER GULBRANSEN TO LEWIS 3-2-84.

University of Pittsburgh
SCHOOL OF ENGINEERING
Department of Metallurgical and Materials Engineering

March 2, 1984

Mr. Marvin Lewis
6504 Bradford Terrace
Philadelphia, PA. 19149

Dear Mr. Lewis,

I received a copy of a letter to you by Harold R. Denton dated February 17, 1984 concerning your request to postpone lifting of the reactor pressure vessel head at T.M.I. #2 Power Station. Attached to the letter was the Director's decision under 10 C.F.R. 2.206 denying your request. I supported your request with a letter and a short paper on the effects of oxygen, nitrogen and hydrogen on the mechanical properties of zirconium.

I would like to make several comments regarding the staffs review of the pyrophoric reactions of zirconium.

1). The zirconium particles were identified as commercially available of 62 microns or less. This is very indefinite. 62 microns is a rather large zirconium particle, probably covered with an oxide film and not very pyrophoric. Nobody ships pyrophoric powders around in bottles.
2) The dangerous size of particles are smaller i.e. 3 microns and free from oxide films and other impurities on the surface. I have hade these ignite at room temperature, $70^{o}F$ in air.
3) Fresh surfaces of fine zirconium particles or turnings, readily ignite. These are the size of particles and conditions I want to warn people about.
4) The experiments described in Mr. Denton's letter may lead the uniformed to false conclusions.

I am glad you brought this question to the attention of the office of nuclear regulation. I am pleased that they considered the problem, but I don't feel they have explored the problem completely.

Very truly yours,

Earl A. Gulbransen

Earl A. Gulbransen
Research Processor

848 BENEDUM HALL, PITTSBURGH, PA 15261

SSINS No.: 6835
IN 84-18

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

March 7, 1984

IE INFORMATION NOTICE NO. 84-18: STRESS CORROSION CRACKING IN PRESSURIZED WATER REACTOR SYSTEMS

Addressees:

All nuclear power reactor facilities holding an operating license (OL) or construction permit (CP).

Purpose:

This information notice is being issued to remind all holders of pressurized water reactor (PWR) licenses and construction permits that PWR systems are susceptible to stress corrosion cracking in the presence of various corrodants. Information is also presented on actions which, if properly and conscientiously implemented, can significantly reduce the likelihood of such cracking.

Discussion:

Stress corrosion cracking in boiling water reactor (BWR) primary pressure boundary piping is currently receiving considerable industry and NRC attention. This circumstance may lead to an unwarranted conclusion that similar problems do not occur in PWRs. The reactor coolant system (RCS) of a PWR has a hydrogen overpressure maintained as an oxygen getter during power operation. As a result, the primary pressure boundary piping of PWRs have generally not been found to be affected by stress corrosion cracking.

However, there are two conditions where significant potential exists for inadvertent introduction of contaminants into PWR fluid systems. The first opportunity is unacceptable levels of contaminants in the boric acid purchased. The second is the free surface of the spent fuel pool which can be a natural collector of airborne contaminants. During refueling operations there is direct communication between the reactor coolant system and the spent fuel pool, as well as increased free surface to collect any airborne contaminants caused by concurrent maintenance activities. At Three Mile Island Unit 1, during the extended shutdown caused by the Unit 2 accident, sodium thiosulfate in some way was introduced into the reactor coolant system and caused extensive stress corrosion attack on the Inconel 600* steam generator tubes. The thiosulfate solution was normally kept in a storage tank to be available as an

*Inconel 600 is an alloy trade name of International Nickel Company.

steamline break, and is required by the plant technical specifications to be operable whenever the unit is at power. Extensive stress corrosion cracking was identified during piping inspections. Unit 1 remained shut down until mid-April 1983, when it was returned to power operation following repairs.

Metallurgical examination of sections of piping removed during the repair effort disclosed extensive stress corrosion attack. A deposit of iron oxide on the inner wall of the pipe contained 79 to 110 ppm of chlorides, 114 to 204 ppm of sulfates, and 10 to 84 ppm of fluorides. The piping system was normally stagnant and heat-traced to 180°F to keep the concentrated boric acid in solution. The source of the contaminants is believed to be impurities in the purchased boric acid which were concentrated under stagnant, heated conditions.

PWR accident mitigation systems are normally in a standby condition and hence provide a fertile environment for stress corrosion cracking. In addition to technical specification surveillance requirements to exercise pumps and valves on a regular schedule, some licensees have initiated measures to recirculate and test system fluids for potential contaminants to facilitate prompt removal of any identified contaminants. In this connection, Northern States Power Co. at Prairie Island is utilizing ion exchange chromatography to detect the presence of potentially harmful contaminants and reports that this is a practical, effective technique.

No specific action or response is required by this information notice. If you have any questions regarding this matter, please contact the Regional Administrator of the appropriate NRC Regional Office, or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: J. B. Henderson, IE
492-9654

Attachment:
List of Recently Issued IE Information Notices

LEWIS
6504 BRADFORD TERR
PHILADELPHIA, PENN
19149

CU95964

GOVERNOR THORNBURG

DEAR SIR:

THERE IS A PIECE OF EQUIPMENT AT TMI #1 & TMI #2 THAT WAS SERIOUSLY INVOLVED IN THE ACCIDENT, HAD PROBLEMS, AND TO THIS DATE HAS NOT APPARENTLY BEEN UPGRADED. FURTHER THE "LESSONS LEARNED" DO NOT REQUIRE ANY REMEDIAL ACTION FOR THIS PIECE OF EQUIPMENT.

A.54

RESPECTFULLY URGE THAT TMI #2 NOT BE ALLOWED TO RESTART UNLESS THIS PIECE OF EQUIPMENT DEMONSTRATES THAT IT CAN PERFORM ADEQUATELY AT TMI #1.

THE EQUIPMENT IS A WATER POLISHER, AND IS DESCRIBED ON PAGE 2 OF THIS LETTER.

Very truly yours

Marvin I. Lewis

3/26/84

THE ADVISORY PANEL FOR THE DECONTAMINATION OF THREE MILE ISLAND UNIT 2

April 16, 1984

(31)

Mr. Nunzio J. Palladino
Chairman
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Chairman Palladino:

During the April 12th meeting of the Advisory Panel on the Cleanup of Unit 2 at Three Mile Island, we again discussed the draft Supplement to the PEIS. The Panel offers the following comments on this document:

1) The staff should discuss fully the uncertainties in the cancer (and genetic) risk coefficient used to estimate the potential health effects to the work force associated with the cleanup of TMI-2. This discussion should reflect the range of expert opinion and any recent data that could impact the estimates of the BEIR Committee or other advisory groups or organizations.

2) The reported range in the estimated potential health effects to the work force should reflect the uncertainty in the cancer risk coefficient as well as the uncertainty in the radiation exposure to the work force.

3) Both the range in potential cancer incidence (morbidity) and fatalities (mortality) should be reported.

4) The discussion of the uncertainty in the cancer risk coefficient and its implication regarding potential health effects should be summarized in the front of the EIS and not just contained in the Appendix.

5) The staff should further examine the alternative of curtailing cleanup efforts following fuel removal and gross decontamination of the reactor coolant system and reactor building. The PEIS

Chairman Nunzio Palladino
April 16, 1984
Page 2

states that increased risk to the public could be expected from this scenario. This alternative should be evaluated (quantitatively where possible) with regard to the risk to the public associated with leaving some residual radioactivity on-site and the potential health impact to the workforce. The economic cost of the cleanup and the availability of funding and timing should be evaluated, if possible.

6) Cleanup plan alternatives 1 and 2 would result in a delay of fuel removal while resulting in no significant savings in occupational exposure. Because of this delay, and the fact that little or no dose savings will be achieved, alternatives 1 and 2 should not be adopted. I should note that relative to this comment, that of the eight Panel members present, four voted in favor of this item and four abstained. It seems to me that more than four members may agree with this opinion but the members abstaining did so because they did not feel that we should be making a recommendation to the NRC regarding which alternative to follow; it was felt by those abstaining that comments on which alternative to follow should be made after the PEIS Update has been finalized.

In closing I would like to offer the Panel's thanks to the NRC staff and the staff of the utility company for providing the expert people at our two Panel meetings which allowed us to better review the PEIS Update and make our recommendations. Please let me know if you have any questions.

Sincerely,

Arthur E. Morris

Arthur E. Morris, Mayor
Chairman

AEM/dk

cc: Mike Masnik
Members of the Advisory Panel

Dear Dr. Snyder:

I would like to comment on the Draft Supplement to the TMI Unit 2 Cleanup Environmental Statement.

I don't think that the present management of TMI should be allowed to continue. They have proved themselves unable to be truthfull when it comes to running the reactors safely.

Thank You,

R.M. Currier

R.M. CURRIER
8 HOLLOW RD.
TELFORD, PA 18969

GPU 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

4410-84-L-0028

March 26, 1984

TMI Program Office
Attn: Dr. B. J. Snyder
Program Director
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Comments on Supplement 1 to the Programmatic Environmental Impact Statement

The attachments to this letter contain GPUNC's comments on the subject document. Attachment 1 contains general comments on the document. Attachment 2 contains section specific comments.

