NUREG-0683
Vol. 2
Appendices A-Z

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

Docket No. 50-320

Metropolitan Edison Company
Jersey Central Power and Light Company
Pennsylvania Electric Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

March 1981

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The table on the following pages 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 in the order received and the page numbers of this appendix where the first page of each letter appears. The letter numbers are used in Chapter 13 (Responses to Comments) in responding to the comments.

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University of Pittsburgh
SCHOOL OF ENGINEERING
Department of Metallurgical and Materials Engineering

August 27, 1980

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

Dear Mr. Snyder:

I thank you for sending me a copy of NUREG-0683 entitled Draft Programatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2. I have read the report with great interest and concern since I have spent 25 years doing research on the chemical reactions of Zirconium and Zircaloy II and IV with oxygen, nitrogen, hydrogen and steam. *These studies* have shown me that great care must be used in handling zirconium and its alloys. The following are my comments and recommendations.

The authors of NUREG-0683 should be alerted to the possibility that zirconium hydrides $ZrH_{1.4}$ and $ZrH_{1.98}$ may exist in the damaged TMI-2 reactor core. According to section 7.1.1 entitled Status and Specific Considerations it is stated that "a large fraction of the fuel rods have ruptured, and there has been oxidation of Zircaloy in the core (about 50% of the total core inventory of Zircaloy, i.e. fuel cladding, control rod guide tubes, and instrument tubes, has oxidized)." No mention is made here or anywhere in NUREG-0683 that hydrides of zirconium may be formed.

Zircaloy may form hydrides especially under the temperatures of 2500°F which occurred in the accident and at the high pressures of hydrogen which exist in the early stages of the accident. Although oxide films may protect Zircaloy from the hydrogen reaction under normal reactor operating conditions, one must not assume that hydride formation does not occur under conditions of the accident at TMI-2. Here cracks, edges, and other defects offer easy access sites for hydrogen into the metal. With the formation of hydride, spalling of the hydride and oxide occurs. Rapid disintegration of the fuel rods results.

The presence of zirconium hydride in addition to highly cracked residual Zircaloy particles may change the procedures and techniques required for the removal of the damaged core materials and for the transportation and ultimate disposal. All debris from the reactor must at all times be kept under water to protect personnel and to prevent fires. Zirconium hydride, $ZrH_{1.4}$, reacts explosively when exposed to oxygen or air. Large quantities of heat are released to form one mole of ZrO_2 and 0.7 moles of H_2O. Breaking of casks of debris-containing zirconium hydride could result in dangerous fires, explosions and scattering of radioactive material.

348 BENEDUM HALL PITTSBURGH PA 15261

Bernard J. Snyder
Page 2
August 26, 1980

The author strongly recommends that the NRC staff re-examine the decontamination procedures of the TMI-2 reactor core.

Very truly yours,

Earl A. Gulbransen
Research Professor and
Professional Engineer

/ps

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Sept. 3, 1980

To Whom It May Concern:

These comments focus on the recent Draft Programmatic Environmental Impact Statement on TMI-2 and, specifically, on sections of that report related to the psychological stress issue.

While the issue of psychological stress is a critical one which the NRC staff wishes had never been raised, it is unfair to attempt to dismiss it as irrational. One expects a more evenhanded discussion from the NRC. I am disappointed at the tenor of the comments on psychological stress because they seem to imply that residents in the TMI area with misgivings about the competence and/or truthfulness of utility and regulatory officials are unreasonable. Let me call your attention to only two typical sections:

p. 3-23: In addition to being a rather poorly written discussion of psychological stress (3.1.7), this section seems to suggest that persons concerned about what might happen are silly. A strong case could be made that the regulatory officials who refused to even consider the nuclear opponents' "what ifs" were the arrogant, myopic and silly ones in view of the actual accident. Who, even among the most staunch defenders of nuclear power, would now want to defend locating TMI so near a large population center? Although the writers of this section suggest that fear of nuclear technology is unwarranted and even a sign of mental unbalance, their own cavalier attitude in the face of such a potentially dangerous technology seems to me the more unhealthy psychological problem. The use of the adjective "phobic" to refer to residents' fears (p. 3-24), for example, suggests an attitude of superiority on the part of the writers which is hardly justified in view of the actual events at TMI in March, 1979.

p. 10-24: This section seems to suggest that the writers know the long-range impact of the "accident water" on human persons (just as other sections suggest the writers know the long-range impact of the krypton and other radioactive gases). Is there any scientific evidence showing that small residues of tritium in the drinking water are completely harmless? If so, do mention them because area residents are interested in searching them out. If not, then where does the staff find support for its assertion that only "negligible health effects" will follow accidental spills?

Another question on same section: Why use "phobic" in the last complete paragraph of p. 10-24 unless it is meant to suggest that the residents in the TMI area are unbalanced if they do not trust those in charge of TMI-2 cleanup? Does the staff realize that this paints at least 60 percent of the residents living within five miles of the nuclear facilities "phobic"? Does such arrogance serve the interests of either the NRC or the public?

There are numerous additional problems with the report which undermine the readers' confidence. Footnote 66 on p. 3-27, for example, has no place in an allegedly scientific report. I'm very disappointed at the obvious lack of objectivity and empathy for local citizens.

Edward J. Walsh

Edward J. Walsh 720 S. Allen Street State College, Pa. 16801

The House of Charles
90 Nittany Drive
Mechanicsburg, Pa. 17055

Dear Mr. Snyder

I would like to know the answers to the following questions. Questions from this letter are related to (NUREG 0683)Environmental Impact Statement.

1.Why the change in the movement of waste material? Page 3-30 Figure 3.2-2. It was my understanding that waste material(high or low) would be sent by Interstate 81 to Interstate 80 W. Looking at your map it would appear that you will transport waste materials on the west side of the Susquehanna River on US 11 and US 15 North. of the Interstate Bridge that crosses the Suquehanna. This route would not keep with in the guide lines of DOT and NRC.

2. Why was the southern routeon U.S Interstate 81 to MD. and then Interstate 70 W. not included?

3.What is the number of truck loads(aprox) of High level materials to be taken from the clean up of th Island? Number of truck loads of low level (aprox.) to leave the island?

4.Why have you not included an update of your Aerial Radiological Survey dated Aug. 1976(A.E. Fritzsche)? It seems a good aerial survey showing background after March 1979 compared to 1976 would help to clear the fears of many people.(see page 4 Appendix C (NUREG-0637)

Thank you,

Sincerely,
Edwin Charles
Edwin Charles

P.S. How could I obtain a copy of the 1979, and 1980 U.S. Nuclear Regulatory Commission Annual Report? I Have a copy of the 1978 and have found it very interestig.

Irwin D.J. Bross, Ph.D.
Director of Biostatistics
Roswell Park Memorial Institute
666 Elm Street
Buffalo, N.Y 14263

September 5, 1980

Richard H. Vollmer, Director
Three Mile Island Support
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Vollmer:

In conjunction with the hearings of the U.S. Nuclear Regulatory Commission on the newly released draft Programmatic Environmental Statement (DPES), I would like to submit this critique. Using the metatechnological analysis appropriate to EIS, this critique demonstrates that, relative to viable technological alternatives, the proposed plan is the least feasible, the most expensive, and the most dangerous to the public health and safety. It is further pointed out that NUREG-0683 is an incompetent document from an epidemiological and biostatistical standpoint and all the estimates of hazard are so remote from the real risks that it constitutes a dangerous fraud upon the public.

There is a much better way to do the job of disposing of the radioactive wastes at TMI-2 but there is no way to make NRC bureaucrats listen to reason when they are in complete control of the proceedings.

Very sincerely yours,

Irwin D.J. Bross, Ph.D.
Director of Biostatistics

IDJB/mak
Enc.

CRITIQUE OF NUREG-0683 BY DR. IRWIN BROSS

Let us start with the question: What is an appropriate basis for a critique of a Draft Programmatic Environmental Statement (DPES) of any plan for the decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2 (TMI-2)?

The clear intent of the National Environmental Policy Act was to insure that the public health and safety be protected. When, as here, there are alternative technologies for achieving the same goal, then the DPES should establish that the technology that is proposed minimizes the danger to the public health, is technologically feasible, and cost-effective. Hence, the critique of a DPES lies in the province of what is now being called "metatechnology". For a more complete discussion see my new paper, METATECHNOLOGY: A TECHNOLOGY FOR THE SAFE, EFFECTIVE, AND ECONOMICAL USE OF TECHNOLOGY, which will be published in the new British journal, METAMEDICINE, in February 1981 (see Schedule A). From this standpoint we must consider alternative courses of action (and alternative technologies) for disposal of the radioactive wastes from the accident at TMI-2. Although there are numerous technological alternatives, for present purposes it will suffice to consider only three:

1. Inaction. No other action beyond present maintenance operations for an indefinite period.

2. DPES*. The programmatic plan proposed in NUREG-0683 for a 5 to 7 year clean-up of TMI-2.

3. Entombment. Disposal of the radioactivity wastes by immobilizing them in concrete in the containment of TMI-2.

A metatechnological evaluation involves comparison of the costs and benefits of the alternative technologies and the choice of a disposal technology that will accomplish its purpose with minimum risks to the public health and safety. The key factors in the cost-benefit evaluation here are the following:

What is the extent to which:

(k-1) Humans are directly involved in the disposal operations?

(k-2) Radioactive materials must be transported inside the containment or removed and transported elsewhere?

(k-3) New technologies must be developed to do the job?

As a rule-of-thumb an unfavorable situation with respect to the key factor will at least double the complexities, practical difficulties, and operational costs of the overall project. It will increase risks to workers and the public by a greater amount, roughly a factor of 4.

Since there is consensus that a first alternative, inaction, is not appropriate for TMI-2, only the second and third alternatives will be considered in what follows. However, an official DPES should also evaluate this alternative carefully. The reassurances to the

public on TMI-2 suggest that NRC calculations do not show any appreciable risk of meltdown from the present haphazard configuration of the rods and other radioactive material. The only scenarios that could produce such a risk (e.g., earthquake) involve the mobility of the rods and the large amount of radioactive water in the containment. The risks become completely negligible if the water used to mix with the concrete and the radioactive materials are immobilized in this concrete. Hence, it follows that the goal of suitable disposal of the radioactive wastes in TMI-2 can be achieved equally well by the plan proposed in NUREG-0683 or by entombment. Earlier claims of further benefit from NUREG-0683 by reactivating TMI-2 are now recognized as absurd. The cost of meeting NRC exposure levels (5 rem/year) by decontamination of TMI-2 (where levels of 100 rem/hr have been reported) far exceed the costs of building an up-to-date installation *de novo*.

Since the benefits for the alternative technologies are about equal, the metatechnological choice here hinges on the costs, particularly the health costs to workers in the clean-up and to the general public living near TMI-2 or downwind or downstream from the installation. The situation with respect to the key factors can be summarized as follows:

With respect to the transport of radioactive materials, the proposed clean-up plan involves removal of these materials from the containment and transportation to other locations. Again, to implement the plan in DPES* there must be purging of radioactive water into a river system that serves or affects many U.S. cities. With entombment the radioactivity stays inside the containment of TMI-2. Therefore, with respect to the second key factor (k2) there is minimal movement of radioactive materials in the entombment option, but extensive movement of these materials (and possible dissemination into the environment) in DPES*. For this reason alone NUREG-0683 should be rejected as an incompetent document by the basic principles of metatechnology.

With respect to the first key factor (k-1), the extent of involvement of human beings in the processing of radioactive materials, the entombment option has minimal involvement. The processes for dealing with concrete (including the use of cooling pipes and other refinements) represent a well-known technology that can be largely carried out by machinery under remote control. In contrast, DPES* makes extensive use of human workers in an environment contaminated by both low-level and high-level radioactive wastes. The estimates of health effects in NUREG-0683 underestimate the actual hazards by factors of 100 or 1000.

The Mickey Mouse arithmetic used in federal agencies for what are called "radiological assessments" involves too many scientific errors to detail here. I have given detailed examples at a hearing of the Department of Energy on West Valley (Schedule B) which explains why exposures are consistently underestimated by factors between 10 and 100. In addition, the health effects for given exposures are consistently underestimated by a factor of 10 or more. Documentation of the new factual evidence on persons actually exposed to low-level radiation (which shows 10-fold higher health risks) was given in my invited presentation to the American Statistical Association in Houston, Texas, on August 13, 1980 (Schedule C). The net effect is that the estimates in

NUREG-0683 concerning death and disability for workers understate the actual risks by a factor of 100-1000. When such unrealistic estimates are used in a DPES, this represents a reckless endangerment of the public health. There is no question but the DPES* involves extremely serious hazards to the workers that are being deliberately covered up by the Mickey Mouse arithmetic of these "radiological assessments".

The combination of the first two factors, extensive use of humans (k-1) in close proximity to radioactive materials (k-2) create a difficult situation for DPES*. Safe operations would require new technological developments that are beyond the present state of the art. The difficulties in attempting to develop new technological tools on-site and on-the-job pose formidable management problems which compound the difficulties. In my draft EIS for West Valley, I have discussed these management problems at some length (Schedule D). While a clean-up of TMI-2 is simpler than a clean-up at West Valley, the record of management at TMI-2 and past failures with simple tasks is not encouraging. Very serious dangers, both to the workers on the job and to the public, from failures of untested technologies developed on-site and on a crash basis are ignored in NUREG-0683 and elsewhere in DOE-NRC planning. In contrast, entombment minimizes worker involvement and the manipulation of the radioactive wastes. It uses familiar concrete technologies that avoid most (though not all) of the problems that would require new technology. There could be added technical problems in cooling systems that would require some extension of existing technology. However, entombment operations are orders of magnitude simpler and less fussy than the clean-up proposed in DPES*.

From this qualitative analysis (which could be supplemented with quantitative metatechnological analysis), it follows that the entombment option is much more technologically feasible than the plan in NUREG-0683. Again, the rule-of-thumb on costs (and the adverse situation of DPES* on all three key factors) means that DPES* will cost at least 8 times more than entombment. If, with inflation, entombment costs $0.5 billion, then DPES* will cost at least $4.0 billion. These costs will have to be paid by ratepayers and taxpayers of Pennsylvania and other states and perhaps by shareholders of the utility. As noted at the start, the extra money will buy no actual benefits. Both alternative technologies will do the disposal job equally well. Moving humans into the containment of TMI-2 and moving radioactive wastes out of it is costly and this money buys nothing but grief for both workers and the public.

The only explanation offered here for the NRC insistence on DPES* is that bureaucrats follow their own special "logic" where it is easier to endanger the health and safety of thousands of human beings than to bend NRC regulations to deal sensibly with the unprecedented situation at TMI-2. If there are legal problems in entombment, I believe Congress would act to change the laws since this will save billions of dollars and perhaps hundreds of human lives.

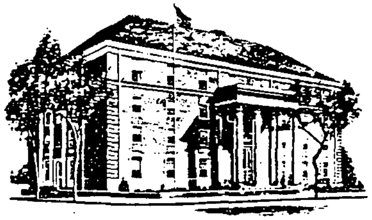
Finally, let us come back to the real issue here, the choice of an alternative technology that will minimize the risks to the public health and safety. NUREG-0683 relies on inadequate "radiological assessments" instead of on more realistic "public health assessments". We now have

more than 20 years of experience and more than 20 specific instances where both kinds of assessments were made (Schedule C). In each case, the "radiological assessment" predicted that there would be no hazard from the exposure to nuclear or medical radiation. In each case a genuine "public health assessment" found evidence of serious hazard to the persons exposed. NRC "radiological assessments" are fake "science" and do nothing to protect the public health and safety from radiation hazards. I have further discussed the distinction between "radiological" and "public health" assessments in a letter written in conjunction with the Krypton purging (Schedule E).

Any adequate "public health assessment" of the danger to the public health and safety from implementation of the proposal in NUREG-0683 would show that the "radiological assessments" have covered up the grave dangers that would occur. Since there is a cheaper, easier, and safer way to dispose of the radioactive wastes at TMI-2--essentially immobilizing them in an ideal "tomb" (a containment that can never again be used for other purposes)--only idiots would go ahead with the NUREG plan. However, from my personal contacts with the decision-makers involved in this issue, I am confident that the clean-up of TMI-2 will follow the NUREG-0683 plan.

NOTE: THE SCHEDULES MENTIONED IN THE ABOVE COMMENT LETTER ARE NOT BEING INCLUDED IN THIS APPENDIX SINCE THEY CONTAIN COPYRIGHTED MATERIAL.

JACOB A. MYERS
CHAIRMAN
NELSON A. PUNT
VICE-CHAIRMAN
ROSEMARIE C. PEIFFER
SECRETARY



SANDRA J. WHITTAKER
CHIEF CLERK
JOHN H. BROUJOS
SOLICITOR
WM. C. COSTOPOULOS
ASSISTANT SOLICITOR

Commissioners of Cumberland County

COURT HOUSE, CARLISLE, PA. 17013

September 5, 1980

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

Dear Mr. Snyder:

A preliminary draft of the Environmental Impact Statement concerning the Three Mile Island clean-up was issued on August 14, 1980. Any decisions on the method of clean-up for T.M.I. will rely upon this statement in weighing the environmental impact of any action to be taken. Comments concerning the draft will be received and used for formulating the final report.

My primary concern is the failure of the Nuclear Regulatory Commission to include Cumberland County in the "impact study area." The importance of this determination is that special consideration is given to the socioeconomic composition of the "impact study area." Dauphin, Lancaster, and York counties were included with this "study area" because of their "proximity" and "the probability of its experienceing the more direct impact." I submit that Cumberland County meets both of these criteria and that special consideration should be accorded to the county.

The densely populated West Shore is no further than most of the Harrisburg area from T.M.I. It is much closer than the city of Lancaster.

Further, the concerns and apprehensions of our citizens are no less than those in our sister counties. The threat of evacuation is just as present to Cumberland County as any other counties. Route 81 and the Pennsylvania turnpike will serve as major evacuation routes. The western sections of Cumberland County will serve as a host area for any evacuation.

Mr. Benard J. Snyder
September 5, 1980
Page 2

Because of this, we urge the Nuclear Regulatory Commission to survey the socioeconomic composition of Cumberland County. We further urge that any decision or action regarding the clean-up be weighed in light of its environmental impact on Cumberland County.

Any accident, leakage, or venting at Three Mile Island will have a direct and substantial impact on Cumberland County. It is time that the NRC recognizes this.

Sincerely,

Jacob A. Myers, Chairman

Nelson A. Punt

Nelson A. Punt, Vice-Chairman

sjb

September 12, 1980

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

Dear Sir:

Your Environmental Impact Statement on Three Mile Island does not guarantee to the TMI area that no risk is involved in the clean-up of TMI 2, nor does it solve the problem of disposal of radioactive waste, which is extremely important.

I, as many others, oppose:

1. The release of radioactive waste into the Susquehanna River or stored on site.
2. The release of gas into the atmosphere.
3. The storage of radioactive waste within this or any nearby areas.

Since TMI 2 is a laboratory for the nuclear industry in the nation, I think it is only proper that the Federal Government stop shirking responsibility.

The Federal Government permits construction, licenses and regulates these plants, therefore they are a "PARTNER". It is obvious that they permitted this industry to be created without knowledge of the impact of an accident such as TMI 2.

We feel that we are being used in experimentation for the nuclear industry and demand that these plants - TMI 1 and TMI 2, also Peach Bottom Nuclear Power Plant be closed down permanently, cleaned up completely and waste disposed of safely.

Yours truly,

Clarice H. Parsons

(Mrs.) Clarice H. Parsons
899 Clearmount Road
York, Pennsylvania 17403

m

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9/19/80

To the Director

As a member of the goverment and therefor an employee of the good citizens of this great nation it is your duty to consider the safety of the public over any profits of a corporation.

I am most definitely apposed to the release of radio - active toxins into the enviroment air, water, land or whatever.

Yours Sincerily

Cory J. LaBrasca

Cory J. LaBrasca

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

September 22, 1980

U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn: Director, Three Mile Island Program Office

Subject: Comments - Draft Programmatic Environmental Impact Statement: Three Mile Island Nuclear Station, Unit 2

Dear Mr. Snyder:

The Commission has received the above noted Statement concerning the proposed decontamination and disposal of radioactive wastes activities, and feels it is not qualified to review and comment on such a technically oriented document.

Very truly yours,

James R. Zeiters

James R. Zeiters
Executive Director

Pennsylvania State Clearinghouse

P.O. BOX 1323 – HARRISBURG, PA. 17120 – (717) 787-8046
783-3133

Commonwealth of Pennsylvania

GOVERNOR'S OFFICE
OFFICE OF THE BUDGET

RE: PSC-SAI# 80C5024

APPLICANT: Nuclear Regulatory Commission

PROJECT: Draft EIS - Decontamination and disposal of radioactive wastes

LOCATION: Three Mile Island

Enclosed with this letter please find the comments of the following State Agencies relative to the project identified above:

Dept. of Transportation

Please consider these the comments of the Pennsylvania State Clearinghouse at this time.

Thank you for your cooperation.

Sincerely,

Anne G. Ketchum

Anne G. Ketchum
Supervisor

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

State Clearinghouse
Governor's Budget Office
Box 1323
Harrisburg, PA 17120
717-787-8046

PSC SAI NO. 5-80-08-024
Draft-Environmental Impact Statement-
Decontamination and disposal of radioactive wastes-Three Mile Island Nuclear Station Unit #2.

FIRST STAGE REVIEW
Preapplication/Notification of Intent
AGENCY REVIEW COMMENTS

INSTRUCTIONS: To be completed by review agency and returned to State Clearinghouse. Check one or more appropriate boxes. Indicate comments below. Return copy 1, 2 and 3 to the State Clearinghouse. Retain copy 4 for your official records. Attach triplicate sheets if necessary.

PART I: Declaration of Interest

[ ] No Interest Declared – Complete Part V and return copy 1 and copy 2 to State Clearinghouse.

[x] Interest Declared – Complete Parts II, III, IV and V and return copy 1 and copy 2 to State Clearinghouse.

PART II: Identification of Agency Review Criteria (Agency plans, programs, policies and/or laws)

Department of Transportation Policies and Plans.

PART III: COMMENTS (Include results of preliminary contact made with applicant and suggestions for improving project proposal)

We have reviewed this document and after consultation with the Department's Hazardous Substances Division, we feel it necessary that the Department submit an adverse comment on plans to transport wastes to the State of Washington disposal site. Plate 3-2-2 indicates plans to use US 15 as a way to reach Interstate 80 for the trip west. This routing includes some two-lane roadway in Perry County which has a recent history of a high accident rate. The use of Interstate 81 north would appear to be a better alternative from a safety standpoint. (All four lanes, away from population centers,etc.). The most direct access to a four-lane facility would be to use the Pennsylvania Turnpike, but this would involve using tunnels, which is prohibited by Turnpike regulations.

PART IV: Recommended State Clearinghouse Action (This action will not be honored by the State Clearinghouse unless Part II and Part III above have been completed)

[ ] Recommend Approval
[X] Recommend Disapproval
[ ] Request the opportunity to review final application.
[ ] Request the opportunity to review environmental impact statement.

PART V: Certification	Authorized Agency Signature	Agency	Date
	R.C. Seamar (signature)	Department of Transportation	Sept. 10, 1980

COPY 1, APPLICANT COPY—Return to Pennsylvania State Clearinghouse

September 26, 1980

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington D. C.

4327 Alconbury Lane #3
Houston, Texas 77021

To Whom it May Concern:

RE: PUBLIC COMMENT ON NUREG-0683, DPEIS RELATED TO DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES RESULTING FROM THE MARCH 28, 1979 ACCIDENT, <u>THREE MILE ISLAND - II</u>

My Comment on the Draft Programatic Environmental Impact Statement is in the area of health physics. As has been pointed out by Officials of General Public Utilities, the TMI-2 event provides an excellent opportunity to study various aspects of nuclear power.

Therefore, I believe a health study of long duration should be a part of the repair and recovery events at this plant. The study would be one of recording the exposure to workers involved in all aspects of the operation where badges are required to record exposure. In addition to the recorded exposure, provision should be made for each persons health to be followed for the next 30 years (the longest period for a carcinoma to develope from exposure). And, of course, the data on the conclusion of the study, and for reasonable intervals through the years should be studied, with the studies released to the public.

This <u>is</u> an excellent opportunity to study the effects of exposure to the radiation from an atomic unit, and I believe the opportunity should not be missed.

Sincerely,
John F. Doherty (signature)
John F. Doherty

jfd

p.s. Please forward this to the proper persons if NRR is not handling public comments. Thank you.

at Anne Arundel Board of Education, Baltimore, MD ...

Maryland Ad Hoc Committee on Three Mile Island

Contact: John Kabler (301) 235-8808 or 235-8810

STATEMENT
OF THE
MARYLAND AD HOC COMMITTEE ON THREE MILE ISLAND
AND
CLEAN WATER ACTION PROJECT
TO THE
NUCLEAR REGULATORY COMMISSION
AND THE
MARYLAND DEPARTMENT OF NATURAL RESOURCES

September 30, 1980

The accident at Three Mile Island left more than a million gallons of radioactive water at the plant, including 600,000 gallons of highly radioactive water still in the containment building. Metropolitan Edison has said that its preferred plan for disposing of this water is to treat it to remove most of the radioactivity and then discharge the water into the Susquehanna River, source of drinking water for several communities downstream (and a backup source for Baltimore) and potential polluter of the priceless Chesapeake Bay, an enclosed and very fragile ecosystem.

A year and a half after the accident the radioactive decontamination of the damaged reactor continues to threaten the health and safety of Maryland citizens while the government's handling of decontamination procedures has seriously eroded the public trust and confidence in state and federal regulatory agencies and governmental safeguards.

The Nuclear Regulatory Commission (NRC) has consistently and effectively precluded the public from adequate participation in the analysis, and subsequent decision making process, concerning the radioactive clean up at TMI. Examples include the purchase and installation of Epicor 11, time constraints imposed in the decision making for the purging of Krypton-85 and NRC's failure to follow up on its promise to form a citizen advisory committee with funding for independent scientific review.

On August 14, 1980, the NRC released its draft Programmatic Environmental Impact Statement (D-PEIS) concerning decontamination and disposal of radioactive wastes at TMI. Under pressure from citizen's groups and Pennsylvania Governor Thornburgh, the NRC has extended the comment period on the D-PEIS until November 20, 1980.

Although we appreciate the NRC's decision to extend the comment period, there are basic flaws in the D-PEIS which cannot be properly addressed through the public comment process and must, instead, be resolved through further studies by the NRC, with subsequent public review and comment.

Independent scientists queried by the Ad Hoc Committee have criticized the D-PEIS on numerous points. Examples include questions raised about incorrect mixing projections, inaccurate and misleading Susquehanna River flow rate figures and inadequate and confusing data concerning quantities of radioactivity involved in various waste products. Other problems in the draft statement, according to Union of Concerned Scientists representative Robert Pollard and others, bring into question the validity of the entire document.

Some basic flaws in the PEIS which might require separate environmental impact statements:

1. <u>The problem of how and where to dispose of the wastes resulting from the accident and cleanup process is inadequately considered</u>. There is no assurance that any waste site will accept the low-level waste in the amount postulated by the NRC staff and ultimate disposal of high-level waste remains an unresolved question.

2. The NRC staff dismisses the question of whether TMI-2 will be decommissioned or prepared for restart by stating that it is not within the scope of the PEIS. <u>In reality the methods of cleanup are very dependent on the decision to restart or to decommission the unit</u>. Certain processes could severely damage the equipment, making the final disposition question essential in selecting the proper methods to be used. Thus the question of restart or decommissioning of the plant must be considered in depth within the PEIS.

3. <u>There is a total lack of cost estimates in this evaluation phase of the PEIS</u>. The NRC staff has promised that the cost factors will be provided in the final PEIS (after the period for public comment has passed). The lack of opportunity for public comment on economic aspects of the cleanup provides an example of how the public is being excluded from the decision making process. In view of the precarious financial condition of Metropolitan Edison, the NRC's assertions that costs are not a limiting factor can hardly be viewed as realistic.

4. <u>In the PEIS the NRC makes the assumption that cesium and strontium from the planned release of processed water (which will contaminate Chesapeake Bay seafood as far south as the Potomac river) will not effect the marketability of the seafood</u>. A separate EIS that includes market research data on radioactivity in Chesapeake Bay seafood must be performed prior to making any determinations as to the effects of radioactive contamination of Bay seafood on the seafood industry.

Post Office Box 473 Severna Park, Maryland 21146

The controversy that exists today is not simply over the D-PEIS and the proposed methods of radioactive decontamination at TMI; It also involves serious doubt, if not suspicion, about the government's real intentions in handling the problem. When public officials or citizen organizations request better avenues for citizen involvement in the decontamination decision-making, the NRC public relations staff responds with self serving explanations of NRC policy and procedures and, typically, no response at all to the specific request.

NRC's method of dealing with the decontamination process has been both inappropriate and irresponsible. Instead of dealing directly and effectively with the cleanup, NRC has preferred to let things drift until a crisis occurs and then, as in the case of Epicor 11, justify subsequent ill-considered actions by blaming the crisis.

NRC officials appeared to be responding to the credibility crisis they had created by publicly agreeing to appoint a citizen advisory panel with funding for independent scientific review in March, 1980. Their refusal to follow up on this promise has further alienated a skeptical public

Whereas it may be easier to make a decision with incomplete information, it will be more difficult to live with the consequences. In our view, it is indefensible that NRC continuously avoids the scientific and public input that, if properly considered, could lead to a safe, effective and politically acceptable cleanup at TMI.

More seriously, NRC now proposes to make a complete mockery of the NEPA process by refusing to hold public hearings on the draft PEIS. CEQ regulations call for such hearings when there is "substantial environmental controversy concerning the proposed action or substantial interest in holding the hearing."

What could be more controversial than the radioactive decontamination of the nation's most serious nuclear accident, located at the headwaters of the world's most valuable, and ecologically sensitive, estuarine system -- the Chesapeake Bay.

NRC must work to restore the public's trust and confidence in their capability and objectivity in determining the best course of action in regard to the cleanup at TMI. Failure to do so will result in increasingly effective citizen action in opposition to NRC plans.

In order to resolve the crisis of credibility that NRC has created, and to restore the public trust and confidence, NRC should agree to hold well publicized public hearings in Baltimore and Harrisburg or Middletown, and to re-initiate its stalled agreement to appoint a citizen advisory committee with funding for independent scientific review.

No new actions concerning the decontamination of TMI should occur until NRC has redesigned their PEIS in response to the public's criticism and the findings of an independent scientific panel.

Finally, no radioactive water from TMI-2 should be released to the Susquehanna, until scientific controversy concerning the safety of such action has been resolved, until NRC and Metropolitan Edison can prove that such releases will not affect the marketability of Chesapeake Bay seafood and until citizens living downstream from the damaged reactor agree to such releases.

First of all, I urge the Nuclear Regulatory Commission to hold public hearings, both in Maryland and Pennsylvania, on the PEIS. It seems to me that the criteria in the Council of Environmental Quality regulations, 40 CFR 1500.7, the importance of the proposals, complexity of the issues, degree of interest in the proposals and the extent of public involvement already achieved, would indicate that public hearings should be held.

I'd like to comment on the prospect of Metropolitan Edison running this cleanup. As I understand it, the NRC will not choose the method of the cleanup but only has a veto over the method Met Ed chooses. We Marylanders who may drink the water possibly released from Three Mile Island or eat the seafood that lives in it, need assurances that the NRC will require Met Ed to use the safest method for the cleanup.

Metropolitan Edison is in bad shape financially. Two weeks ago, it laid off a large number of workers, including 500 working on the cleanup. The NRC should devise plans to continue the cleanup should Met Ed go bankrupt and should devise plans to determine if Met Ed is scrimping on the cleanup to save money in a manner which could jeopardize the health and safety of our citizens.

The cleanup is a unique and difficult technical problem. Met Ed does not have a reputation for technical excellence. Saturday's Baltimore Sun notes that an NRC study found 37 serious deficiencies at the TMI-1 control room and 50 less

serious deficiencies. This leaves the observer with the fear that Met Ed will not do the excellent job required to make the cleanup safe. The NRC must develop plans to monitor the cleanup to see it is being done correctly.

Finally, the NRC must realize that the public does not have great faith in it and Met Ed. There must be some assurance for the public that this process is being done correctly. There must be a truly independent, knowledgeable, well financed body to monitor the cleanup so that we Marylanders who drink Susquehanna River water are not having their health jeopardized and we Marylanders who make their living from the Chesapeake Bay are not having their livelihood jeopardized.

Kenneth May

The Chesapeake Bay Foundation

"Citizen Representation - Environmental Education - Land Preservation"

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September 30, 1980

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

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

Dear Mr. Snyder:

The Chesapeake Bay Foundation is a non-profit, private conservation organization with over 6,000 members. Our basic purpose is the protection of Chesapeake Bay water quality and natural resources.

The Chesapeake Bay is our nation's most productive body of water and its seafood resources are most important to this country.

The Susquehanna River upon which the TMI Unit 2 is located is the single most important contributor of fresh water to the Bay, supplying 80% of the fresh water to the upper Bay and 50-60% to the entire Bay. Thus, the decontamination activities at TMI are of vital interest to the Chesapeake Bay Foundation and the citizens of the State of Maryland.

The PEIS which was prepared by the Nuclear Regulatory Commission (NRC) is important as an analysis of the potential impact of those decontamination activites. However, we believe that there are several deficiencies in it and also note that it presents a series of alternatives, rather than a plan.

In order to guide the NRC in its review of the various alternatives, we believe that certain criteria should be used. It is our position that

the following criteria are most appropriate:

1. Clean up should proceed as expeditiously as possible consistent with proper planning. For example, we are most anxious that the processing and removal of sump water begin in order to avoid additional damage to equipment essential for safe operation and control of the reactor.

2. Adequate planning and impact assessment must be carried out to ensure that the safest and most effective procedures are chosen. This may necessitate further preparation of impact statements if unanticipated conditions occur which require actions which have not been addressed in this PEIS.

3. The accident-generated radioactive water should be promptly processed to remove most of its radioactivity in order to avoid the potential accidental release of this highly contaminated water to the river.

4. Decontamination procedures which would minimize the amount of liquid waste generated should be given preference. Processed water should be re-used as much as possible in the cleanup activities.

5. The processed accident water should not be discharged into the Susquehanna River since other alternatives are available and the potential impact on the marketability of Bay seafood could be serious.

6. Radioactive waste generated by the accident and subsequent cleanup activities must be promptly removed from the island so that TMI does not become our nation's first long-term high level waste disposal site. Its location on an island in the middle of a river which supplies 80% of the fresh water of the upper Chesapeake Bay is not appropriate for such disposal. We urge that the NRC work with DOE to establish an appropriate disposal site for this material.

7. In anticipation of waste transportation and disposal problems, we urge the NRC when selecting procedures for cleanup, to choose these which generate minimum amounts of wastes which are at the same time, in form and level of radioactivity and most readily transportable and suitable for long-term disposal.

8. Methods should be chosen which would keep levels of radiation to workers and the public to the lowest achievable levels.

Regarding the Draft Programmatic Environmental Impact Statement itself, we have both general and specific comments.

It is of special concern to us that the PEIS presents a number of alternatives but does not recommend a plan. Consequently the public has no assurance of the procedures which will be followed or even of the criteria which the NRC may use in considering plans proposed by Metropolitan Edison. We therefore request at this time that the public be given further opportunity to comment when actual proposals are made by Metropolitan Edison for cleanup and disposal activities.

A serious deficiency in the PEIS is the lack of cost estimates for the various alternatives. Although we don't want to have decisions made which would provide less adequate treatment in order to save money, there may be times when such information might help in a choice between otherwise equal alternatives. Particularly, we beleive that a decision regarding the feasibility of restarting Unit 2 should be based to some extent on the relative costs of cleanup to protect all the equipment for restart purposes, on the one hand, versus simpler and less expensive treatment that could be used if the equipment were going to be scrapped.

Since the Chesapeake Bay Foundation is particularly concerned about the potential release of accident generated processed water to the Susquehanna River, we will confine our most detailed comments on the PEIS to that area.

We believe that the PEIS is deficient or erroneous in several instances:

1. Estimates of the concentration and distribution of the constituents in the processed water are dependent on factors which are unknown at the present time, including the condition of the core and primary loop. Yet no best case and worst case conditions are presented regarding this.

2. Total radioactivity which would be released to the river as presented in Table 10.1-2 does not correspond with data in Table 6.3-5 regarding the volume of water and concentration of the radioactive constituents. In fact, Table 10.1-2 shows a total of 2.5 to 3 Ci of radionuclides from the processing of reactor building sump water, whereas a calculation based on the effluent volume, concentration and 1200 dilution factor shows a total of nearly 3,700 curies to be released, most of which is tritium.

3. It should be noted that the average amount of tritium released from a normal generating unit of this size is 400-500 curies/year. If the total amount of tritium in the processed water is 3700 curies, it would take approximately nine years to release it at that rate, instead of the one year that is being proposed.

4. Calculations of the expected dosages to fish from the release of the processed water are presented in Table 6.3-18. Assumed concentration factors are:

tritium	1:1
Cs137, Cs134	3000:1
Sr90, Sr89	500:1

yet the rationals for such factors are not presented in the PEIS. A number of factors which will cause those concentration factors to vary are not even mentioned, such as temperature, salinity and presence of calcium, potassium, etc.

5. A number of studies have been done which discuss substantial variation in concentration factors with many values being significantly higher than those assumed by the PEIS. Concentrations up to 40,000 times for cesium in fresh water low in potassium[1/] and up to 30,000 times for strontium[2/] have been documented. There is even uncertainty regarding the potential for bioaccumulation of tritium, although most scientists believe that tritium does not bioaccumulate.[3/]

6. The potential impact of these radionuclides is barely mentioned in the PEIS. Yet a recent report states, "Because a large percentage of the cesium accumulated by fishes lodges in edible muscle tissue, sport and commercial fisheries suspected to be contaminated by radiocesium should be carefully monitored".[4/] Strontium, on the other hand, concentrates in the bony portions. The same report states, "Because of this bone-seeking tendency, radiostrontium is extremely dangerous." It goes on to state that, "fishes such as sardines which are consumed in their entirety represent the greatest risk to humans, and soft waters contaminated by the radioisotope offer the optium conditions for isotopic bioaccumulation".[5/] Since the Susquehanna is a drinking water source as well as an important area for sport and commercial fisheries, including shad which are often eaten bones and all, we feel that the disposal of water containing these constituents into this river is inappropriate and the potential impact has been under-estimated in the PEIS.

7. The hydrology of the river and its impact on the distribution of radioactive isotopes is incompletely addressed. Estimates of concentrations in the river assume complete mixing during average low flows, (p.6-19). Yet since there are islands to the west of Three Mile Island, the complete river is not available for a mixing zone. As was noted on p. 6-24, fish could be exposed to conditions in which mixing was not complete, causing doses up to 20 times higher than those presented in Table 6.3-18.

8. Sediment deposition processes within the Susquehanna River are quite complex, yet they are barely mentioned. Because of dams downstream, sediments are likely to be deposited in certain rather concentrated areas. The tendency of cesium to be absorbed onto sediment particles creates the likelihood of "hot spots" being created within the river and on the Susquehanna Flats.[6/] We believe that the PEIS incorrectly assumes that a fairly large percentage of the cesium will remain in the water column for some time. Considering sediment loading in the River and studies that have been done on behavior of cesium,we would expect virtually all of the cesium to have dropped out with the sediment within four days.[7/] We are concerned that large storm events would cause a sudden release and resuspension of these contaminated sediments.

9. We must again stress that the release of processed water to the river is undesirable since it could have a substantial impact on the marketability of Bay seafood, which is worth millions of dollars to Maryland's economy and provides employment for thousands of individuals.

10. Viable alternatives exist for disposition of the water. We would recommend that it be immobilized in cement and eventually moved off-site for disposal as is all the other low level waste. In its immobilized state it would not represent a radiclogical threat and could be assigned a low priority for off-site disposal.

11. The apparent inability of the federal government to locate a high-level radioactive waste disposal site is a serious problem which seems to be avoided in the PEIS. Yet its resolution is essential if the high level waste is to be removed from the island. We believe that the seriousness of this problem should be fully exposed so that its solution is given top priority by the NRC and the Department of Energy.

In summary, we feel that the PEIS has inadequately addressed certain areas regarding the potential impact of the release of processed accident water and particularly the impact of such an action on the seafood indsutry. It also needs to address the ultimate waste disposal problem. And finally, criteria must be developed to assist in the selection of appropriate decontamination procedures.

Sincerely,

Nancy G. Kelly
Senior Staff Biologist

NGK/kaw

FOOTNOTES

[1] Preston, A., D.F. Jefferies, and J.W.R. Dutton. 1967. The concentrations of cesium-137 and strontium-90 in the flesh of brown trout taken from rivers and lakes in the British Isles between 1961 and 1966: the variables in determining the concentrations and their use in radiological assessments. Water Res. 1(7): 475-496.

[2] Krumholz, L.A. 1956. Observations on the fish population of a lake contaminated by radioactive wastes. Bull Am. Mus. Nat. Hist. 110(4): 277-368.

[3] Bond, V.P. Evaluation of potential hazards from tritiated water. Brookhaven National Laboratory, p. 287-299.

[4] Phillips, G.R. and R.C. Russo. 1978. Metal bioaccumulation in fishes and aquatic invertebrates: A literature review. Environmental Research Laboratory. Office of Research and Development, U.S. Environmental Protection Agency, p.21.

[5] Ibid., p. 58,59.

[6] Troup, B.N. and O.P. Bricker. 1975. "Progesses affecting the transport of materials from continents to oceans", in Marine Chemistry in the Coastal Environment. American Chemical Society. p. 143-144

[7] Phillips and Russo, p. 20.

Testimony Before NRC Public Hearings Regarding the Draft Programmatic Environmental Impact Statement for Decontamination of TMI Nuclear Station, Unit 2

Both the NRC and Metropolitan Edison admit that they are unable to remove tritium from the hundreds of thousand of gallons of contaminated water resulting from the infamous accident that occurred at Three Mile Island, one and a half years ago. According to their draft EIS, this tritiated water will ultimately end up in the Susquehanna River and be carried downstream into Chesapeake Bay.The plan is to release about 3,500 Ci of tritium over a period of a few months. Now the average annual release of tritium from a nuclear power plant is only 400-500 Ci, which means that on a similar annual basis TMI will be releasing about twenty times more tritium than it would under normal operating conditions. We are told not to be concerned because the tritiated water will be sufficiently diluted with non-tritiated river water so that the actual concentration of tritium shall fall within the NRC safety standards. This assurance does not assuage my concern for at least two very good reasons; namely, it is the cumulative amount of tritium rather than its concentration that is the significant statistic in this case - never before have the people near a nuclear plant been subjected to three and a half thousand curies of tritium in their fishing and drinking water and, secondly, the NRC safety standards for tritium are based on outdated population dosage calculations that grossly underestimate the radiotoxicity of tritium to human life.

The remaining part of my testimony is meant to amplify the two reasons given above in a slightly more scientific vernacular that should be comprehensible to the NRC Commissioners and to the public in general. If the NRC is interested in a more detailed scientific presentation, including documentation of the appropriate research, that is now in the publication process and can be forwarded at some future date.

Inhomogenious Dispersion Versus Uniform Dilution

Conventional engineering wisdom asserts that dissolved tritium or tritiated water rapidly diffuses throughout any body of water, reaches its equilibrium concentration, and remains uniformly distributed in that body of water forever. This rather simplistic view does not take several additional factors into consideration such as convection currents, thermal differences and different rates and strength of physical adsorption. For example, if a nuclear power plant (e. g., Three-Mile Island) discharges its tritiated water into a naturally flowing river (e. g. Susquehanna River) then that tritium does not instantaneously diffuse throughout the total volume of river water to achieve maximum dilution; but rather, it may very well stay within certain currents or be adsorbed by the sediment of the river bed (or its aquatic contents) or even remain within the cooler regions of the river wherethermal diffusion is less vigorous, all of these additional factors would prevent a rapid equilibration of the discarded tritrium within the river thereby resulting in an uneven distribution of the tritium. In other words, parts of the river would have much higher concentrations of the tritium than other parts and thus any ingestion of this more highly tritiated water by fish, animals or even humans would result in greater irradiation of their tissues (by the beta particles) than one would anticipate by the engineering hypothesis of a totally uniform tritrium distribution.

Biological Accumulation or Concentration

The toxicity of any hazardous substance is typically, a function of the quantity of that substance to which a living organism is exposed. Radiation is no exception, the larger the concentration of the radioisotope the greater the risk of genetic and somatic damage resulting in birth defects, stillbirths and cancer. When it came to evaluating the effect of tritium (T), the International Commission of Radiological Protection (ICRP) calculated its population dose based on the tritium activity that would equilibrate with the body fluid (i.e., the inorganic compartment) and totally neglected the covalently bound tritium (i.e., the organic compartment). The implicit assumption of the ICRP dose estimate is that the tritiated body water exchanges its tritiumfor hydrogen only in a polar or ionic transfer with other molecules. Understandably, real life is not that simple and there is now considerable scientific evidence demonstrating that the tritium to hydrogen ratio (T/H) is much greater in the organic molecules or biopolymers (such as polysaccharides, lipids, proteins and nucleic acids) than in the inorganic tritium source (HTO). This results from at least three distinct biological or biochemical phenomena including (1) isotope effects in metabolic pathways (2) concentration of tritium within the organic compartment along a food chain and (3) radiation damage induction of unscheduled DNA synthesis. The metabolic route can, for example, produce covalent tritium-carbon bonds which are much stronger than the more polar hydrogen-oxygen bonds found in the inorganic compartment. Since many of these organic biopolymers are quite stable (i.e., long half-lives), the tritium tends to "hang around" for relatively long intervals. The data also suggests that tritiated organic recursers are more easily incorporated than simple HTO) into organisms, further along a food chain with several trophic levels. Thus the greater chemical stability of the tritiated organic molecules and their concentration along the food chain results in a much greater biological accumulation of tritium than one would anticipate from the oversimplified ICRP hypothesis. The incorporation of tritium into any biopolymer is clearly a function of the concentration of tritiated precursors, the rate of synthesis and the half-life of that macromolecule in vivo. In the specific case of DNA, the beta decay of tritium causes radiation damage to this biopolymer which increases its rate of synthesis, that is, the tritium has an autocatlytic effect on the synthesis of DNA. All three phenomena therefore come into play, producing a greatly increased steady-state concentration of tritiated DNA (T-DNA). In fact, several investigators have found that the incorporation of tritium into DNA was 3 or 4 times that found in the water (HTO), clearly demonstrating the importance of biological accumulation.

Microdistribution Affects Relative Biological Effectiveness

The radiotoxicity of tritium depends, in part, on its exact tissue, cellular and molecular localization. The marked differences in the radiosensitivity of various tissues has been well recognized, however, the affect of the microdistribution of the radioisotope within the cell has only recently been demonstrated. A measure of that cellular radiotoxicity is called the relative biological effectiveness (RBE) or quality factor (QF) and it may be assayed in various ways such as the inhibition of erythropoiesis, killing of oocytes or spermatogonia, frequency of dominant lethal mutations; tissue culture growth rate (e.g., HeLa Cells) inhibition, or the number of single strand breaks in DNA. It appears that the toxicity of tritium varies greatly with its molecular form, for example, the QF of tritiated DNA(T-DNA) is larger than tritiated water (HTO) or even other organic molecules (e.g. tritiated proteins or lipids). Recent studies indicate that the RBE for tritiated-DNA is closer to 4 rather than the 1.7 or 1 designated by the ICRP. The greater RBE for tritiated-DNA is consistent with the increased importance of DNA strand breaks and chromosomal structural aberrations as being primarily responsible for the mutagenic and carcinogenic effects of radiation. In addition to its well-known capacity for rupturing the DNA strand or macromolecule, there have been at least four other mechanisms identified that tend to augment its radiotoxic potential, namely, the (1) beta radiation from tritium retards the rate and efficacy of DNA repair (2) DNA may be altered so that point mutations are introduced by errors in the rapid mechanisms (3) induction of repair mechanisms (by radiation damage) may also facilitate viral transformations of the cells into abnormal or malignant forms and (4) synergistic effects due to the presence of toxic chemicals may enhance the radiotoxic effect of the decaying tritium nuclei within the DNA. Thus any calculation or estimate of the population dose resulting from exposure to tritium or tritiated water must consider both the greater concentration of tritiated DNA than was previously suspected as well as its much larger QF. These two factors alone may represent a ten-fold increase in the radiotoxicity of tritium and must be properly reflected by new government standards for the "acceptable levels of tritium" to which the public may be subjected.

Submitted by:

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16 September 1980

Nuclear Regulatory Commission
1717 H Street, N.W.
Washington, DC 20555

Dear Sirs,

In response to your request for public comment on the Draft Environmental Impact Statement for the clean-up at Three Mile Island (NUREG-0683), we are submitting the following observations and criticisms.

First, the authors of the Statement are to be commended for having included the issue of psychological stress in assessing the environmental impact of cleanup operations. It was a forward-looking step, which we hope will be emulated by the authors of other attempts to predict the impact of important social actions, for many undertakings may be desirable in themselves and yet may cause a great deal of avoidable human suffering if carried out without regard to their psychological impact.

Perhaps the fact that it was a pioneer effort accounts for the amateurish quality of the material on psychological stress. Not only is section 3.1.7 vague and inconclusive, it shows so little grasp of the issues that it appears to have been written by a well-meaning but technically untrained bureaucrat rather than by a qualified professional. Psychological stress is treated in a confused and inconsistent way, but fundamentally without understanding of the kind of concept it is. Stress is not something that exists within a person and has effects; it is not "created from anxiety" (p. 3-24, par. 2) or from anything else. Rather, it is a convenient term for a class of phenomena, just as (for example) perception is a general term for the fact that we take in sensory information and experience the world. Seeing is something studied by psychologists under the general heading of perception; by the same token, the subjective and objective effects of going through upsetting experiences are studied under the general heading of stress. It is perfectly possible to write an entire chapter for a book on <u>Stress and mental disorder</u>, as one of the major pioneers in the study of life stress, Dr. Thomas Holmes, did, without once using the word "stress." In fact, as he suggests (on p. 62 of the above-mentioned 1979 book) it is an excellent idea to avoid the use of this ambiguous term, which so readily lends itself to the reification illustrated in the above-quoted passage from p. 3-24.

On this matter of terminology, the relevant parts of the Statement have a regrettable tendency to fall into jargon instead of plain speaking. A glaring example is the constant misuse of the term "perception" for "belief." True, there is a certain precedent in psychological literature for this usage, but it is unnecessary and positively misleading, as happened here. Perceiving and believing are both subjective cognitive processes, but that's about as far as the similarity goes. More specifically, perception implies forming a subjective impression of the actual status of some aspect of reality: I perceive that this paper is white, regardless of the amount of light actually reflected from it. If I know that someone has written on it in invisible ink, I believe that it contains a concealed message but I cannot perceive that until the paper is heated.

In the particular case of radiation damage, this distinction happens to be extremely important. Someone who has had a 10 REM whole-body exposure perceives nothing, but if he is correctly informed that he has been so exposed, he may well believe not only that he has been irradiated (true) but that he has been damaged (possibly true, possibly false). Only when dosages become heavy enough to cause radiation sickness can a person perceive that he has been harmed. In section 10.6.2, perception is repeatedly misused in this way, implying to the unwary that ionizing radiation is perceptible, when part of its terrifying (or stressful, if you will) effect is that one can receive a severely life-shortening dose without any perception of that fact.

But the consistent use of this inaccurate terminology actually has a much more serious consequence; we have no way of knowing whether it was done deliberately or not. In any case, the text masquerades as scientific but lacks scientific objectivity. By blurring the distinction between false or delusional belief and realistic belief through calling both kinds "perceptions," the author(s) of these sections were able to slip over from discussing rare, pathological kinds of reactions--like delusions and phobias--into talking about normal and adaptive responses to threat such as apprehension about the possible danger from radiation, in such a way as to imply that any concern for the consequences of radiological accidents is psychopathological. Likewise, any mistrust of the NRC or Met Ed is called "phobic" without any justification (phobic means "irrationally fearful"--Wolman's Dictionary of Behavioral Science).

We want to emphasize the danger to the NRC of this kind of apparently self-serving misuse of scientific concepts. It may be temporarily reassuring to accept the purely speculative notion of R. L. Dupont that all fears of radiation are phobic, hence pathological phenomena for which you have no responsibility. True, there are always a few severely disturbed persons who have unrealistic, unjustified, even delusional fears about almost any social institution or major event; doubtless there are psychotic patients in California mental hospitals who are convinced that Love Canal is poisoning them. But it would be a great mistake to conclude that therefore all fear of toxic chemical wastes is a symptom of paranoid schizophrenia! Not only would that be fallacious scientific reasoning, it would be politically suicidal for the relevant regulatory commissions.

The NRC is in precisely the same kind of danger here, if the staff relies on "experts" who concoct such arguments as those presented in sections 3.1.7 and 10.6.2 to justify existing policies. Not only is the job poorly done and immediately seen through by anyone with independent scientific knowledge about psychological stress; it also hinders you from accurately assessing the probable psychological effects of contemplated policies.

In another way, we find the discussions in the cited sections to be remarkably deficient. Nowhere is there any mention of a central paradox of policy here: the dilemma of secrecy. Since radiation and the physical harm it does is imperceptible (and in fact imperfectly known as yet), people will not become upset (or otherwise "stressed") unless they are more or less officially informed about any release of radionuclides, or unless they have other reasons to conclude that such releases may have taken place. Therefore, anyone who stands to lose in any way if people are distressed by such information is strongly motivated to conceal or minimize it. A utility would naturally want to be quite certain that the danger was imminent or actual before giving out any information to the media about a possible release of radionuclides. On the other hand, the public has the right to know, and the right to have enough background information to be able to appraise and understand the dangers of a radiological emergency as well as to know what protective action should be taken. That implies a program of public education--since in fact the level of public information and understanding on these matters is now unsatisfactory--which could be expected to raise the level of anxiety in some persons even without any abnormal incidents at nearby nuclear plants.

In this respect, we are reminded of the controversy that has arisen about the problem of informed consent in medical research. Some scientists argue that giving people enough information so that they can fully understand the possible dangers to which they may be exposed (if, for example, a patient agrees to take an experimental drug for some disease) often upsets them and the apprehension that is caused results in more social harm than the physical side effects themselves might cause. Yet the alternative is unacceptable--putting people unwittingly into situations of danger for a presumed benefit which may be outweighed by the harm, and which not all of them would willingly risk. In a democracy, we must in general accept the risks of having an informed citizenry while trying to minimize them by using care and prudence in the way we carry out the task of public education.

In this light, the psychological aspects of the environmental impact of cleaning up after the TMI accident will differ greatly, depending on what is done about the so-far neglected problem of informing people about the dangers of ionizing radiation. The NRC must face up to the facts that many citizens in the affected area of Pennsylvania distrust the Commission and will not accept at face value information it distributes, and that this distrust is in considerable part justified. Unfortunately, the tendentious reasoning of the parts of NUREG-0683 we have studied suggests that at least the authors of this Statement have not properly heeded the lesson of TMI--the need to change of which the Kemeny Commission spoke.

Summary

The sections on psychological stress, while a good idea, are actually counterproductive because of the following flaws:

1. The concept of psychological stress is confusedly and misleadingly presented.

2. The draft misleadingly implies that the recipient can perceive radiation damage.

3. It falsely treats all concern about radiation damage as morbid or pathological, failing to note that realistic concern and apprehension is the most rational reaction to a danger of uncertain scope.

4. It shows a shocking lack of scientific objectivity. All of its distortions tend to justify NRC policy and to promote the dangerous myth that all opposition is neurotic and may be disregarded. Hence, NRC does not get a true picture of expectable psychological stress, and the public distrust will grow.

5. The people's right to know the full facts about radiation dangers outweighs the desirability of not revealing facts that might upset them.

Sincerely yours,

Leo Goldberger
Professor of Psychology

Adelbert Jenkins
Associate Professor of Psychology

Harold Sackeim
Assistant Professor of Psychology

Lloyd Silverman
Adjunct Professor of Psychology

James Uleman
Professor of Psychology

1536 16th St., N.W.
Washington, D.C. 20036

September 17, 1980

President Jimmy Carter
The White House
Washington, D.C. 20500

Dear Mr. President:

We are writing on behalf of fifteen national organizations and thirty-one Mid-Atlantic groups which are distressed about your administration's handling of the damaged Three Mile Island Nuclear power station.

As you yourself have accepted the responsibility to protect the public health and safety of the citizens in the area affected by TMI, we believe that it is incumbent upon your office to take steps to end the exclusion of the public in deciding how the radioactive decontamination of TMI-2 will proceed.

The Nuclear Regulatory Commission (NRC) has consistently and effectively precluded the public from adequate participation in the analysis, and subsequent decision making process, concerning the cleanup of TMI-2. Examples include:

1. The purchase and installation of the Epicor-II system by Metropolitan Edison before the method was approved by NRC.
2. Time constraints imposed in the decision making for the purging of krypton-85, in spite of a majority of comments opposing the purging alternative.
3. NRC's failure to follow up on its promise to form a citizen advisory committee with funding for independent scientific review.

On August 14, 1980, the NRC released a staff report entitled, "Draft 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 (NUREG-0683)".

This is perhaps the most important health and environment-related document the U.S. Government has issued about decontaminating the crippled reactor. It is essential that a sufficient period of time be permitted for both the public and independent scientists to examine and analyze the cleanup options dealing with ultimate disposal of contaminated water, decontamination of the facility, removal and disposal of the damaged core, and storage, processing, and transportation of radioactive wastes. The public comment period on this extensive draft is limited to 45 days. In our view, the comment period should be extended to a minimum of 90 days to allow the public and scientific community time to respond in a meaningful manner.

There are basic flaws in the PEIS which cannot be properly addressed through the public comment process and must, instead, be resolved through further studies by the NRC with subsequent public review and comment.

Some basic flaws in the PEIS which might require separate environmental impact statements:

1. The problem of how and where to dispose of the wastes resulting from the accident and cleanup process is inadequately considered. There is no assurance that any waste site will accept the low-level waste in the amount postulated by the NRC staff and ultimate disposal of high-level waste remains an unresolved question.

2. The NRC staff dismisses the question of whether TMI-2 will be decommissioned or prepared for restart by stating that it is not within the scope of the PEIS. In reality the methods of cleanup are very dependent on the decision to restart or to decommission the unit. Certain processes could severely damage the equipment, making the final disposition question essential in selecting the proper methods to be used. Thus the question of restart or decommissioning of the plant must be considered in depth within the PEIS.

3. There is a total lack of cost estimates in this evaluation phase of the PEIS. The NRC staff has promised that the cost factors will be provided in the final PEIS (after the period for public comment has passed). The lack of opportunity for public comment on economic aspects of the cleanup provides an example of how the public is being excluded from the decision making process. In view of the precarious financial condition of Metropolitan Edison, the NRC's assertions that costs are not a limiting factor can hardly be viewed as realistic.

4. In the PEIS the NRC makes the assumption that cesium and strontium from the planned release of processed water (which will contaminate Chesapeake Bay seafood as far south as the Potomac river) will not effect the marketability of the seafood. A separate EIS that includes market research data on radioactivity in Chesapeake Bay seafood must be performed prior to making any determinations as to the effects of radioactive contamination of Bay seafood on the seafood industry.

The Nuclear Regulatory Commission has stated that a public hearing is not anticipated and not indicated in this matter. We feel that this position is indefensible and that public hearings must be held on this in accord with the Council on Environmental Quality Regulations, which call for such hearings when there is "substantial environmental controversy concerning the proposed action or substantial interest in holding the hearing. 40 GFR § 1506.6(c)(1).

We ask that your Office of Consumer Affairs convey to the NRC the fact that it is in the public interest to extend the public comment period and hold public hearings in this matter. The hearings should be held in Harrisburg or Middletown, PA, in Baltimore, MD, and in Washington, D.C., and should be recorded and incorporated into the NRC's final evaluation of the PEIS.

We further request that funds be appropriated to enable us to hire independent scientists to review the proposed cleanup methods. This "critical review and public assessment" will assist the NRC in evaluating the safety and feasibility of the TMI-2 cleanup, and will provide for public review of this lengthy and difficult process.

Requests Outlined:

1. Meeting with you to discuss your role in protecting the public during the decontamination of TMI-2.
2. Extension of the public comment period on the PEIS to a minimum of 90 days.
3. NRC (legislative) public hearings to be held on the radioactive decontamination of TMI-2.
4. Funds allocated for independent scientists (selected by our citizens' group) to review the PEIS on TMI-2.

We look forward to your response.

Respectfully,

Steven C. Sholly

Steven C. Sholly, Director
TMI-Public Interest Resource Center
Harrisburg, PA

John Kabler

John Kabler
Maryland Ad Hoc Committee on TMI
Baltimore, MD

Richard P. Pollock (pl)

Richard P. Pollock, Director
Critical Mass Energy Project
Washington, D.C.

Betsy Taylor

Betsy Taylor, Director
Nuclear Information & Resource Service
Washington, D.C.

Representatives of the following endorsers (names attached)

cc: TMI Program Office, U.S. Nuclear Regulatory Commission

bcc: U.S. NRC Commissioners
U.S. Environmental Protection Agency
U.S. Department of Energy
Governor Dick Thornburg of Pennsylvana
Governor Harry Hughes of Maryland
Pennsylvania State Department of Environmental Resources
Maryland State Department of Natural Resources

President Carter September 17, 1980

Endorsers or the preceding letter:

Three Mile Island-Public Interest Resource Center, Harrisburg, PA
Three Mile Island - Legal Fund, Harrisburg, PA
Three Mile Island Alert, Harrisburg, PA
People Against Nuclear Energy, Middletown, PA
- vironmental Coalition on Nuclear Power, State College, PA
Anti-Nuclear Group Representing York, York, PA
Newberry Township TMI Steering Committee, Newberry Town, PA
Susquehanna Valley Alliance, Lancaster, PA

Indian Point New York Public Interest Resource Group, New York, New York
Greater New York Council on Energy, New York
General Assembly to Stop the Power Lines, Minneapolis, Minnesota
Citizens Hearings for Radiation Victims, Washington, DC

Chesapeake Bay Foundation, Annapolis, MD
Maryland Conservation Council, Maryland
Maryland Watermans Association, Annapolis, MD
Baltimore Chapter of Sierra Club, Baltimore, MD
Clean Water Action Project, Baltimore, MD
Coalition of Pennisula Organizations, Baltimore, MD
Upper Chesapeake Watershed Association, Cecil County, MD
Chesapeake Energy Alliance, Baltimore, MD
Bay Alliance for Safe Energy, Ann Arundel County, MD
Peachbottom Alliance, Hartford County, MD
Political Awareness Committee, Baltimore Friends School, Baltimore Maryland
Patuxent Alliance, Columbia, MD
Howard County Peace Action Community, Howard County, MD

Audubon Naturalist Society of the Central Atlantic States, Chevy Chase, MD
DC Public Interest Research Group, Washington, DC
Physicians for Social Responsibility, Washington, DC(chapter)
Potomac Alliance, Washington, DC
Washington, Area of Clergy and Laity Concerned, Washington, DC

Union of Concerned Scientists, Cambridge, MA
Natural Resources Defense Council, Washington, DC
Environmental Action Foundation, Washington, DC
Environmental Policy Center, Washington, DC
Friends of the Earth, Washington, DC
Citizens Energy Project, Washington, DC
Clean Water Action Project, Washington, DC
Institute for Ecological Policies, Washington, DC
Institute for Local Self-Reliance, Washington, DC
Mobilization for Survival, Washington, DC
Karen Silkwood Fund, Washington, DC and Christic Institute, Washington, DC
Washington Peace Center, Washington, DC
Women Strike For Peace, Washington, DC
Environmentalists For Full Employment, Washington, DC

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON 20426

IN REPLY REFER TO:

September 25, 1980

Mr. 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 Mr. Snyder:

I am replying to your request of August 14, 1980 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement Related to the Decontamination and Disposal of Radioactive Wastes Resulting from the 3/28/79 Accident -- Three Mile Island Nuclear Station, Unit 2 -- NRC. This Draft EIS has been reviewed by appropriate FERC staff components upon whose evaluation this response is based.

This staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involed with the proposed action. It does not appear that there would be any significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

Jack M. Heinemann
Advisor on Environmental Quality

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

REPLY TO ATTENTION OF:
NABPL-E

25 September 1980

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

Dear Mr. Snyder:

This letter is in response to your Draft Environmental Impact Statement, Docket No. 50-320, which was received in our office on 16 September 1980. Comments are directed toward the five alternatives, which are presently under consideration, for the decontamination and disposal of radio-active wastes.

This agency's areas of concern are flood control hazard potentials, permit requirements under Section 404 of the Clean Water Act, and other direct and indirect impacts on Corps of Engineers existing and/or proposed projects. In accordance with these responsibilities, our office has the following comments:

a. The Baltimore District, Corps of Engineers, maintains responsibility for certain water resource projects in the Susquehanna River basin. Presently, we do not have any projects, studies, or proposed studies in the immediate Three Mile Island area or downstream from the plant. The nearest study we have underway is for local flood protection for Harrisburg. As this is located approximately 10 miles upstream from the Three Mile Island plant, no impacts upon the local flood protection project are anticipated.

b. Another responsibility of the Baltimore District is to review the need for permits for construction projects which might affect both wetlands and navigable waters. The construction that is being proposed for the plant will not require any permits from this office. It has also been determined that proposed construction will be located above the determined flood plain levels.

The Baltimore District appreciates the opportunity to comment on your Draft Environmental Statement and if we can be of further assistance, please do not hesitate to contact us.

Sincerely yours,

WILLIAM E. TRIESCHMAN, Jr.
Chief, Planning Division

Yale University New Haven, Connecticut 06519

SCHOOL OF MEDICINE
25 Park Street
Department of Psychiatry

September 20, 1980

Gentlemen:

I am writing in response to your Draft Programmatic Environmental Impact Statement of July 1980, on the accident at Three Mile Island Nuclear Station unit two. I am concerned here only with the sections on Psychological Stress and Psychological Effects.

While those two sections contain much that is accurate, they distort the question of the psychological impact of traumatic events in several ways.

The overall emphasis on anxiety in relationship to stress, and especially on the irrational qualities of anxiety, leaves out the very important question of reasonable fear. In extensive work that I and others have done on disasters of various kinds, we have found that a certain amount of fear and tension is relatively optimal for taking constructive action in the direction of saving lives and helping people. Too much fear, or extreme anxiety, can of course be immobilizing. But the inability to experience or recognize danger—the apparent absence of fear—can be equally dangerous, and can take the form of extreme numbing and denial, and lead to highly ineffectual behavior.

In a similar way your repeated use of the term "phobia," as in such phrases as "nuclear phobia" and "phobic concerns," leads to a related distortion. Deep concern about continuing danger, or about actions that may lead to renewed danger, is associated with an irrational symptom, a "phobia." One must question this kind of association in relationship to any traumatic situation, but especially so in relationship to nuclear accidents or threats.

Where there is a question of lingering radiation effects, there is inevitably response of continuing fear. This has been true not only in Hiroshima, but also with American servicemen exposed to nuclear weapons tests, miners exposed to uranium, and ordinary people exposed to past weapons testing in Nevada and Utah. Since scientific authorities on the effects of radiation themselves disagree—and in fact there is no way of determining exact effects—we cannot label continuing fear of these effects as "irrational" or "phobic." They are in considerable degree reasonable reactions to an abnormal situation.

Finally, I would emphasize—and your report is deficient in not acknowledging this—that these reactions need not take the form of a clear-cut medical or even psychological "disease." Rather, they can express themselves in various combinations of fear-related symptoms, impaired overall function, and difficulties in human relationships. In order to make a reasonable assessment of such a traumatic situation, then, one needs to explore the full history of the trauma, and the subtle forms of disturbance that may result from it.

I hope you find these remarks of use in your deliberations on this very important question.

Yours sincerely,

Robert J. Lifton, M.D.

Robert Jay Lifton, M.D.
Foundations' Fund Research
Professor of Psychiatry

QUESTIONS ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (P[illegible]

Relating to decontamination and disposal of radioactive wastes at Three Mile Island, Unit 2.

We have the right protected by the constitution to be born and to live mentally and physically unimpaired. Neither the NRC nor any other governmenta[illegible] body has the authority to cause persons of the United States to develop fatal cancers as a result of the deliberate distribution of radiation into the environment which could otherwise be avoided and which is not related to the needs of national security.

1. The Council on Environmental Quality (CEQ) regulations to implement the national Environmental Policy Act (section 1506.6) and CEQ guidelines on Preparation of an EIS (Section 1500.7) call for hearings when there is substantial environmental controversy concerning the proposed action (draft PEIS) or substantial interest in holding the hearings.

First, please define hearings? Is this what we might call a meeting ? When are the public hearings scheduled?

2. The draft PEIS proposes separate environmental statements on issues that we have yet to encounter in the clean-up. This segmentation fails to take into account the effects on the other steps in the clean-up and the cummulative impact of the the individual clean-up steps to the environment.

Shouldn"t an Environmental Impact Statement develop a program of compatable processes to bring about the safe and expedient clean up of TMI 2.?

3. How can this be considered an Environmental Impact Statement when Appendix B, Commissions Statement of Policy, reads, "it is unrealistic to expect that the programmatic impact [illegible] will serve [illegible] a blueprint, detailing each and every step to [illegible] over the coming months and years with their likely impacts. The plan[illegible] programmatic statement inevitably will have gaps and will not be a complete guide."

4. The PEIS, if it is to operate in accordance with the purpose of the National Environmental Policy Act, will engage the public in the Commissions decision making process.

How will the public participate in this decision making ?

5. The Susquehanna River supplies domestic water to Columbia Borough, City of Lancaster, Safe Harbor Village, Holtwood Village, city of Chester, City of Baltimore, Conowingo Village, Bainbridge Naval Training Station including Port Deposit, Perry Point Veterans Hospital and Havre de Grace. Section 3-19 of draft PEIS states the Susquehanna's use as a community water supply is very limited. Please explain ?

6. The draft PEIS proposes to discharge tritium containing water and venting Krypton gas because of the renewable nature of the Susquehanna River and the regenerative powers and vast disperive capacity of the atmosphere (Section 10-27).

Is this a violation of the Clean Water Act, prohibiting discharge of radioactive wastes into navigable waters and a violation of the National Environmental Policy Act (Section 1508.7) concerning impact on the environment which results from the incremental impact of the action when added to other past, present and resonable foreseeable future actions ?

7. The Clean Water Act prohibits discharge of radioactive wastes into navigable waters causing further dilution and dispersal of radioactivity into the environment. Would any proposed dilution of radioactive processed waste (accident or clean-up) conforming tc NRC standards, discharged into the Susquehanna, violate the intent of the Clean Water Act?

Throughout the draft PEIS, dumping of processed accident and clean up water is discussed. What is the effect of tritium and other radioactive materials on the plants, fish, benthic (plants and animals at the bottom of the sea, river) orgamisms and other wild life which inhabit the down stream portions of the Susquehanna River, all of which may enter the food cha directly or indirectly ?

9. Is it true that the use of Epicor II, a system for the clean-up of radioactive contaminated waste water, has not eliminated any radionuclides from the nuclear plant site thus far? Is it true that we have tritiated water to store and extremely radioactive resin filters that cannot be trucked off the island?

10. Section 5-36 states that Epicor II spent resin filters will be immobilized with cement and packaged in 55 gallon drums. What is the condition of the filters today? Whatdoes your own report from Brookhaven say about cesium and the ability of cement to immobilize it?

11. Why does Met Ed continue to spend significant amounts of money and time constructing the Submerged Demineralizer System (SDS) when the EIS is still in a draft form? There is no reassurance this system will be approved as best to protect the environment and health and safety of the public. Will this expenditure prejudice the NRC's decision as to which alternative for clean up of highly radioactive water will be best ?

12. The public has been assured that radiation doses received during clean up operation is equivalent to or below that of a normal operating reactor. Does this include the krypton venting and the dumping of 400,000 gallons of radioactive water.?

13. Section 10-11 draft PEIS, charts health effects and offsite doses from normal plant operations. How can this chart be used with an accident situation like we have at TMI 2 ?

14. Does the NRC feel that a digging clamshell, used to gouge out and shear segments of the core is a viable alternative for reactor core removal ? Fuel rods are brittle due to accident heat levels, making krypton gas releases eminent with the destruction of the protective cladding, the metal casing.

15. Why are clean up procedures not postponed until the adoption of the final EIS? Section 1506.1 of the National Environmental Policy Act states until an agency issues a record of decision, no action concerning the proposal shall be taken which would limit the choice of reasonable alternatives. We've had the krypton gas venting, operation of Epicor II, now the construction of the SDS.

16. What storage facilities handle spent fuel? Will they handle the damaged reactor core and other highly radioactive wastes, such as Epicor II filters, or proposed SDS filters ?

17. What is to happen with reactor spent fuel? The draft PEIS, Section 3-16, discusses reprocessing of spent fuel, what is the current national policy on reprocessing? Section 3-32, draft PEIS, states processing of spent fuel is not a viable alternative.

18. Section 3-15 draft PEIS, Natural Radiation, should be interpreted to mean normal background including the effects of fallout from past nuclear weapons detonations, past accidental releases of radiation, normal operational reactor releases or radiation and releases from the entire fuel cycle. How does the Draft PEIS take into consideration the cummulative impact? National Environmental Policy Act Section 1508.7 defines cumulative impact as the impact of the environment which results from the incremental impact of the action when added to other past, present and reasonable foreseeable future actions individually minor but collectively significant action taking place over a period of time.

19. Is ionizing radiation the greatest threat to plant workers and area residents during the clean up of TMI 2? Has ionizing radiation been known to cause such human illnesses, as cancer (including lukemia), sterility, genetic mutations, birth defects, cataracts, skin lesions, loss of hair and shortened life span? The results of genetic damage is to cause birth defects in the children of parents exposed to ionizing radiation.

20. Is an Evacuation Plan a requirement for obtaining an operating license for a nuclear power plant? Do we have a working Evacuation Plan?

21. Does the normal operating license of a nuclear power plant include the use of a decontamination system, currently in use at TMI 2? Was Metropolitan Edison's license ammended?

22. Commercial nuclear power plants are not designed with special considerations for large sclae decontamination operations (Section 1-17,DPEIS) Decontamination of various types has been necessary since the 1940s(Section 1-11-1-17 dPEIS) This should be covered under safe plant operation, why is a large scale decontamination system not considered under commercial nuclear power plant licensing requirements?

Developed by the Susquehanna Valley Alliance
Box 1012 Lancaster, PA 17604
717-394-2782--Tues-Wed-Thur--10AM-1230 PM

COMMONWEALTH of VIRGINIA

Council on the Environment

J. B. JACKSON, JR.
ADMINISTRATOR

903 NINTH STREET OFFICE BUILDING
RICHMOND 23219
804 786 4500

October 1, 1980

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 Commonwealth of Virginia has completed its review of the Draft Environmental Impact Statement (Programmatic) related to decontamination and disposal of radioactive wastes resulting from the Three Mile Island accident on March 28, 1979. The Council on the Environment is responsible for coordinating the state's review of environmental impact statements and responding to appropriate federal officials on behalf of the Commonwealth. The following agencies took part in the review of this document:

Department of Health
Marine Resources Commission
State Air Pollution Control Board
State Office of Emergency and Energy Services
State Water Control Board
Virginia Institute of Marine Science.

The Commonwealth anticipates that the decontamination and disposal activities for Three Mile Island will have no adverse effects upon Virginia's resources, provided the specifications in the Programmatic Draft Environmental Impact Statement are followed and the processed water is not disposed of by release into the Susquehanna River.

The release of processed water into the Susquehanna River would, if pursued, pose some questions that merit further discussion. The Virginia Institute of Marine Science has addressed some of the questions in the attached comments; the Commonwealth will want additional review of the matter if this alternative is chosen. Similarly, the Commonwealth reserves the right of further comment if the preferred transportation route for

low-level wates goes through Virginia to South Carolina (pages 3-28, 3-32) instead of north and west to Hanford, Washington as is now contemplated.

Thank you for the opportunity to review this document.