If you have any questions or desire additional clarification, on any of the attached comments, please contact Mr. J. J. Byrne of my staff.

Sincerely,

B. K. Kanga
Director, TMI-2

BKK/JJB/jep

Attachments

CC: Deputy Program Director - TMI Program Office,
Mr. L. H. Barrett

8403300031 840326
PDR ADOCK 05000320
P PDR

Attachment 1

- The discussion in Section 2.2.1.2, "Reactor Disassembly and Defueling", needs to be modified to indicate that although the PEIS supplement was written based on current conceptual designs, as more information becomes available these designs may change. Any change would need to be within the dose estimates contained in the PEIS supplement in order for that activity to stay within the scope of the PEIS.

- The discussion in Section 1.3, "Regulatory and Administrative Controls for Limiting Occupational Dose", should contain some explanation of the degree to which the NRC intends to use the PEIS as a constraint when judging licensee submittals requesting approval to perform TMI-2 recovery activities.

- Although GPUNC concurs that the estimated occupational radiation dose for the TMI-2 recovery is adequately scoped by the PEIS supplement, some of the task specific exposure estimates may be low. For example, based on the historical expenditures listed in Table 1.1 for maintenance, safety, and sampling, Utility and System Maintenance could exceed the doses assigned to this task in approximately three years which is a shorter time period than the expected length of the recovery. Additionally, as shown on Table 1.1, Waste Management activities have already expended 183 person-rem with the greatly increased amount of waste to be generated during the cleanup. The total dose expended on this activity could easily exceed the 485 person-rem listed as an upper range on the dose estimate. The term "within the scope of the PEIS" has particular significance in the context of controlling activities at TMI-2. Therefore, in order to avoid any problems with defining the criteria for acceptance of a specific activity by fitting it into a PEIS supplement task and determining how it compares with the PEIS supplement for that task, the PEIS should state that its scope is the bounding person-rem doses and not the task specific doses. Additionally, the PEIS should also state that the NRC can authorize GPUNC to exceed the dose estimate for a specific task as long as the total dose estimate for the TMI-2 recovery project is not exceeded.

- A statement should be added to Table 2.1, "Licensee's Goals for Dose Rate Reduction", to indicate that these goals are only target values used as a basis for an estimate. They may not be attained and are not a constraint for moving into another period on the cleanup. Additionally, the periods listed in this table are not consistent with the periods shown on Figures 2.10 through 2.13 and as discussed in Section 2.6.3.

- Alternative 3, as described in Section 2.5, is a purely hypothetical option with no practical viability. It is very unlikely that a general purpose robotic device capable of performing all of the reactor building cleanup activities will be developed in the foreseeable future. GPUNC continues to look at remote technology to aid in various cleanup tasks, but to date each task has required the design of a unique tool. It is not practical to develop robotic devices for each task using current technology and it is not likely that the technology for general purpose devices will be available to aid cleanup on any researchable time schedule.

- GPUNC recognizes that the risk estimates in the draft PEIS supplement are based on reports compiled by the National Academy of Sciences 1972 BEIR Committee. The BEIR Committee reports are considered to be among the best available scientific references on the health effects of ionizing radiation. However, the Company considers that the NRC risk estimates of the potential health effects in the current draft PEIS are overestimated due to the conservative assumptions used. These assumptions include the following:

  - Risk estimates of health effects are calculated statistically from observed health effects following exposure to high-dose radiation. Health effects have rarely been observed at low-dose levels, such as those received from occupational exposure. Stated another way, the health effects from low-level exposure occur very rarely, have not been reliably demonstrated and can only be inferred statistically.

  - The most conservative model, the linear no-threshold dose-response model, was used in deriving the number of health effects in the NRC PEIS. This model assumes a straight line projection downward from observed effects at high level exposure, and is considered by most scientists to overestimate the risks of potential health effects.

  - The risk estimates based on the linear model assume no repair of injury in the human body. Evidence exists that effective repair of injury can occur and this is particularly the case when the dose is received over a period of time. The National Council on Radiation Protection and Measurements in Report No. 64 (1980) states that there is substantial decrease in the effectiveness of radiation at low doses and low dose rates; therefore, the radiation risk may be reduced by a factor of between two and ten.

  - No radiation-induced genetic effects have been observed in man, not even in the progeny of the Japanese survivors of the atomic bomb. Risk estimates of potential genetic damaged are based solely on laboratory animal studies with genetic constitutions unlike man.

Attachment 1 (cont'd)

The NRC PEIS health effect estimates are presented as a range with upper and lower bounds. However, because of the statistically inferred nature of the health effects and because the levels of exposure to the workers will be so low, there is a statistical probability that no health effects will occur. Stated another way, the actual radiation health effects from the TMI-2 recovery could possibly be zero. Therefore, the potential additional latent cancer deaths should be stated as zero to some number as opposed to the range given in the PEIS of 2 to 6.

TMI-2 worker exposures are maintained well below federal permissible dose limits. The average TMI-2 nuclear worker (with measurable exposures) has received less than 0.2 rem per year, or about 1/25 of the federal limit. This is about the amount of natural background radiation an individual would receive from living in Denver, Colorado. The potential for any health effects occurring at such low-level exposure is considered negligible.

GPU Nuclear Corporation acknowledges that the NRC PEIS estimates of potential health effects are based on current knowledge. However, while the evidence indicates that there may be potential health risks based on conservative assumptions, the most current scientific and medical evidence indicates that these conservative assumptions overestimate the risk and that the actual health effects from the TMI-2 cleanup will be relatively small.

The Radiation Protection Program at TMI-2 was developed to ensure that worker exposures during the TMI-2 cleanup are maintained well below NRC limits and that the health risks to individual workers are maintained low when compared to risks in other occupations. GPU Nuclear considers the health and safety of the workers to be of foremost importance and will take all appropriate steps to minimize potential radiation exposures during the course of the TMI-2 recovery.

Attachment 2

The following specific comments are provided on the Draft Supplement to the PEIS:

Page	Paragraph	Line	Comment
Cover Sheet and Abstract	4	9	Change "1700 person-rem to read "1814.1 person-rem based on self-reader data. . . required."
iii 2.2	2 6	3 1-2	Change "August 1983 to "December 1983" and "1700 person-rem" to "1814.1 person-rem". These changes should be made throughout this Supplement to the PEIS
1.1	1	15	Change "ther" to "their" and "supplents" to "supplements".
1.1	2	5	Change "impact statement" to read "PEIS".
1.1	2	12-13	Change "August 22, 1983" to "December 31, 1983" and "1700 person-rem" to "1814.1 person-rem".
1.1	3	1	Change "impact statement" to "PEIS".
1.2	1.2	15	Change "280" to "310".
1.4	1	2	Change "1982" to "1983".
1.4	1	3	Change "August 1983" to "December 1983".
1.4	1	3	Change "1700 person-rem" to "1814.1 person-rem".
1.4	Table 1.1		Delete table and replace with new table (Attachment 3). This revision provides information on the recovery of TMI-2 through the end of 1983. The data are more representative than those previously provided. It will be noted that the totals have not changed significantly. Detailed descriptions of the exposure categories and sub-groups are available from TMI-2 Radiological Engineering.
1.8	2	13	Change "the work" to read "each task".
1.8	3	1	Change "done" to "performed".
1.9	Figure 1.3		Delete figure and replace with new figure from data in Attachment 4.
2.1	Section 2.1.1	5	Change "430 mrem/hr" to "0.430 person-rem/person-hour".
2.3	1	1	Change "140 mrem/hr" to "0.145 person-rem/person-hour".
2.3	2	1	Change to read "...which is <u>currently</u> reached...".
2.3	2	4	Change "minimize" to "eliminated the".
2.4	1	1	Change "240 mrem/hr" to "0.240 person-rem/person-hour".
2.4	1	1	Change "110 mrem/hr" to "0.110 person-rem/person-hour".
2.4	2	7	Change "120 mrem/hr" to "0.120 person-rem/person-hour".
2.4	2	9	Change "80 mrem/hr" to "0.080 person-rem/person-hour".
2.4	2	9	Add: Dose rates on the reactor vessel/service structure averaged 0.056 person-rem/person-hour. The average airborne activity within the reactor building, based on BZA results, is 15.4 MPC-hours/hour. The radioisotopic mix is as follows: Sr-90 6.5 MPCs Cs-134 0.9 MPCs Cs-137 3.0 MPCs
2.4	3	7	Change the word "purified" to "processed".
2.5	1	5-6	Delete: "Although...have been made". Add: "One individual descended to the bottom step to collect a sample of sludge from the floor of the 282-ft elevation. However, there are no routine entries made on this elevation at this time"

2.6	1	4	Change to read "282-ft elevation and above."
2.6	1	9-10	Change to read "The sump is not readily accessible for dose rate measurements; however, samples have been collected for analysis."
2.6	2	2-5	Delete: "The sludge...small." Add: "Only a small amount of the radionuclides from the sludge have leached into the decontamination water and have have been removed. Therefore, the sludge acts as a plane source which contributes to the dose rate."
2.7	2	2	Change "done" to "performed".
2.7	3	14	Change "purified" to "processed".
2.8	Section 2.1.2	20	The quoted estimate of 45,000 Kg of rubble and fines has not been verified in any way. The document should reflect more strongly the fact that this is merely an estimate based on engineering judgement rather than a definitive number.
2.10	3	1	Change to read "of the remaining 63 lead screws...".
2.10	3	4-6	Change "A test...head lift." to read "Radiation measurements have been made to determine the radiation contribution from the parked lead screws."
2.10	5	6	Change "auxiliary and fuel-handling building" to "fuel handling building".
2.14	4	1	Change "schedule" to "program".
2.15	2	1	Change "schedule" to "program".
2.15	Section 2.2.1.1		Revise in its entirety. In keeping with the licensee's commitment to the ALARA concepts and principles, dose reduction is a major part of the recovery effort. To this end, the Director of TMI-2 established a Dose Reduction Task Force to evaluate and recommend a course of action. As a result of this effort, the Technical
2.15	Section 2.2.1.1 (Continued)		Planning Department has issued a Planning Study on Dose Reduction TPO/TMI-039. This plan describes both the overall program and details some specific actions to be taken for dose reduction. The licensee considers this plan as the most representative source of information on their dose reduction program and, as such, it should be the guideline in the discussions on the objectives and goals of the dose reduction program. TPO/TMI-039 was previously provided and should serve as a basis (source document) for the dose reduction of the PEIS Supplement, Section 2.2.1.1, Page 15, and Table 2.1.
2.22	Table 2.2		Change "1700" to "1614.1". It should be noted that this change in person-rem to date will impact on estimates that have been made. Additional information is attached on systems in the auxiliary and fuel handling buildings that require decontamination (Attachment 4). It is estimated that it will take ∿ 31,680 person-hours to complete for ∿ 317 person-rem. Appropriate adjustments should be made to the estimated person-rem so that the total person-rem values are not changed.
2.26	Table 2.3		
2.29	Table 2.4		
2.33	Table 2.5		
3.2	Table 3.1		
3.2	Table 3.1		No units are given.
3.3	Section 3.3		Data on health effects for exposure to ionizing radiation should be based on the most recent scientific work when it is available. Although BEIR III (1980) and UNSCEAR (1982) were not available when the PEIS was originally prepared, they should not be ignored at this time. The NRC genetic risk estimator is very misleading. Since only a fraction of one generation will be exposed during the TMI-2 recovery effort, and since for finite populations the geometric mean of the equilibrium risk estimator actually overestimates the genetic risk, it is more appropriate to use first generation risk estimators to calculate genetic effects on progency.

3.3 Section 3.3 (Continued)

It is unrealistic to carry out the calculation for all time without at the same time providing a numerical estimate of the genetic disorders expected due to the natural incidence. In the equilibrium case both parents are exposed and the denominator goes to infinity, thus making comparisons impossible.

It is appropriate to estimate incidence of genetic effects in progeny by adjusting for parental age, sex of the exposed worker, and also for the fraction of the 30-year generation exposed. The NRC should put genetic risk estimation into perspective. For a known population, it is more appropriate to use first generation effects and compare with the 10% natural incidence in the general population.

Statements which appear in Page B.1 regarding the perspective of these risk estimators regarding natural incidence need to be amplified and moved into the main text. It would be useful to give examples of impacts using the TMI-2 population which will have occupational exposure compared to natural incidence.

<u>Example</u>:

$$\left[10{,}000 \text{ workers}\right]\left[1\ \frac{\text{rem}}{\text{worker}}\right]\left[260\text{X}10^{-6}\ \frac{\text{effects}}{\text{rem}}\right]\left[1\ \frac{\text{progeny}}{\text{worker}}\right] = 2.6$$

Compared to normal incidence of 1070 in 10,000 progeny.

2.6/1070 - 0.25% increase over natural incidence from 1070 to 1073.

It is appropriate to qualify these estimates by stating that if an older than average work force is involved and if doses are, in fact, less than 1 rem per person on the average, effects will be reduced commensurately.

3.4	5	4	Change "...(exclusive)..." to "...(exclusive...".
5.2			Add: "Dose Reduction Planning Study, 1983, TPO/TMI-039".
A-2			Add: "James A. Flanigan GPUN Radiological Engineering"

Attachment 3

Table 1.1 Occupational Exposure at TMI-2 Based on Self-Reader Data from March 28, 1979, through December 31, 1983

	1979	1980	1981	1982	1983
Decontamination/Dose Reduction					
Reactor Building	--	12.1	53.6	181.3	138.0
Aux. Fuel H. Building	97.3	87.7	2.6	14.5	27.3
Systems	0.5	1.8	3.1	4.9	2.2
Reactor Disassembly & Defueling	--	--	4.3	117.6	133.9
Radioactive Waste Management					
Solid Waste	13.6	23.2	8.9	7.6	14.6
Liquid Waste	29.5	10.8	17.6	12.4	15.8
Waste Transport	--	--	--	--	--
Routine Operations & Surveillance					
Plant Operations	73.2	80.7	32.4	36.1	78.4
Plant Maintenance	82.4	31.3	31.1	19.6	37.7
Support Systems	95.2	33.3	9.5	4.1	4.4
Other	94.8	32.2	0.1	0.9	0.0
TOTALS	486.5	313.1	163.2	399.0	452.3
CUMULATIVE TOTALS		799.6	962.8	1361.8	1814.1

Attachment 4

NUMBER OF RADIATION WORKERS VERSUS YEARLY OCCUPATIONAL DOSE RANGE FOR TMI-2 RECOVERY

Whole Body Dose (Rem)	NUMBER OF PERSONNEL BY WHOLE BODY DOSE RANGE				
	03/28/79 - 12/31/79	1980	1981	1982	1983
Less than 0.1*	1,586	734	516	417	204
0.100 - 0.250	507	296	177	117	52
0.250 - 0.500	281	167	115	80	58
0.500 - 0.750	97	33	35	50	37
0.570 - 1.000	42	19	19	49	34
1.000 - 2.000	50	28	25	109	96
2.000 - 3.000	6	1	1	37	29
3.000 - 4.000	3	0	0	1	0
4.000 - 5.000	0	0	0	0	0

*Does not include "no measurable dose".

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(716)-832-4200

February 13,1984

Dr.Bernard J.Snyder
Three Mile Island Program Office
U.S.Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr.Snyder:

Since I have received a reminder notice on commentary for NUREG-1060 and -0683, it would appear that my intentions in my letter of January 24, 1984 (and its enclosed letter) have been misunderstood. This material was submitted as commentary and this is stated in the first sentence of the letter. It was my intention that this material would be used as my commentary and I think this should be done. This letter is further commentary.

My point is that, as I had previously told NRC, the exposure estimates were underestimates by a factor of at least 10 and the risk estimates per unit of exposure are still underestimating the actual health effects by a factor of 100. Thus the new estimate of 49,000 person rem for workers represents over 10,000 doubling doses for leukemia--a very serious hazard when the direct new risk estimates of my Yale paper (cited in the letter of January 24,1984) are used in place of the obsolete indirect BEIR risks used by NRC. This makes it imperative that NRC recalculate the cost-benefit ratios for the two viable options here, removal of the fuel rods vs. fixing them in concrete inside TMI-2 ("entombment").

The costs of entombment, both the dollars cost and the cost in genetic damage to workers and residents at TMI-2, are only about 10% of the proposed costs and the same ends are achieved with either option. It is absurd to endanger the public health and bankrupt the utilities merely to preserve an NRC regulation which certainly could be modified in this instance to permit entombment.

Very sincerely yours,

Irwin D. Bross

Irwin D.Bross, Ph.D.
President
Biomedical Metatechnology,Inc.

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ERIC EPSTEIN [Tr-17]: My name is Eric Epstein. I had sent a copy of four questions I had to you in certified mail, and never received a response, so this may be redundant to you, but I will address the questions to you anyway. I don't know if you ever received it or not.

[Discussion]

The first question I have is, in the report, you seem to maintain a link between lack of funding and worker safety, however direct or indirect. In a meeting I had with yourself, Mr. Dushare and Commissioner Ahearne last May, Commissioner Ahearne maintained that a lack of money has never been a problem. Well, it seems to be a problem, and I was wondering how you plan on attacking that problem, what pressure can the NRC exert on GPU and the nuclear industry to raise funds for cleanup of Unit 2, so that the extended radiation dosage to workers can be mitigated somewhat.

[Discussion]

When you say "subsequent delays," and you correct me if I'm wrong, I believe ALARA in their safety code says what you had said before, cost-effective of economically feasible. What is meant by economically feasible or cost-effective? When you start trading off, you know, radiation exposure for cost-effectiveness --

[Discussion]

My second question is -- I'll paraphrase it -- the TMI site is not suitable as a permanent repository for radioactive wastes generated by the accident, which I agree. However, there are few federal laws concerning interstate transportation, and there are new interstate compact laws which have arisen, and states which once welcomed waste are starting to have serious reservations. How can the NRC assure the public that these new developments will not result in a long and costly delay in transporting radioactive wastes from Three Mile Island?