Sincerely,

J. B. Jackson, Jr.

JBJr:CHE:pw

CC: The Honorable Maurice B. Rowe, Secretary of Commerce and Resources
Dr. Paul L. Zubkoff, Virginia Institute of Marine Resources
Mr. Raymond E. Bowles, State Water Control Board
Mr. A. C. McNeer, Department of Health

COMMONWEALTH of VIRGINIA

STATE WATER CONTROL BOARD
2111 Hamilton Street

R. V. Davis
Executive Secretary

Post Office Box 11143
Richmond, Virginia 23230
(804) 257-0056

September 24, 1980

Mr. Charles H. Ellis, III
Environmental Impact Statement Coordinator
Governor's Council on the Environment
903 Ninth Street Office Building
Richmond, Virginia 23219

Dear Charlie:

RE: DEIS-Three-Mile Island Nuclear Waste Decontamination and Disposal

We have no comment regarding the above-referenced document; however, we reserve the right to comment later should discharge to the Susquehana River become the chosen alternative for disposal of "processed water."

Thank you for the opportunity to review this document.

Very truly yours,

Raymond E. Bowles, P.E.
Director
Bureau of Surveillance
and Field Studies

:scc

cc: EIS File

8. REVIEW INSTRUCTIONS:

A) Please review the document carefully. If the proposal has been reviewed earlier (e.g., if the current document is a FINAL EIS), please consider previous comments.

B) Prepare your agency's comments in a form which would be acceptable for responding directly to a project sponsoring agency.

C) Use the space below for your comments. If additional space is needed, please attach extra sheets.

Return your comments to:

Charles H. Ellis III
Environmental Impact Statement Coordinator
Council on the Environment
903 Ninth Street Office Building
Richmond, Virginia 23219

CHARLES H. ELLIS III
ENVIRONMENTAL IMPACT STATEMENT COORDINATOR

COMMENTS

A careful review of NUREG-0683 leads us to believe that there should be no problem for Virginia from the TMI decontamination and disposal activities as stated in the EIS providing the specifications found in the document are used. Therefore, we find no basis for objection to the project proceeding as expeditiously and prudently as possible.

(SIGNED) [illegible signature]
(TITLE) Radiological Health Spe., Bureau of Radiological Health
(AGENCY) Virginia State Department of Health

CHARTERED 1693
COLLEGE OF WILLIAM AND MARY
VIRGINIA INSTITUTE OF MARINE SCIENCE
SCHOOL OF MARINE SCIENCE

Department of Environmental Physiology

Gloucester Point, Virginia 23062 Phone (804) 642-2111

September 30, 1980

Mr. Charles H. Ellis, III
Environmental Impact Statement Coordinator
Council on the Environment
903 Ninth Street Office Building
Richmond, Virginia 23219

Dear Mr. Ellis:

Enclosed are the comments of the Virginia Institute of Marine Science on the Draft Programmatic EIS related to clean-up of TMI-2 (NUREG-0683). Since speaking to you on the telephone, we have reinterpreted Figure 3.1-5 to indicate that the intakes to TMI-1 and TMI-2 are on the Center Channel and the combined 2 unit discharge is into the Center Channel. The comments of the enclosed text take this reconsideration into account.

If I may be of further assistance, please feel free to call upon me.

Sincerely,

Paul L. Zubkoff

Paul L. Zubkoff, Ph.D.
Senior Marine Scientist

PLZ:lj

Enclosure

Draft 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. 50-530 July 1980

Comments by Paul L. Zubkoff, Ph.D.
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062
804/642-2111 X133

The following comment is addressed to the discussion of treatment of processed water (pages 5-6 and 5-7). Processed water which may potentially enter the Chesapeake Bay via discharge into the Susquehenna by controlled or accidental means is discussed in 6.3.5.4, Postulated Accidental Effects (6.26-6.30).

In the discussion, 2 scenarios are identified for the potential of the sump containing 500,000 gallons of radionuclide (^{3}H, ^{137}Cs, ^{134}Cs, ^{90}Sr and ^{89}Sr) contaminated water:

1. Controlled release of plant effluents into the Susquehenna River at (30 gpm - 1800 gph) which is the equivalent of release for 277.78 hours (Table 6.3-16)
2. Accidental release of entire sump effluent over a two-hour period (Table 6.3-17)

Either scenario estimates a 1000 fold immediate dilution of the 500,000 gallon with 4.5×10^{6} gpm river flow rate. Under either of the above conditions, dilution of the radionuclide-contaminated sump water will be effectively diluted upon further flow down the river.

The discussion also mentions adsorption by suspended particles (especially in the freshwaters for ^{137}Cs) and the possibility of trapping particles behind the dams (Safe Harbor Dam, Holton Dam and Conowingo Dam), the escape of particles in the freshwater flow, the entry into the Chesapeake Bay, and the subsequent entry into the food chain (water-food chain-fish or water-food chain-shellfish). The assumptions of 1% equilibrium of the water-food chain-shellfish are introduced and the following reasonable concentrations factors between fish or shellfish are used:

^{3}H	1:1
^{137}Cs, ^{134}Cs	3000:1
^{90}Sr, ^{89}Sr	500:1

Under the above conditions, the effects of either controlled release or accidental release are of the same order of magnitude (Table 6.3.18). The effect to biota in the lower Susquehenna under such levels ultimately reached is minimal from technical considerations.

The above conditions also provide further estimates of radionuclide concentrations in fish of the Chesapeake Bay (Table 6.3-20). The effects associated with fishes of the Chesapeake Bay are approximately 0.1% of those associated with fishes of the Susquehenna (Table 6.3-18), and are also negligible.

Comments

1. With reference to Figures 3.1-5 and 3.1-6, the assumption of river flow (10,000 cfs≅4.5x10^{6} gpm) has been stated. Does this figure relate to the flow of the Susquehenna through the Center Channel or West Channel or over the York Haven Dam. Figure 3.1-7 refers to minimum flow of 10,000 cfs at Harrisburg, Pa.
2. The mention of particle absorption of radionuclides and the subsequent trapping of particles behind dams has been discussed. What proportion of the release of radionuclides would be expected to be absorbed to particles during the time of release from the Three Mile Island-2 discharge canal into the Center Channel and passage over York Haven, Safe Harbor, and Holtwood Dams and what proportion of released radionuclides would be expected to be trapped behind Conowingo Dam?
3. The assumption of dilution and flow are based upon the 500,000 gpm value. However, the flow through the Susquehenna and the Center and West Channels is probably variable. The conditions to be addressed are the minimum flow conditions and normal flow conditions through Center Channel. The conditions utilized are not explicitly indicated for this critical first-phase dilution.
4. As has been shown elsewhere (Eaton et al., 1980), particles originating in the Susquehenna River basin reach as far into the Chesapeake as 100 Km below the Conowingo Dam. The time of transport is unknown, although the distribution of particles is seasonally (stream-flow) dependent. The duration of radionuclides in the water column is not clearly estimated, nor the amount adsorbed to particles and released under other conditions estimated, nor the cycling of radionuclide adsorption and resuspension addressed.
5. The question of radionuclides and other contaminants in the TMI-2 sump needs further clarification. If the sump also contains detergents, oils, greases and chelators used in clean-up operations, the assumptions of radionuclide - mineral absorption and ion-exchange may easily break-down because of interferring substances (Appendix G, this report). The radionuclides and their matrix should be better identified in order to effectively test the models proposed concerning radionuclide release to and recycling within the environment.

Eaton, A., V. Gross, M. G. Gross. 1980. Estuar. Coast Marine Sci. 10:75-83.

6. With respect to the conclusions listed on pages 6-30, the following changes are in order because the questions of time scale and recycling are not resolved:

1. Susquehenna River and Upper Chesapeake Bay sediments would remain contaminated with low, but measureable, levels of ^{137}Cs after either controlled or accidental discharges. This might be a source of continuing public concern since radioactivity might be detectable in the sediments for *decades* after the releases are completed; however, it would pose very small hazzards to man or other organisms. [There are presently ^{137}Cs residuals in the sediments of the lower Susquehenna either from fallout in the 1950's, associated with Peach Bottom discharges, or some other unknown source].
2. Low but detectable levels of ^{137}Cs from TMI-2 might persist in some fish of the upper bay dependent upon the form of radionuclides and other substances such as chelators present in the releases of processed water. [The time is not indicated in the calculations and remains in doubt until the question of cycling of radionuclides is addressed.]
3. At the postulated radionuclide concentrations, radiation effects on fish, shellfish and other biota in the Susquehenna River and Chesapeake Bay would be minimal and have no impact on aquatic populations or on man.

Paul L. Zubkoff

341 N. West End Ave.
Lancaster Pa 17603
Sept. 29, 1980

U.S. Nuclear Regulatory Commission

Enclosed please find my personal comments to you on NUREG 0683. While availing myself of the right to comment, I wish to protest to the Commission the ineffectiveness of this type of procedure.

I have been present at hearings, have written letters, have read documents and so on since the Three Mile Island accident occurred. Other than giving those who are concerned a chance to ineffectively "blow off steam" these procedures have no relevance to your decision making process. Our comments are not of any visible importance. The questions we raise are never answered, and they are left hanging in some never-never land.

This is understandable in the sense that you are more expert in the field than the general public. It is not understandable when your actions limit my constitutional rights , when your decision makes my life less important than another citizen's.

I do not think that any of you intended this accident to be a lesson in civil disobedience. You did not intend that public comment proved to those who commented that their views were to be ignored. You did not intend to convince the public that regulatory agencies make decisions based on the interests of those pressure groups with whom they work. You did not intend to be a violator of t public good.

I heard the Chairman of NRC tell a house Committee last May you do not know what to do with the demand of the public to be involved. I agree, you do not know how to handle it. What we are learning is to distrust our government, to move away instead of reforming the process, and to realize that we can not afford to have our day in court or in an administrative hearing.

No country based on the rule of law and the consent of the governed can long abide with such a situation.

Sincerely yours
Walden S Randall
Walden S Randall

341 North West End Ave.
Lancaster Pa.17603
Sept. 30, 1980

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Subject: Draft EIS on TMI July 1980 NUREG 0683
Docket No. 50-320
Public Comment

Gentlemen:

The following are comments on the draft EIS on TMI. Overall, the long complex document is very disappointing. On most of the issues which directly affect those of us who live near the accident site, determinations are put off, incomplete, cannot be presently solved in a satisfactory manner or are unknown. The conclusion after reading it must be that the NRC intends to treat the cleanup as only slightly more involved than previous accidents, to utilize past methods of decontamination although the scale is vastly larger and longer and to ignore their own conclusion that the island is completely inappropriate as a waste site, even a temporary one. There is no attached estimate of costs, which ignores the crucial point: is this method of electrical generation for commercial purposes rational? The potential health effects are segmented into unrelated pieces, so as to minimize their effects when truly estimated over an area's total impact. Lastly, a refusal to deal with the re-opening of Unit One as related, and the question of the goal: decomissioning or restart, makes the document pointless and appear to be one long exercise in regulatory obstruction.

Specifics:

1. Although continually the document states that the site is not appropriate for a waste site, it will continue to be one for an unknown amount of time.
Example: p. 3-32 Sec 3.2.3. , p. 2-2 Sec 2.0 among others too numerous to quote.

The NRC has continued to operate these plants without a solution to the waste issue. According to this document it will now operate a temporary waste facility in violation of its own regulations. This site contains, and will contain in ever-increasing amounts as the resins accumulate from EPICOR I, II and the SDS systems unique medium level and high level waste which cannot be accepted by any dump now operable.

On p. 2-17 Sec 2.2.3. the special nature of the wastes is noted and we who live near it are told:

" special measures may have to be taken"

what measures? when? under what guidelines? to where? who pays for it?

p.2-14 Sec 2.2.2.:

"...it was never anticipated that such wastes would be created. Accordingly, the wastes resulting from TMI-2 cleanup will have to be reviewed on a case-by-case basis..."

and how will we who live under their threat respond? do we review each case? how will we know what is going on? if the decisions are being influenced by cost considerations, how can that be stopped

If the NRC feels that this type of proposal is a full environmental impact statement of how to clean up Three Mile Island, I am appalled. What we are being asked to accept is a blind faith judgement that someday in the future, someone will decide on a case by case basis what to do with the waste. Trust them.

2. While we are waiting for this decision and the money to finance it and a location to which to take it, the resins, to pick one issue as an example, will be stored on the island, in the current desilting basin region. p. 10-19,20, Sec. 10.5

The document then discusses a PMF or probable maximum flood, determined in some unspecified way but assumedly from the Agnes storm of 1972. A description of the casing of the containers, lids etc. ensu with estimates of how deep the water will be and for how long. It is confidently concluded that leakage is not possible in any major way because:

"... the PMF would top the station dike for only four days..."
p.10-20 Sec. 10.5.3.

and

"...There is no driving force for release of radionuclides except diffusion in water, and that would begin only when a continuous water path were available..."
p. 10-20 Sec. 10.5.3.

For the NRC to base its storage planning on a theoretical projection that any flood in the Susquahanna River will only cover the resins for four days is incomprehensible. To then state that the only way leakage will occur is if they are wrong, and a bigger flood happens and provides the "continuous water path" boggles the mind. If NRC has assurances from the forces which determine weather cycles that no bigger flood will occur between now and when the wastes are stored in a "permanent deep geologic repository", they should so document. All available data from other sources such as the National Flood Insurance Program is exactly contrary. The Susquahanna River is projected to be subject to greater and increasing flooding problems in the future, due to increases in impermeable surfaces such as parking area construction due to greater developmental density in the region. Lancaster County has numerous watershed studies underway now to diminish the flooding problems already related to growth. If it is not true that the river's flooding problems are on the increase, then why did the Pennsylvania State Legislature pass last session Act 282 specifically demanding each county develop storm water management regulations to deal with the issue? Are they to be designated as "phobic", or unduly concerned with the "what ifs" instead of the realities of a situation, as the document refers to those who continue to show signs of stress related to cleanup?

To store wastes of this nature at this site at all involves jeopardizing the safety of the largest fresh water estuary on the Eastern seaboard. It is unconscionable, and should be rejected by the Commission outright. Unfortunately, due to previous grievous errors in judgement by the same Commission, they are between the devil and a hard place. They have developed this industry without planning for the waste. They have no where to put it. This EIS now documents this for all time if that were really needed.

3. Cumulative health effects. Because of two factors, there is no easily comprehensible way to deal with this data as presented in the EIS. All the numbers are projections, not measurements, and these are currently under challenge by the Heidelberg Report and other studies, as well as serious questions about the "safety" of the current standards. Funding for research is so poor that health data on the effects of tritium, for one, do not exist. Constant demands for more research on low level radiation by such people as Dr. Arthur C. Upton of National Cancer Institute have fallen on a deaf Congress, pressured by the nuclear lobby to proceed with the business of profitable operation. In the EIS, the definition of "natural background" clearly reveals the shabby state of

affairs.

> " 'Natural Background' should be interpreted to mean normal Background, including the effects of fallout from past nucl. weapons detonations and the nuclear fuel cycle.."
>
> p. 3-15 Sec. 3.1.4.3.

To begin one's measurements of health effects in an already "dirty" system by stating that "dirty" is clean stretches the mind's credulity. Would it not be more valid to assume the approach that BECAUSE irreversible damage had already been done, MORE care and smaller increments are needed to be deposited into the environment? The EIS looks at each proposed increase in environmental load separately, one at a time: speaks of its compliance with the standard as if there was no contaminated bottom line but a bald slate. Ignored are other sources of pollution, other radiation producers such as hospitals, other plants and facilities on the same river. The fact is stated that the river is already out of compliance with safety standards in iron and sulfur content frequently: how does C134& C137 bind to these constituents? Why does the NRC believe it operates in a vacuum: that the same individual down river whose syst is already insulted by a variety of other burdens can without effect absorb more? Based on what thirty year data are such estimates being made? Where are these "funny numbers" coming from? Some disintereste qualified academic center with independent funding or Argonne Laboratories?

The fragile agreement reached by the City of Lancaster with NR. is shredded by an infinity of "if approved" phrases concerning the eventual disposal of the partially filtered water into the river. We will rapidly be drinking huge amounts of Tritium, and other isotopes or pay for our own replacement sources. Chesapeake Bay will be the cesspool of the cleanup by regulation.

This EIS is a depressing illegal parody of the intention of the law which required its development. It is to be hoped it will be summarily rejected by the NRC, and those who developed it removed f: the staff. If it is accepted, let the Commission members know that the families of those who live near this plant will someday ca them to account for their actions.

Sincerely yours

Walden S. Randall

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
JOHN FITCH PLAZA, P. O. BOX 1390, TRENTON, N. J. 08625

October 9, 1980

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: Draft Programmatic EIS Related to Decontamination and Disposal of Radioactive Wastes Resulting from March 28, 1979, Accident
Three Mile Island Nuclear Station, Unit 2

Dear Mr. Snyder:

The above noted Draft Programmatic Environmental Impact Statement has been reviewed by the Department of Environmental Protection's Bureau of Radiation Protection. As a result of this review, the Department does not have any specific comments. However, we do wish to express our appreciation to the Nuclear Regulatory Commission for the opportunity to review this document.

Sincerely,

Lawrence Schmidt, Chief
Office of Environmental Review

New Jersey Is An Equal Opportunity Employer

Oct. 10,1980

Samuel J. Chilik, Secty. of the Commission
Docketing and Service Branch
Nuclear Regulatory Commission
Washington, D. C. 20555

RE: Comments on: Draft-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 Aug.14/80

Dear Sirs:

It seems futile for the NRC staff to attempt to give costs or human exposure to radioactive materials to be cleaned up at Three Mile Island Nuclear Station Unit 2, when there is no designated repository for those materials. Since the Federal Government has NO permanent disposal site, you do not know how long the materials must be kept in temporary storage, what the transportation costs in the future will be, or how long the exposure to workers/public from temporary storage will be, and so cannot have either a figure on either the human health costs or the monetary costs. With permanent inflation in the U.S., the future costs must also include this inflationary factor per year added into cost of clean-up and temporary storage, until a final repository and/or disposal of the materials is found.

A. E. Wasserbach
Box 2308 W. Saug. Rd.
Saugerties, N.Y.12477

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

REGION THREE
31 Hopkins Plaza
Baltimore, Maryland

October 9, 1980
IN REPLY REFER TO:
HDE-03

Mr. 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 Mr. Snyder:

Because of time constraints, our Headquarters has requested that the FHWA Regional Office provide comments on the Draft Environmental Impact Statement related to decontamination and disposal of radioactive wastes from Three Mile Island Nuclear Station, Unit 2 (Docket No. 50-320) directly to your office.

Our review concentrated in particular on the transportation aspects of the proposed action and our comments are as follows:

1. Page 9-17, it is indicated that three to six transport accidents can occur for the range of shipments from TMI-2. It would appear this estimate is based on gross statistics for the trucking industry as a whole and does not take into account difference between intrastate and interstate operations which have different regulatory requirements, nor does it recognize different levels of driver training for the various classification of haulers. Since the transportation of radioactive material is very heavily regulated compared to other industries, we believe the potential number of accidents may be substantially overestimated.

2. From our review of this document, we did not note any discussion of regulatory requirements or proposed control strategies to be employed in order to minimize the risks associated with the transportation of the TMI waste material. A worse case scenario of radioactive material release and contamination (pg. 9-18 and 9-19) without a presentation of proposed mitigation measures to limit exposure does not provide a very objective analysis.

- more -

We appreciate the opportunity to review this Draft. Please advise if we can provide additional information or if there are any questions concerning our comments.

Sincerely,

George R. Turner, Jr.
Deputy Regional Federal Highway Administrator

Mr. Bernard J. Snyder Oct. 13, 1980
Program Director
TMI Program Office
Office of Nuclear Reactor Regulation

Dear Mr. Snyder: Thank you and Mr. Denton for the PEIS for TMI. Reading it over I see where ion-exchange resins are used in the water clean-up. I would make the suggestion that you people try (on a lab scale) a material having the ability to remove cations and anions from plating rinse waters, for example. This material is Insoluble Starch Xanthate (ISX). This material is cheaper than resins and is not made from petroleum derivatives. It can also be made on site by the user. It can be obtained from several commercial suppliers or the U.S.D.A. Northern Regional Laboratory in Peoria, Ill. in sample amounts.

I am strongly in favor of nuclear power generation and wish your agency the best of success! Respectfully

Leo L. Navickis

P.S. Please let me know if you do try this mat'l.

LEO L. NAVICKIS
1501 GARDNER LN. #81
PEORIA HTS., ILL. 61614

414 Belvedere Rd.
Harrisburg, Pa. 17109
October 3, 1980

Dear Sir,

I am a resident of Harrisburg and live twelve miles from Three Mile Island. I am very concerned about the clean up procedures and possible reopening of Unit I.

I feel that every step of the clean up of the Unit II reactor should be very closely supervised by the Nuclear Regulatory Commission and the Environmental Protection Agency. The public has lost all faith in Met. Ed.'s ability to be responsible for our safety. I feel the clean up of Unit II is a situation in which the federal government should step in and help supply the funds necessary to ensure the safest clean up possible. No price can be put on the mental and physical wellbeing of human beings.

The psychological trauma of the accident, venting, and future clean up activities is immeasurable. I personally have been under much stress over the past seventeen months. I fear something worse might happen or else in ten or twenty years we will discover that all the reassurances of no danger to our health were unfounded. This is the first time a major clean up operation of this scale has been necessary so some risk is involved. My husband and I are moving thirty miles further from Three Mile Island. Hopefully this will be far enough away, but I understand that there is no monitoring of low level

radiation further away than fifteen miles from Three Mile Island. Please keep us aware of any new clean up procedures or problems. Not knowing what is being done is very hard to cope with.

I am definately opposed to releasing any water into the Susquehanna River or the deep well injection method. The people of Columbia, Lancaster, and all the other areas down river from Three Mile Island have a right to safe water and fish.

I am also opposed to ever allowing Met. Ed. reopen Unit I. They have proven their ineptness in handling a nuclear reactor safely. I hope you will strongly consider the data collected by the Three Mile Island Alert including many examples of negligence and noncompliance with NRC standards. I do not want Unit I opened under another company either. We have suffered enough psychological stress and have the right to say no more. Nuclear power has no future. This accident has educated us on how foolish this source of energy is. It is no comfort to know that after thirty years, the reactors are so radioactive that they must be closed. There is also the dangerous problem of where to safely dispose of the waste. Why are the largest number of nuclear plants in the state with the largest coal deposits? (Especially when clean use of coal is possible if clean air standards are enforced.)

I am asking that you try to put yourself in the place of those who live around Three Mile Island before you make any decisions. A public vote should be carried out before the reopening of Unit I

SHOULD EVEN BE CONSIDERED. I FEEL THERE IS NO QUESTION OF WHAT THE RESULTS WOULD BE.

PLEASE DON'T LET US DOWN AND ENDANGER OUR HEALTH AND OUR FUTURE. IF YOU HAVE ANY CONSIDERATION FOR THE MENTAL AND PHYSICAL WELLBEING OF THE PEOPLE AROUND THREE MILE ISLAND, UNIT I WILL NEVER BE REOPENED. THANK YOU FOR YOUR TIME AND HOPEFULLY YOUR CONSIDERATION.

SINCERELY,

SUSAN L ROUDEBUSH

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
FOOD AND DRUG ADMINISTRATION
ROCKVILLE, MARYLAND 20857

OCT 10 1980

Mr. Harold Denton
Office of Nuclear Reactor Regulations
U.S Nuclear Regulatory Commission
Washington, D.C. 20556

Dear Mr. Denton:

The comments of the Bureau of Radiological Health on the Draft Programmatic Environmental Impact Statement for the Three Mile Island cleanup (NUREG-0683) apply only to potential radiological contamination in food pathways.

Obvioulsly, the primary food pathway would be through discharge of radiological contaminants into the Susquehanna River. We recommend that an appropriate river water and biota monitoring program be initiated to measure H-3, Sr-89, Sr-90, Cs-134 and Cs-137 downriver and even into the Chesapeake Bay. This should be coordinated by the EPA as part of their long-term State/Federal TMI environmental surveillance program. The surveillance should be carefully planned with routine sampling at predetermined sampling points principally downriver, but also a few miles upriver, on a monthly or quarterly basis. In addition to providing assurances to the public during periods when unplanned discharges are unlikely to occur, the monitoring effort would yield a reference background data base for use whenever a planned or unplanned discharge might occur.

Although accidental airborne releases (evaporation) of H-3 (as tritiated water) are quite unlikely to occur, efforts should be made (or continued) to monitor off-site tritium in air levels.

We have some question about disposition of processed (cleaned up) water from the Unit 2 containment building. In Chapter 5 of the document, several alternatives for disposition of processed water from the auxiliary and fuel handling buildings are presented, such as long-term storage in tanks on site, evaporation, chemical solidification, and discharge into the river. (See Section 5.2.2.2, pages 5-12 and 5-13.) However, when the fate of the processed water from the reactor is discussed in Chapter 6, it appears the only proposed disposition is into the center channel of the Susquehanna River. (See Section 6.3.4.1, page 6-19.) If only for academic reasons, alternatives for disposition of this water, parallel to those cited in Chapter 5, should be discussed in Chapter 6.

Sincerely yours,

John C. Villforth
Director
Bureau of Radiological Health

1 Woodthorne Ct. #5
Owings Mills, Md. 21117
Oct. 14, 1980

Dr. Bernard 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,

Please find enclosed a comment of mine on the PEIS for TMI-2, NUREG-0683.

Yours truly,

Kenneth Kay

Comments on NUREG-0683

A sizeable portion of our economy in Maryland is the seafood industry of the Chesapeake Bay. At the scoping hearings in Baltimore, both Daniel Beck, president of the Baltimore County Waterman's Association, and I testified that the safety of fishery products could be damaged in the public's eyes by discharge of wastewater since many people would assume the products were not safe no matter what the truth is. The PEIS sloughs this concern off by saying that "the marketability of fishery products from those bodies of water should not be adversely affected"[1] if the effects are understood by consumers. However, the PEIS in no way indicates the empirical basis for this assertion, like a marketing study, nor does it indicate how consumers will be educated. As a federal court has stated, "Where there is no reference to scientific or objective data to support conclusory statements, NEPA's full disclosure requirements have not been honored."[2] In conclusion, the "analysis" of this important issue does not fulfill NEPA requirements and you should do some kind of study to determine the real effect on the seafood market of the possible dumping of radioactive wastewater.

As I understand it, the engineering company that will do the work on the cleanup is Bechtel Corp.[3] The Bechtel Corp. last year settled a sex discrimination suit brought by a group of female employees for $1.4 million and is currently being sued by a group of black employees for racial discrimination.[4] The company has a policy that female attorneys will not be allowed in Arab states, where Bechtel has a number of projects.[5] In 1976, the Justice Department charged that Bectel had, since 1971, conspired to boycott companies and individuals blacklisted by Arab nations.[6] This boycott was especially aimed at Jews. In January 1977, Bechtel agreed in principle to a consent agreement on the suit. Caspar Weinberger, chief counsel of Bechtel, lists his Episcopalian affiliation on his biographical information to reassure clients who may think that he is Jewish.[7] These facts raise the possibility that a company which may discriminate against women, blacks and Jews is being inserted in the Three Mile Island area as a large employer. The possible effect of this on the employment and social structures should be analyzed in the impact statement.

FOOTNOTES

1 PEIS, p. S-11

2 NRDC v. Grant, 355 F. Supp. 280 (E.D.N.C. 1973)

3 The American Lawyer, October, 1980, "Mixed Results for Weinberger at Bechtel", p. 20

4 Ibid., p.13

5 Ibid., p. 20

6 Ibid.

7 Ibid.

THE Maryland Watermen's Association INC.
48 Maryland Avenue, Annapolis, Md. 21401 • (301) 268-7722 • 268-7723 • 269-6622

October 2, 1980

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:

Enclosed are comments from our organization that I understand will be made part of the public record on the Draft Programmatic Environmental Impact Statement (NUREG-0683).

I cannot stress enough the fact that the Susquehanna River and Chesapeake Bay must be protected throughout the entire clean-up process. Avoiding any further accidental or planned environmental degradation and stress to these natural resources is something we must do not only for the hundreds of thousands of people who depend on them for their livelihood, but for the entire population related to and linked to these resources in any number of ways.

As I understand it, the Commissioners of NRC will ultimately decide what methods of decontamination and disposal is used. When will this decision be made?

Also, I would like a list of the Commissioners.

Sincerely,

Debby George

Debby George
Administrative Director

THE Maryland Watermen's Association INC.
48 Maryland Avenue, Annapolis, Md. 21401 • (301) 268-7722 • 268-7723 • 269-6622

COMMENTS OF

THE MARYLAND WATERMEN'S ASSOCIATION, INC.

(PEIS), NUREG-0683
Draft Programmatic Environmental Impact Statement Related to Decontamination and Disposal of Radioactive Wastes Resulting from the March 28, 1979 Accident at Three Mile Island Nuclear Station, Unit 2

The Maryland Watermen's Association is a non-profit trade association working on behalf of all commercial fishermen in Maryland. Our organization represents 1800 individual watermen, that is, independent businessmen who have chosen as their profession harvesting various sorts of seafood from the Chesapeake Bay and delivering high quality seafood products to consumers. In addition to our 1800 individual members, we also represent 18 regional Watermen's Associations. We think you will agree that watermen have a definite vested interest in protection of the Chesapeake Bay from it's headwaters to the mouth and a definite vested interest in people's perception and opinion of the quality of the waters of the Bay and seafood harvested from it.

Having spent a good deal of time reveiwing the PEIS we must conclude that it is insufficient and damaging itself to the integrity of Chesapeake Bay seafood. This document was not submitted for the general public. It does not address concerns of the general public. It is not written and prepared in terms that laymen and laywomen or consumers or the general public or anyone other than a "scientist" can easily understand.

At least one of the reasons this is so critical is addressed -- VERY BRIEFLY -- in the PEIS itself. In the Summary at the beginning of the document, page S-11, under the heading Socioeconomic Effects, it is stated..."Potential economic impacts include the effects of increased electricity rates, reduced tourism, and possibly resistance to consumption of agricultural and fishery products that the public may think are radioactively contaminated. Families involved in agricultural production are likely to be affected to the largest degree." Further in the same section..."Low but measurable concentrations of Cs-137 would persist in sediments in both the river and the bay for some years following a discharge of water from TMI-2, but the levels would be so low as to have no radiation effects on aquatic species or on man. If these effects are understood by consumers, the marketability of fishery products from those bodies of water should not be adversely affected. It is therefore important that the public be properly informed if and when such releases occur." (end quote from PEIS) As to the statement that if the effects of the clean-up are properly understood the marketing of seafood products should not be adversely affected,we must go back to our comment on the PEIS itself. This is not an example of properly informing the public of effects.

The marketing of seafood products of the Bay, and indeed of the entire nation, is a long time goal we are just now catching up on. Potential damage that exists from this situation could be just tremendously damaging to our overall goals and to the economy of our state. This is not even addressed in the PEIS.

We need to have more public participation in this process. Now. Even if it means slowing down the overall clean-up process slightly. We are not saying the clean-up process should be slowed excessively, but we do need to "properly inform the public." We need a Citizen's Advisory Council on this one, respected and recognized citizen's representatives need to be <u>involved</u> in <u>every step</u> that occurs in the clean-up process.

It was stated by Dr. Bernard Snyder of the TMI Program Office that 25 public meetings had been held to explain and receive comments on the PEIS and alternatives discussed in it and that he felt this was "quite sufficient".[1] We do not feel 25 meeting of this type are sufficient to properly inform the public of what is being done about clean-up of the TMI accident.

At the Annapolis, Maryland September 30, public meeting Dr. Snyder stated rather emphatically several times that the release of processed water from TMI into the Susquehanna River was only an alternative, that the NRC was definitely open to other alternatives; that it was a "very bad assumption" to think the water would definitely go down the Susquehanna However, all throughout the PEIS and during presentation of NRC Staff at the public meeting we were able to attend, continually the alternative of dumping into the Susquehanna and dilution into the Chesapeake Bay comes up as the favored method of disposal and it is very evident that most of the energy invested into these alternatives focused on the Susquehanna dumping method. We must consider this "dumping" and we can not condone, support, understand or lend credulence to this as a viable solution. The Upper Chesapeake Bay fisheries are in a critical condition.

(1) Public Meeting sponsored by MD. Department of Natural Resources and Nuclear Regulatory Commission, Annapolis, Maryland, Sept. 30, 1980

The Maryland Department of Natural Resources, Tidal Fisheries Division recently concluded a survey of the population of shad in the Upper Bay. The concluded there were only between 2400 and 7500 fish (shad) present in the entire Upper Bay. 2400 - 7500! For some time now various finfish have not been reproducing in the Chesapeake Bay. The only answer to this, so far, the Maryland Department of Natural Resources has been able to discover is that "there is something wrong with the water."[2] Suppose those "low but measurable" quantities of Cs-137 were to persist in the bodies of those 2400-7500 finfish that are in the Bay now? We cannot condone anything so potentially dangerous to the presently (undeclared) endangered species of the Chesapeake Bay.

The final concern we will voice here is there appears to be some consternation and indeed disagreement within the scientific community over some of the data that is the basis of the conclusions in this PEIS. This must be resolved. Because of this, we must agree with the Maryland Ad-Hoc Committee on TMI, that an <u>independent</u> group of scientists needs to be appointed to either further study the processes the EIS uses or confirm the validity of the concepts used and conclusions reached. This group of independent scientists needs to be selected by the citizen's group we mentioned earlier or another <u>citizens</u> group.

(2) Quote from W.R. Carter, Maryland Dept. Natural Resources, Tidal Fisheries Division at a meeting of the Maryland Watermen's Assn., Inc. Board of Directors; September 5, 1980

October 14, 1980
Lancaster, PA.
31

Att. Mr. John Aherne

Dear Mr. Aherne,

I am writing to express my concerns about TMI. I am absolutely opposed to the re-start of Unit I. I do not want low-level or high activity waste stored on the island for any amount of time. The conditions of the place are so unstable, I don't see how you and the other commissioners could justify either of these actions.

Please be assured that we the people do not want any of the "treated" water dumped into our drinking water — the river is dirty now with fecal matter, iron deposits, releases from Peach Bottom, etc. We don't want the waste from TMI added to what we already have.

I never want to see TMI opened as a nuclear facility.

Please see that my statements are documented, along with the many you will receive from the citizens of this area.

Thank You.

Mrs. Brenda A. Witmer
1570 Ridgeview Ave.
Lancaster, PA 17603

Oct 11 1980

M I Lewis
6504 Bradford T
Phila., Pa
19149

Chairman Carnesale

Sec. Samuel Chilk

U S N R C

Wash., D C 20555

Sirs:

Please Find enclosed my comments on the Programmatic Environmental Impact Statement for the Clean-up for Three Mile Island #2. To say that the P E I S is deficient is an understatement. To say that the N R C has been negligent in its duty to protect the health and safety of the public is now merely an obvious cliche.

I will attempt to communicate my disgust at subterfuge and inadequecies of the P E I S by this:

The PEIS makes no bones about a "few" deaths from the cleanup. I sincerely hope that those "few" deaths refferred to in the PEIS, by some stroke of chance, are those of the N R C Commissioners.

Marvin I. Lewis

Marvin I. Lewis

TABLE OF CONTENTS COMMENTS OF PEIS TMI#2

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There is a principle taught at many engineering schools, which states that, where calculations are used in a report, there should be some means to recheck the calculations. This recheck of calculations can be accomplished by several means. The actual calculations can be put in the report; the technical explanations for the derivation of the numbers can be given; or a reference containing the explanation of the calculations can be included.

I have read the PEIs draft. Numbers seem to jump out with little or no explanation of their derivation or origin. I read most of the references in the report. Again, there was little or no clue as to the actual calculation of the volume and Curie numbers. For instance, the numbers 5.2.4. to 5.[illegible].5.[illegible]. are clear examples. This particular example is repeated in chapters 6,7,8 and 9. The Table 5.2-4 upon which most of the following material is based refers to "basedon experience with more complex operation". The references on Page 5-22 are no more helpful. Since there apparently was no way to determine the numbers in that table 5.2-4- from the information in the PEIS, I went to the NUREG 0591, with various assumptions, I could get just about any number I wanted out of these documents.

All this points out that the calculations in the PEIS may as well have come out of the air. There is no way to check them. There is no way to duplicate them from the information in the PEIs. There is no way to find out how they were developed from the references. There is no way to independently ascertain their worth or lack of worth.

This same criticism carries thru for similar paragraphs in Chapters 6, 7, 8 and 9.

This same criticism seems proper for every number in this report, and the only reason that I am not extending this criticism to every number in the report, is that I have only checked these chapters 5,6,7, 8 and 9, which I mention above.

There is not one word in the PEIS as to how a crash of an aircraft would or would not affect the cleanup. This is a gross omission.

This is a gross omission which the [illegible] at this plant. ECNP raised the question of an airplane crash at TMI #2 in the operating license hearings. The Aircraft Crash Contention has still not been resolved, and is in continuing litigation before the ASLB, in the the matter of an Operating License. The aircraft crash hazard has not been investigated in this PEIS as part of the clean-up. An aircraft crash can affect the safety of the clean-up at TMI #2. It must be addressed in this PEIS.

[illegible] errors seem to abound in the nuclear industry but especially at T M I #2.

A case in point is opening a door. There is an air lock at TMI #2 which made the national news. An air lock is merely an entryway that is built in the form of a double entry closet. Most often an air lock is used to isolate atmosphere on one side of the lock from atmosphere on the other side of the lock. Therefore, air locks are sealed to air.

Normally, air locks take no more than a few minutes to negotiate. The air lock at TMI #2 took about 6 weeks to enter after the first try.

This excessive time is most important. TMI is not a normal reactor. There will be excessive times, exposures, and unexpected occurrences. Some rule of thumb is needed to determine how much emphasis should be given to the fact that this is an extremely damaged reactor.

This air lock is a perfect example from which to generate a rule of thumb.

Normally, it takes only a few seconds to negotiate an air-lock. A literature search of time-study manuals yielded no data on times required to negotiate air locks.

Ten minutes is a very comfortable amount of time to negotiate an air lock. However, this air lock took 6 weeks after the first attempt. We can, thereby, develop a rule of thumb, for what this reactor will require is what a normal would require.

Rule: What takes less than 10 minutes in a normally undamaged reactor can take 6 weeks at TMI #2.

10 minutes is to 6 weeks
10 minutes is to 6x7x24x60 minutes
10 minutes is to 60480 minutes
10: 60480
10: 6x 10

This rule of thumb can be extended to all circumstances and operations at T M I #2.