[Discussion]

I'm not talking about the history. I'm projecting into the future what would happen if things become more stringent about moving the wastes. I was just wondering if there would be any guarantees that the wastes would be removed, no matter what.

[Discussion]

What I'm asking, is there any guarantees the NRC can give the people living around Three Mile Island that the wastes will be taken away no matter what?

[Discussion]

Question three, again paraphrasing; a radiation worker may receive no more than three rem of radiation dose in a three month period. No worker may average more than five rem per year past the age of 18. I was just wondering if five rem a year is a high dosage, because I'm wondering if you take into account the background radiation somebody may receive.

[Discussion]

A radiation worker may receive no more than three rem of radiation dose in a three month period. No worker may average more than five rem per year past the age of 18. I was just wondering -- it would seem that five rem a year is a high dose, since a worker may be receiving other radiation from background radiation from other sources. Do you feel that five rem is an acceptable dose per year for a worker at TMI, is what I'm asking.

[Discussion]

Is five rem acceptable for a woman that is pregnant, in you opinion?
[Discussion]
And also, you may receive as much as three rem in a three-month period. Is there any time period where you receive an excess? What I'm saying is, if you receive three rem in a day or if you receive three rem in three months, is that too much in the time schedule where you may receive a certain amount of dosage?
[Discussion]
My other question, are there any studies planned to look at -- more in the future to look at what has happened to women who may have been pregnant during the cleanup or were pregnant during the cleanup or had been pregnant during the accident? Do you plan any studies of that nature?
[Discussion]
Why wouldn't the NRC be doing that? Why would that be up to the State of Pennsylvania?
[Discussion]
I'm talking about on-site.
[Discussion]
Radiation doses received by women who may have been pregnant during the cleanup, and on-site doses. Why is there no studies planned or why have there not been studies?
[Discussion]
Why do you have to look at detectable effects?
[Discussion]
Is that an opinion, though, that the dose is not that great at five-tenths [of a rem], or is that an established scientific fact?
[Discussion]
Is it possible to look in another report and that report would say that that level is a damaging level? What I'm asking is, isn't that basically a duty you have?
[Discussion]

MARY OSBORN [Tr27]: Mary Osborn, from Swatara Township. I have two questions. On the chart, you show two to six additional fatal cancers. I was wondering, how many people there that work get cancers that they will be living with? You only mention the fatal cancers.
[Discussion]
My other question: are the dose records that are kept on the GPU workers -- do they also keep records on, like, the people that I call sponges, that just come in and do cleanup work? I know that GPU is bragging about how low their doses are for the workers, but they don't seem to take into consideration all the other people that are not their employees.
[Discussion]
Do employees also get copies?
[Discussion]

JOHN MURDOCH [Tr-31]: Dr. Snyder, my name is John Murdoch, from Camp Hill, Pennsylvania. I have approximately four questions, addressed to various members of the panel. Ms. Munson said that there were some remaining unknown areas in the cleanup. I would appreciate knowing in general what those might be.
[Discussion]

Secondly, you had said that various alternatives had been considered in preparing this draft supplement. Was entombment of Unit 2 one of those alternatives? And that has been suggested for possible study, suggested by the Commonwealth of Pennsylvania to the NRC, or is to be shortly.
[Discussion]
The third question, and I'll address it to Dr. Snyder, is: has this draft supplement been discussed with TMI workers themselves? If so, where and when? And if it was discussed with them, did the workers express any particular concerns over the findings or the matters included in the supplement?
[Discussion]
I'm compelled to make a comment in answer to that, Mr. Barrett, and that is, certainly if I were involved in an industry where my health was in question, I would want to attend any meetings to learn as much as I could about it. And if I interpret your answer correctly, it is that the employees do not appear to be overly concerned about this. Am I correct?
[Discussion]
Finally, it was estimated, I believe, in this draft supplement that approximately 10,000 workers in toto will be involved in the cleanup before it is completed, is that correct?
[Discussion]
The estimates of unfavorable results healthwise from that cleanup were estimated then in general as six to ten, in the ratio of those to 10,000; but is it not true that a number of those workers will be employed for considerably longer periods than others will be, and will be involved in more hazardous types of activities down there; so that a generalization of six to ten to 10,000 does not, to my mind at least, give a true picture of the adverse effects. It would seem to me that 5,000 or some other figure might be a more realistic approach.
[Discussion]

ED CHARLES [Tr-37]: Ed Charles, Mechanicsburg, Pennsylvania. Thank you for leaving us have the opportunity to present some of our comments. Most of my questions deal primarily with something I found absent in the last environmental impact statement, at least in a quick reading. It is rather technical to me, but I find very little on the idea of transportation mentioned. There's a footnote related back to the original environmental impact statement with the comments Linda made this evening. With the additional time, the additional entries needed, additional waste accumulated from clothing, et cetera, there will be a lost more transportation trips. Also, in the same line or related to the same transportation issue, the latest technology in the decommissioning or removing materials from the Shippingsport reactor requires a load limit to be shipped down by barge down the Mississippi River up through the Panama Canal to Washington. I am wondering, to remove that type of material from a much larger reactor than the Shippingsport reactor, how we're going to move that type of weight limits.
[Discussion]
Would it be timely or cost-effective to make those decisions now? [regarding ultimate disposition of the plant]
[Discussion]

Is it a possibility?
[Discussion]
How is that decision made, and how far down --
[Discussion]
And that is approximately how many years down the road?
[Discussion]
That gets into some of my transportation area. On 2.22 of the new environmental impact statement, all you have footnoted under the chart 2.2 is Waste Management and Transportation with a little footnote down to see the original environmental impact statement. There is no statement on the amount of transportation occurring. I don't see anything in the statement regarding additional needs for transportation of waste in the statement offhand. I might have missed it .
[Discussion]
But in your question-and-answer book, next to last question, number 94, truck drivers taking a 60 mile trip to Washington or Richland are receiving not above normal radiation, but they are receiving significant amounts. It says here, "For an extreme case, consider a truck driver who spends 2000 hours per year driving, half of that hauling radioactive material." He may receive various amounts of radiation on those trips to Washington or elsewhere. Those trips, even if they may be small, are not being added into the lengthy discussion I heard at the panel meeting the other night. Where does all this waste go, and is it being counted again and again as it's being packed, shipped, transported from one place to another?
[Discussion]
So, you're not using dose accumulations of people in Hanford or Albuquerque or Utica --
[Discussion]
Can you give me a number, roughly, how many trips to Washington?
[Discussion]
I didn't see anything in the new one --
[Discussion]
Only projections in the original.
[Discussion]
Well, just a little calculation from your update, I have 219 loads plus 16 loads going to Washington at about $5,000 a trip. I have radioactive materials going from the island to 19 different states in shipments. I calculate roughly, by looked at a map plotting those various places, that that material has reached just about every state but nine in the United States. So, I'm saying, the waste is not only a problem in Middletown and Central Pennsylvania; ; that waste is being handled again and again, and where it ends up, how many times it's being handled --
[Discussion]
If it goes to Albuquerque --
[Discussion]
I have 939 shipments leaving the island.
[Discussion]
I'm referring to the log of waste transportation off the island.
[Discussion]
That's not in the update, because there wasn't that much leaving --
[Discussion]

I understand, a lot of these are very small shipments, samples. Nevertheless, it is posing somebody else handling that material, unpacking, testing, relaying -- Albuquerque, it has to be transported someplace else, a low-level waste site. How many times or much is this waste going to be handled before it reaches its destination?
[Discussion]
You have 67 trips to Idaho already?
[Discussion]
You calculate 400 trips; that's to Idaho, and in that it's being handled as research material. Therefore, it will be researched, handled, and then deposited someplace for a little bit of time?
[Discussion]
From the mining to the end result, and to realize just the whole picture of -- not just the little picture of TMI, but the whole picture of this fuel cycle and exposing, researching, and how many cancers or how many genetic defects this whole process has --
[Discussion]
But that was not including the accident?
[Discussion]
So, once it leaves the island, it's no problem to anyone else?
[Discussion]
How many different sites do you ship to?
[Discussion]
No, I'm talking low-level and high-level.
[Discussion]
But right now you have, since the time of the accident, shipped to 39 different locations?
[Discussion]
So, you don't feel any need for updating your estimates of the number of trips and locations and your upgrading of maps from the originals?

BEVERLY DAVIS [Tr-50]: My name is Beverly Davis. I feel that we're getting to be on a first-name basis with all the people that are on this table, so I know at this point that you are all very professional and all very concerned and very human people. However, I find this whole statistical exercise very macabre and, I must say, obscene, because thinking of it in human terms, I'm asking really, if I had to pinpoint and point out -- I am going to say that there are going to be six people, in Middletown, probably, or Hershey, that I'm picking out and giving a sentence. When I'm talking about genetic effects, I'm talking about not only this generation but many, many generations to come. And I find that the whole exercise as a commentary on the nuclear industry is a very inhuman kind of thing to do. Now, I realize your restrictions, and I realize your assignment. However, I have to make that comment. I also, after listening until midnight the other night to the experts in the field, I have to ask the question as to whether, when we get down to these figures of two to six fatalities and three to twelve genetic defects, if we're actually talking about only the middle of that bell curve, or have we somewhere in these figures accounted for these ends of the bell curve which are not as highly probably but are still possible.
[Discussion]

I also was rather disturbed by the kind of discussion that was given there in that these were -- certainly some of them had to be, from the sound of the discussion, had to be some of the most outstanding experts in the country, the people who prepared the BEIR report, in fact. And those people admitted that they didn't really know. Their figures are based on Hiroshima and Nagasaki which, having attended the health conference last March here in Harrisburg or in Middletown, I find that those are certainly incomplete. And they're also based on some studies of mice, but they are not based on direct biological data of human populations. I find it very disturbing to be making decisions based on that kind of data. I realize that it may be inevitable and there may be no other way to do it, but I have to ask something, as very much an amateur. What ever happened to things like the Mancuso study, which were studying workers?

[Discussion]

Well, I still come back to my original question about the Mancuso study, which -- their discussion the other night really seemed to hinge upon the fact that there was that BEIR report, which is the one they mentioned most or seemed to be talking about most, which was based on a computer model. It was based on, as you say, geneticist's projections and so on, but it was not based on biological data in general. With studies like Mancuso, and certainly your knowledge of -- pointing out that there are others, I don't understand why that is true and why we're making assumptions based on the computer models and projections instead of basing it on studies of workers.

[Discussion]

The question, of course, in my mind is, why wouldn't there be -- I understand you're saying human populations. Obviously, Hiroshima and Nagasaki is a human population. But the rate of worker exposure would seem to be in this case so much more relevant or so much greater, that I would think that that would be the overriding kind of data on which you would base your conclusions, rather than simply on the broad, general picture which takes in a complete range of people or animals or whatever, you know, the hundreds of different settings seem to be.

[Discussion]

One of the things that I find in the draft supplement, there was a flat statement made, and it was made again tonight, that obviously the island is a poor place for storage of waste. I wonder why they didn't think of that when they licensed them, but it is a poor place for the storage of wastes, and that therefore that's the beginning and the end of that discussion. But it seems to me that what we are weighing here is not simply how much exposure -- I mean, we don't seem to be weighing anything. We're just deciding whether to have this much exposure to workers or this much more exposures to workers in cleaning out this core. I'm not say that I know for sure, that I have a sound opinion on whether or not that core should be taken out, but it seems to me the discussion has not been fleshed out on whether we are making a choice that is really -- we have been told that that alternative is ruled out. I would wonder why we have not had more discussion about whether there is that much more danger. The reason I am concerned about is because Dr. Carl Morgan, when he was here last March, had indicated that he felt the cleanup should stop immediately, and that the only safe exposure to workers was for the plant to be stopped at that point. That's a year ago. I have not heard other people comment on that, and I realize that there are obviously scientific differences of opinion. However, it would seem that maybe that discussion should be fleshed out a little so that if we're making a choice, that we would know exactly what that choice is. One of the things in this statement that you have drawn into the supplement does indicate about thinking that half the core could be removed and the rest could be left there without danger of recriticality. The recriticality issue is one that we haven't heard enough discussion about, and I think it would be helpful.

[Discussion]

Your statement about borated water being a crucial thing in keeping this from going critical again, there is a statement in this draft supplement which indicates that they were supposed to use deborated water. If you did figure out how to use water which did not contain boron, there was no discussion previously and I am wondering if I'm reading this correctly, and if there should be some discussion of whether putting deborated water into that highly radioactive basement poses a risk of criticality; also, what that would do, if indeed that is a serious proposal.

[Discussion]

The last thing that I wanted to say is that I do not understand -- I understand you're giving a wide range, but I'm no sure you answered the question that was asked previously here, whether that wide range includes all of the many scenarios which seem to be indicated but not spelled out in this draft supplement. There seem to be many, many different scenarios which -- each one is a building block. If this happens, then we do this; if this happens, we do this. Do you cut it up? Does it have a tolerance? All these questions seem to be remaining here. Does the wide range take into account the ultimate number of scenarios which might be suggested by the basic scenario which is put forth in here?

[Discussion]

One last thing: this recent flap over the Bechtel bill in the state legislatrure indicates that some of these companies and subcontractors would like very much to get out from under the liability which they should rightfully assume. Technicalities or not, it seems to me that that's a strong question, is it absolutely positive that the NRC's control of the ALARA and the ultimate exposure extends to all these subcontractors as well as GPU itself?

[Discussion]

JANE LEE [Tr-64]: My name is Jane Lee, Etters, Pennsylvania. I can't believe that after five years, we're still going to meetings. I've got meetings scheduled for every day this week in connection with nuclear power, every day this week. Of course, I don't get paid like you do. I view this entire proceeding as a mere formality to fulfill the letter of the law, just as you constructed the EIS (phonetic), and just as I knew when you used that as a guideline for what you're doing right now. Not too much has been said about the off-site exposures, those people who haven't volunteered to go into that plant and work. In view of the fact that you don't know the methods and procedures that you're going to use to clean up that plant, you therefore have no idea how much you're going to lose to off-site, the innocent victims who live near Three Mile Island. I

might state right here, too, that you're the same kind of experts who told us before the accident happened how safe and clean and cheap it all was. It's like ashes, not only in your mouth, but ours, too. So, you see, your credibility isn't any better today than it was yesterday or ten years ago. As for all those studies you talked about, Dr. Branagan, I know about some of those studies, too. I know how they skewered the reports on atomic veterans. I know how Dr. Tokahata (phonetic)skewered the infant mortality rates that he submitted to the federal government and very conveniently dropped 88 infants' deaths; and when an investigation was never done on the huge increase in the crib deaths -- clustered, by the way, clustered in Lancaster County along with the hypothyroidism cases; clustered, by the way, in the exact same geographical location where the chickens are now dying by the millions because of a mutant growth. Incidentally, avian flu is a very common disease among chickens. The difference today is, it's now a mutant. And anybody, including many of our laypeople in this room, know that radiation will mutate. It will cause a mutant. Prove it? Of course we can't prove it, any more than we're going to be able to prove that we're going to be victims of cancer because of what you have done, or are doing. I'm going to ask you a question, hypothetically. Supposing I was in an accident and I needed a victim to correct the accident, and I took the names of all five of you up there and put them in a hat, and I drew one of your names; and then I came back to you and I said very bluntly, "I'm sorry, but I have had an accident, and it's going to cost you your life." Now, ladies and gentlemen, what you're doing up there on that stage is determining who is going to die and who isn't going to die. This is a document of premediated murder, that's what it is. In the most blunt terms, that's what it is. I cannot believe that we live in a society today that we parade before the world and we tell the whole world how free we are, and that we are concerned about human life; and then we promote this kind of monstrosity. The dimensions, the moral dimensions of your proposal are mind-boggling. You're willing to sacrifice unborn children, unborn children who have absolutely nothing to say, who will be brought into this world retarded, who will not be a proud individual, who will not be able to earn an income. How can you do this? Do you feel comfortable with yourself? Do you? There's got to be something wrong with a person's conscience somewhere. Never mind me; as far as I'm concerned, I've lived my life. That's not important. I'm not pleading here for myself. I'm talking about a lot of innocent men, women and children, unborn, and you're willing to sacrifice them to just to boil water. That's all it is, just to boil water. And you come in here with your statistics; well, I've been down that road a thousand times, and you know what you can do with your statistics, because I know very well what the experts have done with the statistics. Do you depend on GPU to report exposure levels to the employees? Do you depend on GPU for those figures for worker exposure?
[Discussion]
You are there when workers are being exposed?
[Discussion]
You are right on site?
[Discussion]
You know about some of the employees who sat in contaminated areas unaware that the area was contaminated? You are aware of that? That's