Apparently the NRC used a maximum ratio of 10 for its comparison of best versus worst case. This is used for volumes and dosage in the PEIS. From the historical example cited above, a ratio of one to 6 x 10 is appropriate. Justification for the comparison of worst case versus best case numbers are not given in the Chapters 6, 7, 8 or 9 for volumes nor in any of the Chapters for the dosages. My suggested ratio has the force of history behind it. The PEIS must be rewritten using my more defensible ratio, 1: $6x\ 10^4$. It is derived empirically from historical fact.

There is a very grave omission in this report. The TMI #1 restart hearings are proceeding along at this very minute. There is a possibility that TMI #1 will be operating during a period or part of the cleanup. This could be the part of the cleanup which is most dangerous, which would be the time during which the damaged fuel is being removed in my professional opinion as a metallurgical engineer. There is no guarantee that T M I #2 will not be subjected to another accident on the island during the cleanup. This "other incident" could be the TMI #2 scenario occurring at T M I #1. The PEIS must look into the ramifications of a TMI #2 accident at TMI #1 during the cleanup of TMI #2.

Some indication of the frequency of TMI #2 accidents can be found in Glasstone and Jordan <u>Nuclear Power and its Environmental effects</u>, chapter 4, "It occurred once in approximately 800 years of reactor operation".

If the dangers are significantly increased, during the time of cleanup, there should be a prohibition against reactor operation during the cleanup.

At a minimum, information must be developed and placed in the PEIS of cleaning up a damaged reactor near an operating reactor. This will include interactions in the case of an accident at TMI #2 during cleanup and TMI #1 during start up and full power operation with special emphasis on the TMI #2 scenario.

Several Court cases require that cumulative impacts be included. That means that the cumulative impacts of T M I #1 operation and accidents on the clean up of T M I #2 be included in the PEIS.

Further, some e tim te of the increased off side dangers and comparison with the dangers spelled out in the Rasmussen Reactor Safety Study as far as magnitude of danger for a single nuclear disaster musb be answered and how the water supply will be affected and apportioned during an accident of crises.

Will there be sufficient water for TMI #2 cleanup at all times as well as an accident condition at TMI #1. No mention of adequacy of water supply under all conditions seems to be addressed in this PEIS. There were not the design water supply conditions in the PSAR. This change of water design conditions require at least a technical specification change and preferably an evaluation to be included in the P E I S.

This PEIS is a mystery wrapped in an enigma. Most criteria and parameters needed to write anddevelop a report of this type are just unknowns.

Page S-1 "The precise condition of the reactor core or reactor building is not known."

"The disposition o f the facility -- whether to decommission or restore it to a condition acceptable for licensed operation--, is not within the scope of this PEIS."

These are the very criteria which are most necessary.

The Reasons for Cleanup Page S-3 state,"The cleanup operations will remove sources of radiation exposure that currently pose risks to the health and safety to the station workers and those members of the community residing in nearby communities." Unless there is some indication of what the criteria is that the cleanup is striving to achieve , there will be much that has to be redone which will increase exposures.

Examples are many: Broken items , which are not radioactive, need not be removed for mothballing. They must be removed or replaced for restart. Much piping , which got radioactive during the accident, may have to be replaced for restart. These pipes need not be excised for mothballing if they are not too badly contaminated. Much electrical wiring would have to be torn out and replaced for restart, but would not need to be touched for decontamination preparatory to decommissioning.

The following table might help compare the differences in the problems of restart versus decontamination for decommissioning.

	Problems Associated with Decommissioning	Restart
Complexity	Medium	Very high
Dosages , person-rem	High	Very high
Volumes of waste	Very high	High

The point of this table is to show that the problems for decommissioning and the problems for restart are not the same. If you don't know which one you are going to tackle , you get into having to handle the worst problems from both. This is sure to increase dosages , dangers of accidents, andcosts.

I conclude this Introduction andGeneral Comments with a few contemporary and timely issues.
Chairman Aherne told a Congressional Panel chaired by Representative Eckhardt (D Texas) that the shoddy craftmanship that forced the NRC to halt work on one nuclear power plant and fine anther another$100,000 may be common.(Sept. 24,80 Phila Bulletin.)
The plant that the NRC recently stopped work on is the South Texas Project. Work and Marble Hill was temporarily suspended for similar reasons , but recently resumed.
This is the same kind of workmanship that we will face at TMI. No matter hew well intentioned the NRC may or may not be , there is no way to overcome shoddy licensee add contractor craftmanship. I submit tht not only are no solutions to this problem of shoddy craftmanship provided in the PEIS; but also , this problem of shoddy craftmanship is not addressed in the PEIS where it must be so addressed.

Poor performance must be known ad addressed in the PEIS How deficient performance will affect the reactor must be known for at least the following areas of concern:
1. Health and safety of the public
2. Dosages received by workers and public
3. Record keeping for quality assurance purposes
4. and maneuvers to overcome the effects of poor performance on the health and safety of the public.
Improper practices may increase the chances of an accident.
This brings us to the topic of anOn Site Emergency Preparedness Program in the event of an accident. The site will have increased numbers of workers on it due to the ongoing TMI#1 restart program and the TMI#2 Cleanup. Traffic is also hampered by a wire fence separating #1 from #2.
On Sept 24 , 80 , I received aletter from Robert W Reid NRC, to Robert C Arnold, Met, Ed., stating,"Additional information and committments are required before we can conclude that your Onsite Emergency Preparedness Prgram meets the evaluation criteria of NUREG 0654."
Yet Page 4-3 alludes to the Emergency Plan as if it were complete and in working order. The Emergency Plan connot be considered accpptable until all parts are demonstrated as effective and in-place for both reactors.

In a letter dated March 20 , 1980. Gus Spaeth of the Executive Office of the President , Council on Environmental Quality, states in this letter to Chairman Aherne,"The discussion in these statements of potential accidents and their environmental impacts was found to be largely perfunctory, remarkably standardized, anduninformative to the public."
This tradition , described by Gus Spaeth,is continued in the PEIS. The accident scenario'sand descriptions are"largely perfunctory, remarkably standardized and uninformative to the public." This tradition does not inspire public confidence.
This letter has several attachments all describing the past deficiencies of EIS's as far as accident scenario's and descriptions.
I would also direct the staff to Jordan and Glasstone's latest book Nuclear Power and its Environmental Effects andRichard Webb's Accident Hazards of Nuclear Power Plants. The description of accidents in these two books should be emulated by the staff in the preparation of all EIS's.
Finally, a word about the future. The cleanup will generate great quantities of waste. These wastes will have to be disposed of in ourlifetimes. We have no right to foist this problem on future generations. No human being has a right to damn his or her progeny to safeguarding this generation's deadly garbage for all eternity.
Therfore, we must know what we will eventually do with all these wastes. Presently , there are a few badly overloaded low level waste sites which have been closed to TMI wastes in the past and may again be closed to TMI wastes in the near future.
Not only are there no high level waste sites in existence in the USA ;but also the Courts have ordered the NRC into investigating the question of whether there will ever be high level wastes sites of any kind, anywhere. (Docket PR 50,51)

These questions are not addressed in the PEIS except for transportation accidents on the way to non-existent waste sites.
This treatment is not adequate or proper. The question of where and when these wastes will finally be put to permanent and peacefully uninterrupted rest must be answered. Met Ed , NRC and the State of Pennsylvania have no right to endanger its own residents and the populace of other states with radioactive wastes until and unless the question of ultimate disposal of these wastes is settled.

COMMENTS ON SPECIFIC ITEMS IN PEIS.

These comments are not meanto be comprehensive , definitive, or complete. They merely point out errors , omissions and unexplained coincidences. Correction of the referenced pages will not make this PEIS meet the NEPA requirements. See the Intoroduction and General Comments for guidance in meeting some of the NEPA requirements. Also see the NEPA guidelines published by the Councilon Environmental Quality and the NEPA Act itself. The guides published by the NRC for meeting NEPA guidelines have many flaws, the least of which is that the NRC guidelines attempt to meet the letter of the NEPA law without meeting the Spirit of the NEPA law.

Page xvi Glossary ; The Glossary is incomplete as far as anagrams. This makes reading very difficult. x/Q; Page 6-20 OW,MW, DW. These are just afew examples. Most can be figured out from the text . The problem is that this lack of complete glossary slows down reading and is mast annoying.

Page 1-1. "This information has been included to the extent it is presently available from the licensee." Licensee information must not be a prime mover in this PEIS. The NRC must have more and better sources of information to call . Depending upon the Licensee as the prime mover is both unfair and dangerous. The Licensee has the financial health of Metropolitan Edison as his first concern. The NRC is supposed to have the Health and Safety of the Public as its first concern. Therefore , depending upon the Licensee for information places the health and safety of the public in a secondary position to the financial health of Met.Ed.,which is contrary to NEPA law and the NRC Charter.

Page 1-6 Spells of out that some of the Aux Building water was decontaminated. However, there is very little useful data in the report from the decontamination to date. If the volumes, Curies, and other essential data were included in this report for the decontamination which has been accomplished to date , some extrapolation of this data could be used to determine the volumes, Curies, amount of waste , and dosages which could be expected from decontaminating some of the remainder of the wastes. This is especially true for Chapter 5. The wastes which have presently been decontaminated at TMI#2 have been those from the (chap 5) aux+FHB

Page 1-7 Is reference 2 available? Where? Expected costs were changed! Update is immediately needed for financial difficulties and cost [illegible]

Page 1-16. "Costs of alternative methods...." Alternative methods cannot be considered on the basis of price. There is no cost /benefit ratio until a determination is made as to whether this reactor will be returned to service or decommissioned. Then, when there is a basis for a Cost /Benefit ratio, can price be considered.

Chapter 1.5 Total and cumulative exposures are strangely missing from the comparisons in this chapter. Any comparison is useless and counterproductive without some definition of parameters , such as volumes , dosages, Curies anddescription of difficulty.

Chapter 2 Page 2-3. "If the existing condition continues (leakage of 145 gallons per day), the valves will be incapacitated within about 3 months." This appears to be a major concern that can lead to many accident conditions and scenario's with increased complexity(such as an increased leak rate as most leaks tend to do.) Some exploration of this condition is needed for completeness and hazard evaluation.

Page 2-13."No regulatory framework was developed to specifically address the types of unique wastes that have been generated at TMI#2 since it was never anticipated that such wastes would be created."

This may well be the most telling sentence in this report.

1. "No regulatory framework" Some regulatory framework must be developed and in place before any of these"unique wastes" are extracted from the reactor.

2. "It was never anticipated that such wastes would be created. " This is an untrue statement! Anti-nuclear groups and responsible government scientists have warned of the possibility andthe probability of major accidents for years. Richard Webb published The Accident Hazards of Nuclear Power in 1976. Chauncey Kepford made predictions on the NRC record long before them. Dr Johnsrud and many nuclear groups petitioned to have "Class 9" accidents included on the OL and CP hearing records at LImerick , Berwick, and several other nukes. Contrary to the NRC's statement these wastes were anticipated by everybody but the NRC, the nuclear industry and the unimformed andmisguided public.

Page 2-17"to a transuranic waste storage facility." Where is this facility? Has it contracted to take all TRU wastes? Are there any stipulations? What if Met Ed goes bankrupt and can't pay? These same questions are also appropriate for low level waste, high level waste, non-radioactive waste (below low level but not completely non-radioactive) and any other disposable materials generated on the Island.

Chapter 3-8. Papers in the Harrisburg area reported that the River has run dry for short periods in front of TMI. How does this effect the tables on Page 3-8 and the safety of cleanup with an operating nuke on the same island?

Page 3-21 "Contract with the U of P (Hospital?) for handling more complex cases." Is this the U of P in Phila.? Are there ambulances available able to handle radioactively contaminated people? Can the U of P handle contaminated People? How extensive isthis contract? 100 cases per accident ? 10/?

Page 3-24"a distrust of those responsible for these activities." This PEIS and the actions in the ensuing months have done nothing to instill trust and an awful lot to increase distrust. This sad excuse for a PEIS really is the topper. If the NRC wanted to increase the distrust people feel about it, they could not have chosen any other route which would have increased distrust more.

Page 3-28 One and a half pages of discussion and 3 undetailed maps are all the warning people are getting out of this document on the routing of all the radioactive wastes from TMI. My comment is obvious. This is insufficient treatment of "Transportation Alternatives and Routes that may Be Affected!"

Page 3-30 This map is particularly deceptive as it does not show that the route is really going thru a heavily populated urban are a.

Page 4-3 "Introduction of underborated water could result in the core becoming critical." Yet, the Licensee was unable to analyze the Boron content of this water for several weeks this summer. Apparently no attempt was made to analyze this boron content at other than the lab which was out of commission for these weeks. (NRC TMI Program Office Weekly Status Report-entire summer 1980) This action was approved by the NRC. This fiasco demonstrates the lack of concern for the health and safety of the public by both the NRC and the Licensee

Page 4-4. The sampling of primary coolant has not been 20 to 30 mrem dose per sample. Actually during the accident 2 workers were overexposed getting a sample. Thisis an example of picking and choosing statistics. Another problem is the off hand way that the NRC talks of one chance in 480 of a genetic effect or one chance in 950 of a fatal cancer.

These are real andhorrifying numbers when you are the guy dying of cancer or raising a damaged child. Further, these numbers are based on outdated information. New studies are continually showing that the dangers of low level wastes and radioactivity are highly underestimated. A projection using Bross, Stewart, and Morgans' data must be included for the cancer and genetic projections.

"The differences would not be expected to be greater than a factor of four.:" Factor of four- too high or too low. How about a clue as to what you are estimating?

"70 to 310 mrems" Where isthe natural, <u>not technologically enhanced,</u> backgriound radiation 310 mrems in the continental USA? This is confusing or misleading. I need more information totell which.

Page 5-4 Para. §.1.3.9. "<u>about</u> 136,000 person- hours." Why "about"? Don't these people punch time cards? What is the total radiation exposure todate for this work effort <u>from film badges</u>? Why is regulation mandated information so sparce and hard to get?

Para 5.1.4.1. This is a particularly erroneous paragraph. "Mixture of fission products in this surface contamination is similar to that of the water in the reactor building sump."

This could be true only by coincidence. The sump contains many materials which were loosed after separation or closing of valves to auxiliary building. Also the sump must have acted like a settling basin. There is no reason to believe that the sump and the surface contamination in the AFHB is similar to any ~~major~~ large extent.

Have the HEPA filters in the next paragraph been checked, repaired or replaced? Will they be?

Why is Reg Guide 1.140 <u>not</u> rigorously applied.? Who allowed this dispensation from the Guide? Why are guides not rigorously applied when such application gives higher doses and greater losses?

Page 5-5 Para 5.1.4.2 "Subsequent percolation through the rock." Would this be the only pathway to the river if the Island is submerged as it has been in the past? Explain with mapping.

Page 5-6 Whole body doses are not enough and are misleading. Include hand and organ doses. Include doses of overexposed workers which occured after accident.

Page 5-7 Para. 51.5.2. "wnw secter at .37 mile" Explain the "North west anomaly."

Page 5-9 "The actual dose is likely to be within the range of 500 times greater or smaller than the estimated dose ." This is an admission that any accident described in this report can be 500 times worse than what is admitted to in the report. That does not inspire confidence and trust. There must be a way to do a better PEIS.

Page 5-14 Table 5-2-3 Even if the water at TMI tests out within EPA requirements, it must not be released to the River. The people in this area have no reason to trust any govermmental or licensee numbers. Release of treated water would only exacerbate THE CONTINUING trauma.

Page 5-25 "spill prior to the accident" Was the spill reported? Was this spill radioactive? What is the history of the spill? How did it happen ? When? Why wasn't it cleaned up? Did poor housekeeping on a non-radioactive spill now increase the complexity of cleanup from the 3-28-79 accident? Is housekeeping poor on non-radioactive areas? in safety related areas? What housekeeping measures in effect to minimize dangers of fire, falls, and vermin disease to ...

Page 5-27 "estimate "CONSIDER" estimated" These estimates were made in the air. They have no basis in fact from the information presented in the report . They are indefensible. Either put a reasonable amount of inform-ation in the PEIS from which to develop these numbers, put the exact reference in the bibliography, or include some of the calculations as an addendum.

I cannot comment on these volume numbers without further information which I was not able to get out of the text or references. I have commented on this problem in my introduction and general comments.

Page 5-35 Table 5.4-3 "AFHB Solid Waste Generation for Maximum and Minimum Alternatives."

There is no justification in the table or in the references for the numbers in this table. Table 5.4-2 is just as much of an enigma. Answering a question with a question may be an excellent rhetorical device but it does not supply the needed infromation.

My comments on Chapters 5, 6,7,8,and some of 9 are essentially the same. All these chapters are deficient in justification of the numbers given for dosages, volumes, man hours. They do not base anything upon the actual historical dosages or man hours. They use ridiculously small error bands .

There are some strange coincidences that bear mentioning:

1. On Page 8-40 Table 8.4-1 PEIS

Liquids
Reactor coolant system Maximum 200,000 gallons

NuREG 0686 DEIS Primary Coolant System Chemical Decontamination At Dresden BWR. Page 4.6 "The first rinse containing about 200,000 gallons of liquid."

This coincidence of numbers is very suspicious. I wonder if this 200,000 gallons was not merely picked out of an advertising brochure for the supplier as I was told to do by phone when I CALLED.

2. There is a series of NUREGS one of which is NUREG / CR 0130 Technology , Safety and Costs of Decommissioning a reference PWR. Many of the numbers in PEIS seem to come directly out of this series. Some numbers apparently are changed by a small factor in consideration of the small difference in power between the Reference PWR and the TMI#2 rating. Otherwise the numbers ae are very similar. This might be justified except for one essential fact that the NRC seems to overlook:

The Referenced PWR in NUREG /CR 0130 is an undamaged plant. TMI#2 is a badly damaged reactor!

183 Valley Road
Etters, PA 17319
October 18, 1980

Three Mile Island Program Office
Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen?

In response to the Environmental Impact Study:

BULL!

Disrespectfully,

Jane Lee

Regional Planning Council
2225 North Charles Street Baltimore, Maryland 21218 (301) 383-5838
Milton H. Miller, Chairman C. Bowie Rose, Sr., Vice Chairman Walter J. Kowalczyk, Jr., Executive Director

Date: October 17, 1980

Mr. 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: Metropolitan Clearinghouse Review and Referral Memorandum, Project: 80-364 Draft EIS - Decontamination of Three Mile Island Nuclear Station Unit 2

Dear Mr. Snyder:

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, Harford County and Howard County.

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

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

Sincerely,

Stephanie O'Hara, Coordinator
Metropolitan Clearinghouse

Attachment

Baltimore City Anne Arundel County Baltimore County Carroll County Harford County Howard County State of Maryland

REGIONAL PLANNING COUNCIL
2225 N. Charles Street
Baltimore, Maryland 21218

R & R File No. 80-364
R P C Meeting October 17, 1980

REVIEW AND REFERRAL MEMORANDUM

PROJECT IDENTIFICATION

Jurisdiction: Baltimore Region

Project Name: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

Applicant: U.S. Nuclear Regulatory Commission

Grant Program: 05.111 EISSS EIS

Cost:

DESCRIPTION

This programmatic environmental impact statement is an overall study of the activities necessary for decontamination of the facility, defueling and disposition of the radioactive wastes which resulted from the accident on March 28, 1979 at Unit 2 of the Three Mile Island Nuclear Station. The status of the contaminated facilities has been reviewed, together with methods available to carry out cleanup operations. It is asserted that methods exist or can be modified to perform these operations with minimal releases of radioactivity to the environment.

COMMENT

The Draft Programmatic EIS for decontamination of Three Mile Island Nuclear Plant outlines the steps proposed for cleanup of the plant, and discusses the relative radiation exposure or risk for each step. The biggest impact on Maryland of the cleanup operation is the potential for flooding and accidental release during the long cleanup period, and the possible release of decontaminated water to the Susquehanna River. The NRC staff favors release of the decontaminated water to the river. The radioactive material that is removed would be shipped by truck to a nuclear waste disposal site in Washington State.

The water released to the river would be well within NRC operating standards at point of discharge and EPA drinking water standards at the point of nearest intake. The release could be completed in 1 - 3 years. Thus, the NRC sees no scientific reason why the water should not be released under a carefully controlled release rate and proper monitoring. Although they have found some technical errors in the EIS the Maryland Power Plan Siting Program agrees with this conclusion. Currently, an agreement between the NRC and Lancaster, Pennsylvania prohibits release of any water from TMI until mid 1981.

The other alternatives to release of the water to the Susquehanna River include: (1) storing it in liquid form on site; (2) releasing the water to the air through forced evaporation; and (3) solidigying the water in concrete and storing it either on or off site. Storing the water on site would make it subject to accidental leakage and unknown possibilities of flooding. Forced evaporation would create fog under certain situations, and qould limit disposal under specified meteorological conditions. Solidigying the 480,000 gallons of water in the auxiliary and fuel handling building would create 100,000 cubic feet of concrete. In addition, there are 1 million gallons of water in the reactor building. If it were solidified, the 1 million gallons of water would fill 36,000 55 gallon drums, and require at least 600 truck trips to move.

The Coastal Zone Metropolitan Advisory Board, after review of the draft EIS, recommends against release of the water to the Susquehanna River because of the possibility of bioaccumulation of radioactive material and its effects on the Susquehanna River and the Chesapeake Bay.

The Maryland Power Plant Siting Program has found that the fear of bioaccumulation levels have already been calculated in NRC determination of safe release concentrations, and calculates that slight traces of radioactivity may be distinguishable in the northern part of the Bay, but will be so small as to be indistinguishable from normal background levels from fallout and Peach Bottom Nuclear Plant.

The Regional Planning Council, after consideration of the consequences of alternative disposal options, supports the Draft EIS findings with the following conditions:

1. that cleanup of the plant proceed as rapidly as possible;
2. that contaminated water in the plant should be processed and the radioactive residue removed from the plant site and the processed water should be reused as much as possible in subsequent cleaning activities;
3. that whereas the Draft EIS identifies the potential problem of public fear of consuming fish caught in the Susquehanna River and Chesapeake Bay, it does not discuss how the problem might be addressed. The final EIS should include ways to alleviate public fears of using these waters and the NRC should consult with EPA and Maryland agencies on this problem. Since there is widespread public concern abour the safety of releasing decontaminated water to the Bay, the NRC should make a concerted effort to respond to public fears; and
4. that if the water is released, the current federal monitoring program should be expanded along the Susquehanna River and upper Chesapeake Bay to include slack-water areas, and sediment where suspended material is likely to settle, together with monitoring of fish above and below Conowingo Dam. This monitoring program should commence before an water release and continue until the end of the cleanup operation.

The attached resolution was adopted by the Regional Planning Council and is affixed as part of the Council's comments.

I HEREBY CERTIFY that at its 198th meeting, held October 17, 1980, the Regional Planning Council concurred in this Review and Referral Memorandum and incorporated it into the minutes of that meeting.

October 17, 1980
DATE

WALTER J. KOWALCZYK, JR.
Walter Kowalczyk
Executive Director

REGIONAL PLANNING COUNCIL
2225 North Charles Street
Baltimore, Maryland 21218

RESOLUTION

URGING THE OPPOSITION OF THE RELEASE OF WATER USED IN THE CLEANUP OF THE THREE MILE ISLAND NUCLEAR STATION (UNIT 2) TO THE SUSQUEHANNA RIVER.

WHEREAS, The Coastal Zone Metropolitan Advisory Board has been appointed by the Regional Planning Council to serve as their advisor on coastal zone matters; and

WHEREAS, the Coastal Zone Metropolitan Advisory Board has reviewed the Draft Programmatic Environmental Impact Statement (EIS) related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident, Three Mile Island Nuclear Station, Unit 2; and

WHEREAS, the DEIS acknowledges that radioactive tritium, strontium 90 and cesium 137, as well as other radionuclides present in the water to be released to the Susquehanna River, will be detectable in fish as far south as the Potomac River for as long as two years; and

WHEREAS, the DEIS states that these levels will have no impact on the seafood industry or public health, but does not address the concentration of these bioaccumulative radionuclides in the food chain; and

WHEREAS, the health of Maryland citizens and their economy may be endangered by the unknown effects of this bioaccumulation; and

WHEREAS, Maryland depends heavily on the Chesapeake Bay for both seafood and recreation; and

WHEREAS, the Coastal Zone Metropolitan Advisory Board, considering the above facts, has recommended that the Regional Planning Council oppose the release of water from the cleanup of the Three Mile Island Nuclear Station (Unit 2) to the Susquehanna River.

NOW, THEREFORE, BE IT RESOLVED that the Regional Planning Council opposes the release of cleanup water from the Three Mile Island Nuclear Station (Unit 2) to the Susquehanna River; and

BE IT FURTHER RESOLVED that the water should be stored or removed from the area so that it may not endanger the public health or the health of the Chesapeake Bay.

I HEREBY CERTIFY that the above Resolution was duly passed by the Regional Planning Council at its 197th meeting on October 17, 1980.

October 17, 1980
Date

WALTER J. KOWALCZYK, JR.
Walter J. Kowalczyk, Jr.
Executive Director

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

DATE: August 19, 1980

B & P Meeting: 9/5/80
R P C Meeting: 9/19/80

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

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

REGIONAL PLANNING COUNCIL
OCT 17 1980
BALTIMORE, MARYLAND

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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, Bur. of Community Hygiene

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JURISDICTION'S COMMENTS

Check One

______ This jurisdiction has no comments on this particular project.

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

______ This project raises problems concerning incompatibility with local plans, or intergovernmental, environmental or civil rights issues and a meeting with the applicant is requested (attach comments).

______ This project raises problems concerning incompatibility with local plans, or intergovernmental, environmental or civil rights issues, however, a meeting with the applicant is not requested (attach comments).

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

RETURN TO:
Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 N. Charles Street
Baltimore, Maryland 21218

Signature [signature]
Title ______
Agency ______
Date ______

Copies
Reich
Paull
Smith
McLaughlin

BCHD: Rec'd. 9/16/80
Ret'd. 9/19/80 - NCW

Date: August 19, 1980

TO: Mr. Larry Reich, Director c/o Evans Paull
Department of Planning
222 E. Saratoga Street
Baltimore, Maryland 21202

SUBJECT: PROJECT NOTIFICATION REVIEW

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

Check One

_____ This agency has no comments on this particular project.

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

_____ This project raises issues concerning incompatibility with local plans or intergovernmental problems and a meeting with the applicant is requested (Specify below).

_____ This project raises issues concerning incompatibility with local plans or intergovernmental problems, however, a meeting with the applicant is not requested (Specify below).

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

Comments ① The table on p. S-10 should be clarified - are the excess deaths & genetic effects "per 100,000 population", "per worker population", or what?
② p. S-12 We strongly recommend that the official monitoring team include the State of MD (Dept. of Health & Mental Hygiene) & the City of Balto. (Dept. of Public Works). Much of Metro Balto. increasingly relies on Susquehanna River for drinking water.

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature Donald T. Torres
Title Director Bureau of Community Hygiene
Agency Baltimore City Health Dept.

cc: Mr. Hoot
Mr. Wolinski
File

FROM: Mr. Alexander Spear
Referral Coordinator
Office of Planning & Zoning
Arundel Center
Annapolis, Maryland 21401

DATE: August 19, 1980

B & P Meeting: 9/5/80
R P C Meeting: 9/19/80

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

REGIONAL PLANNING COUNCIL
SEP 8 1980
BALTIMORE, MARYLAND

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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) W. Richardson of Civil Defense

JURISDICTION'S COMMENTS

Check One

_____ This jurisdiction has no comments on this particular project.

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

_____ This project raises problems concerning incompatibility with local plans, or intergovernmental, environmental or civil rights issues and a meeting with the applicant is requested (attach comments).

✓ This project raises problems concerning incompatibility with local plans, or intergovernmental, environmental or civil rights issues, however, a meeting with the applicant is not requested (attach comments).

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

RETURN TO:
Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 N. Charles Street
Baltimore, Maryland 21218

Signature Alexander L. Spear
Title Referral Coordinator
Agency Anne Arundel Planning & Zoning
Date Sept. 3, 1980

Date: August 19, 1980

TO: Mr. Alexander Spear
Referral Coordinator
Office of Planning and Zoning
Arundel Center
Annapolis, Maryland 21401

SUBJECT: PROJECT NOTIFICATION REVIEW

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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

Comments - Request that the Maryland State Government be allowed to have a representative on site to monitor clean-up operations and to take samples of any radioactive water which has been treated for possible future discharge into the Susquehana River.

(continued on back)

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature [signature]
Title DIRECTOR
Agency CIVIL DEFENSE

FROM: Mr. John Seyffert
Office of Planning & Zoning
County Courts Building
401 Bosley Avenue
Towson, Maryland 21204

DATE: August 19, 1980

B & P Meeting: 9/5/80
R P C Meeting: 9/19/80

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

REGIONAL PLANNING COUNCIL
SEP 19 1980
BALTIMORE, MARYLAND

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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✓ Planning
_____ Public Works
✓ Environmental Protection
_____ Human Relations
_____ Others (specify) _____

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RETURN TO:
Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 N. Charles Street
Baltimore, Maryland 21218

Signature [signature]
Title Asst. to Administrative Officer
Agency Baltimore County
Date 9/18/80

Date: August 19, 1980

TO: Mr. John Seyffert
Office of Planning and Zoning
County Courts Building
401 Bosley Avenue
Towson, Maryland 21204

SUBJECT: PROJECT NOTIFICATION REVIEW

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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Comments ___

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature [signature] JOHN D. SEYFFERT DIRECTOR OF PLANNING

Title ___

Agency ___

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

DATE: August 19, 1980

B & P Meeting: 9/5/80
R P C Meeting: 9/19/80

REGION ... AUG 25 1980 BAL...

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

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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___ Planning   ___ Public Works

___ Environmental Protection   ___ Human Relations

___ Others (specify) ___

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RETURN TO:
Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 N. Charles Street
Baltimore, Maryland 21218

Signature [signature]

Title Director

Agency Department of Planning and Development

Date August 21, 1980

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

DATE: August 19, 1980

B & P Meeting: 9/5/80
R P C Meeting: 9/19/80

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

REGIONAL PLANNING
SEP 2 1980
BALTIMORE, MARYLAND

SUBJECT: REFERRAL COORDINATOR REVIEW SUMMARY

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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____ Planning
✓ Public Works
____ Environmental Protection
____ Human Relations
____ Others (specify)____

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RETURN TO:
Coordinator, Metropolitan Clearinghouse
Regional Planning Council
2225 N. Charles Street
Baltimore, Maryland 21218

Signature Thomas G. Harris, Jr.
Title Referral Coordinator
Agency Howard County
Date 8-27-80

Date: August 19, 1980

RECEIVED
AUG 26 1980
OFFICE OF PLANNING AND ZONING
OF HOWARD COUNTY

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

SUBJECT: PROJECT NOTIFICATION REVIEW

Applicant: U.S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station, Unit 2

R & R File No.: 80-364

Comments Should be Returned By: 8/26/80

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Comments ____

RETURN TO LOCAL REFERRAL COORDINATOR NAMED ABOVE

Signature George F. Neimeyer
Title Director
Agency Department of Public Works

United States Department of the Interior

GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
P. O. Box 1107
Harrisburg, Pennsylvania 17108

October 21, 1980

Mr. Oliver Lynch, Section Leader
Environmental Review Section
TMI Program Office
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Lynch:

On, or about, September 15 last, Mr. Helm of this office spoke with you, by telephone, about statistics in the Surface Water Hydrology section (3.1.4.1.) of the recently-released NRC report "Draft Programmatic Environmental Impact Statement" on the TMI accident. Subsequent to receipt of a copy of this report from you we have reviewed section 3.1.4.1.

The following corrections and comments are submitted for your information and consideration should the NRC decide to publish corrections:

Page 3 - 6, first table:

Stream	Drainage Area, sq. miles	Average Flow, cfs
Conodoguinet Creek	506	640
Yellow Breeches Creek	219	295
Swatara Creek	571	960
Conewago Creek (West)	515	590

Page 3 - 6, second table:

Characteristics	Flow, cfs
Minimum daily flow (9-18-64)	1,700
Average annual discharge	34,500
Mean annual flood	260,000
Maximum flood of record (6-24-72)	1,020.000

Page 3 - 6, last paragraph:

For the past several years minimum releases for Raystown Dam have been 300 cfs; however, recent flows at the gage below the dam (01563200) have been as low as 200 cfs. We understand the pumped storage project for Stony Creek was suspended with the State's declaration of this creek as a "Wild River".

Page 3 - 8, fourth paragraph:

The date for the minimum observed flow at Harrisburg is September 18, 1964.

Page 3 - 8, second table:

The monthly (August - December) 100-year minimum flows reported herein appear to be in considerable error. USGS has not made a routing analysis of low flows for the lower Susquehanna River since WRI 77-12 (copy enclosed) was prepared. The simulated post-Raystown curve of Figure 19 of that report could be extrapolated to indicate the 7-day, 100-year flow (with a Raystown Dam release of 480 cfs instead of the present 300 cfs) as about 2,900 cfs. The corresponding 30-day (or October) minimum flow would be about 15 percent greater, or 3300 cfs. Minimum 100-year flows for August, September, November and December would be proportionally greater -- per the top illustration of Figure 3.1-7. The Susquehanna River Basin Commission has made additional low-flow routing analyses for the lower Susquehanna River, to which you may wish to refer.

Figure 3.1-7, bottom illustration:

The curves in this figure, particularly that for the 50-year recurrence interval, do not entirely conform to our statistical analyses of daily flows for a similar (1892-1972) period. A copy of p.283 of the report "Low-flow Characteristics of Pennsylvania Streams", which summarizes our frequency data for gage 01570500, is enclosed.

Page 3 - 12, table:

The cited source for this table -- Figure 1 of PA-77-2 (copy enclosed) -- provides data on monthly median flows, but not for average flows. A printout summary of monthly flows and a statistical summary thereof, for the 1941-70 flow records of gage 01570500, is enclosed.

Please call us if you need additional hydrologic information.

Sincerely,

Henry J. McCoy
Acting District Chief

Enclosures (4)

NOTE: Due to their length and bulk, the enclosures mentioned in this letter are not included in this appendix.

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October 20, 1980

Mr. & Mrs. Jeffrey Cope
RD 2, Box 238
Elizabethtown, PA. 1702

Dear Sir:

I am the wife of a police officer and the mother of two small children. We live five miles from the Three Mile Island Nuclear Power Plant, unfortunately.

We do not want to move. We built a nice home, our family is here, and we are not polluting the environment and causing stress to the people around us.

I resent any company, no matter what service it performs, that allows such an accident to happen and all the ramifications associated with the accident. I also resent a government who shakes its finger and tells them to be better next time. They don't deserve a next time.

The radiation that is emitted during normal operation from a nuclear plant is not particularly healthy. Not only do we have to put up with this 'safe' radiation, but we have to worry if there are going to be further occassional emissions (of course not exceeding regulations, not likely to be detrimental to health, blah, blah). Your assurances are not reassuring.

Are we supposed to thank Met Ed for being able to turn our lights on -- for giving us electric at ungodly rates -- for allowing the high amounts of radiation that were emitted into the environment and into my home at the time of the accident -- plus all the other emissions of clean-up?

Is the mental, and more important, the physical health of the residents of the area of TMI your first concern in regard to the clean-up? Your last concern? Why should we make your job easier -- we're concerned about our children's health. Are you?

Please don't allow Unit I or II to resume operation. The children of Middletown had enough radiation. Give them a chance for a happy, healthy, stress-free future. They deserve it.

Met Ed deserves nothing.

DOES ANYONE OUT THERE CARE?

-Linda Cope

Joanne Gingrich
209 5th street
Mt. Gretna, Pa., 17064

10/23/80

My fellow inhabitants,

I'm writing to you hoping that we can avoid alot of intellectual garbage (sic) and
can just get to a common sense level. Anyone who has any awareness of the nuclear sit-
uation, be it industrial or military, knows it can do no possible good when you look at
the final product - nuclear waste. Maybe to some there's a justification for this unim-
aginable stuff with the "precious" power it can produce, but to me the only precious pow-
er we all can produce is the unification of people and a learning of how to live with
less extravagance of our resources.

And that is the key word concerning nuclear waste - resources. Look around just
the area here (TMI surrounding communities) and think of the fantastic fields and streams
(not to mention the fantastic children, women and men) which are being subjected to all
of the nuclear garbage, and if it continues what good will all these things be? Who cares
if there's enough electricity if we can't grow food in our fields? What good is it if we
can't drink our water? And don't assume us common people are so ignorant not to know
that once something is contaminated there's no way they can ever be returned to the state
intended for its use.

I am just amazed at the logic of giving up the invention that got out of hand that
I can't understand how supposedly intelligent people can't see how all the evils far out-
weigh the few benefits of nuclear power. I would hope that all of the brain power would
be focusing on how to control the waste we already have accumulated, and would think that
we don't need one more ounce. Does anyone really want a dump site near their home? or
in their oceans? or in their mountains? We can't get rid of this stuff so we had better
figure out a way to control it before it takes over our lives, or just plain takes our
lives.

I hope I have opened up a space in your heads, and hearts, and that you'll consider
doing what is best for us, the people who like living here on this could-be great planet,
by not allowing any further seepage of nuclear waste into our already battered environ-
ment.

Sincerely, Joann Gingrich

Ps(Do any of those considering dumping Met-Ed's garbage into the Susquehanna River think
they want their children, or themselves, to drink it? or eat the fish they could catch,
if the fish survive it? I hope not and hope they have the sense to know no one else
wants to either. There's nothing wrong with admitting a mistake - let's shut down TMI
and get on the right track to a safe environment.) Jason Gingrich

Robert H. Gingrich

COMMISSIONERS
ROBERT C. ADAMS
PRESIDENT
ELKTON, MD.

WILLIAM C. MANLOVE
EARLEVILLE, MD.

FRANK D. RAGAN
CONOWINGO, MD.

Cecil County Commissioners

ROOM 101, COUNTY OFFICE BUILDING
ELKTON, MARYLAND 21921

TELEPHONES: 398-0200 or 658-4041
EXTENSION 100

DENNIS S. CLOWER
ATTORNEY

DAVID T. PINDER
ADMINISTRATIVE ASSISTANT
AND CLERK

TO : The Nuclear Regulatory Commission

FROM: Frank D. Ragan, Cecil County Commissioner

RE: Regarding Three Mile Island

DATE: October 27, 1980

The letter follows:

Please accept my sincere apology for being unable to attend your meeting regarding the Three Mile Island incident.