even before your time, but I haven't forgotten. My files are full of incidents at Three Mile Island where workers were exposed -- not five rems; way beyond. Don't tell us about worker exposures. Don't tell us about your good, clean, typewritten pages and how neatly it's going to fit in to your proposal because we know better, we know better. And the idea that the Nuclear Regulatory Commission would still, after five years, rely on a company who has lied, who has been guilty of falsification of leak rates -- not just at Unit 2, but Unit 1 -- lied repeatedly about everything; and you think they're going to tell you the true dose of the exposure to workers? You really believe that? You're only fooling yourself; you're not fooling us, but for a second. Do you know if there are strict, accountable records of each employee at each nuclear power plant in this company and all of the dose rates that they have received in their entire life, the X-rays, the CAT scans, the bomb tests? Are they a veteran? Were they in bomb tests? Every dose is an overdose. Don't use the word "safe," Mr. Barrett. There's no such thing as a safe dose of radiation.
[Discussion]
There is no such thing as a safe dose of radiation. Every dose is an overdose. Not only is it an overdose, it's cumulative.
[Discussion]
I think you should strike the word "safe" from your conversation whenever you're discussing this type of a subject.
[Discussion]
I asked a question. Do you keep records on the entire dose that a worker has gotten in his lifetime?
[Discussion]
Do you agree that those doses are cumulative?
[Discussion]
So that, all dental X-rays, all medical X-rays, CAT scans, anything at all that a worker is exposed to on the domestic scene is cumulative?
[Discussion]
So that, we only compound the problem, do we not, by allowing workers five rems a year?
[Discussion]
Do you feel comfortable allowing workers in there with that risk?
[Discussion]
You think that's perfectly all right, to damage the genes of an individual who's going to pass that on to their offspring?
[Discussion]
I hear you, but I can't believe what you're saying. Another thing that I found rather surprising, although at this point nothing really should surprise me, and that is the methods by which you intend to clean up the plant have not even been determined.
[Discussion]
We still don't know the procedural methods, exactly?
[Discussion]
We live in an era of robots. Have you considered robots in the cleanup?
[Discussion]
Question 27: I would like to make a recommendation. "Do NRC regulations spell out how much radiation a worker can receive?" The response: "Yes. A radiation worker may receive no more than 3 rem of radiation dose in

any three-month period. No worker may average more than 5 rem per year for each year past age 18." I respectfully request that the part of the sentence "for each year past age 18" be stricken. And I do that knowing how GPU operates, that you could juggle the figures, send them to work in a power plant at age 18 -- more like 35, 40, and so you could increase the amount of exposure to a worker and be within the letter of the law.
[Discussion]
Well, if you believe that, then you're a bigger fool that I thought you were. There isn't anybody in this room who believes that, including you, not really, you say what you have to say because you have to say it, but there isn't anyone that believes that. I've concluded my statements for this sham. That's what it is, a big sham.

MARY MITCHENER [Tr-72]: My name is Mary Mitchener, M-I-T-C-H-E-N-E-R. I live here in Middletown, after the accident. I was very happy I wasn't here. What type of genetic changes do you think might occur, what basically, a couple of examples?
[Discussion]
Such as without a hand or something of that nature?
[Discussion]
Secondly, you have on there the table that shows different occupations and their dangers; and a fireman may be a very dangerous occupation. Down at the bottom, it says, nuclear workers, people working at TMI. A fireman doesn't have to worry about whether or not his kid and his child's child on down the line is going to have a genetic problem. Chemists might have a problem, I don't known, but firemen and a lot of other workers don't have the unknown, and that is the problem here, that it is unknown. You cannot see radiation, you cannot feel it, and that is the problem. If you can't trust people, like a lot of us here do not believe you can trust Met-Ed -- figures do get changed, because to somebody who doesn't read behind the lines, if you just looked at the surface and say, "Gee, this is a good job to have because it's safe." But you look behind the lines to your children and their children, it's not as it appears.
[Discussion]
But don't you think there are other jobs that would be listed as much higher in occupational hazard as what you list nuclear workers here? And there really isn't any genetic effect. There is nothing that's as hidden as it is with radiation.
[Discussion]
You also say that things are compounded, okay? Right here in Middletown, we got TCE in our water, okay? There's talk of EDB in food. It's all compounded. We have fallout from the tests in the sixties. We have fallout from the tests still going on, tests that now aren't as stated as they used to be; underground tests which once in a while leak like they did in '75, I think it was. It gets compounded. People back in the 1800's said, "Gee, look at this great big river. It isn't going to hurt to pour the wastes of this factory into it." And they did it and they did it and they did it until the Potomac was dead. Ten years ago, 15 years ago, the Potomac was considered dead. I went there with other people and we tested it. It was dead, okay? But 100 years ago, they said, "Gee, it's okay to keep polluting it." And the same thing is

happening to our atmosphere. The same thing is happening to our water. And I'm saying, it's compounded. My kids have a better chance of having cancer than my generation and the generation before them, not just because of TMI, but because of the water problem, because of the problem with food. And for you to sit there and say, "Gee, it's acceptable," it isn't acceptable to me. And it's not acceptable to a hell of a lot of people who never came here. There's a lot of people who won't stand up here and talk, because they don't know that it's so doggone easy. They don't understand you can read these things without being a scientist. And it makes me very angry and it makes me upset that you drag things on, A, to stop people from coming because if you have meetings all the time, a lot of people aren't going to be like Jane Lee, and willing to come and willing to donate their time. A lot of people like me who have four kids don't have that much time. So, if it's dragged on, it's not really fair to us. You people have the time, because it's your occupation. I don't want it for my second occupation, but I live near that plant. And people tell me, "Why don't you move?" To where? Where are we going to move that there isn't fallout or radiation, that there isn't radiation from a plant accident or -- it's not fair to us. And to say may, maybe we won't decommission it, well, I hope that it never comes to maybe that it won't be decommissioned, because I hope the people in this town won't stand for it ever opening again, especially Unit 2, because it was called the worst nuclear reactor accident, right, commercial reactor accident in the country, correct?

[Discussion]

Then how come the Enrico Fermi plant, which also had a very bad accident, was shut down and decommissioned, and they're still saying this one might run? Enrico Fermi in Detroit.

[Discussion]

Wasn't it also shut down because if there had been another accident, there would have been more people upset and the nuclear industry would never have gotten as far as it has? And it's gotten on our backs. We pay the taxes that support the dump that's going to be in Utah or wherever it ends up. We're the ones who support it. Our children will support it. But really, we weren't told 20, 30 years ago what was going to be ahead of us down the line. You're talking about, "Decommissioning, we'll face that problem when we come to it;" it should have been faced before the license was given out. It's not fair to postpone it. It's just like the other things that were postponed and put on our children. It's not right.

DONALD HOSSLER [Tr-77]: My name's Donald Hossler, from Middletown. I got here kind of late. I had a Little League basketball game, so I didn't get dressed up. If I ask a question that may have been asked, please straighten me out. When I received the draft in the mail, I started reading through it. And then I read in the paper where the Commonwealth is going to make a recommendation that other alternatives be looked at, and I sort of lost interest. But anyhow, I've got some of my notes here, and I just have a couple questions for you, really. I note in the draft that you talk about 10 millirems per hour as what you consider a normal dose rate for a normal operation. I think they're talking about the 305 foot level -- or is that for the entire reactor building?

[Discussion]
And do you really believe that eventually TMI-2, the containment building would eventually be gotten down to 10 millirem?
[Discussion]
Again, I understand that that's your concern, defueling and decontamination, but you have to remember that as a resident living in the area, that 10 millirem per hour looks pretty good. After you've completed the defueling and decontamination, you talk about the marginal value of the cleanup. I guess you're talking about robotics technology to try to get it down to 10 millirem eventually?
[Discussion]
On page 2.5, you talk about the 282 foot level, which you call the basement. It looks like that is a very highly contaminated area, and it looks like that's going to be a very difficult area to really get at; just making some comments as I look through it. Also on page 2.7, you talk about the airborne radioactive material that becomes redeposited on clean surfaces. Are there certain areas that were being cleaned, and now you've stopped cleaning them because of this?
[Discussion]
What specific areas, what foot levels of the building are they going to decontaminate?
[Discussion]
On page 2.9, it looks like there's about seven foot of core area there that's unknown, something like that. What do you think is in there? Do you have any idea?
[Discussion]
On page 2.10, you talk about the uncovering of the lead screws, that the handling of these could be very significant in terms of radiation dose or exposure to the workers. Can you give me some idea of -- when you handle these, do you handle them one at a time or three at a time, and what's the possible total dose at one job?
[Discussion]
On the top of page 2.11, it looks like you talk about mechanically removing fuel particles from the reactor piping system. It looks to me like you're probably going to leave the particles in there for future tearing apart of the reactor piping. Is that right, you can't get to it?
[Discussion]
On the top of page 2.14, what's really troubling to me, one of the things, is we read the glowing General Public Utilities reports that talk about how well the cleanup is going; yet I note in that first paragraph that the auxiliary and fuel-handling building still has major decontamination efforts which are still required. You may not be aware of it, but I know when the utility talks of things, they usually refer to the reactor building. It looks like it is going to require a major effort to get the halfway feed building decontaminated. And then I go over to page 2.15, and I notice that in tasks and sequencing that the last two items of the five with large periods -- you say, "reactor building and equipment cleanup, to proceed as resources allow," and then the next one, "cleanup of the auxiliary and fuel-handling building, presently underway, concurrent with that reactor building work." What percentage of the radioactivity would you say is in the auxiliary fuel-handling building compared to what's actually in the containment building?

[Discussion]
If its' a small percent, why -- it must be major decontamination because of the cubicles --
[Discussion]
They are hard to get to.
[Discussion]
Would robotic technology be a good idea for those cubicles?
[Discussion]
The fuel canisters and particulate filters you talk about on 2.20, are those readily available now, and how many do you estimate -- I didn't bring my final PEIS with me -- but how many do you estimate will be necessary?
[Discussion]
Would they be the same thing they might use for Shippingport?
[Discussion]
And particulate filters, would you transport those in the same fuel canisters, or do you have some way to transport those?
[Discussion]
Now, I'm wondering on page 2.23, the third paragraph, how likely it really is that the immersion decontamination would be suggested by the licensee. I know you do say that it was not evaluated due to limited knowledge of its effectiveness. I wonder if you just didn't through that in there just for the sake of throwing it in. Do you think it's likely, that they would want to fill it up with water and do some more processing on that magnitude?
[Discussion]
On page 2.31, I notice something that was already mentioned. It looks like the NRC may well be willing to let half the fuel be removed and the other half to remain before you put it into what's considered a monitored interim storage. Would it be fair to say that?
[Discussion]
The third paragraph on page 2.31, you talk about the fact that only about half the fuel would have to be removed before the chance of criticality would be inconceivable. Is that what that says?
[Discussion]
Now, the next question would be, why didn't the licensee propose the thing the Commonwealth is going to propose, this other alternative? Why didn't the licensee -- they seem to be proposing everything through the years. Why did the Commonwealth of Pennsylvania have to --
[Discussion]
Why wouldn't GPU advance that?
[Discussion]
This proposal that the Commonwealth is going to present, then, do you think this would decrease the need for immediate funding, or do you think the funding level would remain about the same?
[Discussion]
The commonwealth's alternative would not be accepted several years from now, so that actually the estimates for funding which we're looking at now would probably be low.
[Discussion]
Finally, I know you're all concerned about the cleanup, but I would just like to give you this scenario. I know the push is on to restart TMI-1.

I know we are not here to speak about that. But I think that one consideration that those of us living around here through this, you know, back in 1979 and 1980 -- I remember I went to the Forum. And you asked me, Dr. Snyder, you said, "Well, Don, do you want it cleaned up or don't you?" I said, "Sure, I want it cleaned up." And now we're getting some different stories here about things getting lengthened out, certainly through no fault of ours. And one of the reasons why -- when I started reading through the draft after I heard about the Commonwealth's thing, I thought that the possibility of getting it completely cleaned up was being secretely considered or however you want to say it. The thing I want to just remind everyone about is that if TMI-1 would ever restart, I personally can see a scenario coming about where GPU would say, "Gotta buy new stream generators. We can't complete the cleanup until we've bought new steam generators and had them installed," particularly if the tube problem does not work out like some people think it will. And I'd just like to relay to you that I believe we would be a hostage again if No. 1 were allowed to start, because any kind of mechanical problems there, be they steam tubes, steam generators or whatever, I could see GPU saying -- and I think you know that yourself -- saying to the NRC, "Well, we've got mechanical problems here with TMI-1, and we have to keep it in the rate base, because that's going to allow any cleanup." And so, all of a sudden, we're hostage again. And I believe it's very important that -- I know some of the ladies have used this idea before of the spilled milk. You know, when a child has spilled a glass of milk, you have to get it clean up. If you don't, the milk might ruin the floor, the tile, or somebody might slip in it. Also, you really haven't taught the child how to handle things responsibly. I think people sometimes think of this issue as a national nuclear issue. It really isn't, for me or for a lot of people in this auditorium. I think it's here in TMI. I think the thing we really want to do is for the industry to prove that this can really be done. And we have to leave TMI-1 out of it. And I read the Harrisburg paper, I guess in early February, an editorial the Patriot wrote on February 7. Tom Jerusky was saying about the Commonwealth's idea that if they were to do this proposal, that right about the time TMI-1 would be finishing its operation, that it would be time to take care of both the plants. I'm really surprised that the Commonwealth would come up with a comment like that. The point I'm trying to make here is that I think we need to just forget about TMI-1. You're probably sitting here wondering, why am I telling you this. I think the reason why is because you talk with the NRC staff, you might talk with the Commissioners and maybe informally give them ideas on how the people feel. I personally feel that probably about 85 to 90 percent of the anxiety about this whole cleanup and everything would be gone if GPU and its board of directors would just decide to seek some other way to get TMI-1 taken care of, working with the Public Utility Commission or something other than restarting it. I really believe that. And I believe that we would be concerned about the cleanup; but I think you need to relay that for me to the people at the NRC. I really believe that TMI-1 is a tremendous stumbling block and has always been. And now that this cleanup is being lengthened, it appears -- and some cynics, I suppose, are wondering whether the fuel will ever get out; they wonder whether it will ever be completely decontaminated -- it just is unconscionable, in

my mind, to restart No. 1 until the industry has really proven that TMI-2 can be taken care of. So, I appreciate the answers to some of my questions. And like I said, in going through, I was going to put something in writing. But when I read the Commonwealth's possible proposal, it sort of stunned me in a way. I was very surprised. But I wish you would carry that message back to the NRC.
[Discussion]

ELIZABETH CHABEY [Tr-94]: My name is Elizabeth Chabey. I have been approached many times by people who live nearby, and they would like to know what would happen if the ultimate test of the crane fails.
[Discussion]
We'd also like to know if the public will be notified when this ultimate step is taken.
[Discussion]
Do you think that this possibly could be scheduled for a weekend, since our emergency evacuation crew said that the only time that they could really function is on a weekend?
[Discussion]

JANET LEE [Tr-96]: Will we be notified in advance [about the polar crane test]?
[Discussion]

PAUL SHOOP [Tr-97]: I'm Paul Shoop, S-H-O-O-P, representative of the International Brotherhood of Electrical Workers. I know the International Brotherhood of Electrical Workers is concerned. We have members not only in our utility branch -- which the local union is here in Middletown -- we also have members in our building trades, which is located in Harrisburg. The members are concerned. They have reviewed the supplemental PEIS. As you stated earlier, you don't hear a lot from the workers. They are very well educated. They are very well trained. They know what they're doing. They're not very vocal when things like this meeting come about. However, they do raise concerns. I am here because they are concerned, and they requested that I be here. The IBEW has about 11,000 members permanently assigned to all the nation's operating power reactors. We have tens of thousands of members in the building trades, from vendor specialty crews, and members of the utility and other sites that rotate through the plants for major maintenance or refueling. The IBEW is very concerned about the exposure they get. The greatest hazard to the IBEW member is not radiation. It is not a lot of the things that they have in there. The biggest threat to the IBEW member is electrocution. Every year, between 40 and 50 IBEW members are electrocuted on the job because of one reason - we work equipment hot. The public demands uninterrupted electric service. We pay the penality, because of what society wants. We know what risks are. This is the risk that we pay, we forfeit with out lives. So, we do understand risks. Society wants us to work equipment hot so they have electricity; they have electricity. Society demands that as radiation workers that we work in radiation fields; we know that we have to receive radiation. Compared with electrocution, all other threats pale. Another way of looking at the total man-rem -- and pardon me, I still use "man-rem" instead of "person-rem;" I've never been converted -- if you look at the man-rem for 1982, the last published figures from the NRC, it was slightly over 50,000 man-rem for all power reactors. The projected max for the nine year period is about 46,000. So, we are talking about the same risk to radiation workers in power reactors for the nine year period as we have during 1982. Another way to break that over -- you know, it's not going to be even increments over the nine years -- but if you look at the highest record man-rem for any station for 1982, it was almost 4,000 in Quad Cities. This, on an average over the nine years, it will be about 5,000, so they're somewhat equal. It should not be any greater risk at one station than at the other station. You're going to have a large number of people involved. Again, just in the supplemental PEIS, these are estimates based on the best you had available to you at the time. We will not be surprised, we would not be shocked if you have to revise the figures upward. We know these things happen. You get in there and get better data; it could go up or it could get lower. If robotics come in, if -- and we're not counting on robotics coming in within the next nine years -- if it would happen, exposures to people would be a lot less. Robots can taken an awful lot of exposure. It's not unlimited, because they're electronic, and certain things happen to electronic devices because of radiation. Worker are concerned. You don't often hear us comment on it, but the IBEW members in the building trades, the IBEW members in the utility branches in the area who are going to be doing the work there are very much concerned, and they have reviewed it. We can work with the figures that they have. And incidentally, we're not sponges. All exposures at all power reactors are ALARA. This is one thing -- you do hear from us when we're convinced that they are not ALARA exposures. So, the 52,000 man-rem we had for 1982 were all ALARA. I am convinced that all the exposure for TMI-2 cleanup will all be ALARA.

MARY OSBORN [Tr-100]: My name is Mary Osborn. I have a comment to make regarding Mr. Shoop. I had a friend who was an electrical worker at TMI. He quit before the accident, the year before. The reason why a lot of union people do not come to these meetings is fear of being blackballed by the unions. When people work 10, 12 hours a day, seven days a week at a nuclear power plant, you become fatigued and then you become electrocuted. Another thing -- before the accident, the men who worked there didn't wear their badges. They had them in their boxes. So, a few things have happened and a few people have finally wised up. But it's good that the man was here to speak. But the men are not here because they don't want to learn -- they're afraid to show their faces because of all the harassment they get from the unions. I have a lot more to say, but I'll say it elsewhere.