I commend the Nuclear Regulatory Commission (NRC) for the countless hours spent on this project. It has occurred to me that perhaps those persons operating the plant did not know the responsibilities that were bestowed upon them and the effect it has on the citizens.

Now, a year later, they are discussing the 'big job'--cleaning up. This job could have another enormous impact on the public just as the original problem did. I sincerely hope that all methods of clean-up have been considered by the NRC and that you use the greatest discretion in making your decision.

I am hereby requesting that the NRC refuse to reissue the license to the Three Mile Island plant and all other nuclear power plants.

Perhaps if more were known about the effects of nuclear power and the way to use it safely without endangering the land, water, and lives of the residents in our area nightmares like the Three Mile Island incident would not occur. We were lucky with the Three Mile Island incident, but what about the next time?

Is the NRC prepared to take on the responsibilities that go with nuclear power. I must remind you that the NRC sets the rules that govern the nuclear power plants, but we all must live with them.

Nuclear Regulatory Commission
October 27, 1980
Page Two

It is my opinion that the NRC shoudl hold Three Mile Island accountable for all costs of clean-up, documentation, and studies regarding the Three Mile Island incident.

Please be advised that I am also against the dumping of waste in the Susquehanna River; as it has a very large impact on the residents in the Cecil County area.

Should you have any questions, or desire any further comments, please do not hesitate to contact me.

Very truly yours,

Frank D. Ragan

Frank D. Ragan
Cecil County Commissioner

STATEMENT OF SENATOR PAUL S. SARBANES
TMI DRAFT ENVIRONMENTAL IMPACT STATEMENT
NUCLEAR REGULATORY COMMISSION PUBLIC MEETING
HAVRE DE GRACE, MARYLAND
October 29, 1980

On March 20, 1980 the Nuclear Regulatory Commission convened a public meeting in Baltimore to discuss the scope of its programmatic environmental impact statement on the cleanup of radioactive wastes at Three Mile Island. At that meeting I submitted a statement to the Commission urging that:

> no steps should be taken to release any contaminated wastes into the Susquehanna River until after the completion and review of a full Environmental Impact Statement.

It was my belief that no radioactive substances could be responsibly discharged into the environment without benefit of the detailed analysis that an environmental impact statement would provide. Now that a draft EIS has been prepared by the Commission's staff and presented to the public for review and comment, I would like to once again express my strong concerns about the cleanup process and the public's involvement in it.

Of paramount importance to Maryland citizens is the effect that cleanup operations will have upon the Susquehanna River and Chesapeake Bay. As you know, the Susquehanna River is a source of drinking water for many state residents, and the Chesapeake Bay is an invaluable seafood resource. The Commission's draft EIS explores eight alternatives for the ultimate disposal of radioactively contaminated water currently being stored at Three Mile Island. They include solidification in portland cement, long term storage on site, natural and forced evaporation and discharge into the river following treatment and dilution. Thoughtful review of these alternatives is hindered, however, by the document's failure to reveal the full cost of each. In addition, the document offers little indication of the relative merits of these options beyond the conclusion that, on balance, the benefits of a cleanup outweigh the costs of preserving the status quo. Given the as yet incomplete nature of the information available, I urge the Commission to take no action during the cleanup of Three Mile Island that may adversely affect the quality of Maryland's drinking water or threaten the vitality of its seafood industry.

A second issue that must be addressed is the nature of the public's involvement in the ongoing cleanup process. The Commission staff has estimated that the decontamination of Three Mile Island will take at least five to seven years. Given the unprecedented and highly complex nature of this undertaking, it would be unreasonable for the Commission to consider that its obligation to consult with the public can be totally fulfilled by meetings, such as this one, in the cleanup's preliminary phase. I, therefore, also urge the Commission to assure Maryland's citizens and public officials that they will be consulted prior to and be given a chance to comment upon any significant action which the Commission proposes to authorize during what apparently will be a lengthy process.

Thank you for your careful consideration of these comments.

COMMENTS PRESENTED TO THE NUCLEAR REGULATORY COMMISSION ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL STATEMENT FOR DECONTAMINATION OF THREE MILE ISLAND 2.

By Kathy Ellett, League of Women Voters of Maryland, with the concurrence of the League of Women Voters of Pennsylvania.

The League of Women Voters of Maryland has long promoted an environment that is beneficial to life. We strongly believe that governmental procedures that might affect the health and safety of our environment must always be accompanied by adequate information and subsequent public participation. This is particularly important for the Three Mile Island clean-up because of widespread public suspicion and lack of credibility of the utility and the NRC.

The League does not intend to make comments on the technical aspects of the EIS. However, we do have some concerns we would like to express:

* The clean-up process is estimated to take 5-7 years. It is an experimental process and all decisions about how to adequately decontaminate the facility and dispose of the wastes will not and cannot be made at this time. Therefore, it is extremely important that the formal public hearing process not be limited to this preliminary EIS. There should be public information and comment at all stages of the process. This is the only way the people will ever accept any exposure that proves necessary during the clean-up period. The importance of this cannot be overstated.
* We would like to express our concern about the importance of designating off-site waste disposal facilities as soon as posible. An island in the middle of the Susquehanna River is not a suitable or acceptable disposal site even on a temporary basis.
* The greatest non-occupational exposure to radiation from the clean-up process will apparently be to the people along the waste disposal transport route. ALARA procedures as well as adequate regulations

should be inplace and stringently enforced during transport of these wastes. This program should include information to local areas, provision for accident response plans, and training of drivers on emergency procedures.

* Many individuals and groups in Maryland are deeply opposed to any cl[illegible] radioactive water being eventually released into the Susquehanna River and entering the Chesapeake Bay. It is difficult for non-scientifically trained people to fully understand the risks involved in low-level exposure to radioactive compounds. The seafood Industry reported a drop in consumption of fish after the accident at Three Mile Island. There is concern that the public will respond the same way if any tritiated water, or water containing additional contaminants, is dumped into the [illegible] factor. If any way can be found to economically and technically avoid the dumping of radioactive [illegible]

Thank you for giving [illegible] our concerns.

My name is Kenneth Kay and I live in Owings Mills, Md. I have one statement with a related question to make. The PEIS does not include any economic figures. The Baltimore Sun, on October 21, 1980, said that, "It is estimated by state officials that the dockside value of the fish and shellfish extracted from the bay each year exceeds $35 million, and that the industry generates total business activity of $150 million annually."

The PEIS claims that possible dumping of radioactive wastewater should have no effect on the marketability of seafood products if the public is properly educated. I have attended meetings of this kind in Annapolis, Md., York, Lancaster and Middletown, Pa. Many of the people at these meetings read the PEIS and some, like Nancy Kelly of the Chesapeake Bay Foundation, have very well reasoned doubts about the accuracy of the document. I have yet to meet an opponent of nuclear power who has been convinced by the PEIS and the NRC briefings that dumping of the wastewater is safe. If the NRC can't convince nuclear opponents with whom it can communicate in public meetings of the safety of the water dumping, how can it convince nuclear opponents outside the affected area, with whom it has never communicated, that dumping is safe.

I cannot predict how many people will quit eating Maryland seafood if the radioactive wastewater is dumped. If there's only a drop of 2%, a conservative estimate, that will be $3 million a year. Further, it may take years to win back these consumers' confidence so that figure should at least be doubled or tripled. In fact, I believe the economic damage would be much greater. I hope you will include these figures when you calculate the economic cost/benefit relationship of various alternatives.

Finally, let me ask you one question. Will therebe an opportunity for the public to comment on the economic figures in the final EIS?

COUNTY COUNCIL

OF

HARFORD COUNTY, MARYLAND

Resolution No. 63-80

Legislative Session Day 80-29 (October 21, 1980)

Introduced by Council President Hardwicke and Council Members Risacher, Rahll, Schafer, Spry, Kreamer, and Hutchins

WHEREAS, Harford County is a member of the Coastal Zone Metropolitan Advisory Board appointed by the Regional Planning Council to serve as advisors on coastal zone matters; and

WHEREAS, the Coastal Zone Metropolitan Advisory Board has reviewed the Draft Programmatic Environmental Impact Statement (DEIS) proposed by the Nuclear Regulatory Commission relating to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident, Three Mile Island Nuclear Station, Unit 2; and

WHEREAS, the DEIS acknowledges that radioactive tritium, strontium 90 and cesium 137, as well as other radionuclides present in the water to be released into the Susquehanna River, will be detectable in fish as far south as the Potomac River for as long as two years; and

WHEREAS, the DEIS states that these levels will have no impact on the seafood industry or public health, but does not address the concentration of these bioaccumulative radionuclides in the food chain; and

WHEREAS, the health of Maryland citizens and their economy may be endangered by the unknown effects of this bio-accumulation; and

WHEREAS, Maryland depends heavily on the Chesapeake Bay for both seafood and recreation; and

WHEREAS, the Coastal Zone Metropolitan Advisory Board, considering the above facts, has recommended opposition to the release of water from the cleanup of the Three Mile Island Nuclear Station (Unit 2) into the Susquehanna River;

NOW, THEREFORE, BE IT RESOLVED by the County Council of Harford County, Maryland, that the County opposes the release of cleanup water from the Three Mile Island Nuclear Station (Unit 2) into the Susquehanna River; and

BE IT FURTHER RESOLVED that the water at Three Mile Island should be stored or removed from the area so that it may not endanger the public health or the environment on the Chesapeake Bay; and

BE IT FURTHER RESOLVED that a copy of this Resolution shall be sent to the United States Nuclear Regulatory Commission, Washington, D.C., Attention: Project Director, Three Mile Island Program Office.

Attest:

Angela Markowski
Secretary of the Council

John W. Hardwicke
President of the Council

ADOPTED: October 21, 1980

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS: G-WS/TP11
U.S. COAST GUARD
WASHINGTON, DC 20593
PHONE: 202-426-2262

28 OCT 1980

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

Dear Mr. Snyder:

This is in response to your letter of August 14, 1980 concerning a draft environmental impact statement on the decontamination and disposal of radioactive waste resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2, Docket No. 50-320.

The material submitted has been reviewed by the concerned operating administrations and staff of the Department of Transportation. The Federal Railroad Administration had the following comments to offer:

> "The document assumes that wastes will be transported by truck from TMI-2 to Hanford, Wasington. Although rail and intermodal rail-truck transportation are mentioned as possible shipment alternatives, drawbacks to using rail for shipment are noted, and truck shipment is considered to be the most likely mode of transportation for the majority of TMI-2 waste. If some use of rail or intermodal (rail-truck) transportation is contemplated, as mentioned in several places in the document, the environmental effects of these alternatives should be discussed in greater detail in the final EIS."

The Department of Transportation has no other comments nor do we have any objections to this statement. The final statement, however, should address the concerns of the Federal Railroad Administration.

The opportunity to review this draft statement is appreciated.

Sincerely,

W.R. RIEDEL
Chief, Ports and Waterways
Planning Staff

October 25, 1980

The Damn Expensive ECONOMIC SYSTEM! Where ARE We Going? 44

Sensing the unrest and concern of the citizens at the NRC-People of Middletown area meeting (Oct. 20), one wonders "Does the panel really try to understand? Do they see the agony of the people expressing their fears and concerns?" They are asking for more than professional cliches and worn-out records. If this meeting was an example of bureaucracy in action, it is no wonder that the thing malfunctioned and that creditability of Public Relations throughout the system is at such a low level.

In trying to present an answer to the understaff's reports, it is no wonder the assumptions leave so many, who attempt to express themselves effectively, feel so frustrated. There is always some arrogance amid the well-fielded (money-based) interests. Such arrogance always adds to the problem!

To the observation of some nuclear vehicles spraying (leaking) liquid on private vehicles, other nuclear vehicles speeding at 80 MPH on public highways, etc., the responses varied from "Other nuclear carriers are on the road beside those from TMI (assurance/reassuarance?)" to the old Passing The Buck syndrome (police function). One again wonders - who is responsible to whom? If equal time were spent where the action is - if families were moved to our area, the statistics might appear more relevent, the reassurances might be more reassuring.

The grafetti of documentation expense would be better applied to the determined solution, so that confidence ~~was~~ be improved and the mental stress of the public victims could be abated. The cunning diversionary hearings, where more comment is given and less public input is really heard, add to the travesty of the system. Where half-truths abound, tensions never die.

When will we - the general public - ever learn? Learn that actions speak louder than words? Letters to the elected officials are more effective than meeting with ~~arrogant~~ MISSINFORMED, subordinate "officials". Unlike October 20, November 4 was an accountable day. Did you show your concern by voting?

Sincerely,

Dan Peffley

Dan Peffley

R.D. #1 Hummelstown

P.S. Like cancer - The cause, rather than the cancer itself must be cut out, If the malay is To be controlled! Has the "anxiety-Seveso" in the greed to Sell + Promote "Better Life" Thro "Electricity-chemistry" (modern technology) gotton out of Hand? I Think so! Love Canal, N.Y. - Sevesco. ITALY - DEVILS' SWAMP, LA.! Charles City, IOWA - ELIZABETH, NJ.! HARDEMAN Co. Tenn! (T.M.I.) IRRESPONSIBLE - MISSINFOR[illegible] [illegible] BULLSHIT [illegible] SAY IT THE WAY IT IS! [illegible]

SENATE OF MARYLAND

ANNAPOLIS, MARYLAND 21401

ARTHUR H. HELTON
SIXTH DISTRICT
HARFORD COUNTY

DISTRICT OFFICE:
P. O. BOX 696
HARFORD COMMUNITY SERVICES BUILDING
ABERDEEN, MARYLAND 21001
(AC301) 273-6670 — 575-6759

October 31, 1980

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

Dear Dr. Snyder:

The Draft Programmatic Environmental Impact Statement for the Decontamination of the Three Mile Island Nuclear Station Unit 2 is now available for comment. I have had the opportunity to review this document and a host of related reports, critiques and summaries and feel very strongly that the greatest weakness of the E.I.S. is the tendancy to hedge or "best guess" some of the short and long range effects of the dumping of waste water into the Susquehanna River. The consequences of this cleanup are too critical to the Bay area and the population that resides in the area, to be left to what "may" happen if dumping is permitted in the near future.

The E.I.S. acknowledges that radioactive strontium and cesium my be detectable in fish and shellfish as far south as the Potomac River for as long as two years. It is also stated that cesium 137 will accumulate in detectable levels in the area of the Susquehanna flats near Havre De Grace. The half lives of strontium 90 and cesium 137 are 30 years and 28 years, respectively, so they will be an influence in the Bay for quite some time to come.

My reasons for opposing the dumping of the waste are not based upon misguided fear or emotional stress, but upon the inadequacies and unanswered questions not addressed in the E.I.S. Strontium and cesium are bioaccumulators which also accumulate as they move up the food chain. Food chain concentration is not addressed by the E.I.S. The Chesapeake Bay is one of the most productive bodies of water on the earth and must be protected from any degradation.

The disposition of high level wastes must also be spoken to. The resins to be used, if filtration techniques are employed, will be highly contaminated and should not be stored on the island for any prolonged period of time. The danger of flooding is great.

The transporting of waste matter across the entire length of the United States appears to be a dangerous proposition, in light of the fact that there is another alternative. I am enclosing a copy of a letter recently forwarded to President Carter from Governor Harry Hughes, formally requesting the President's intervention with the Department of Energy regarding the disposal of high and low level waste.

On behalf of my constituency residing in Harford County, and the unusual threat this nuclear accident cleanup will have on everyone living in the State of Maryland and on the Bay, I oppose without question, the dumping of waste from Three Mile Island into the Susquehanna River. The people of Pennsylvania and Maryland should be exposed to as little danger as possible and I believe the Nuclear Regulatory Commission has a clear mandate to see that the people and the Bay are so protected.

Sincerely,

ARTHUR H. HELTON
Senate of Maryland
District Six

AHH:jo

Enclosure:As stated

cc:Honorable Harry Hughes

STATE OF MARYLAND
EXECUTIVE DEPARTMENT
ANNAPOLIS, MARYLAND 21404

HARRY HUGHES
GOVERNOR

October 3, 1980

The President
The White House
Washington, D. C. 20500

Dear Mr. President:

I am writing to request your assistance in a matter of great concern to the State of Maryland. The Nuclear Regulatory Commission's draft Programmatic Environmental Impact Statement for the Three Mile Island clean-up has failed to address any alternatives which provide assurance that the radioactive wastes will be removed from the island without decades of delay. All plans addressed require that the Department of Energy first establish a storage facility or repository for commercial high level radioactive wastes and high specific activity wastes. However, the lack of progress towards establishment of such facilities over the last 25 years renders any current schedules subject to skepticism.

There is one option which can guarantee the capability for timely removal from the island of the high level wastes, transuranic wastes, and those high specific activity wastes unacceptable at existing commercial repositories. This is for DOE to accept these wastes for storage with the similar wastes that DOE now handles from the defense-related nuclear projects. Although Maryland formally suggested during the scoping process that NRC consider this alternative, it was dismissed in the draft statement with the simple declarations that DOE policy does not allow for disposal of TMI low-level wastes at government facilities, and that DOE is studying the high-level waste problems.

I am therefore requesting that you use your authority as President to direct DOE and NRC to explicitly consider the technical feasibility of this option, and to direct DOE to make an exception to its policy by accepting these TMI clean-up wastes for which there is no available off-site storage facility.

The unusual nature of the accident derived wastes is reason enough for such an exception. The recent decision by the Pennsylvania Public Utilities Commission prohibiting use of revenue from ratepayers for the TMI clean-up, has created a situation of institutional instability for the Metropolitan Edison Company. This makes it imperative to identify and confirm at this time a location to which the wastes can be removed. The clean-up activities should be planned and conducted in a manner that will insure that disposal with defense related nuclear waste remains a viable option.

The draft environmental impact statement reveals that federal agencies are following a course of action that will make Three Mile Island a long-term storage dump for radioactive waste. Nothing could be more dangerous to Chesapeake Bay and the people of Maryland. No responsible agency would locate a dump for radioactive waste on an island in a flood plain above the water supply of a major metropolitan area, and poised at the head of Chesapeake Bay. Yet, because of refusal to consider any other realistic alternative, that will be the result of actions described in the draft environmental impact statement.

Because this is an unusual situation and because of the unusual threat to people in Maryland and Chesapeake Bay, I am making this unusual request that you intervene with the Departments of Defense and Energy and insist that all of the radioactive waste be removed from Three Mile Island as quickly as safety will permit-- even if it means disposing of them for some extended period with waste from defense operations.

I would appreciate your response at your earliest convenience.

Sincerely,

Harry Hughes

Governor

Christine C. Yost
17 South Mary St.
Lancaster, Pa. 17603
October, 1980

Director, Three Mile Island Program
Nuclear Regulatory Commission
Washington, D.C. 20555

To the staff:

I attended a public meeting on the PEIS on October 6 in Lancaster. I do not feel that anyone left that auditorium feeling better or more assured than when they arrived. Questions were answered with neat quotable facts of what is known today.

Perhaps this is part of the problem. I, as part of the public, want guarantees for the future. I want to know if fifty years from now we will all be suffering from some new reaction from the radiation that we are receiving today. What is really a safe low level dosage of radiation? We were told it is not known. Then what are we doing fooling around with nuclear power with the possibilities of such deadly consequences if something goes wrong with so little knowledge. Of course that point is mute for TMI - unit 2 sits there damaged and daily poses danger to us.

One of the greatest concerns of mine, and most of the people present at that meeting, is the release of treated or diluted radiative water to the Susquehanna River. The PEIS report did not begin to answer the questions on the environmental impact on the aquatic life in the Susquehanna and the Chesapeake Bay not to mention human life. The PEIS report states "Effects on aquatic organisms in the Susquehanna River and the Chesapeake Bay is low but measurable concentration of Cs-137 would persist in sediments for some years following discharge of water." The NRC must realize that both the Susquehanna and the Chesapeake are bodies of life. Fish spawn, fish and other aquatic life live and eat there, children play, plants grow and the water is used for irrigation and drinking right here in Lancaster. How can the report say there will be so few effects when fish today can have traces of arsenic, cadium, copper, lead, chromium plus a long list of chemicals and pesticides. Will not additional concentrations like Cs-137 and tritium cause problems. Even though many of these amounts are supposidly not harmful to humans eating the fish, these substances may kill the eggs or result in deformed offspring that do not survive. Can humans who make their livelyhood in aquatic life survive a reduction in their catch?

Already we see the decline of rockfish, oysters, grasses and crabs in the Chesapeake Bay. Many of these begin their life in the mouth of the Susquehanna? The decline goes unexplained with vague references to chlorine and lists of the millions of chemicals that can find their way into the bay despite strict regulation. The Bay cannot afford any additional contamination nor can we.

How can we be told these chemicals won't have any effects on aquatic life when kepone poisoning in the James River is still taking its toll on aquatic life by remaining in the sediment. Tritium like most chemicals settles and remains in the sediment. For animals that are sediment dwellers this spells death or genetic problems. Can our sediment take any more chemicals without dangerous consequences? What happens with this sediment when the water is dredged? What new dangers could be brought in-land?

I am against the release to the river of radioactive liquids after onsite dilution and mixing in water. More questions and answers concerning our safety must be adequately addressed and answered.

None of the chemical treatments of radioactive liquids suggested remove tritium from the water. Tritium has a half-life of 12.5 years. I

am disturbed that the consequences of tritium being left in the water is not addressed further in this report. What is the effect of tritium on the plants, fish, benthic organisms and other wild life which inhabits the down-stream portions of the river all of which may enter the food chain?

With horrible incidents like Love Canal and other exposures from chemical waste dumps can anyone give me assurances that a steel container covered with cement or any other container used to hold wastes will safely contain them for many years?

TMI is on a flood plain it must not become a waste dump. When will the Epicor II treated water, compactible trash, noncompactible trash, drums of solidified chemical decontamination solution, ion-exchange resins be removed from the site? How and where will the tritium and other radioactive wastes left in the water be treated and stored?

The public has been assured that radiation doses received during clean up operation is equivalent to or below that of a normal operating reactor. Does this include the kyrpton venting and the dumping of radioactive water? If the clean up operation radiation doses will be equal to or below that of a normal operating reactor, how safe is a normal operating reactor? Also, the PEIS does not take into consideration the cumulative effect of "normal" background radiation including the effects of fallout from past nuclear weapon detonations, past accidental releases of radiation, normal operational reactor releases of radiation and releases from entire fuel cycle with the additional "non-normal" radiation of the clean up operation. Has the PEIS proposed an evacuation plan for workers and people in surrounding areas?

What does the NRC have to say about Met ED's employees for the clean up. Are clean up workers required and assigned the clean up or are volunteers chosen. Are workers given an explanation of the additional health and birth defect hazards they face. Will they be receiving extra pay?

All of us are concerned with the question of who is going to pay for this clean up. With new estimates of up to 5-7 years and over 200,000 p erson hours of labor estimated for only the reactor building cleanup the cost is enormous. Met-Ed is crying foul and proclaiming bankruptcy is near. Why then is Met-Ed spending money on an unapproved SDS system? Are stockholders receiving reduced dividends? The public is being charged in the long run with aggravation, psychological stress and higher Met-Ed bills. I do not want to see the government, state or federal, or the Met-Ed customers to foot the bill for their mismanagment and mistakes.

In the PEIS report on reasons for the cleanup the staff recommends all clean up operations must be performed to (1)"remove sources of radiation exposure that currently pose risks to health and safety of station workers and public residents nearby; (2)" to remove radiation sources in form of airborne contamination, wastewater contaminated by radioactive materials, plateout, damaged fuel; and (3)"as long as water radioactive substances allowed to occupy sumps and tanks their exists a small possibility of leakage into groundwater and subsequently into Susquehanna." To me this implies that there are real dangers that exist at TMI with the unit just sitting there. Yet, throughout the report and especially at the public meeting we are told there is no danger, that all radioactive levels are low and everything is being examined. The PEIS did not make me feel safe. The TMI -2 cleanup operation is a large operation with many people taking part . Human error seems to have played a large p art in the accident,with so many new procedures, so many unknown conditions within the reactor, so many

additional radiation exposures, and so many more wastes to dispose of , can we not feel the situation exists for another error --accident.

I want TMI cleaned up expidiously but even more importantly safely. The PEIS must address the clean up more thoroughly and answer our questions. I need to feel the NRC is out to protect all life and not out for the easiest and cheapest way to appease Met-Ed, which definitely is not concerned with life.

Thank you.

Christine C. Yost

R. D. #5
York, Pa. 17402
November 5, 1980

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, Docket No. 50-320
Draft Programmatic Environmental
Impact Statement

Dear Mr. Snyder:

The best interests of the public would be served by decontaminating Unit 2 just to the point of allowing core removal. Unit 2 can be sealed after the fuel has been removed.

This solution to the problem of TMI Unit 2 is the most environmentally and economically sound way to do it.

By creating a minimum of additional radioactive waste used in the cleanup and much less highly concentrated radioactive waste, the problem of shipping this radioactive waste will be greatly reduced and the release of radioactive particulates to the atmosphere will also be greatly reduced.

When the unit is sealed there will be no further disturbance.

There is only one reason why you would want to completely decontaminate Unit 2 and at the same time not make a firm commitment to decommission it. That reason is so that you will be able to put Unit 2 back into operation regardless of cost. You know that and I know that. As much as the Environmental Impact Statement tries to avoid that fact and proclaim that the disposition of Unit 2 is not within the scope of the PEIS, no one is being fooled.

I hope these opinions and comments that you ask for are given more consideration than they were the last time.

Sincerely,

George A. Herman

George A. Herman

cc: Three Mile Island Alert
cc: Council on Environmental Quality
cc: Congressman Allen E. Ertel
cc: Congressman Bill Goodling

Nov. 6 - 1980

Dr. Snyder

I represent the Cecil-Harford County Watermens Assoc. I attended the public meeting at Havre De Grace on Oct 29, with an open mind to the problem at TMI. After leaving the meeting that night I had the feeling that the method to dispose of the zeolite treated contaminated water is going to be to dump it to the Susquehanna River. The slide that was shown in dark blue, beginning below Conowingo and going to the mouth of the Sassafras River encompasses the area of our concern. I do not have the education or knowledge to discuss the degree of contamination of this water. I do know however that the publicity that will occur when this water is dumped will mean the end of a now growing and lucrative seafood harvesting business at the head of the Chesapeake Bay. The live eel business is probably the largest of all. This product is shipped to Japan, Germany, France, Italy and many other foreign markets. When a house wife in any of these countries reads in her news paper that TMI water was dumped into the Chesapeake Bay from whence she buys her eel, she will scratch that from her shopping list.

I would ask you to consider the evaporation and rain alternative with the sludges disposed of at the Salem I site or push the DOE to make use of its facilities which are much closer than the state of Washington.

Hopefully you will not dump water to the Susquehanna River. If you feel that you must, when you open that valve remember you will be ending a way of life that has existed for 300 years and is now beginning to hold more promise than has been seen since the late 1940's.

The two county watermens organization I represent has a combined membership of 112 people, this is only a small fraction of the working watermen further down the Bay from us, who are as greatly concerned as we about what comes down the river which supplies more than half of the Chesapeake's fresh water.

I thank you for your consideration

Frank W. Pratt Sr.
Pres: Cecil-Harford County Watermens Assoc.

304 S. West Street
P. O. Box 225
Carlisle, PA 17013

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Gentlemen:

We live only 20 miles from Three Mile Island - as the crow flies, or as the wind blows, and we submit that Cumberland County should be included in the area designated as one which could be affected by the clean-up of the damaged reactor on TMI.

The fact that NO LOCALITY wants nuclear waste transported on its highways or railways should be an indication of the seriousness of the problem of nuclear waste disposal.

WE BELIEVE THAT, SECOND ONLY TO SAFETY, NUCLEAR WASTE DISPOSAL IS THE MOST PRESSING PROBLEM FACING THE NUCLEAR INDUSTRY - AND THAT THEREFORE ALL PRESENT NUCLEAR POWER INSTALLATIONS SHOULD BE PHASED OUT, AND NO NEW ONES CONSTRUCTED.

Our most immediate concern is, of course, Three Mile Island. When and if the damaged reactor is ever cleaned up, we are absolutely opposed to its ever again being put into operation. Furthermore, we recommend that the undamaged reactor be put out of use also. Let the whole island be "cleaned up" so that there will be no leakage into the Susquehanna river which has enough problems without radioactive water and/or any nuclear waste being dumped into it.

Sincerely yours,
Kathryn F. Brougher
(Mrs. John F. Brougher)

John F Brougher
John F. Brougher

Copies to:
Council on Environmental Quality
Congressman Allen E. Ertel
Congressman Bill Goodling
Three Mile Island Alert

Met-Ed / GPU

Metropolitan Edison Company
Post Office Box 480
Middletown, Pennsylvania 17057
717 944-4041

Writer's Direct Dial Number

TMI Program Office
Attn: Dr. B. J. Snyder, Program Director
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Programmatic Environmental Impact Statement

In response to your letter of August 14, 1980, General Public Utilities has made an extensive review of the draft Programmatic Environmental Impact Statement (PEIS) relating to the decontamination and disposal of radioactive waste resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2 (NUREG-0683), and is pleased to submit its comments on the report.

Detailed comments on the PEIS are provided in Attachments A, B, and C. Attachment A provides specific comments on sections of the report. Attachment B provides suggested modifications to the text of the report to reflect the comments. Suggested revisions are identified by line markings in the margins. Attachment C is a preliminary revised schedule for TMI-2 decontamination and fuel removal and a preliminary assessment of additional costs recognizing the progress to date and the impact of regulatory and financial constraints that are anticipated to exist throughout the duration of the effort. While we have made our best judgment for developing estimates of the schedule and costs, we believe these estimates are still subject to substantial variability because of the many uncertainties that still exist about technical, regulatory and financial factors.

In addition to our detailed comments, we have a number of broader comments on the PEIS and its use. These are presented in the following paragraphs.

Overall

The cleanup of TMI-2 is a difficult task, and we realize its importance to the health and safety of all concerned. We also recognize the importance of the PEIS which evaluates the overall TMI-2 cleanup and its impact on the environment. In this respect, we believe the PEIS, if properly modified during its finalization, will fulfill the need for demonstrating the

environmental acceptability of those actions required for the cleanup where evaluation shows that the environmental consequences of the action fall within the bounds described in the PEIS and thus are acceptable for accomplishment.

We think it should be a source of considerable reassurance to everyone that the analyses conducted to support the draft PEIS clearly indicate the cleanup can be conducted with negligible releases to the environment and consequently less radiation exposure to the public than would occur from normal plant operations. When the potential social and economic impacts on the public are also considered, the draft PEIS demonstrates that the interests of the public and of the workers are best served by conducting the cleanup expeditiously. We believe this result should be a major influence in determining the processes used in providing approval for cleanup activities.

It is essential that all of the agencies involved not be diverted from completing the cleanup and the removal of the core by unnecessary preoccupation with matters which have little, if any, capability to improve the reliability of performance of the cleanup, which are unnecessary, and which will delay cleanup. We believe the regulatory interface associated with cleanup activities can be properly conducted in the required careful manner in accordance with existing regulations and Commission procedures, specifically including 10 CFR 20, and that additional special requirements are not necessary. Specifically, proposed additional specifications R.1.3 (1), (2) and (3) set forth in Appendix R of the PEIS are unnecessary in view of the existing requirements repeated in proposed specifications R.1.3 (4), (5) and (6) and with the imposition of proposed specifications R.2.3 (1) and (2).

We also believe that unnecessary special requirements for cleanup of TMI-2 would be a disservice to the public in that they would reinforce beliefs and allegations that existing Commission regulations are deficient in areas where they are not. Even indirect Commission support for such a position is harmful and tends to divert public, Commission and industry effort from more useful tasks.

Acceptable Alternatives

The PEIS clearly indicates that releases to the environment and potential health effects to the public from required cleanup activities are negligible. The PEIS also lists a number of alternative approaches to various cleanup actions. In a few cases, it states that certain alternatives are unacceptable. The PEIS is, however, in GPU's opinion, seriously flawed in that it does not state whether any of the various alternatives are acceptable. To fulfill its basic purpose, the PEIS should clearly state the environmental acceptability of the alternatives considered so as to provide a framework within which future activities can be judged. Such a statement of acceptability would not, of course, relieve the NRC staff of their responsibility for determining that the releases and public impact of licensee proposals are, in fact, consistent with those evaluated as acceptable in the PEIS and with other established requirements such as ALARA.

Timeliness

In February, 1980, the NRC established a Special Task Force on Three Mile Island Cleanup. It was chaired by Mr. Norman M. Haller. A portion of the cover letter to Mr. Haller's report to Mr. William J. Dircks reads as follows:

> "The main thrust of our findings and recommendations is that prompt action is needed by NRC to restore forward motion of the Three Mile Island cleanup process. During our meetings with NRC staff, licensee management and Pennsylvania State officials, we observed frustration with the pace of the cleanup, the lack of criteria, the tedious decision process, and the erosion of what once was a high priority program. We have not observed strong initiatives to change these conditions."

Unfortunately, while certain actions have been taken, such as establishment of interim criteria for radiological effluents from TMI-2 for application by the Deputy Program Manager, TMI Program Office and the Director, Nuclear Reactor Regulations, the situation is not much different, and in some respects worse, than it was at the time of Mr. Haller's report.

To establish a proper basis for future action, the PEIS should recognize the risk of deleterious impacts on health and safety of the public and the workers due to delay and should contain a clear, definitive statement affirming the importance of expeditiously proceeding with the cleanup. Such a clear expression of how the public interest will be best served is, we believe, fully consistent with the objectives of the PEIS.

We recognize, as we believe NRC does also, that resolution of the financial situation in a timely manner is also required to permit proceeding with expeditious cleanup.

Waste Issues

The draft PEIS does not adequately address disposal of wastes arising from TMI-2 cleanup operations. The PEIS should address alternatives to disposal of wastes which, for whatever reason, can not be disposed of via shallow land burial. It should clearly indicate that 1) properly designed on-site storage is acceptable for an interim period until ultimate disposal is determined and the criteria applicable to such interim storage facilities should be set forth; 2) leaving the radioactive material in its present dispersed and mobile form is unacceptable; and 3) resolution of off-site disposal questions need not and should not be a prerequisite to proceeding with on-site cleanup activities.

Criteria

The draft PEIS, in Section 1.6, discusses regulatory requirements, other constraints, and future criteria generally as they apply to environmental

and on-site radiological issues. As regards environmental release criteria, this section is generally adequate but does not state that meeting the defined criteria (i.e., 10 CFR 50 Appendix I) is sufficient. Such a statement should be added.

Safety criteria for design, construction and conduct of operations at TMI-2 are not addressed adequately in the draft PEIS. The criteria remain ill-defined. Experience indicates that continual widely varying interpretations are made of what criteria are and are not applicable to these activities. To fulfill its purpose and preclude future problems, the PEIS should result in a clear definition that existing operating plant safety criteria, properly applied in consideration of the short term nature of many of the recovery activities, are adequate for design, construction and conduct of operations activities at TMI-2. Whether such a statement is made in the PEIS or separately is matter for decision by the NRC. GPU considers that such a clear articulation of requirements will go far to eliminate confusion and delay that has resulted in the past.

Unnecessarily Restrictive Sequence of Events

The draft PEIS is unnecessarily restrictive in prescribing a very specific sequence of events based on conservative preliminary estimates of radiation levels in the reactor building. It is our recommendation that the PEIS not constrain the sequence of events. The sequence should be determined by actual reactor building radiation levels, data from trial use of decontamination methods, and the merits of various alternatives. The PEIS should permit other alternative sequences and establish acceptable criteria for making the selection of sequences. This process would reflect the realities of a complex program and can be done consistent with the PEIS objective of defining the environmental consequences of the overall program.

Off-Site Shipment of Contaminated Liquids and EPICOR-2 Unsolidified Ion Exchange Material

The draft PEIS precludes the shipment of contaminated liquids offsite and mentions that EPICOR-2 expended ion exchange material must be immobilized per the NRC order permitting operation of the EPICOR-2 system. It should be noted in the PEIS that small quantities of contaminated liquid such as reactor coolant system and auxiliary building water samples are and will continue to be shipped off site. Also, it has been proposed that dewatered EPICOR-2 expended ion exchange material be shipped off site for laboratory examination.

The acceptability of such shipments off site for analytical and research/development purposes should be specifically affirmed in the PEIS.

We appreciate the opportunity to comment on the draft PEIS and will be pleased to discuss our comments with you at your convenience.

Sincerely,

G. K. Hovey
Vice-President and Director, TMI-2

cc: J. T. Collins

ATTACHMENT A

Summary

1. Section S.3 - It is stated that no liquids that are currently contaminated or become contaminated during cleanup will be shipped offsite in liquid form. Presently we ship liquid samples offsite for analysis of reactor coolant activity, and for other Research and Development purposes.

2. Section S.3 - The feasible variations to ion-exchange systems for treating radioactive liquids should include Epicor II and the Submerged Demineralizer System (SDS).

3. Section S.4 - We suggest the conclusions in the summary Section S.4 be presented in the first two pages of the report. This will provide the reader an immediate response as to the expected impacts from the decontamination of TMI-2.

4. Section S.4 - In discussing the occupational and offsite doses, comparison should be made not only to naturally occuring sources, but also to exposure from medical sources.

5. Section S.4 - This section states that leakage of all the reactor building sump water to the river would not cause a significant hazard, however, in the event this did happen, NRC suggest installing a grout curtain. This is a massive project considering the minimal consequences of such an accidental spill. Cost of alternative methods should be available as a basis for selection versus environmental impact.

6. General - The PEIS summary section should recognize the risk of deleterious impacts on health and safety of the public and the workers due to delay and should contain a clear, definitive statement affirming the importance of expeditiously proceeding with the cleanup. Such a clear expression of how the public interest will be best served is, we believe, fully consistent with the objectives of the PEIS.

CHAPTER 1

INTRODUCTION

1. Section 1.2 - Last paragraph on Page 1-3 should be updated to describe conditions observed in recent containment entries.

2. Section 1.3 - First paragraph requires updating to the lastest released cost estimate and schedule.

3. Section 1.4 - The PEIS should be modified to make it clear that the NRC does not necessarily agree with the public concern as stated in the tabulation. For example, we disagree that cost of alternative methods should not be a consideration. Cost always has to be a consideration and must be considered with other factors.