BRUCE MOLHOLT [Tr-112]: My name is Bruce Molholt. I'm a Ph.D. I teach genetics at Bryn Mawr College. I have done cancer research in the past, and I am presently doing research on the molecular mechanisms of mutagenesis, in DNA. I appreciate the opportunity to represent at least one segment of public opinion in the Panel discussion tonight; however, I don't think this is a very efficient forum for expression of public opinion, in that it seems to be more of a dialogue between the Panel and the NRC. Therefore, I will try to limit my comments. I certainly will not reiterate the written comments that I have already submitted to the NRC. I will just try to comment in terms of perspective, at least my perspective on what I've heard tonight. And one of the reasons I want to limit it, too, is that I, among my teaching obligations, have one early in the morning, and that means that, like many of you, I'll have a tight schedule. I heard and read the expeditious cleanup philosophy supported in terms of the NRC's mandate, again and again -- and I believe I'm quoting from a number of sources, because it's reiterated -- as "to ensure the long-term health and safety of the public." Now, that particular rationale to support expeditious cleanup has a deja vu for me, because I heard the same things being said four years ago, when various alternatives to decontamination of the containment building atmosphere were being considered, and, again, the rationale was for the health safety of the public, what would be the most rational approach. I believe that the approach that was taken at the time, supported by the NRC staff, and not contested by comments to the environmental impact thereof, was in released beneficial consideration of public health and safety, and the rationale was a strange one, and I believe has bearing on what we are trying to consider tonight, and what you've been considering for quite some time. The rationale was that perhaps these materials inside the containment building atmosphere, which were mainly, at that time, Krypton-85 gas about 43,000 curies of Krypton-85, that those materials might accidentally leak out and cause some type of harm; therefore, expeditiously, they were intentionally released into that same atmosphere over a two-week period, without much regard for meterologic conditions, although the Environmental Impact Statement said that those conditions would certainly be monitored. I see us in the same position now, but with a much more serious potential public hazard; and that is, we are expeditiously recommending decontamination of, not any longer 43,000 curies, but a half-million curies. Now, I'm going to direct almost all of my comments to the core cleanup, per se, and hope that at the end of my comments I might have time for a few questions that, partially may be answered by the NRC staff and partially by members of the Panel. The half-million curies that are in the core include all of the fission products of uranium, include many byproducts from neutron bombardment and other radiation of cladding and other reactor components, include 150,000 curies of plutonium, and I believe there has been a somewhat cavalier assumption that defueling of that contaminated core is going to proceed in some manner or fashion similar to what defueling connotes; that is, an efficient underwater removal of 177 fuel packets in easy-to-remove, bundled form. The condition of the core, of course, is quite a bit different, much of it unknown. No probes, as far as I know, have been taken lower than four feet above the bottom -- that is, the exact condition of the four feet of rubble on the very bottom of the reactor vessel is still an unknown entitity. As far as I know, all evidence indicates that there is not one fuel rod that has sustained the thermal shock at the time of the accident, and there is every reason to believe that 90 to 95 percent of the fuel is crumbled, fused and in one coherent mass, that would be rather difficult to remove from the reactor vessel. Now, I would like to address some of that difficulty in removal a little bit later. But my point is this. If the rationale for expeditious removal of that core is to protect the public, is to protect the public health and safety, then by no means should we start to do that operation prior to understanding whether the head and plenum are warped that once we open them we will never be able to reseal them. Indeed, we find scenarios more difficult than the worst case scenario that I see in the supplemental PEIS. Secondly, if we find that the fused fuel in the bottom of the core is in such a state that it requires excision by either robotic or manually operated separated devices, that will entail much more than the -- as I understood it tonight -- 500 person-rems in 1984 for beginning that operation. If we find that dissection by sawing or acetylene torches, or whatever devices will be used to separate that core underwater, in order to remove pieces of it, is considerably more complicated than I see addressed in either the original or supplemental Environmental Impact Statements, then I would suggest that it is not in the best interest of the public health and safety to start removing those pieces, but that, indeed, the public is in danger for exposure to that whole whooperie of radionuclides that exists within that core material. In addition, as has been brought up before, there is no safe repository for that material at present. So I -- if that's the only reason to be expeditious, I think it is not in the best interest of public health and safety. Now, in order to help me to assess whether that is the reason for expeditious approach to the core cleanup, I have a few questions that I'd like to ask, if the Chair will tolerate these questions. I'm addressing them to anyone who is knowledgeable about the nature of the core at present.

[Discussion]

The first question is, is the danger -- is the core, at present, in danger of assuming recriticality.

[Discussion]

So, as I understand it, then, the possible recriticality of that core is not a reason, then, for expeditious cleanup. Is this correct?

[Discussion]

I also understand that one curie of Krypton-85 is being released from the TMI-2 facility per day, on an average basis. Is that correct?

[Discussion]

Is that per entry, or is it just ---

[Discussion]

per day?

[Discussion]

Okay. My rough calculation shows that if one curie of Krypton-85 is being made -- and I believe that can only be made through the fission process -- that that is equivalent to abut .2 percent criticality. So my --

[Discussion]

My physics tells -- and you're the physicist, Dr. Cochran, but my physics tells me that if this were residual, that you would not have a constant amount on a daily basis over such a protracted period of time. Plus the fact that Krypton-85 would be eight time -- I believe eight years -- or is it 8.3 -- I'm sorry; I don't remember that.
[Discussion]
And I would assume that both from the standpoint of decay and from the standpoint of pollution operations, bleed-and-feed type operations, as was used in venting, that the amount per day ought to decrease quite markedly, but it seems to be steady. The real question is has the -- has the core, in its present state, any portion which is not being protected from neutron bombardment and, therefore is in a critical or sub-critical state --
[Discussion]
Now, I'd like to return, then, to the issue of public health and safety with respect to decontamination of that core, and ask a few more questions about how the various portions of the core are to be removed. I understand that the process will first require removal of particulates from the primary coolant, feed a filtration apparatus, part of a filtration apparatus, and then the soluble radionuclides will be removed by the submerged demineralizer system. My comment, then, addressed to the -- what happens to that particular filter, double-filter system, upon dissection of the core, upon dissection of, like 100 tons of fused material? If appears to me -- and I must admit that I'm looking at this in a lay capacity -- it appears to me that for every dissection operation of that fused core, that you're going to release many more particulates and many more soluable radionuclides into the primary coolant, and that this operation may take longer than visualized in either the PEIS or its supplement, and that this will result in much higher worker exposure levels than found in the supplemental PEIS.
[Discussion]
Each time that there is a dissection operation you're going to have this cloud of particulates re-entering the primary coolant.
[Discussion]
Are you taking up the primary coolant? No. He's taking up the particulates that are released that have crumble sides. You think that the vacuum operation will be able to remove all those particulates?
[Discussion]
I feel that we're working in a arena of uncertainty, because this type of cleanup operation has never been.
[Discussion]
Well, I think I can save the Panel some time by just merely making a conclusory statement; and that is that I keep hearing answers of certainty, when it's at least admitted throughout the document I have in front of me, the Supplement PEIS, that there are huge uncertainties, and I don't see those uncertainties taken into account in getting a range of dose estimates. The condition of the core is now know in much more detail, although, certainly, not by any means well enough, compared to what we know at the time of the final PEIS, which was previously issued. That caused the approximately six-fold increase in worker exposure in the supplemental PEIS. My caveat is that I don't think we still know enough to dilemma what worker exposures will be. And I endorse the Panel's

discussion heretofore of what those final person-rem exposures will be, whatever the range will be -- and I'm suggesting, at the moment, it's conservative. I endorse the Panel's discussion and the recommendations that those person rems be translated with a wider range of uncertainty into human genotoxy editions, either carcinogenic or mutagenic. I have a lot of other fine point questions, but I will not belabor those. I guess I still have time to put down some of those into another final statement by April 20. Thank you.

APPENDIX B

CONTRIBUTORS TO THE SUPPLEMENT

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The overall responsibility for the preparation of this statement was assigned to the Three Mile Island Program Office of the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission. The statement was prepared by members of the TMI Program Office with substantial assistance from other NRC components, the Pacific Northwest Laboratory, and other consultants indicated below. The assistance of GPU personnel, particularly James A. Flannigan, is greatly appreciated. The individuals who were major contributors to the Supplement are listed below with their affiliations or expertise:

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In accordance with the National Environmental Policy Act, the Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Waste for the 1979 Accident at Three Mile Island Nuclear Station Unit 2 has been supplemented. The supplement was required because current information indicates that cleanup may entail substantially more occupational radiation dose to the cleanup work force than originally anticipated. Cleanup was originally estimated to result in from 2000 to 8000 person-rem of occupational radiation dose. Although only 2000 person-rem have resulted from cleanup operations performed up to now, current estimates now indicate that between 13,000 and 46,000 person-rem are expected to be required. Alternative cleanup methods considered in the supplement either did not result in appreciable dose savings or were not known to be technically feasible.

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