4. Section 1.5.1 - Requires updating to describe recent containment entries.

5. Section 1.6.1.2 - The 10 Ci/ft^3 loading for organic resins should not be used as a limiting factor, however, it is not expected that organic resins will be loaded beyond this limit.

6. Section 1.6.1.2 - Proposed 10CFR Parts 60 and 61 are proposed regulations and should be treated as such.

7. Section 1.6.2.2 - Change Permit 2275214 to 2275724, with amendments; change January 19, 1986 to December 31, 1986; change December 12, 1981 to December 31, 1981.

8. Section 1.6.3 - There appears to be a printing error in the text (top of page 1-26).

9. Section 1.6.3.2 - The criteria stating that doses from the previous year must be added to those estimated for a new activity is too restrictive. The new activity doses should be added to previous doses to make up a total 1 year dose, not 1 year plus the new activity.

10. Section 1.6.3.2 - The PEIS proposes modification to the Technical Specifications to request the licensee to calculate potential offsite doses for each step of the recovery process.

Since the draft PEIS concludes that the "health effects over the period from the on-set of the accident through completion of the cleanup operation will be non-existent," it does not appear to be a useful utilization of the licensee's engineering staff nor

the NRC staff to generate and review thousands of calculations of insignificant off-site radiation effects. Perhaps the NRC can offer some better guidelines for the calculation of radiation hazard to make the exercise useful, yet minimize the need for excessive useless calculations.

11. Table 1.6-1 - Table title should mention this applies for unrestricted access.

12. Fig. 1.2-1 - There is only a partial shield on one D-ring over the pressurizer.

13. Fig. 1.2-2 - Requires updating.

14. Fig. 1.3-1 - Requires updating.

CHAPTER 2

MAJOR DECONTAMINATION AND WASTE DISPOSAL ALTERNATIVES

1. Section 2.1.1.2 - The decay heat valves are opened. Therefore the electric motor operability is less important, however the ability to operate these valves is still a desirable operational feature. To say that the valves must remain operative in order to maintain safe cooling is wrong. Safe cooling can be maintained without an operational mini decay heat removal system (MDHRS).

2. Section 2.1.2.1 - Methods for treating sump water addressed in 6.3 includes a method (direct solidifcation) that does not involve "processing the water to remove dissolved radionuclide ions."

3. Section 2.1.2.2 - Requires updating based on recent containment entries.

4. Section 2.1.3.3 - Direct solidification of reactor coolant system (RCS) inventory should be included as an option (See Appendix G, Section G.2.2).

5. Section 2.2.1 - There is no mention of strategic nuclear material (SNM) in this section with regard to waste forms. Guidance is needed as to what concentrations of uranium & plutonium in wastes is classified as SNM and therefore needs to be disposed of in a facility with an active SNM license.

6. Section 2.2.1.2 - The Accident Water paragraph is misleading. The reactor building sump water and RCS are not unique because they contain sodium, boron, colloids, sludge and solids. These were all present in the auxiliary and fuel handling building (AFHB) water. The sump and RCS are more complex due to the higher radionuclide concentration.

7. Section 2.2.1.4 - Disposal of Kr-85 from the reactor coolant system should be considered here.

8. Section 2.2.2 - The standards applied to unique wastes are not given in this section. The NRC should commit to establishing criteria as soon as the waste forms are identified. Based on the extensive study contained in the PEIS on waste forms (Chapters 5,6,7 & 8) the NRC should be developing some criteria now. To the extent possible, the case-by-case approach should be avoided by establishing special categorization in the PEIS and assessing the impact of intermediate depth burial or other options.

9. Section 2.2.3 - Definition of "conditioning". The word "immobilization" is used where "solidification" is meant. This is important because solidification will not necessarily immobilize to a greater extent that mere capture on ion exchange media.

10. Section 2.2.3.1 - This section should discuss vitrification and the use of metal low specific activity (LSA) boxes.

11. Section 2.2.3.1 - The "onsite storage facility" is misleading in that it implies a single facility. Furthermore, trash boxes are not the only waste that may be stored in unshielded enclosures. Facilities may be fenced or otherwise enclosed without shielding and only have to meet regulatory standards for dose rate and other requirements.

12. Section 2.2.3.1 - A more reasonable lower bound for incineration volume reduction factor is 50 rather than 80.

13. Section 2.2.3.1 - Dry storage of spent fuel should be addressed as a storage option.

14. Section 2.2.3.1 - Research facilities will also receive portions of our radwaste/fuel assemblies for post-mortem examination and evaluation.

15. Section 2.2.3.2 - The surface radiation levels on some resin beds is frequently low enough to permit "hands on" package handling rather than the use of remote handling techniques.

16. Section 2.2.3.2 - It is noted that there are epoxy resin combined volume reduction and solidification processes. Also, calcination and vitrification has been mentioned by others. Processes which are not mentioned, or are assumed non-applicable in the PEIS, may in-fact be viable. The PEIS should allow for unmentioned processes.

17. Section 2.2.3.2 - To state that "The destination of all shipments will be a commercial low-level waste disposal facility" conflicts with earlier case-by-case statements. If in fact what is stated is a position, then it should be restated in Section 12.

18. Table 2.2-1 - Metal LSA boxes are not mentioned as an alternative. Vitrification should be included as a option. Include note that discharge of accident water is prohibited at the present time.

19. Table 2.2-3 - Use of bitumen to immobilize incinerator ash should be included (See Appendix H, Section H.3.2).

20. Table 2.2-3 - Acid digestion of organic material should be included as a treatment alternative.

CHAPTER 3

THE ENVIRONMENT AND POPULATION WHICH MAY BE AFFECTED

1. Section 3.1.3.2 - Mention should be made that Met-Ed has been collecting meteorological data from its on-site weather station since May 1967.

2. Section 3.1.5.2 - Parts of Shelley Island are still used for agriculture (see Figure 3.1-8). The southern third of TMI is not all forested but rather only the eastern half and the western periphery of this lower third is forested. The rest of this third is mostly grasses and low shrubs.

3. Section 3.2 - Discussion as to why Beatty and Barnwell burial sites are not being used should be provided. Typical routes to these sites should be shown.

4. Section 3.2.2 - Specific state and municipality transportation requirements should be discussed if they have an impact on the technical shipping requirements.

CHAPTER 4

MAINTENANCE OF THE REACTOR IN SAFE CONDITION

1. Section 4.1 - The option of using MDHRS as just a backup for decay heat removal and using heat loss to the reactor building ambient as a long term cooling mode should be mentioned.

2. Section 4.3.3 - The MDHRS may not be the primary method of transferring decay heat. It is a method.

3. Section 4.5.1 - The 390 mrem dose for the quarter is based on a sampling frequency of once per week. The text fails to mention this.

CHAPTER 5

DECONTAMINATION OF THE AUXILIARY AND FUEL HANDLING BUILDINGS

1. Section 5.1.1 - Change the sentence "as of May 1," to read, "As of Sept. 1, the only remaining contaminated water in the AFHB is primary coolant."

2. Section 5.1.4.2 - Credit for HEPA filters is assumed for the fire analysis here and in other sections. If the HEPA filters are normally out of the flow path, no credit for their removal of radionuclides should be assumed.

3. Section 5.1.4.2 - 3×10^{-8}uCi should be changed to 3×10^{-10} Ci.

4. Section 5.2 - In the third paragraph the first sentence should be changed to state that all of the initial AFHB water has been processed. The last sentence is not totally correct. Epicor II processing of AFHB water has added approximately 20,000 gallons to the total inventory due to seal water, flush water and tank farm steam educator usage.

5. Section 5.2 - The footnote is incorrect. Epicor I will not be transferred to Unit-2.

6. Section 5.2.1 - This section needs to be updated to reflect completion of initial AFHB water. Also, the storage locations need updating. In addition to the 330,000 gallons stored in the BWST, over 182,000 gallons of Epicor II processed water is stored in the 'A' condensate storage tank which was modified and isolated for this purpose.

7. Section 5.2.2.2 - The decay of tritium should be well established thus eliminating the need for error bounds in estimating the time required to reduce tritium concentrations to specified levels.

8. Section 5.2.3.1 - Paragraph 4 states the chemical cleaning building is watertight up to a height of 13.5 feet above the basement floor. This statement is in error. The description of the building used in Appendix D of the PEIS should be used for a proper description.

9. Section 5.2.3.1 - The description of Epicor II is inaccurate. The prefilter/demineralizer and the two demineralizers each can contain any or all of the following materials; anion, cation, or mixed resin, zeolites or precoats.

10. Section 5.2.3.2 - It is not clear why an additional 1 million gallons of storage will be required. The tritium decay quoted in this paragraph is inconsistent with the tritium decay in Section 5.2.2.2.

11. Section 5.2.3.2 - Epicor II processed water would most likely be discharged from the evaporator condensate test tanks (WDLT-9A & B), therefore, the Epicor II processing rate and the rate of release to the river are not interrelated. Also, if these tanks are used, release rates of 0.8 gpm cannot be achieved with the currently installed equipment.

12. Section 5.2.4 - The Kr-85 remaining in the processed water should be addressed.

13. Section 5.2.5.1 - "four 8-hours shifts per day"?

14. Section 5.3.3 - Sludge in the reactor coolant bleed tanks (RCBT) has already been processed by Epicor II.

15. Section 5.4 - Accident water and tritiated water are essentially the same now that AFHB water clean-up is complete.

16. Section 5.4.1.2 - The Epicor II administrative limits on maximum specific activity per liner is:

1st stage liners - 1300 curies

2nd stage liners - 1300 curies

3rd stage liners - 20 curies

Using the resin volumes supplied in Footnote c, the maximum specific activities listed in Table 5.4-2 are incorrect.

17. Section 5.4.1.2 - The 1300 curie limit is self imposed based on two shipping cask designs. If another cask is chosen, curie loading could go much higher.

18. Section 5.4.2.2 - This section states the requirement for solidification of all liners. There has been a request to send several dewatered liners to a DOE facility for research. Further, all questions concerning disposal of these liners have not yet been fully resolved. If long time storage on site is required, dewatered resin may be preferable to solidified resin. Therefore, the dewatering option should be addressed by the PEIS.

19. Section 5.4.2.2 - As stated in Appendix H, by today's methods to use a polymeni process, the waste must first be mixed with the organic polymer. Therefore to use this binder it is necessary to transfer waste from its present container by sluicing. The water used to sluice the resin will add to the volume of the waste resulting in a volume increase factor larger than 1.5. Further, satisfactory solidification with cement may be achieved with a volume increase factor of less than 2.0. It has not been demonstrated that solidification with vinyl ester styrene would actually result in less disposal waste volume than cement. The text should be revised accordingly. Also, this section should indicate uncertainty for the stability of vinyl ester styrene with waste of high specific activity.

20. Section 5.4.5.2 - The X/Q is incorrect as written. It should read 6.7×10^{-6} sec/m^3 not 6.7×10^{-7} sec/m^3.

21. Table 5.1-1 - The Sr-89 value is incorrect. The concentration of release value should be 1.0×10^{-24} not 3×10^{-25}. This was calculated as follows: Conc. of Release (u Ci/ml) of Sr-89 = $(1 \times 10^{-9}$ u Ci) $\div$ (65000 CFM)

(1440 Min/day) (365 days) $(28318 \frac{ml}{ft^3}) = 1 \times 10^{-24}$ u Ci/ml.

22. Table 5.1-2 - The values for the concentration of release are juxtaposed. They should read as follows:

	Concentrations of Release (u Ci/ml)
H-3	1.2×10^{-10}
Cs-137	1.1×10^{-13}
Cs-134	1.4×10^{-14}
Sr-90	1.8×10^{-15}
Sr-89	5.1×10^{-16}

23. Table 5.2-1 - This table needs updating. The most recent analysis of RCBT 'C' and tank farm water is as follows:

	Cs-137	Cs-134	H-3
RCBT 'C'	56	9.2	0.29
Tank Farms	13	2.2	0.05

Footnote b, should state that AFHB water processing is completed. Footnote e, should be corrected to state that the Tank Farm is located in the "A" spent fuel pool.

24. Table 5.2-2 - This table needs to be updated as follows:

Month	Processed (Gals.)	Cumulative Liners Used 4 ft x 4 ft	6 ft x 6 ft
February	125,000	24	4
March	164,000	29	5
April	255,000	38[b]	5[b]
May	310,000	52	6
June	360,000	58	6
July	435,000	62	6
August	500,000	63	6
September	510,000[c]	65	7
October	520,000[c]	66	7
November	530,000[c]	68	7
December	540,000[c]	70	7

Footnote b is incorrect. The cumulative liners used are Epicor II liners only.

25. Table 5.2-4 - This table should also list Kr-85.

26. Table 5.2-4 - Throughout the report when water processing is discussed mention is made of particulate releases. This table is one such reference. To date, in connection with contaminated water processing, there has been no detectable particulate releases. To be consistent with the text, the wording in the table should be revised to make it clear that the figures cited are a conservative estimate of releases.

27. Table 5.4-1 - The listing of 1000R/hr maximum surface radiation level for Epicor first stage liners is too low.

28. Table 5.4-1 - If 1300 Ci on a 4 x 4 liner gives a radiation field of 1000 R/hr, then 60 Ci will not give a 75 R/hr reading. Column labeled "Volume" should be re-labeled "Container Volume". Another column should be added labeled "Waste Volume Per Container."

29. Table 5.4-3 - The volume reduction factor for incineration would be reduced if solidification of this waste is required. Spent filter cartridges can be packaged in a 4 x 4 liner as well as the 55 gallon drum.

30. Table 5.4-5 - The number of packages listed does not include the empty Epicor liners that will result if resin is sluiced into drums or liners for solidification. Further, footnotes a and e should be deleted since it is not clear that vinyl ester styrene would result in less overall volume than cement (See comment 19 above).

31. Table 5.4-7, 5.4-8, 5.4-9, 5.4-11 - The Ba-137m reference should be eliminated. Ba-137m and Cs-137 are in equilibrium and the reference to Cs-137 is sufficient for curie inventories.

32. Table 5.4-12 - Presumably the occupational dose for packaging Epicor II resins, sludge, and decontamination solutions does not include solidification. For example, each package of solidified resin would add 500 - 1000 m-mRem.

CHAPTER 6

DECONTAMINATION OF THE REACTOR BUILDING AND EQUIPMENT

1. Section 6.1.5.2 - Cancer risk numbers should not be rounded off. For example, 0.76 person-rem x 1.4 x 10^{-7} cancer death/mrem equals .00017. This equates to 2 chances in 12,000. The staff rounded .00017 to .0002 which gives them 2 chances in 10,000. In other words, by rounding off the number they increased probability of cancer mortality by 20%.

2. Section 6.2.1 - The fifth paragraph, last sentence should be changed to read, "The extent of any damage this may have caused is not completely known."

3. Section 6.2.1 - Add a new paragraph which states: "The two initial entries into the reactor building on July 23 and August 15 revealed little damage from the hydrogen burn and pressure pulse. The door to the enclosed stairwell on the 305' elevation indicated damage due to the pressure pulse. A telephone and some wiring on the 347'6" elevation indicated some damage due to the hydrogen burn. Some 55 gallon drums were damaged due to the pressure pulse.

   "The two initial entries indicated radiation levels of 500-700 mrem/hour gamma and 250-1000 mrad/hour beta on the 305' elevation. On the 347'6" elevation, levels were 100-200 mrem/hour gamma and 250-1000 mrad/hour beta."

4. Section 6.2.1 - The last sentence indicates that there is no light source inside containment. This statement is both incorrect and insignificant to the PEIS.

5. Section 6.2.1 - In the last sentence of the first paragraph after Table 6.2.1, add the words "and equipment" after "intervening concrete floor."

6. Section 6.2.2 - In the last paragraph, the use of robots is rejected by the NRC as an alternative. The wording should be revised so that their use is not precluded from future consideration.

7. Section 6.2.3 - In the third paragraph, it should be noted that the sump draining operation and reactor building decontamination operations may overlap.

8. Section 6.3.1 - In the second paragraph, second sentence, change "will" to "may". It should also be noted that the additional 330,000 gallons will most likely be recylce water. The text implies this is an added water volume.

   In paragraph three, 2.4 mg/ml is about 9360 kg of oil or 2700 gallons. This estimate appears high and a technical basis should be provided. In the third sentence, change "will" to "may".

9. Section 6.3.2 - Epicor II should be addressed as an alternative for processing reactor building sump water. A very real possibility is the concept of removing the gross activity with the SDS zeolite and then further polishing the water with Epicor II. For this reason, the PEIS should not make the statement the Epicor II will not (or can not) be used to process reactor building sump water.

10. Section 6.3.3.1 - The process configuration of the zeolite/resin system as shown in the various sections of the PEIS should be clearly characterized as a typical system, and not the one and only zeolite/resin system which might be employed. In application the actual configuration will depend on the results of continuing evaluations and tests and will probably continue to be refined after going into operation. As an example, it may be desirable to use the SDS system for initial processing and EPICOR II for polishing and recalcitrant species removal. The PEIS should clearly state that the configuration presented is not to be considered the only one and that there are many ways in which filters and demineralization beds can be configured in order to achieve efficient processing.

    This section should be updated to reflect the most recent consideration of Zeolite/resin systems.

    It is further noted that assumption of DF's (decontamination factor) in the PEIS for the zeolite/resin system may be optimistic and in actual operation the system could generate more volume of wastes than assumed in the PEIS. The demineralization characteristics of the reactor building sump water will not be fully understood until actual processing has begun. Furthermore, EPICOR II experience suggests that variations can be expected during processing, and we could eventually be making individual batch decisions as to processing optimization by filter/SDS/EPICOR II combinations. The PEIS should state that if the assumed DF's are not achieved, one should not infer that system performance is unsatisfactory and that new environment impact evaluations would be required.

The PEIS should state that there are many possible ways of configuring demineralization media for processing reactor coolant system water in order to optimize processing efficiency. The configuration and parameters assumed in the PEIS should not be interpreted by the reader to be a requirement.

11. Section 6.3.3.1 - In the second paragraph it should be noted that the SDS system is under construction (not design). Also a mixed resin bed is to remove radioactive anionic species rather than just I-129.

12. Section 6.3.3.1 - In paragraph two, logically, water should pass through the zeolite beds before the cation resin. The sentence "The relatively high sodium content of the sump liquids..." appears to be out of place.

13. Section 6.3.3.1 - In the last paragraph add the word "normal" prior to "dilution".

14. Section 6.3.3.2 - The DF for iodine (and other volatile chemicals) and the DF for non-volatiles is typical of the 1973 generation of evaporators. Present generation evaporators achieve DF's of 10^4 and 10^5 for volatiles and non-volatiles respectively. The volume reduction factor of 30 is also low now that forced circulation crystallizers are available. With present technology, this factor can approach 120. For these reasons, the volumes of mixed resin, evaporator bottoms and filters are too high. The cation resin bed is eliminated altogether.

15. Section 6.3.3.4 - Comment Deleted.

16. Section 6.3.3.4 - Comment Deleted.

17. Section 6.3.4.1 - In the last paragraph, the tritium release rate from tank venting is stated as 0.49 uCi/min and 0.017 Ci total. Using the assumptions stated, the values should be 3.7 uCi/min and 0.12 Ci.

18. Section 6.3.4.2 - The analysis of leakage of reactor building sump water into the groundwater and subsequent percolation into the river is not discussed in sufficient detail. The leakage of the sump in one to two days is very conservative. The 1.6 year transit time is not explained as to its basis.

The analysis needs to be explained in greater detail since it leads to the conclusion that there is little incentive to proceed deliberately with cleaning up the sump. This analysis could be used to justify prolonged delays in the sump cleanup effort. The risk of maintaining 500,000 curies in mobile form would appear to be greater than indicated in this section.

19. Section 6.3.4.2 - The last sentence is incorrect. The 13 cfs is not the flow rate into the east channel, but rather the flow rate over the Red Hill Dam for case 1.

20. Section 6.3.4.2 - Cs-137 concentration at Brunner Island (2.8×10^{-16} uCi/ml) appears to have taken credit for ion exchange in the ground. NRC should check for a typographical error here.

21. Section 6.3.5.1 - In the first paragraph it is stated: "Based on a dose range of 0.3 to 0.6 person-mrem per curie . . .". Data has been processed which shows that the 500,000 gallons of AFHB water, containing 55,000 curies, was processed with an operations and maintenance total exposure of 15 Rem which equates to 0.27 person-mrem/Ci. With this value as a base, the cumulative occupational dose for the processing of the 500,000 curies in the Reactor Building sump water would be 135 person-rem.

22. Section 6.3.5.2 - The doses listed in Table 6.3-12 appear to be low. For example, for tritium from the zeolite/resin option:

$$2400 \frac{pCi}{\ell} \times \frac{4 \text{ mrem/year}^*}{20,000 \text{ pCi}/\ell} = .48 \text{ mrem/year}$$

*From EPA National Interim Primary Drinking Water Regulations Table IV-2A

23. Section 6.3.5.3 - An adult consuming 20 liters of this accident water from the river would receive a whole body dose of 8 mrem (Case 1) and 2.7 mrem (Case 2) and not 4 mrem (Case 1) and 1.6 mrem (Case 2).

<u>Calculational Basis</u>: EPA National Interim Primary Drinking Water Regulations, Table IV-2A states that an adult drinking 730 liters per year of water containing 20,000 pCi/ℓ of H-3 would receive a whole body dose of 4 mrem.

Therefore: 4 mrem = (730 ℓ) (20,000 pCi/ℓ)

For Case 1:

$$\text{Adult whole body dose} = \frac{(20 \ \ell)(1.4 \times 10^6 \text{ pCi}/\ell)(4\text{mrem})}{(730 \ \ell)(20,000 \text{ pCi}/\ell)}$$

$$= 8 \text{ mrem}$$

For Case 2:

$$\text{Adult whole body dose} = \frac{(20 \ \ell)(5 \times 10^5 \text{ pCi}/\ell)(4\text{mrem})}{(730 \ \ell)(20,000 \text{ pCi}/\ell)}$$

$$= 2.7 \text{ mrem}$$

24. Section 6.4.1.1 - Table 6.4-1 provides a gross estimate of gamma exposure rates of all elevations in the reactor building with water in the sump. Data from the initial entries provides much more useful data; however, the data does not lend itself to presentation in the same form as Table 6.4-1. It is suggested that radiation surveys be used in lieu of Table 6.4-1.

For Table 6.4-2, the radiation surveys from the initial entries should be sufficient at the 347-ft. and 305-ft. elevations since radiation through the floor from the sump in a drained condition is negligible. No data is available from the entries to indicate the exposure rate at the 282-ft. elevation with the sump drained.

25. Section 6.4.2.1 - A fourth option of removing the sump water should be included. This option is to remove the sump water via WG-P-1 which is already installed.

26. Section 6.4.2.1 - This section would appear to make containment decontamination prior to removal of the sump water unacceptable. This alternative should remain.

27. Section 6.4.2.1 - Semiremote decontamination methods should also include ice blasting and foam.

28. Section 6.4.3.4 - The plausible decontamination sequence mentioned in this section should not preclude other sequences.

As noted in the planning study for Phase II, reactor coolant system inspection and disassembly may begin as soon as reactor building decontamination at the 305' elevation and above is complete to the point where exposure levels are sufficiently low. The sump water was assumed to have been processed and replaced with water for shielding. The containment sump may not require decontamination until after defueling is complete.

Another potential alternate sequence is to shield the sump from the 347' elevation and proceed with decontamination of the 347' elevation and above. It may be possible to reach some point in the RCS defueling sequence prior to actual completion of sump draining.

It is our recommendation that the decision concerning sequence of recovery events not be made in the PEIS.

29. Section 6.4.4.2 - If the logic in Section 5.1.4 for the analysis of a fire is followed, the release to the building ventilation system would be 8×10^{-7} of the total activity processed. Using the 3000 curie estimate of plateout activity in the reactor building as the assumed source term, the release to the HVAC filters would be about 3 mCi. This compares to a value of 52 uCi stated in paragraph two of 6.4.4.2. Should the fire occur outside a building in a storage area, no credit for HEPA filters would be available. This accident should be analyzed in the PEIS.

30. Section 6.5.2 - Considering the amount of oil and grease film that will need to be removed, 20,000 gallons of decontamination fluids appears low.

31. Section 6.5.2 - Volume of decontamination liquids (i.e. 14,000 to 20,000) appears to be very low. Likewise, the number of solidified drums (470). The Phase 1 Study (Page 9-29) indicated about 600,000 gallons of liquid which would be approximately 14,000 drums using the NRC solidification assumptions.

32. Section 6.5.2. - Ion exchange should be considered. If a water based decontamination solution is used (such as can-decon) ion exchange is a very viable method.

33. Section 6.5.5.1 - The second paragraph indicates that 0.7 to 2.0 additional cancer deaths will occur from exposure to 0.7 to 2.0 person rem. This is an error and should be corrected in the final PEIS.

34. Section 6.5.5.2 - Table 6.5-4 is intended to list the gaseous release from the cement immobilization process over a three month period. Table 6.5-1 is also for a three month period for the same evolution. The two tables should agree.

Also the data in Tables 6.5-2 and 6.5-5 should agree. Tables 6.5-3 and 6.5-6 should also agree.

35. Section 6.6 - The proposed zeolite/resin system is a new idea which has not been proven. Based on the SDS system test results, the waste volumes listed in this section appear unrealistic.

36. Section 6.6.2.2 - Shallow land burial should not be ruled out without further investigation.

37. Section 6.6.2.2 - The difference in assumption leading to the NRC staff's and Licensee's estimates on number of zeolite/resin containers should be explained in the last paragraph. The paragraph makes it appear that no one has an understanding of these systems.

38. Section 6.6.2.2 - The comments made on Section 6.3.3.2 also apply to Table 6.6-3.

39. Section 6.6.2.3 - In Table 6.6-5, the resin volume for zeolite should be 10 ft.^{3}.

40. Section 6.6.3.1 - If solidification of the zeolite and cation resin is not required, these beds can be loaded with 10 ft.^{3} of resin.

The mixed bed vessel has a volume of 195 ft.^{3} and will be loaded with approximately 155 ft.^{3} resin.

This comment also applies to Table 6.6-9. See comment 19 on chapter 5 section 5.4.2.2 concerning relative waste volumes resulting from solidification of organic resin with vinyl ester styrene or cement. The text of 6.6.3.1 and table 6.6.-9 should be revised accordingly.

41. Section 6.6.3.4 - It is not clear how contamination would be controlled at the baling station while compressing sheet metal and mirror insulation.

42. Section 6.6.3.5 - It is not clear how the 2,500 to 5,000 drums mentioned relate to the 14,000 to 20,000 gallons of decontamination solution mentioned in earlier sections.

43. Table 6.2-1 - *Revise the table to read as follows:*

Location and Source	Whole-Body Dose Rates from Gamma Radiation (rad/hr)	Skin Dose Rates from Beta Radiation[b] (rad/hr)
347-ft. Elevation		
Plateout	0.1 to 0.2[c]	0.2 to 1.0
Sump Water	0	0
305-ft. Elevation		
Plateout	0.1 to 0.2	0.2 to 1.0
Sump Water	0.4 to 0.5	0
Stairs No. 1 and 2		
Plateout	0.1 to 0.2[d]	0.2 to 10[d]
Sump Water	-	-

Notes to the table should be changed as follows:

b The skin dose rates are for workers not wearing protective clothing. Clothing with a thickness of 500 mg/cm^2 is sufficient to stop beta radiation from all of the major plateout sources except Y-90, for which only 95 percent of the beta radiation is stopped.

c From measurement made by licensee on August 15, 1980.

d The staff assumed that plateout on the stairs was about the same as the plateout on the 305-ft. elevation.

44. Table 6.3-16 - This table lists concentrations of radinuclides in the processed water flow which are significantly different than those allowed in the NRC letter of 2/1/80.

45. Table 6.4-1 Table 6.4-2 - These should be revised to reflect current data from containment entries. This statement applies throughout the PEIS.

46. Table 6.4-3 - The number of curies removed seems to greatly overestimate the total number of curies expected in the containment, based on current data.

47. Figure 6.3-3 - Effluent is greater than feed volume. Also, the asterisk is in the wrong place.

48. Figure 6.3-4 - A key should be added as follows:

OW = Observation Well (dipped samples)

MW = Monitoring Well (pumped samples)

49. Figure 6.4-1 Figure 6.4-2 - The inclusion of these figures should not preclude alternative designs. The reference to "air tight' doors on the figures should be deleted.

CHAPTER 7

REACTOR SYSTEM INSPECTION AND PRIMARY WATER PROCESSING

1. Section 7.1 - A significant amount of inspection and examination is to support R&D requests. Examinations of this nature that do not also contribute to direct plant decontamination and defueling are optional.

2. Section 7.1 - The conditions of the reactor vessel will also be determined with respect to its design structural characteristics; for example, the surveillance specimens may provide information regarding material properties.

3. Section 7.1 - The PEIS identifies a need for special equipment for fuel accountability without describing the requirements for the fuel accountability program. In particular, any fuel accountability program must be oriented toward cleanup goals. Care must be taken to not confuse this with the goals of other accountability programs which are theft related.

4. Section 7.1.1 - In addition to the damage modes noted, fuel assemblies/rods will be distorted and/or bowed.

5. Section 7.1.2 - The sequence shown assumes the containment building is decontaminated before primary system breach. This may not be the case. An optional path should be shown for partial containment building decon. It may be possible to remove the fuel sooner the optional way.

6. Section 7.1.2 - Sequence of stages - an item indicating that the fuel will be encapsulated in some form prior to removal to the spent fuel pool should be included.

7. Section 7.1.3 - Experience at other plants has shown that due to protective clothing, respirators, high ambient temperatures, work-breaks, etc., the worker productivity can be as low as 25%.

8. Section 7.1.3.1 - Wastes generated should also include reactor system items such as gaskets, control rod drive mechanism (CRDM) parts, recovered debris, etc.

9. Section 7.1.3.1 - The worst case numbers in Table 7.1-2 appear high for direct work in head removal, plenum removal and reactor defueling. They certainly represent a conservative estimate for worst case condition.

10. Section 7.1.3.1 - Radiation Levels - The 10mR/hr assumption is opti-
7.1.3.2 mistic as is 25mR/hr for worst case. The estimates of occupation exposure for the worst case condition appear reasonable. The PEIS uses 10 mR/hr as an average dose rate. This may be low. The combination of conservative manhour expenditures and low dose rate result in a somewhat realistic estimate of the worst case condition.

11. Section 7.2 - "to the extent possible there will be no new (uncontaminated) water added....." It is immaterial (environmentally) whether or not new water is added. The cleanup systems remove fission products to very low concentrations and thus whether processed water is recycled or released should be left as a water management option. Note that Section 12 conclusions support the acceptability of release.

12. Section 7.2.2 - The first sentence is misleading in its potential technical interpretation. We have no hard information that permits us to say that we can use any part or all the spent fuel purification or the makeup purification system with only minor modification. This sentence should be specifically worded to be conjecture so that the public is not led to believe that we are creating new clean-up systems when we already have installed systems which could otherwise be used.

13. Section 7.2.2.1 - Processed RCS water could be returned to the RCS via the standby pressure control (SPC) system. This would avoid dependence on the makeup pumps which could overpressurize the MDHRS.

14. Section 7.2.2.1 - Normal RCS Purification System: The ability to use the RCS makeup purification system is speculative at this time. There are many considerations other than the normal operating mode specifications. If in fact it could be operated, water as high as 1 uCi/ml can be processed with it. The same limit applies to the spent fuel pool (SFP) cleanup system.

15. Section 7.2.2.1 - EPICOR I System: The EPICOR I System has not been transferred to Unit 2.

16. Section 7.2.2.1 - EPICOR II System: The RCS must be in a decay heat cooling mode before it can be drained to 26,000 gallons. It may be advisable to reduce the activity of the RCS before going on to the decay heat

removal system for several reasons. For example, cleanup of the RCS will permit access to additional areas of the AFHB. Also earlier clean-up would result in less contamination to the decay heat removal system. In any event, a feed-and-bleed alternative should not be rejected as it has distinct operational advantages over drain down.

In a study under review, it is proposed that, for RCS cleanup via EPICOR II, the prefilter be loaded exclusively with zeolite. The mixed bed polishing liner would be eliminated. This would permit EPICOR II to function as a Zeolite/Resin system. Operating EPICOR II in this mode permits a higher curies loading in the prefilter and reduces overall waste generation to 20 prefilters and 7 cation beds.

EPICOR II does not always remove boron as stated in the paragraph. More water has been processed by EPICOR II without boron removal than with boron removal. The concern about radioisotope leaching from the core applies to any reactor coolant processing system.

17. Section 7.2.2.1 - Filter/Zeolite/Resin Process: This paragraph is too specific. For example, a mixed resin bed might prove to be more efficient than a pure anion bed.

18. Section 7.2.2.1 - Evaporator/Resin Process: The last sentence should be changed to read, "An Evaporator System....is being considered.

19. Section 7.2.2.3 - Maximum Concentration Level Alternatives: The last sentence is far too generalized. There are too many variables in the curies estimate, the waste estimates, etc., to make such a sweeping statement.

20. Section 7.2.2.4 - To assume that RCS processing residues will be solidified is contrary to NRC indications that it should not be solidified until disposal method is settled upon. This inconsistency is further reason why the PEIS should designate categories of waste and disposal alternatives.

21. Section 7.2.3.1 - Prefilter/Resin Process: EPICOR II can take its supply from RCBT's and tank farm in addition to the makeup water holding tank (MWHT). The effluent can be returned to the RCS via the SPC as well as the others mentioned.

22. Section 7.2.5.1 - The most recent calculation over a three month period indicates 0.19 person - mRem per curies processed.

23. Section 7.3.2 - Alternate Methods Considered: If the 41 uCi/ml Cs-137 level listed in Table 7.2-2 is used for calculations, the RCS now contains 15,000 Ci of Cs-137 in solution not 40,000 Ci as stated in the second paragraph.

24. Section 7.3.2 - The spent filter cartridges will not be in a solid form if the ORNL precoat idea is adopted.

25. Section 7.3.3.1 - See comment 19 on chapter 15 section 5.4.2.2 concerning relative waste volume resulting from solidification of organic resins with vinyl ester styrene or cement. The text of sections 7.3.2, 7.3.3.1 7.3.3.2 and tables 7.3-4 and 7.3-5 should be changed accordingly.

26. Section 7.3.3.4 - Last sentence - long-term onsite storage conflicts with next to last paragraph on page 12-2.

27. Section 7.3.4.2 - What justification is used to base an EPICOR II accident on 600 Ci instead of 1300 Ci?

28. Table 7.1-1 - Pressure Control Mode, should read, System filled with water, makeup and pressure controlled via Standby Pressure Control System.

29. Table 7.3-1 - The 1300 Ci limit was based on two shipping cask designs. If a different shipping cask is used, the EPICOR liners could be more heavily loaded resulting in less radwaste.

30. Figure 7.2-1 - The A and B spent fuel pools do not, and have not contained High Density fuel racks.

31. Figure 7.2-2 - The storage racks pictured in the deep end of the transfer canal were removed, and the internal storage stand was moved from where it is shown in this figure to the deep end of the transfer canal prior to the accident.

32. Figure 7.2-3 - This seems to be a preaccident diagram, because the SPC and MDHRS are not shown.

33. Table 7.3-2 - Statement in footnote b that "EPICOR II prefilter materials will not be immobilized is not consistent with other statements in the PEIS.

CHAPTER 8

REACTOR DEFUELING AND PRIMARY SYSTEM DECONTAMINATION

1. Section 8.1.1.1 - The current rate of heat production is about 85 KW compared with 2,700,000 KW during normal operation or .003% of normal power. Thus, heat load is not a significant factor in planning these operations.

2. Section 8.1.1.1 - No attempt has been made to move either the control rods or axial power shaping rods (APSR). It is therefore not known which rods are movable.

3. Section 8.1.2.1 - The PEIS indicates 3.5 ft.^{3} as the maximum container size. The maximum volume is a function of geometry. Fuel assembly shaped containers should permit larger volumes for the debris containers.

The decay heat load of the fuel debris is so low that a "mesh screen for circulation" is probably not required. We may be able to seal the containers and place them in storage with decay heat removal thru the container walls to the storage pool water.

4. Section 8.1.2.1 - The option of using dry fuel storage containers should also be included.

5. Section 8.1.3.1 - The reactor pressure vessel head (RPVH) insulation and CRDM cabling may not necessarily be wastes.

- The need to seal weld the seal plate has not been established.

6. Section 8.1.3.1 - The stuck studs may be stripped for removal to avoid the need to cut the studs.

7. Section 8.1.3.1 - The text indicates lead screws will be placed in the "park" position. Current plans are to remove these lead screws to minimize radiation levels in the head area and to improve access for decontamination of the underside of the head prior to head removal.

8. Section 8.1.3.1 - It may not be necessary to remove the RPVH service structure to handle the CRDM's that cannot be uncoupled. An option to cut a "working access" thru the service structure is being considered.

Alternate methods are being evaluated to cut the CRDM leadscrew extensions inside the RPVH without cutting the CRDM housing.

9. Section 8.1.3.1 - The worst case scenerio for removal of the plenum assumes cutting the plenum into approximately 150 pieces inside the reactor pressure vessel (RPV). In our judgement, this is a low probability event since alternate methods can be developed to free the plenum from the RPV and core support structure (CSS) without the need for complete disassembly inside the reactor. It is, however, an option and represents a <u>bounding</u> case.

10. Section 8.1.3.2 - The best-case does not represent a bounding lower estimate in that estimates for working time are conservative compared with "normal" conditions. Some of the operations may be carried out with substantially less working time than the best-case estimates.

11. Section 8.1.5.2 - The PEIS concludes that offsite health effects are non-existent for the reactor cleanup operations. The NRC staff should utilize this conclusion to simplify the NRC review process for these operations and decrease the need for extensive insignificant environmental effects calculations for each step of the program.

12. Section 8.2.2.2 - Cutting the CSS baffle plates to remove the first fuel assembly is a very low probability approach. The most likely approach is to destructively disassemble the first assembly to create the initial cavity for subsequent assembly removal operation.

13. Section 8.2.3.2 - The specific tooling for handling core debris has not been designed. The types of tools described in the PEIS are represenative of the types of tools that will be used during the fuel removal operations.

14. Section 8.2.4.2 - A calculation should be made to estimate the amount of Kr-85 removed from the core (via venting, accident release, etc.) compared with the amount of Kr-85 produced by the fission process during TMI-2 power operation.

The assumed 320 cureis/per assembly maximum residual may be high when all Kr-85 removal paths have been evaluated.

15. Section 8.2.5.2 - The PEIS estimated that the best-case defueling time is 10 months. This may not be the lower bound on defueling depending upon the final procedures selected.

16. Section 8.3.1 - The assumptions analyzed should not preclude the option of using a non-chemical decontamination with spot applications of chemicals.

Removal of internal plateout may not be necessary if the plant is to be placed in operation again.

17. Section 8.3.2.1 - Using a core filter will be a delicate operation because using one pump (alternately) in each loop will back-flow the opposite loop and may "wash out" whatever filtrate is trapped on the filter.

18. Section 8.3.2.2 - In the line after "coolant" in the third paragraph add the word "pumps".

19. Section 8.3.3.1 - The radiation level of 10 mR/hr nominal to 30 mR/hr maximum are potentially gross under-estimates of the actual radiation levels that could be experienced with these filters. This number should be treated with caution.

This same comment applies throughout Section 8.3.3.1.

20. Section 8.3.3.2 - The entries regarding radiation levels for RCS, for RC drain tank and for reactor coolant pump and motor decontamination appear to be low. These numbers should be treated with caution.

21. Section 8.3.3.4 - Same comment as above for Section 8.3.3.2.

22. Section 8.3.5.1 - If you take the occupational doses listed in Table 8.3-2 and adding the appropriate values to give a cumulative dose and multiplying by probability of health effects given in Table 4.5-1, page 4-5 you get the expected number of additional cancer mortalities to range from 0.057 to 0.25 not 0.068 to 0.13. The number of additional genetic effects would range from 0.11 to 0.47 and not 0.51 to 1.0.

23. Section 8.4.2.3 - Under the entry "Material" in Table 8.4-2 include neutron sources with orifice rods, control rods, burnable poison rods and axial power shaping rods.

24. Section 8.4.3 - Removal of fuel via the equipment hatch should not be excluded.

25. Section 8.4.3.1 - It is estimated that 50 of the 177 fuel assemblies will require failed fuel containers. This number appears low and would approach 177 for the worst case.

26. Section 8.4.3.2 - It is indicated that the CRDM pressure housings will be cut. This is not planned except, possibly, for the first one removed.

27. Section 8.4.5.2 - The X/Q value should read 6.7×10^{-6} sec/m^3 not 6.7×10^{-7} sec/m^3. Consequently, the total body dose is 2.0×10^{-9} mrem not 2.3×10^{-10} mrem. The exposure from vegetable consumption is 3.8×10^{-8} mrem not 4.4×10^{-9} mrem. From these corrected doses the probability of either an adult cancer death or genetic effect is less than 10^{-14} and not 2.6×10^{-12} and 4.6×10^{-12} respectively.

28. Table 3.1-1 - Present plans do not include the use of the internals indexing fixture.

29. Table 3.4-2 - Thermal insulation, seal plate, studs, nuts, electric cable, coolant lines, and CRDM's should be considered contaiminated, not irradiated.

30. Table 8.4-6 - Volumes of compactible trash are less than half of estimates provided in Phase I Study (Page 9-30 and Figure 4-14).

31. Figure 8.1.1 - This is not a representative figure of the RPV and internals for TMI-2.

CHAPTER 9

STORAGE, TRANSPORTATION, AND DISPOSAL OF FUEL AND SOLID WASTE

1. Section 9.1.1 - In this section the PEIS refers to the interim storage facility. On site, we refer to this same facility as the long term staging area. We call the initial inground storage area the interim storage area.

2. Section 9.1.1 - Epicor I liners have also been shipped.

3. Section 9.1.2 - The PEIS states here that all drums reading greater than 200mR/hr on contact will be shipped in a shielded cask. This is not correct. It is possible to ship drums greater than 200mR/hr in a normal shipment of LSA by positioning the drums where they will be shielded by the lower level drums. Also, shielded vans are available which can transport more drums than a shielded shipping cask.

4. Section 9.1.3.1 - Reference is made to logistical constraints due to the number of available Type A or Type B certified casks. As we may purchase or lease casks not currently available, the restriction to using available casks should be removed.

5. Section 9.1.3.2 - Dose limit 2 should read 200mR/hr at any point on the external surface of the <u>vehicle</u>.

6. Section 9.1.3.2 - Contrary to the first statement, we have made overweight shipments.

<u>Paragraph 4</u>: This paragraph states that legal weight shipments are limited to 38,000 lbs. This is in error; we normally load to 42,000 lbs. as our maximum weight.

7. Section 9.2.1.1 - Change 700 to 800, 25 to 60, 500R/hr to 500mR/hr and 0.5mR/hr to 0.6mR/hr.

8. Section 9.5.1.1 - The worst case transport distance is listed as 2,300 miles. The actual distance is 2,570 miles which will increase the PEIS estimates of exposure to the drivers.

9. Table 9.1-1 - Our estimates are close to the best case conditions listed in the table, if only containment building work is considered. The additional work that will continue outside of containment yields a total somewhere between the best and worst cases.

Footnote a: PEIS uses 88 drums as the average load. It is difficult to determine the accuracy of this estimate. Our normal LSA drum shipment is 145-155 drums, dependent upon total weight. The estimate of 88 drums/shipment probably assumes a percentage of Type B waste in the total number of drums.

Footnote b: Same as above except that normal load will be 14 - 18 boxes. If we compact into the LSA boxes, we will be limited to about 10 boxes per shipment.

Footnote c & d: The number of shielded drum shipments will probably be higher than these estimtes if the compactable waste is incinerated. The PEIS estimate is based on 14 drums per shipment, a more realistic number is probably 8 drums per shipment.

10. Table 9.1-6 - The worst-case number of shipments is slightly less than current estimates as published in the Phase I Study (Figure 4-4). For purposes of worst case estimates therefore this number should be increased.

11. Table 9.1-7 - This chart omits the 10ft^3 SDS zeolite/resin liners.

12. Table 9.1-9 - This is only a partial list and should be labeled as such.

CHAPTER 10

SUMMARY OF ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIVITIES

1. Section 10.2.2 - The NRC is inconsistent in the risk factors they are using in determining health effects. Here they use a value of 131 fatal cancers in exposed workers per one million person-rem whereas in Chapter 4, Table 4.5-1, page 4.5 they use 147 cancer deaths per million person rem. They should use only one of these factors throughout their report.

2. Section 10.4.1 - There are two typos, one in the penetration factor (i.e. 3 x 10^{-4}) and one in Table 10.4.1 (H-3 value should read 1.5 x 10^{-4}).

3. Section 10.4.2 - Add the word "not" before "support combustion".

4. Section 10.5 - Releases due to aircraft impact on the containment recovery service building or a tornado going through the interim solid waste staging facility and other similar events should be discussed in a manner similar to that used in Section 10.5 on flooding.

CHAPTER 11

ENVIRONMENTAL RADIOLOGICAL MONITORING

1. Section 11.2 - Our monitoring program extends out to 21 miles not 15 miles.

2. Section 11.2 - Air particulate samples are analyzed weekly for gross beta activity and gamma spectral analyses are also performed monthly.

3. Section 11.2 - We now collect milk samples semimonthly.

4. Section 11.2 - Fifth paragraph should be rewritten as follows:

   Water samples from Met-Ed's off-site water sampling network are collected from 8 stations. These samples are composited hourly over a two week period utilizing automatic water samplers. These semimonthly samples are analyzed for iodine (semimonthly), gamma scan and gross beta analyses on monthly composite, tritium on a monthly and quarterly composite, and Sr-89 and Sr-90 on a quarterly composite. In addition, grab samples are taken weekly at two surface water stations. These are composited and the above analyses are performed. Daily grab samples are also taken from the plant discharge and composited for the above analyses.

5. Section 11.2 - Change last sentence in seventh paragraph to read:

   These dosimeters are exchanged on a monthly (20 stations) and a quarterly (53 stations) basis.

6. Section 11.2 - A new paragraph should be added as follows:

   Met-Ed has a groundwater montioring program (see Figure 6.3-4, page 6-20) that presently samples from fifteen observation and monitoring wells. Tritium analysis and gamma scans are performed on the samples taken.

CHAPTER 12

CONCLUSIONS

1. In Item 1 reword paragraph such that "1.7 in 10 million" value is compared with "2 million in 10 million" (vs one in five) to make the comparison more apparent. This should be adhered to throughout the report.

2. In Item 4, at what point downstream from TMI are the doses calculated?

3. Comment Deleted.

4. According to a study compiled by the Pennsylvania Economy League, the value of property assessed in 50 school districts in Dauphin Cumberland, Lancaster, and York counties increased $76.2 million between 1979 and this year. This is contrary to the statement in Item 6 concerning reduced property value.

5. No assessment has been made to determine the impact of the increased construction workforce on the surrounding communities and the local economy.

6. The conclusion that "long-term or permanent storage of high-level waste is not appropriate at the TMI site" is not supported by the conclusion in Item 8, which states, "No significant environmental effects are expected". The PEIS should be more explicit as to the reasons why it would not be appropriate to utilize TMI as a waste repository.

APPENDIX F

DESCRIPTION INFORMATION FOR SOCIOCULTURAL PROFILE

1. Table F-1 - The number of people serviced by Lancaster Water Works alone is approximately 130,000 which represented 36% of the total population (1980 projection of 359,000 people).

APPENDIX G

ENGINEERING CONSIDERATIONS RELATED TO PROCESSING OF DECONTAMINATION LIQUIDS

1. Section G.1. - Flushing with nontritiated water prior to manual decon is not necessarily valid. Tritiated water may be used.

2. Section G.1. - The volume of decon liquids (i.e. 14,000 gallons) appears to be very low.

3. Section G.2. - The vinyl ester styrene solidification system should also be included as an option.

4. Table G.3. - The basis for the factor of 1.44 increase should be developed.

Appendix H

ENGINEERING CONSIDERATIONS RELATED TO IMMOBILIZATION OF RADIOACTIVE WASTES

1. Vitrification should also be addressed as a processing technique.

2. It appears that the terminology in table H.4 for "Volume Increase Factor" is inconsistent with that used in other sections of this document.

Appendix I

JUSTIFICATION FOR RADIATION FIELDS USED IN SECTION 7 AND 8

1. Our experience indicates that radiation levels above the pool will be well above the 2 to 3 mR/hr assumed by the NRC.

2. The assumption of zero contribution to general area radiation levels from residual reactor-produced radioactivity inside the building is unrealistic.

3. The Surry pump decontamination experience cited in Section 1.5.2.3 of the PEIS should be considered in Appendix I and the analyses based on this Appendix. The small decontamintion factor experienced in decontaminating the Surry pump (2 R/hr to 500 mR/hr) indicates that achieving a general area background radiation level of 10 mR/hr may be very difficult.

APPENDIX L

AVERAGE INDIVIDUAL QUARTERLY DOSE LIMITS USED IN DETERMINATIONS OF WORK FORCE ESTIMATES

1. Appendix L indicates that certain administrative check points used at TMI to control radiological exposures are limits and conceivably implies a quarterly dose of one rem may be established as a working requirement. This section should be reworded to clearly indicate that the requirements of 10CFR20 will be observed, that the company uses administrative check points to ensure personnel do not exceed 10CFR20 guidelines and to indicate that the company will at the same time maintain personnel and total man-rem exposures as low as is reasonably achievable.

Appendix R

Note: The forwarding letter makes recommendations concerning Appendix R. These modifications are proposed if the recommendations in the cover letter regarding deletion of certain proposed technical specifications are not adopted.

PROPOSED ADDITIONS TO TECHNICAL SPECIFICATIONS FOR TMI-2 CLEANUP PROGRAM

Recommend modification of the wording as follows:

R.1.3 - Specification

(1) The licensee must submit a plan of operations for the cleanup steps in the Recovery Program to the Deputy Program Director of TMI-2 Cleanup. This plan should reference appropriate sections of the PEIS.

(2) Procedures shall be developed for each operation of the proposed plan and submitted to the Deputy Director. These procedures must contain ....(as presently worded).

(3) Delete or modify the paragraph for the following reasons:

Since the PEIS has concluded that the potential for off-site hazard is negligible, the procedure should only have to illustrate that the proposal procedure is bounded by the Analysis of the PEIS.

To carry out the calculations illustrated for each operation appears to be an unnecessary burden on the licensee since the NRC Staff has already concluded that the off-site safety considerations are negligible if the operations carried out have been bounded by analyses in the PEIS. These submittals should only be necessary if the analysis shows that the release potential is considerably greater than that shown in the PEIS.

ATTACHMENT B

These experiences illustrate that available techniques can be modified to suit the conditions at TMI-2. Applicable experience in removing damaged fuel and core components is limited, hence development of specific techniques will be required.

Treatment of Radioactive Liquids

Large quantities of water were contaminated with fuel debris as a result of the March 28, 1979, accident. Additional water, as much as 330,000 gallons, may become contaminated if remote washing of the reactor building internal surfaces is employed. About 14,000 to 20,000 gallons of decontamination liquids, only a small fraction of the sump liquid volume, would be generated during the semiremote and hands-on decontamination of the reactor building. However, the concentration of solids in the wash water will be higher than in the sump liquids. In addition, the presence of detergents, complexing agents, and organic solvents will complicate the treatment of these liquids. Water will be circulated through the damaged core during defueling. Depending upon the extent of damage to the core, up to 300,000 additional Ci could be released to the circulating water, either during defueling or during the subsequent flush of the coolant system.

None of the liquids that are currently contaminated or become contaminated during cleanup will be shipped offsite in liquid form. The safety-related problems involved in shipping the contaminated liquids offsite before treatment and the fact that the commercial low-level waste burial grounds will not accept liquid wastes for burial eliminate this as a feasible alternative. On the other hand, if storage of highly contaminated liquids on the island were allowed as a long-term solution, the liquids would be a source of direct radiation exposure to the workers.

Radioactive liquids can be treated by one of two general approaches: (1) direct solidification or (2) reduction of the concentration of radionuclides in the liquids with a resultant increase of radioactivity in a secondary solid material. None of the chemical treatments remove the tritium in water. Solidification of the liquids in portland cement probably would be the simplest treatment alternative to put into effect. While there would be no liquid effluent from this method of solidification, about 10,000 cubic yards of concrete weighing 11,000 tons would require transportation and disposal. Therefore, the staff does not regard solidification with cement a reasonable alternative for all the liquids. It may be a reasonable alternative for small quantities, such as the building decontamination liquids (few hundred cubic yards final volume).

Liquid treatment steps considered can be classified into filtration, ion exchange, and evaporation processes. Filtration alone would result in removal of solids, oils, and greases from the liquids, but the resulting liquid (filtrate) would still be highly radioactive and could not be released to the air or the river. Providing adequately shielded, corrosion-resistant storage facilities for temporary storage before further treatment complicates the cleanup operation without markedly contributing to its end goals.

A process analogous to that used in household water softeners is commonly used in the nuclear industry to remove dissolved radionuclides. The water is passed through a column of special porous solid (an ion exchanger or demineralizer) and the material to be removed from solution is collected in the solid. Ion exchangers can be made of minerals (zeolites) or plastics (organic resins). The zeolites are more stable in the presence of high radiation fields than organic resins and remove considerably more radionuclides per unit volume. The zeolites and resins are often used in combination for optimum results.

Two feasible variations to the ion-exchange system exist. An evaporation and condensation step prior to treatment by resins would reduce the original volume of liquid by about 30 times and the concentration of radionuclides (except tritium) by about 1000 times. Most of the radionuclides and borates (from the criticality-control boron) would be left in the precipitate sludge at the bottom of the evaporator. Further processing of the sludge would be required. Considerable experience exists with evaporator systems, and the evaporation process can handle solutions containing suspended solids.

In another variation of the evaporator and ion-exchange systems, a flammable asphalt material (bitumen) would be added to the water and the resultant mixture would be evaporated in a rather complex operation. The resultant solid would be ready for shipment offsite, but the resultant water condensate would still have about the same volume and about one-thousandth of the radionuclides of the original water. Further treatment of this water with a resin system would still be necessary, and operating difficulties would likely prove greater for the asphalt system than for the evaporation system.

The above treatment processes can be designed such that the concentration of radionuclides in the resultant water will meet proposed NRC limitations (Sec. 1.6.3.2) at the station discharge. Alternatives considered for disposition of the processed water are:

3.2 TRANSPORTATION ALTERNATIVES AND ROUTES THAT MAY BE AFFECTED

Only the low-level waste disposal site operated by the Nuclear Engineering Company (NECO) near Richland, Washington, currently is being used for disposal of TMI-2 wastes. However, since some of the wastes resulting from the cleanup activities will not be acceptable for burial at this site (e.g., failed fuel assemblies and certain high-specific-activity wastes), it is necessary to consider other sites for disposal of these wastes. The ultimate choice of waste storage and disposal sites for TMI-2 wastes will be influenced by political and institutional as well as technical constraints.

The general considerations and requirements for waste disposal and transportation and their implication in the shipment of TMI-2 wastes are given in this section. The discussion includes method of shipment, transportation routes, and storage and disposal sites. The environmental impacts associated with transportation of the wastes are discussed in Section 9.

3.2.1 Method of Shipment

The available transportation methods for shipment of the TMI-2 waste are:

- Truck shipment from TMI-2 to the storage or disposal site.
- Rail shipment from TMI-2 to the storage or disposal site.
- Intermodal rail and truck shipment (rail shipment for the entire route may not be possible since some storage and disposal locations do not have rail spurs).

The waste packages will be shipped in a transport vehicle consigned for exclusive use for TMI-2 waste shipments. The following dose rates apply to shipment of all radioactive materials and would apply to the transport of radioactive materials from TMI-2.[1]

1. 1,000 millirem per hour at 3 ft from the external surface of the package (closed transport vehicle only).
2. 200 millirem per hour at any point on the external surface of the car or vehicle (closed transport vehicle only).
3. 10 millirem per hour at any point 6 ft from the vertical planes projected by the outer lateral surfaces of the car or vehicle; or if the load is transported in an open transport vehicle, at any point 6 ft from the vertical planes projected from the outer edges of the vehicle.
4. 2 millirem per hour in any normally occupied position in the car or vehicle, except that this provision does not apply to private motor carriers.

On the basis of these criteria some wastes can be shipped in unshielded vehicles, and others (e.g., high-specific-activity wastes and failed fuel) will require shielded shipping casks to reduce the radiation levels.

3.2.2 Transportation Routes

For the purpose of evaluating the environmental impacts of transporting the TMI-2 wastes to storage and disposal sites, the wastes are assumed to be transported by truck from TMI-2 to Hanford, Washington, a distance of about 2300 road miles. The complete route to this disposal site is shown in Figure 3.2-1, the local routing around the TMI site in Figure 3.2-2, and the routing leading to the Hanford site in Figure 3.2-3. This route makes use of the Federal interstate highway system except for short distances near the starting and termination points where local, Commonwealth of Pennsylvania, and State of Washington roads are used. In the process of selecting this route, Met-Ed consulted the states and municipalities through which the wastes are being transported for specific requirements. These requirements are being satisfied at this time.

Additional sites suitable for waste disposal are discussed below.

For the shipment of irradiated fuel, consideration must be given to the proposed DOT regulation regarding the highway routing of radioactive materials (45 FR 7140, January 31, 1980), the physical protection of shipments of irradiated fuel (10 CFR 73.37) and the interim guidance for physical protection of such shipments (NUREG-0561, Rev. 1, June 1980).

3.2.3 Storage and Disposal Sites

In determining acceptable storage or disposal sites for the TMI-2 wastes, it is necessary to consider the various types of wastes from the decontamination activities.

4. MAINTENANCE OF THE REACTOR IN SAFE CONDITION

4.1 OBJECTIVES AND ACTIONS

The objectives of maintaining the TMI-2 reactor in a safe condition can be summarized as follows: achievement of a thermally stable primary system in which the decay heat from fission products is continually being removed; maintenance of subcriticality of the reactor core; and confinement of the radioactivity within the reactor building.

Since early April 1979, natural recirculation has been used to remove the decay heat from the reactor core to steam generator "A", where subsequent cooling by the secondary water transfers the heat to the atmosphere. However, Met-Ed has noted that as decay power continues to decrease, the natural recirculation has become susceptible to hydraulic fluctuations. Therefore, a new forced circulation system, the mini-decay-heat-removal system, has been proposed by Met-Ed for potential use in the removal of heat from the reactor for the long term mode. An alternate method, employing use of the reactor building fans and coolers, may be used.

Subcriticality of the reactor is being ensured by the maintenance of sufficient boron in solution in the reactor primary coolant. The one operable source range neutron detector is used to monitor subcriticality. A small amount of control rod material is believed to have melted during the accident. The shutdown margin available at TMI-2 is estimated to be about 15% δk/k.1.*

The probability of recriticality under various hypothetical circumstances has been examined independently by several groups.[1-5] Based on these analyses it can be concluded that with 3500 ppm of boron in the primary coolant, the reactor can be maintained in a subcritical state even in the total absence of other control materials. The most probable cause of recriticality was found to be boron dilution, which, however, is perceived as a slow enough process that any approach to criticality can be detected and remedied.

The TMI-2 reactor building is being kept at a slightly negative pressure ~~(about -0.2 psi)~~ with respect to the outside atmosphere. The pressure differential is maintained by the operation of the building's air cooling system to lower the building air temperature. This leads to a lessening of reactor building pressure and consequently prevents leakage of the reactor building atmosphere to the environment. The fans for the building's cooling system have operated continuously since March 28, 1979; however, they were designed to operate under 100% humidity, 286°F and 60 psi conditions without maintenance for only 3 to 4 hours. Eventual failure can be expected if maintenance is not performed.

4.2 MONITORING OF REACTOR AND REACTOR BUILDING

The reactor and the reactor building are being monitored by instruments measuring the reactor and building temperature and pressure and the water level in the sump inside the building. Experiments have been performed through which a television camera and radiation detector have been installed through a penetration in the Reactor Building. The Reactor Coolant System leakage is continuously monitored and provides a good and continuous indication of the condition of the RCS envelope. The chemistry and inventory balance of the reactor coolant water are checked weekly. One instrument channel is still functional for monitoring the low neutron flux level. In-core thermocouples as well as hot-leg and cold-leg resistance temperature devices are available to monitor temperature inside the reactor coolant system.

4.3 DECAY HEAT REMOVAL

The term "decay heat" refers to thermal energy generated by radioactive fission products and other in-core materials after the shutdown of a reactor. The decay heat power of the TMI-2 reactor at the time it was first shut down a few seconds after 4:00 a.m. on March 28, 1979, was 160,000 kW. By January 31, 1980, the decay heat generation rate had decayed to approximately 200 kW and the rate of heat reduction continues to diminish.

*This means that there are approximately 15% too few neutrons to sustain nuclear chain reaction at a constant rate.

4.3.1 Decay Heat Removal Mechanisms Employed Since the Accident

From the onset of the accident until 8:00 p.m. March 28, 1979, when reactor coolant pump 1A was restarted, heat removal from the reactor core was inadequate and was effected primarily by releases of primary water to the reactor building through the pressurizer relief valve that was stuck open. Between 8:00 p.m. on March 28, 1979, and April 27, 1979, decay heat was removed through steam generator "A" by forced circulation with a reactor coolant pump (see Fig. 1.2-1).[3] Subsequent to April 27, 1979, decay heat has been removed by natural convection circulation of the primary water through steam generator "A" in a steaming mode. This is expected to continue until the operational capability of the proposed mini-decay-heat-removal system (MDHRS) is completely demonstrated and the use of the system approved. The MDHRS then may be used to remove all of the heat being generated by the core in addition to sparing the normal in-plant decay heat system from becoming grossly contaminated. In addition to the heat removal mechanisms mentioned above, heat is lost from the primary system by heat transfer to the reactor building, which contributes to the total decay heat removal capability.

4.3.2 Backup Decay Heat Removal Systems

Following the accident, provisions were made for long-term decay heat removal through steam generator "B". Thus, cooling can be accomplished by using the "B" steam generator cooldown system, the normal in-plant decay heat system, and reversion to natural circulation. By March 1981 the decay heat rate should decrease to between 60 and 70 kW. At this low decay power, convection heat losses from the primary system to the reactor building should be capable of maintaining the coolant below 200°F without active cooling.

4.3.3 Mini-Decay-Heat-Removal System

The MDHRS has been installed. It is considered a method of forced circulation decay heat removal to remove heat from the fuel, in the Reactor Coolant System and to transport that heat to the nuclear service water system. The MDHRS is a non-preferred cooling option but may be used both for long-term decay heat removal as well as during defueling operations when the Reactor Coolant System is not configured to maintain natural circulation. The system includes two pumps and two heat exchangers, arranged in a manner that will permit independent operation and thus provide redundant decay heat removal capability. Each heat exchanger has the capability to remove the total decay heat. As of May 1, 1980, pre-operational testing was being conducted on the system prior to actual application.

4.4 EFFLUENTS AND RELEASES TO THE ENVIRONMENT

4.4.1 Normal Releases

From the time when steam generator "A" started operating in the steaming mode (April 27, 1979) until July 11, 1980, when the reactor building atmosphere was vented, about 66 to 80 Ci of Kr-85 had been leaking out of the TMI-2 reactor building every month.[6] In the steaming mode of steam generator operation, the turbine side of the steam generator is maintained in a partial vacuum by the plant air ejectors. Consequently, the pressure difference between the reactor building atmosphere and the turbine side of the steam generator enhanced leakage of Kr-85 from the reactor building through the packing of various steam valves to the secondary system. The Kr-85 gas and other gases (nonradioactive) were subsequently discharged from the secondary system through the auxiliary building ventilation system to the environment. This amounted to about 20% of the radioactivity release permitted in the technical specifications.

4.4.2 Accident Scenarios and Associated Releases

There are two broad categories of core-related accidents that could result in the release of additional radioactive fission products from the damaged fuel in the reactor core. The first is sufficient overheating or mechanical damage (fracturing) that leads to the escape of some of the radioactive fission products still held within the core. Most of the remaining fission products are still trapped within the fuel particles in the core and would require very high temperatures (on the order of those reached during the original accident) to be released from the fuel. However, there may be small pockets of more readily released fission products (e.g. Kr-85 in a small gas bubble) that could be released by mechanical damage. The second broad category of core-related accidents is an inadvertent restart of the reactor with the associated generation of new fission products and heat. This latter category is referred to as a recriticality accident. Recriticality and accidents related to overheating of the whole core are discussed in the sections that follow.

4.4.2.1 Recriticality

Some neutrons, from extraneous sources and the spontaneous fission of uranium, are present in the core even when the reactor is shut down. These neutrons do cause some uranium atoms to

5. DECONTAMINATION OF THE AUXILIARY AND FUEL HANDLING BUILDINGS

The auxiliary and fuel handling buildings (AFHB) house equipment for treatment of radioactive wastes and for fuel handling. The general layout of the buildings for three elevations is shown in Figures 0.1 through 0.3 of Appendix 0.

The objectives of the AFHB decontamination are to allow access without restriction because of surface or airborne contamination, to minimize radiation exposure from gamma sources, and to prevent recontamination in the event of system leaks. The following guidelines and criteria are applied to determine whether these objectives have been satisfied:

- Removable contamination is less than 500 dpm β-γ/100 cm²,[1]
- Airborne contamination is less than the 10 CFR Part 20 limits for restricted areas,[2] and
- General radiation levels are at plant design values--generally 0.4 mR/hr.

5.1 DECONTAMINATION OF BUILDING SURFACES AND EQUIPMENT

5.1.1. Description of Efforts to Date and Status of Those to be Completed[3]

Surveys of the general access areas (corridors and normally nonrestricted areas) shortly after the accident showed radiation levels of 150 to 500 mR/hr in the fuel handling building and 50 to 100 mR/hr in the auxiliary building. The cubicle areas, containing contaminated filters, tanks, and pumps, in the AFHB had much higher radiation levels. Levels exceeded 1000 R/hr in some areas, such as the reactor coolant bleed holdup tank cubicles.[4]

The initial general area and sump decontamination, which began in April 1979 and is continuing as shown in Figure 5.1-1. is expected to continue at a substantial level of effort until July 1981.

Low-radiation areas were treated first. The decontamination team left many high-radiation areas, such as the reactor coolant bleed tank cubicles, until later because it is first necessary to remove highly radioactive sources from the tanks and piping. Once the equipment has been flushed and the filters changed, the radiation levels are much lower and it becomes possible to proceed with the decontamination with much less radiation exposure to personnel.

The general areas had been decontaminated by April 1980; however, some of those areas have to be recleaned periodically because of recontamination. Construction related to the installation of new equipment, like the mini-decay-heat-removal system (MDHRS), has resulted in some additional decontamination efforts because contaminated material is tracked into previously decontaminated areas. Leakage of barrels containing contaminated industrial detergent, which has now been corrected, caused similar problems. The movement of contamination has required the routine monitoring of previously decontaminated areas and repeated decontamination when smear levels are above 500 dpm/100 cm².

Another factor affecting decontamination efforts is the increased potential of leaks from systems because of lack of maintenance for nearly one year. This problem will become more acute with time and is continuing to receive attention during decontamination.

In December 1979 individual area (cubicle) decontamination began and is expected to continue until July 1981. . The cubicle areas tend to be more difficult to decontaminate because they contain equipment and may require special shielding to protect workers from radioactive equipment sources. As of September 1, 1980, many of the tanks, filters, and much of the piping still contained water or primary coolant contaminated with radionuclides. The final general area and AFHB sump decontamination is expected to take place through July 1981, after which the AFHB should be at acceptable radiation levels.

The decontamination schedule is contingent upon there not being any unforeseen problems in decontaminating the remaining high-radiation areas.

A more detailed outline of the initial and current (as of May 1, 1980) decontamination status of the AFHB is given in Tables 0.1 through 0.3 of Appendix 0. The areas described in those tables

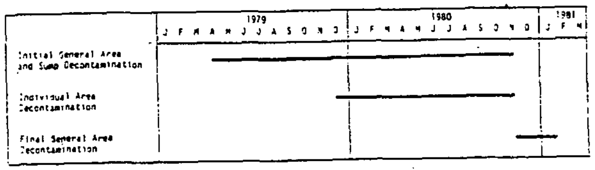


Figure 5.1-1. Auxiliary and Fuel Handling Building Decontamination Schedule.

are identified by labels keyed to the layouts in Figures 0.1 through 0.3. Of the 56 areas requiring decontamination (not including the general area), 6 areas were completely decontaminated (except for fluid transfer and filter changes in 2 of the 6 areas), 17 required only light decontamination, 26 were partially decontaminated, and 7 had received no decontamination. Transfer of fluids, changing of filters, and/or flushing of lines were still needed in 18 of the 56 areas. It is expected that some additional decontamination also will be needed periodically in the general access areas (corridors, stairwells, etc.) because of airborne dispersion and tracking by workers from cubicles that are still undergoing decontamination.

5.1.2 Methods Used

Appropriate combinations of standard methods have been used in the decontamination of the AFHB. The following methods have seen at least limited use, with the first five used predominantly:

- Removal of all nonessential items, such as wood, tools, hoses, cords, loose equipment.
- Dry vacuuming of dry floors and equipment (piping, valves, cable trays, etc.) with high efficiency particulate air (HEPA) filter on vacuum exhaust.
- Wet vacuuming of industrial detergent after hand scrubbing.
- Manual wiping with disposable towels or oil-impregnated wipes.
- Low pressure hot water misting and washing ;
- Removing strippable coatings on floors, walls, portable shields, and other surfaces.
- Electrochemical decontamination of tools and small equipment.
- Freon cleaning and Freon ultrasonic cleaning of electrical equipment and tools.
- High-pressure water jet use on floors, tanks, piping, and valves.

These methods are discussed in more detail below. All of these methods, except perhaps the water jet, require the decontamination crew to be relatively close to the contamination. In areas of high concentrations of airborne radioactive particulates, personnel must be equipped with a respiratory protector, such as an air pack or filter respirators. Protective clothing also is used to protect workers and to control the spread of contamination.

Various combinations of the decontamination methods are selected by decontamination personnel to minimize exposure and maximize effectiveness. The decontamination personnel rely on their experience and testing in some cases to determine the best method to use for each particular task.

5.1.3 Details of Methods Selected and Associated Facilities

The details of the methods used and any support facilities required for their use are described in this section. Also discussed are limitations and concerns regarding their use. A breakdown of the work effort (person-hours) and average exposures for each of the tasks described below is not available; however, the overall level of effort and worker doses are given in Sections 5.1.3.9 and 5.1.5.1. Unless otherwise stated, worker exposure comes primarily from radiation from the contaminated environment--nearby contaminated equipment and building surfaces and airborne particulates.

5.1.3.1 Removal of Nonessential Items

The decontamination crews have found tools, loose equipment, barrels, boxes, staging, cables, hoses, wood pallets, and other miscellaneous items in many areas. Rather than decontaminate these items in place, the crews have moved them to staging areas for cleaning and eventual storage or disposal. Some of the items have been disposed of as LSA waste. Most of the items can be handled by the personnel. Some items with fixed contamination have been stored for future use in contaminated areas. Large pieces of equipment may be decontaminated in place. Worker exposure comes from the contaminated items that must be moved, as well as from the contaminated environment.

5.1.3.2 Dry Vacuuming of Dry Floors and Equipment

In many areas where dry, contaminated dust has accumulated, dry vacuuming has been effective. Dry vacuuming does not work well on crusted deposits; therefore, it is used primarily in areas where dust has not been wetted or crusted. The vacuuming involves the use of a specially equipped machine with a HEPA filter in the exhaust stream. Radioactive particles are retained in the filters. Worker exposure from airborne activity may be increased by the vacuuming activity even though most of the particles are picked up by suction.

5.1.3.3 Wet Vacuuming

Wet vacuuming has been the primary method for decontaminating areas where contaminants adhere tightly to surfaces. The method involves scrubbing with water and industrial detergents and then wet vacuuming the resulting solution. The wash solution is stored in barrels until it can be solidified for disposal. There have been limitations on the types of cleaning compounds used since their effect on the solidification process has not been fully evaluated. To date, only one commercial detergent has been approved. The scrubbing is a slow and tedious process that brings workers into close contact with contaminated wash solution.

5.1.3.4 Manual Wiping

Manual wiping, a worker-intensive technique, may be used to remove dust and accumulated contamination that cannot be vacuumed. Disposable towels or oil-impregnated wipes ordinarily are used. This technique requires workers to be close to contaminated areas; thus the exposure may be higher than for semiremote techniques, such as vacuuming, for a given level of contamination. Manual wiping is normally used only after radiation levels have been reduced by gross decontamination using other methods. This method is also used for controlling contamination in areas previously decontaminated.

5.1.3.5 Removing Strippable Coatings

This method involves the application and subsequent removal of a strippable coating. As the coating is removed, it takes with it the surface contamination. Strippable coatings are useful on portable shielding, making it easy to decontaminate. It involves close worker proximity to contamination, but there is less likelihood of the contamination being spread to other surfaces, such as clothing or gloves, than for manual wiping. Strippable coatings are commonly applied to decontaminated areas to facilitate subsequent decontamination if recontamination should occur.

5.1.3.6 Electrochemical Decontamination

Electrochemical decontamination is an electropolishing procedure used on metal objects to remove a thin layer of the exterior surface and attached contamination. The method employs a tank containing an acid solution and a low-voltage, high-current source. At TMI this method can be used only for small objects because the electrochemical decontamination tank is about 3 ft by 3 ft by 2 ft deep. Small tools and parts can be cleaned in a very short time.

The phosphoric acid in the decontamination tanks is recirculated through a filter that accumulates much of the contaminated solids removed from the surface. The major limitations of this method are that the objects must be metal, they must be small, and they must be removable.

The electrochemical decontamination apparatus is set up in a facility removed from the AFHB. Vapors from the facility are circulated through HEPA filters to limit radioactive releases to negligible amounts.

5.1.3.7 Freon Cleaning and Freon Ultrasonic Cleaning

This decontamination method involves the use of Freon, either by spray, brush, or ultrasonic bath, to clean electrical tools and small, intricate parts. *The ultrasonic bath using Freon as* a fluid will remove most contaminants, but only small parts can be cleaned in this manner. Larger electrical components, such as motors and switchgear, can be decontaminated by spray cleaning with Freon. Precautions are taken to ensure adequate ventilation in order to minimize inhalation of Freon vapor by workers. About five gallons per week in the form of vapors are removed by the facility ventilation system. The freon cleaning and ultrasonic freon cleaning equipment is located in the same facility as the electro chemical decontamination equipment, and uses the same ventilation system.

5.1.3.8 Use of High-Pressure Water Jet

A high-pressure, low-flow-rate, water-jet spray system can be used to remove surface contaminants. The system is effective and fast in removing contaminants and reducing personnel exposure time and that large areas can be cleaned quickly and thoroughly.

Two water-jet units are available onsite at TMI-2 for decontaminating the AFHB. One operates at a nominal pressure of 1200 psi and the other at 10,000 psi. The water flow is relatively low, about 7 gpm for the 1200 psi unit.

Use of the water jet was limited prior to March 1980 because of restricted water usage. It is now being used extensively with water processed by EPICOR II. Use of this processed water, rather than additional water pumped into the facility, has reduced the water inventory buildup and permits extensive use of the water jet. Tests of the atmospheric contamination caused by use of processed water have been conducted with the water jet in closed quarters. At saturation conditions the tritium level was approximately 10 percent of the 10 CFR Part 20 limits.[2]

5.1.3.9 Low Pressure Water Washing

A low pressure hot water misting and washing is used to dissolve chemicals in the walls, floors, and components. This system is effective in dissolving dried boron deposits and controlling airborne contamination. This method is used prior to high pressure water jet spray.

5.1.3.10 Work Effort for Decontamination of the Auxiliary and Fuel Handling Buildings

During the period from April 15, 1979, through November 1, 1979, there were 80 persons doing decontamination work inside the auxiliary and fuel handling buildings on a schedule of two 12-hour shifts per day; from November 1, 1979, through September 1, 1980, the work force was reduced to 50 persons doing decontamination work inside the AFHB on a schedule of two 10 hour shifts per day.

Completion of the major decontamination effort is scheduled by Met-Ed for July 1981, with a decreased effort through December 1981. The work from September 15, 1980 through December 1981 will be manned by a total of 29 persons.

5.1.4 Effluents and Releases to the Environment

5.1.4.1 Normal Operations

Planned operating procedures for decontamination of the AFHB will not result in initial liquid releases to the environment. However, depending on the process alternatives used, the resulting liquids ultimately may be released to the river or to the atmosphere, or they may be solidified and shipped offsite. When steam or clean water is used as the decontamination medium, the resulting solutions will be treated along with the radioactive water in the auxiliary building as described in Section 5.2. Resulting releases to the river, should this option be authorized, are discussed in that section.

The estimated airborne releases from decontamination activities are listed in Table 5.1-1. The surface area inside the AFHB that had not yet been decontaminated as of May 1, 1980, was estimated by the staff to be about 40,000 ft^2, and the average level of contamination of this area was estimated to be about 20,000 dpm/100 cm^2 (see Tables D.1 through D.3, Appendix D). These values lead to an estimate of 0.003 Ci for the surface contamination remaining in the building as of May 1, 1980. The staff assumes that the mixture of fission products in this surface contamination is similar to that of the water in the reactor building sump (see Sec. 6.3.) According to the licensee's estimate (Fig. 5.1-1), the time required to complete the decontamination would be about nine months.

Two pathways of release to the building atmosphere are possible during dry vacuuming: (1) disturbance of contaminated surfaces (in which case it is estimated that 0.1% of the material becomes airborne), and (2) the effluent from the single-stage HEPA filter (penetration fraction = 0.001) attached to the vacuuming device. The material released to the building would pass to the air-cleaning system, consisting of two stages of HEPA filtration having a penetration rating of 9×10^{-8}. This is based on a penetration of 3×10^{-4} per HEPA stage, which is considered to be readily achievable.

It should be emphasized that for safety evaluation, NRC Regulatory Guide 1.140 allows only an ultraconservative penetration factor of 10^{-2} for the entire exhaust system and then only if the HEPA filters test in-place to an efficiency of 99.95% or greater. Thus, the guide gives no additional credit for HEPA stages in series. Rigorous application of the guide would result in an increase of the values in Table 5.1-1 of about 1.1×10^5.

5.3 DESLUDGING AND DECONTAMINATION OF AUXILIARY BUILDING SUMP AND TANKS

The purpose of desludging and decontamination of the auxiliary building sump and tanks is to dispose of the contaminated waste solids and sludge and to decontaminate inner sump and tank surfaces, to design radiation limits. The objective is to restore the sump and tanks to a condition in which they can be used for subsequent decontamination tasks.

5.3.1 Description of Efforts to Date and Status of Those to be Completed

During and after the accident, contaminated water and sludge were pumped through many of the pipes and tanks in the auxiliary building. Filters in some of the lines became clogged and were subsequently bypassed in order to maintain flows. Most of this contaminated material is in the auxiliary building sump, the sump tank, and the miscellaneous waste holdup tank (see Figs. D.1 through D.3, Appendix D for the locations of these tanks).

The procedure now in use for tank and filter desludging starts with replacement of the inlet and outlet filters, as required. The tank then is flushed several times and that portion of the tank sludge entrained with the water is collected with a portable recirculating vacuum filter system (RVFS) with disposable filter cartridges. Sludge that is caked to the walls of the tank can be dislodged with a high-pressure water jet and then collected in the RVFS. Standpipes (drain pipes that extend above the bottom of the tank) may complicate the desludging effort. Pumps, valves, and lines need to be decontaminated.

As of September 1, 1980, the condensate test tanks and contaminated drain tanks had been cleaned. The tentative work sequence for desludging of the tanks and associated equipment is shown in Figure 5.3-1.

The following systems in the auxiliary and fuel handling buildings (AFHB) may be required for primary coolant system and reactor building decontamination:

- Reactor bleed holdup tanks and associated equipment
- Reactor coolant pump water cooling and seal water systems
- Miscellaneous waste holdup tanks and associated equipment
- Coolant evaporator system
- Degasification system
- Fuel transfer ports and machines
- Fuel storage pool and handling cranes
- Canal cooling and purification systems
- Other handling equipment, such as cranes

These systems will be used in the handling of processed water, and other liquids, they will require additional decontamination following reactor defueling and decontamination of the primary system and reactor building. As the defueling and decontamination planning progresses, it may be determined that other systems will be needed for specific tasks./ If so, the additional systems can be decontaminated and desludged also.

5.3.2 Alternative Methods Considered

The desludging and decontamination operations may be broken down into the following tasks: (1) removal of the sludge deposits and decontamination of the areas from which the sludge is removed, and (2) immobilization of the sludge in a form suitable for disposal.

5.3.2.1 Removal of Sludge Deposits and Decontamination of Underlying Areas

Criteria for selecting acceptable alternatives for sludge removal are:

- The procedure should not have a destructive effect on the surfaces from which the sludge is removed.
- Radiation exposure to the workers should be as low as is reasonably achievable.
- Standard equipment should be used, unless such equipment is not available or large overall reductions in worker exposure can be attained with special equipment.

In applying the last criterion, the impact of the delays that would be involved in designing, constructing, and testing new equipment is an important consideration.

The alternatives for sludge removal may be divided into the following categories:

- Dissolve the sludge so that it can be removed as liquid waste,
- Remove the sludge by mechanical means (scooping and scraping), or
- Resuspend the sludge as a slurry that can be removed as a liquid.
- Filter the sludge through a filtration system decanting the water back to the tanks and sumps.

Dissolution of the sludge, which consists largely of calcium sulfate and various silicates, would require strong reagents that would damage the underlying surfaces and the drain hardware. This alternative would be, therefore, reasonable only in the circumstance of a prior decision to decommission, which is beyond the scope of this document (see Sec. 2); hence, it will not be considered further herein.

If mechanical removal were done by hand, using shovels and scrapers, the radiation exposure to the workers would be much higher than for the other alternatives. Mechanical devices for scooping and scraping that would permit semiremote or remote operations are not available as standard equipment and would, therefore, have to be designed, constructed, and tested. On the basis of these considerations and the criteria listed above, mechanical removal also was deemed unacceptable and not considered further.

The following alternative methods for removal of the sludge by resuspension have been considered:

- Resuspension and removal of the sludge by means of a portable recirculating vacuum filter system,
- Resuspension by flushing and/or backflushing and entrapment of the sludge on the inline filters using existing piping and pumps.

The second alternative is very effective for those tanks containing small fractions of sludges. The worker radiation dose that would be required to change the inline filters on which the sludge was collected would be essentially the same as for the underwater vacuum system. The agitation would be less than for the first alternative, so that the sludge removal would be less effective, and there would be a greater likelihood of spreading the sludge to other parts of the system. A high-pressure water jet also could be used to loosen and remove caked sludge from surfaces and, if necessary, to assist in resuspending the sludge when agitation from recirculation or from the vacuum system is insufficient for this purpose.

The staff did not consider methods that would require the design and development of new equipment because they are not aware of any such methods that would lead to a large reduction in worker radiation exposure compared to the above-described methods (for which commercial equipment is available). If, during the course of desludging and decontamination, new methods that would allow large reductions in worker exposure became known, they could be considered for use.

5.3.2.2 Decontamination of Desludged Areas

Once the sludge has been removed, the decontamination procedures that must be used on the desludged equipment are essentially the same as for any other surface. Alternatives for surface decontamination are considered in Section 5.1.

5.3.2.3 Stabilization or Encapsulation of Sludge

The alternatives considered for stabilization or encapsulation of the sludge in a form suitable for disposal are:

- Cement immobilization,
- Bitumen immobilization, and
- Proprietary vinyl ester styrene systems.

These alternatives also were considered for processing of sump liquids from the reactor containment building and reactor coolant system (see Secs. 6.3, 7.2, and Appendices K and H).

5.3.3 Details of Proposed Methods and Associated Facilities

The sludge in the auxiliary building sump is largely cement residue from an unfinished part of the floor and in the floor drains and drain piping with a admixture of ion-exchange resin beads from a spill prior to the accident. The accident caused flooding to a depth of about 6 inches. The largest portion of the sludge was washed into the 9000-gallon sump by the flooding. From here the slurry was pumped into both the sump tank and the miscellaneous waste holdup tank. Smaller amounts of sludge may be present in the other tanks in the auxiliary building, but this has not been confirmed by direct examination.

The sump, 14 ft wide by 24 ft long, is 3 ft deep at one end and 4 ft deep at the other. The bottom slopes toward an outlet pipe at one end, where the sludge is 2 to 3 inches deep; at the other end the sludge curves up to a depth of 12 to 14 inches. The total volume of sludge in the sump is estimated to be on the order of 200 ft^3. This volume of wet sludge will yield about 40 to 50 ft^3 of dewatered sludge. Debris also are present in the sump. A 6-inch hose, a 2.5-inch firehose, tie rods, and a temporary sump pump have been noted. Radiation levels vary from 2 R/hr to 12 R/hr at different locations in the vicinity of the sump.

It is assumed, on the basis of estimates by the licensee, that the miscellaneous waste holdup tank contains about 10 to 15 ft^3 of sludge. This tank is being used as a feed tank for the EPICOR II operations. The continuing need to use the tank for this operation may delay desludging and decontamination. During the period from August 1979 to April 1980 the radiation level near the tank rose from about 5 R/hr to about 30 R/hr as a result of sludge accumulation due to liquid transfer in and out of the tank.

The amount of sludge present in the sump tank also is quite uncertain because the interior is not visible; it is assumed by the licensee to be on the order of 5 to 10 ft^3. The radiation level at one end of the tank is about 20 R/hr.

The total sludge in the remaining tanks is assumed by the licensee to be about 10 ft^3 or less. These tanks include the reactor coolant bleed tanks, which constitute about three-quarters of the total liquid storage capacity in the auxiliary building, the spent resin tank, the concentrated waste tank, and other tanks identified in Figure 5.3-1, Table 5.2-1, and Figures O.1 through O.3 of Appendix O. Desludging of a tank cannot begin until most of the liquid within the tank has been processed or removed. Liquid from reactor coolant bleed tanks A, B, and C has been processed. Flushing the tanks with processed water has decreased the radiation levels and some of the sludge has been removed with this method.

The estimated total volume of sludge in the tanks and the sump in the auxiliary building is 200 to 250 ft^3. For a sludge density of 1.6 g/mL (100 lb/ft^3), the total weight of wet sludge to be removed, fixed, and stored is on the order of 20,000 to 25,000 pounds.

Estimates of the suspended solids, oil and grease, and radionuclides in the auxiliary building sump and sump tank and reactor coolant bleed tanks are given in Table 5.3-1. The concentration of radionuclides in the filtered solids is assumed to be the same as for the sludge, which is formed by settling out of the suspended solids. The vessels could not be stirred for sampling; nevertheless, the sump liquid contained about 300 g/L of suspended solids and the sump tank liquid about 10 g/L. The major elements in the solids were Ca, Mg, Fe, Si, and S. The latter probably was sulfate from the thiosulphate used as a wash in the auxiliary building to suppress volatilization of iodine after the accident. The other constituents are representative of cement and perhaps corrosion of steel. Lesser constituents were K, Na, Al and some Zn (perhaps from galvanized surfaces).

Table 5.3-1. Concentration of Suspended Solids, Oil, Grease, and Radioactive Materials in Auxiliary Building Sump as Determined from Liquid Samples Taken on January 2, 1980

Sample	Suspended Solids (g/L)	Oil, Grease (g/L)	Radionuclides[a]				
			Cs-134	Cs-137	Sr-89	Sr-90	Pu
Sump, as received[b]	290	2.4	28	140	-	-	-
Sump, supernate[b]	-	-	2.6	13	0.5	0.2	-
Sump, filtered solids[b]	-	-	170	850	120	50	1
Sump tank, as received[c]	9	0.24	0.7	3.7	-	-	-
Sump tank, supernate[c]	-	-	0.8	4	0.14	0.1	-
Sump tank, filtered solids[c]	-	-	230	1180	340	260	1.5
Reactor coolant bleed tanks, as received[b]	5	0.003	5	27	1.7	0.7	0.01

[a]Units are µCi/mL for liquids as received and supernate and µCi/g for filtered solids, except Pu is given in parts per billion.

[b]Oak Ridge National Laboratory intralaboratory memo from W.D. Shultz and J.A. Carter to R.E. Brooksbank, January 10, 1980.

[c]Letter from J.H. Carter, Oak Ridge National Laboratory, to R.J. McGoey, Metropolitan Edison, March 10, 1980.

Table O.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts (see footnotes)
E4	Makeup Pump C	Respirators used, initial pass reduced smears to 5×10^5. Light decon needed.	$>10^6$		<5,000		1,2,4
F1	Neutralizer Tanks	Water was cycled in and out of tanks reducing dose rate at door to 45 mR/hr.		150[d]	3,000		1,2
F2	Neutralizer Filters	Decontamination complete.		150	<1,000		6
F3	Neutralizer Pump Room	This room decontaminated several times, still requires additional effort. Piping needs flushing.	$>10^6$	100	<1,000	40	1,2
G	Reactor Coolant Waste Evaporator	Further light decon required.			<5,000		4
H1	Reclaimed Boric Acid Tank	Initial decontamination completed with supplied air. Subsequent passes reduced levels further. Maintenance in progress.	$>10^6$	<40	<5,000		1
H2	Reclaimed Boric Acid Pump	Same status as H1.	$>10^6$	50	<5,000		1
J1	Spent Resin Tank A	Seven decontamination passes reduced levels to about 2K DPM. Final decon to be completed prior to addition of cleanup resin.	$<10^6$	125	<1,000	<24	2
J2	Spent Resin Tank B	Six decontamination passes reduced levels to 2K DPM. Final decon to be completed prior to addition of cleanup resin.	$<10^6$	30	<1,000	<10	2
J3	Spent Resin Pump Room	Seven decontamination passes reduced levels to 1.5K DPM. This area used for Radiac wash drum storage--total decon required prior to transfer of cleanup resin.	$<10^6$	5	<1,000	3	6

Table O.1. Decontamination Status for Elevation 281 as of September 1, 1980

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts (see footnotes)
A	Liquid Waste Transfer Pump Entrance Way	Initial entry made with Scott Air Packs. Radiac wash, decontaminated to door.	$>10^6$		5,000		1
B1	Cleanup Demineralizer and Filter A	Decon complete except for demineralizer resin. First personnel entry with supplied air, respirators later. Hydrolaser used.		5,000	<1,000		2,4
B2	Cleanup demineralizer and Filter B	Decon will require disposal of spent resin in spent resin tank, transfer of cleanup demin. resin, change filter. No action taken yet.		10,000[d]		10,000[d]	2,3
C	Liquid Waste Transfer Pumps	Area has been gross decontaminated for maintenance.	$>10^6$	65,000	<50,000	250	1
D	Evaporator Condensate Test Tanks	Floor drain removed, Radiac wash used. Decon complete except for filters and motors.	$>10^6$		<1,000		2,4
E1	Makeup Pumps Entrance Way	Entrance ways to all MP cubicles have been decontaminated but require additional work.		10,000	3,000		4
E2	Makeup Pump A	Respirators used. Gross decon completed; light decon need, except for strainer and motor.	$>10^6$	10,000	<5,000		4
E3	Makeup Pump B	Gross decon complete.		>100,000	<25,000	<5,000	1,2

[a]See Figures O.1 through O.3.
[b]DPM/100 cm^2.
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table D.2. Decontamination Status for Elevation 305 as of September 1, 1980

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts (see footnotes)
A	Intermediate Cooling Pumps/ Seal Return Valve Room	High level decontamination done. Spill area and hot spots require further work. Filters changed.	>10^6	2,500	<5,000	<30	1
B	Makeup Demineralizers	No entry to date				5,000[d]	2,3
C	Gas Analyzer Room	High level decontamination complete. Filters changed.		<100,000	<5,000	<300	2,4
D	Makeup Tank and Filters	No entry to date.		10,000[d]		10,000[d]	2,3
E	Spent Fuel Cooler Area	Decontamination completed. Used for storage of Radiac wash drums. Construction area.		700	<1,000		4
F1	Spent Fuel Demineralizer	Decontaminated. Previous Radiac drum storage area. Filters need changeout.			<1,000		4
F2	Spent Fuel Filters	Decontaminated, filters changed.			<1,000		4
G1	Waste Gas Decay Tank	Floor decon complete, tank inspected.		10,000	<1,000	<4	4
G2	Waste Gas Filter	Decon complete, tank inspected.			<1,000		4
G3	Waste Gas Decay Tank	Decontamination near completion, waiting final inspection.		2,000	<1,000	<1	4

[a]See Figures D.1 through D.3.
[b]DPM/100 cm².
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

D-8

A-104

Table D.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts (see footnotes)
K	Oil Drum Storage	Room is being used to store Radiac wash drums and floor drain strainers. Storage shelves and unidentified boxes located in room. Room scheduled for decon after drums transferred to solidification.		700	<1,000		6
L1	Makeup Valve Rooms Entrance Way	Area cleaned and decontaminated. Construction overhead, some final decon may be needed.			<2,000		4
L2	Makeup Valve Rooms Access Corridor	Hydrolaser has been used on floor with good results.		<2,000	<10,000	<200	1
L3	East Valve Room	Hydrolaser has been used on floor with good results.		<15,000		<200	1
L4	West Valve Room	Hydrolaser has been used on floor with good results.		<20,000		<200	1
M1	Liquid Waste Disposal Valve Room	High level decontamination has been done. Hydrolaser used.	>10^6	<250	<30,000		1
M2	Entry Way	Some decontamination completed	>10^6	<100	<20,000		1
N1, N2	Bleed Holdup Tanks	Gross decontamination complete.		10^6	<5,000	<7,000	1
O1	Auxiliary Sump	Sump needs desludge, total clean and decon. Priorities being established on shielding, desludge, and decon. Hydrolaser used. Filters changed.	>10^6			5,000	1
O2	Auxiliary Sump Tank	Transfer of water from sump tank reduced dose rate 40%. Hydrolaser to be used for final decon resulting in low exposure. Tank desludge commenced		3,300		2,000	1,2
O3	Auxiliary Sump Valve Room	High level decontamination done. Hydrolasing complete.	>10^6	1,200	<50,000		1,5

D-9

ATTACHMENT C

PEIS - PRELIMINARY RECOVERY SCHEDULE AND ASSESSMENT OF COSTS

The preliminary revision to the schedule for TMI-2 decontamination and fuel removal reflects the impact of regulatory constraints, including the PEIS approvals and the processes described in NUREG-0698, and the availability of funds for cleanup. The effects of these developments results in a projected removal of fuel in August 1985 versus April 1983 as depicted in our baseline schedule issued in August 1980 with the Project Estimate. It is considered reasonable to anticipate that the schedule extension of 28 months may be conservative because of the continuing regulatory and financial constraints.

A preliminary assessment of the costs associated with the schedule extension and future funding constraints is expected to increase the baseline estimate by about $150 million. The Project Estimate of August 1, 1980 projected a cost of about $400 million from 1981 to 1985. Added to this cost is 1979 and 1980 costs of about 200 million and now an estimated schedule extension cost of $150 million. This results in a preliminary estimate for cleanup cost of about $750 million, in 1980 dollars. If the inflation rate is assumed to be 10 perent per year, this would add about $250 million and bring the total TMI-2 cleanup costs to approximately $1 billion. This is $700 million over the $300 million of insurance coverage.

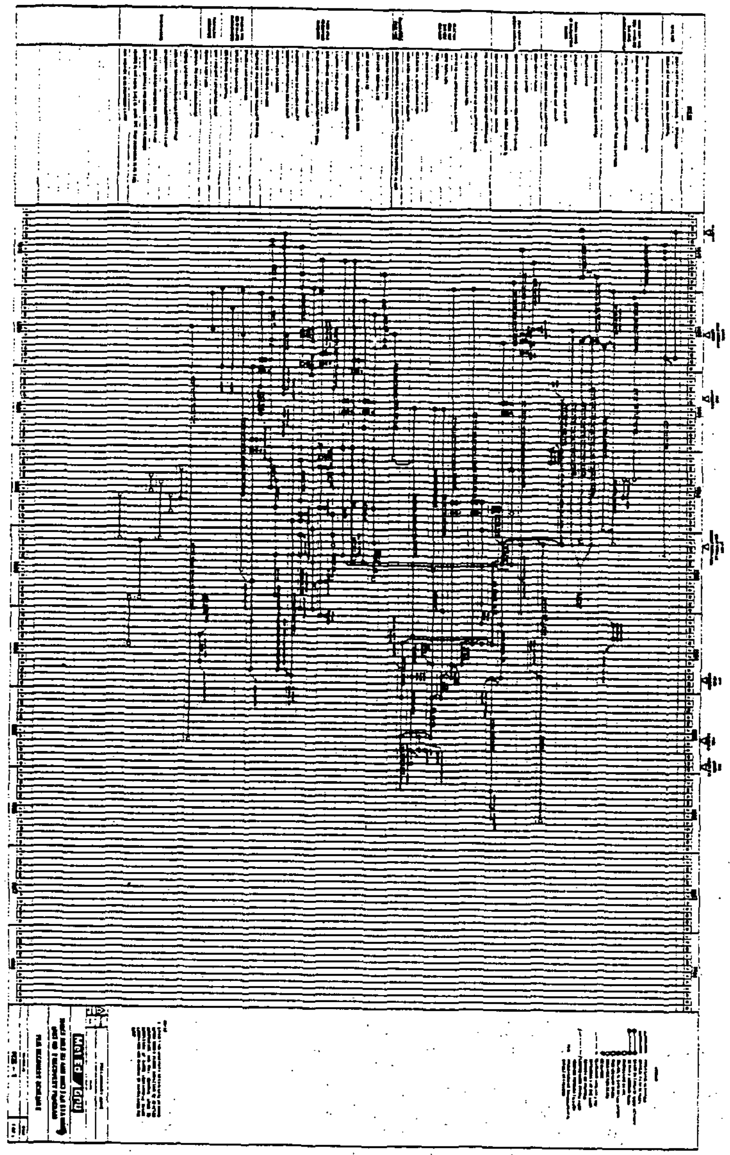
Table 0.3. Decontamination Status for Elevation 328 as of September 1, 1980

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts (see footnotes)
A	Concentrated Waste Tank	Initial decon done.		3,000		<40	1
B	Mix Tank Area	Gross decon complete, floor drains unplugged. Maintenance required for further decon.					1
C	FHB East Corridor	North section decontaminated, south section high dose rate from N_2 filters.	200,000		1,000		2,4

[a]See Figures 0.1 through 0.3.
[b]DPM/100 cm^2.
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--*not yet started.*
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

0-10



Met-Ed GPU

Metropolitan Edison Company
Post Office Box 480
Middletown, Pennsylvania 17057

Writer's Direct Dial Number

November 14, 1980
TLL 594

TMI Program Office
Attn: Mr. Bernard J. Snyder
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 2 (TMI-2)
Operating License No. DPR-73
Docket No. 50-320
Programmatic Environmental Impact Statement Comments

Please replace page 2 of Attachment 2 to our TLL 578, dated November 7, 1980, with the attached page.

Also, the notes on the PEIS Recovery Schedule on Attachment C to TLL 578 should be replaced with the following:

1. Studies are underway to re-examine the schedule logic and alternate approaches to or sequencing of cleanup and defueling activities. Such studies, along with an increased understanding of conditions in the reactor building, may result in future changes to this schedule.

Sincerely,

G. K. Hovey
Vice-President and
Director, TMI-2

GKH:EDF:dad

cc: John T. Collins

Enclosure

CHAPTER 1

INTRODUCTION

1. Section 1.2 - Last paragraph on Page 1-3 should be updated to describe conditions observed in recent containment entries.

2. Section 1.3 - First paragraph requires updating to the latest released cost estimate and schedule.

3. Section 1.4 - The PEIS should be modified to make it clear that the NRC does not necessarily agree with the public concern as stated in the tabulation. For example, we disagree that cost of alternative methods should not be a consideration. Cost always has to be a consideration and must be considered with other factors.

4. Section 1.5.1 - Requires updating to describe recent containment entries.

5. Section 1.6.1.2 - The 10 Ci/ft^3 loading for organic resins should not be used as a limiting factor.

6. Section 1.6.1.2 - Proposed 10CFR Parts 60 and 61 are proposed regulations and should be treated as such.

7. Section 1.6.2.2 - Change Permit 2275214 to 2275724, with amendments; change January 19, 1986 to December 31, 1986; change December 12, 1981 to December 31, 1981.

8. Section 1.6.3 - There appears to be a printing error in the text (top of page 1-26).

9. Section 1.6.3.2 - The criteria stating that doses from the previous year must be added to those estimated for a new activity is too restrictive. The new activity doses should be added to previous doses to make up a total 1 year dose, not 1 year plus the new activity.

10. Section 1.6.3.2 - The PEIS proposes modification to the Technical Specifications to request the licensee to calculate potential offsite doses for each step of the recovery process.

Since the draft PEIS concludes that the "health effects over the period from the on-set of the accident through completion of the cleanup operation will be non-existent," it does not appear to be a useful utilization of the licensee's engineering staff nor

Met-Ed GPU

Metropolitan Edison Company
Post Office Box 480
Middletown, Pennsylvania 17057

Writer's Direct Dial Number

November 26, 1980
TLL 627

TMI Program Office
Attn: Mr. Bernard J. S
U. S. Nuclear Regulato sion
Washington, D.C. 20

Dear Sir:

Three Mile I .d Nuclear Station, Unit 2 (TMI-2)
Op ating License No. DPR-73
Docket No. 50-320
Programmatic Environmental Impact Statement Comments

Please replace page 21 of Attachment A to our TLL 578, dated November 7, 1980, with the attached page.

Sincerely,

G. K. Hovey
Vice-President and
Director, TMI-2

GKH:GJM:dad

cc: John T. Collins

Enclosure

40. Section 6.6.3.1 - If solidification of the zeolite and cation resin is not required, these beds can be loaded with 10 ft.^{3} of resin.

The mixed bed vessel has a volume of 195 ft.^{3} and will be loaded with approximately 155 ft.^{3} resin.

This comment also applies to Table 6.6-9. See comment 19 on chapter 5 section 5.4.2.2 concerning relative waste volumes resulting from solidification of organic resin with vinyl ester styrene or cement. The text of 6.6.3.1 and table 6.6.-9 should be revised accordingly.

41. Section 6.6.3.4 - It is not clear how contamination would be controlled at the baling station while compressing sheet metal and mirror insulation.

42. Section 6.6.3.5 - It is not clear how the 2,500 to 5,000 drums mentioned relate to the 14,000 to 20,000 gallons of decontamination solution mentioned in earlier sections.

43. Table 6.2-1 - Revise the table to read as follows:

Location and Source	Whole-Body Dose Rates from Gamma Radiation (rad/hr)	Skin Dose Rates from Beta Radiation[b] (rad/hr)
347-ft. Elevation		
Plateout	0.1 to 0.2[c]	0.2 to 1.0
Sump Water	0	0
305-ft. Elevation		
Plateout	0.1 to 0.2	0.2 to 1.0
Sump Water	0.4 to 0.5	0
Stairs No. 1 and 2		
Plateout	0.1 to 0.2[d]	0.2 to 1.0[d]
Sump Water	-	-

Notes to the table should be changed as follows:

b The skin dose rates are for workers not wearing protective clothing. Clothing with a thickness of 500 mg/cm^2 is sufficient to stop beta radiation from all of the major plateout sources except Y-90, for which only 95 percent of the beta radiation is stopped.

c From measurement made by licensee on August 15, 1980.

d The staff assumed that plateout on the stairs was about the same as the plateout on the 305-ft. elevation.

November 4, 1980

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

Dear Mr. Snyder,

I know that the NRC is interested in our comments and questions on the Environmental Impact Statement. After reading the EIS, I have the following questions and/or comments.

1. Why has Cumberland County been left out of the total EIS (3-19)? You have given no information on the population, geography,etc. is given for Cumberland County. Please use the 1980 census statistics instead of 1970 census statistics for the final EIS.

No mention is made of two major military installations in the area - New Cumberland Army Depot and the Mechanicsburg Navy Depot. What would happen if these facilities were forced to close because of another accident at TMI Unit II? Many employees of these depots did leave the area during March 1979. It seems strange to me that you discuss Lancaster and even Gettysburg, but do not give any consideration to these military installations.

2. Where will the high and low level waste materials from the Unit II cleanup be sent? It is general knowledge that the Hanford Washington will probably not be available after 1981 for nuclear plant waste. (NUREG 0732)

I was glad to see that you had a new map for the route to be used for waste transportation. (Question 110) However, I do not like your answer, "Currently the truck goes...". What about future use? Will you use the route shown in the EIS draft?

On page 2-1 you state, "It is unlikely that the site could be qualified as a candidate high-level waste repository site because of such factors as nearby population densities and hydrology." This has disturbed many of us. What is the difference between site selection for high level waste and site selection for a nuclear power plant? At a meeting in Swarata Township John Collins stated that it is possible that we could have nuclear waste at TMI for 50 to 60 years. To my children and I this represents a rather permanent storage site.

Is the waste that is stored on the island considered to be safe from air traffic accidents? The NRC said that the reactor buildings were safe from air collision, how about the waste materials and the pools of water in which the rods are to be kept? The Harrisburg International Airport was not mentioned in the EIS draft.

3. Met-Ed has slowed clean up operations and reduced staff because of financial problems. When does the NRC step in to keep the clean up operations going and to maintain a pace the NRC has considered to be so important? What will happen to the clean up and the plant if Met-Ed goes bankrupt?

4. What ever happened to the evacuation plans? It has been over 18 months since the accident and the public has still not been informed or issued evacuation plans. Why wasn't an evacuation plan part of the EIS? At no place in the EIS is the possibility of evacuation due to problems during clean up mentioned?

5.Can Unit I be used to help in the cleanup of Unit II? For example, could Unit I be used to store waste water, could storage pools be used, or could it help provide better security? Is it hazardous to have Unit I go back on line prior to having Unit II cleaned-up? Should information on Unit I be included in the final EIS? It seems that public officials do not want to discuss Unit I bacause of the hearings on Unit I restart.

6. Figure 3.1-2. Cumberland County and its county seat, Carlisle are not on the map. Neither is Mechanicsburg, where the Naval Supply Depot is located or New Cumberland, where the Army Depot is located. The corrected map on page 24 of the Question and Answer Booklet should be corrected to show TMI in Dauphin and not Lebanon County.

7. Many of your references are secondary references. For example, in References--Sec. 3.1, reference 3 is a geology text book, "Structural Geology of North America." Please include the state, federal, and contracted studies in your reference list. Use original sources.

Much of what you use from Reference 1, is outdated material and should be checked before being used. What is the geology 1000 feet down? Should you know this information if you are going to store waste in the area?

I was also concerned about you references for weather and hydrology. I hope your weather information is based on more than Reference 9 - Local Climatological Data. Shouldn't you have additional weather data if you are to release krypton, etc.? What are the upper winds aloof, etc.?

Concerning hydrology (3-6) I think you should check your information on the pump storage facility consisting of two reservoirs and dams scheduled for completion in 1980-1984. Please update the Stony Creek Project. Will this change your flood forecast for TMI? What is the height of the dike or flood wall around the island and the waste storage areas?

I have the aerial photographs of Three Mile Island during the flood of June 1972. On the photographs it appears as if most of the island was covered. Is this true. Is it true that the bridges and access to the plant were inundated?

8.On page 3-24 you state that "The continuing tension seems related to two issues: future decomination plans for TMI-2, and a distrust of those responsible for these activities." I think that you have neglected to mention another source of tension and that is the prospect of Unit 1 being allowed to restart. Living in the shadow of the TMI towers is bad enough at the present time without having the additional threat of another accident at the plant being a part of our lives. The estimated time for cleanup is 7 to 10 years this alone is enough to cause stress for many of us.

9. Where are the containers holding resins from the Epicor II being stored? I have recently read from <u>Inside NRC</u> that radioactive decay of isotopes stored in some of the containers on site may be causing the resins to degrade into a jelly-like matter that could emit gases and cause the canisters to corrode. The possible solution to this dilema was said to be onsite incineration. Would this incineration release additional radiation into the atmosphere?

Now that we have lived through the week long venting of krypton, and continue to live with the almost weekly ventings of additional kyrpton do we have yet another large emmission of radioactive gas to look forward to?

Sincerely yours,

Edwin Charles Mary Ann Charles

Edwin and Mary Ann Charles

cc: Gus Speth
Allen Ertel
Bill Goodling
Governor Thornburg

JAMES B. COULTER
SECRETARY

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

BUREAU OF MINES
ENERGY OFFICE
POWER PLANT SITING PROGRAM

November 20, 1980

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

RE: Draft Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident at Three Mile Island Nuclear Station Unit 2 (NUREG-0683)

Dear Dr. Snyder:

The subject document has been carefully reviewed by Maryland's Department of Health and Mental Hygiene, Department of Natural Resources and the Governor's Committee of Three Mile Island. These comments are submitted on behalf of the State of Maryland by the Power Plant Siting Program, which has been designated as lead agency for Maryland's TMI related activities. The recommendations made to the Governor by his Committee are attached as Appendix A.

Maryland concurs completely in the only decision recommended by the document: that the "no action" alternatives be given no further consideration. It is our position that the TMI Unit 2 should be decontaminated to normal levels as rapidly as is consistent with careful planning. The draft document is a compilation of much useful information and is thus one step forward in this planning effort. In providing comments on the document, it is necessary to bring out its weaknesses and errors so that the document can be improved. On balance we believe the document reveals considerable progress on the part of the NRC in evaluating the options available for the cleanup at Three Mile Island.

Three serious deficiencies in the current draft of the document make it insufficient for programmatic planning, however. No viable option has been presented for prompt removal of the radioactive wastes from the island. There are no data presented on the costs of the various options for each step. There is no serious attempt to evaluate the economic impacts to the Maryland fishing and hunting related industries in the Chesapeake Bay that might be caused by highly publicized releases of decontaminated water to the Susquehanna River. Consequently, the document is substantially incomplete and provides insufficient basis for comprehensive public input to NRC's decision making process. In order to keep the decision process moving as quickly as possible, we have provided policy choices and technical opinions where it was possible to do so on the basis of the information contained in the document.

A set of detailed technical comments is attached as Appendix B. It has been divided into three sections: deficiencies, errors and comments. In addition, we wish to make and discuss several recommendations.

With regard to the difficulties involved in the planning for removal of radioactive wastes from the island, the draft document fails to substantively address the option recommended by Maryland during the scoping process, that DOE accept all wastes unsuitable for operating commercial burial sites and store them with similar wastes that Department obtains from defense related projects. The draft document simply dismissed this option as being contrary to DOE policy. Governor Hughes has written the President asking that an exception be made to this policy for TMI accident-generated solid wastes. A copy of this letter is attached as Appendix C. The NRC should evaluate this option from a technical perspective. If there are any technical constraints on the physical forms of waste that could be handled by DOE, these should be identified by NRC, now. The choice of the various decontamination options and the design of the actual systems must be made in such a manner that the waste forms are readily acceptable by DOE. If the decontamination processes were to be conducted in some other manner, such that DOE was required to establish new facilities or processes before accepting TMI wates, the wastes would probably be stranded on the island for decades.

The lack of cost data in the draft document makes it impossible to recommend among many of the various options. Should the cost of the cleanup process bankrupt the Metropolitan Edison Company, environmental protection is not assured and decontamination would be long delayed, at best. Recent rulings by the Pennsylvania Public Utilities Commission, restricting the finances available to the Metropolitan Edison Company for the decontamination process, serve to illustrate that cost is an important consideration. The NRC must carefully weigh the costs of systems and the cost of delays for procurement and installation of systems. The public should also have available to it the costs of the options before it is expected to make its recommendations to the NRC.

With regard to the option of discharging decontaminated water to the Susquehanna River, the draft document fails to consider the economic impact that may occur to Maryland's fishing and waterfowl hunting related industries due to the public reaction. Without any quantification of the impact, nor of the costs of no-discharge alternatives, we have no sound basis for choosing among the options.

We wish to be absolutely clear on one point: we concur with the NRC's conclusion that the radiological impact of releasing the decontaminated water would be trivial. This is based upon our own analyses of the impacts of much greater quantities of the same materials that are routinely released to the same river by the normal operations of Three Mile Island and Peach Bottom. Thus, the dispersion and bioaccumulation mechanisms actually at work in this ecosystem have been taken into account empirically in our calculations. A summary of our approach is attached as Appendix D. We do wish to stress two areas where our conclusions differ from those in the draft document. First, the bioaccumulatable radioisotopes of cesium and strontium will be trapped mainly in the Susquehanna Flats, not distributed down the Bay as far as the Potomac. (The tritium will not be trapped anywhere; it will follow the normal course of water as part of the hydrologic cycle.) The detectability of the TMI discharges in Maryland is also overstated by the draft document. The amounts of cesium and strontium proposed for release are small enough, in absolute terms, that they would be barely detectable in a pristine environment. However, the Susquehanna River and Chesapeake Bay have concentrations of the same isotopes from fallout and from releases of normally operating reactors. Since these other inputs far exceed that associated with the TMI decontaminated water, the incremental concentrations in Maryland's environment due to TMI releases would not be distinguishable from fluctuations in the totals caused by variability of Peach Bottom discharges and environmental dispersion factors.

In comparing the potential discharge of decontaminated water from TMI to the discharges from a normally operating reactor, it is clear that the accident at TMI has decreased the dose to Maryland's citizens compared to what would have occurred without the accidents. Our conservative estimates of the dose due to discharge of all the decontaminated TMI water is 0.9 mrem, about one fifth the dose associated with a single year's discharges of water from a reactor in normal operation, and about one thirtieth of the permitted annual dose from water discharged by a single reactor in normal operation. The discharge would be well within the TMI Operating License limitations.

However, it has been frequently demonstrated over the last 19 months that some persons will insist upon making incorrect and disturbing statements regarding the impacts of any release from TMI Unit 2, and that the news media will constantly bring these statements to the public's attention. Since the public has little factual knowledge of environmental radiation, it lacks the context for putting such pronouncements into proper perspective. This makes it very easy to generate fear in the public's mind, but very difficult to create sufficient public understanding to allay unnecessary fears. Consequently, it is very likely that any discharge of decontaminated TMI water will have associated with it some avoidance reaction, which is proportional to the intensity of the assertions by various pressure groups, rather than proportional to the magnitude of the release.

We are concerned that the fear created by the misleading assertions will cause the public to avoid fishing or hunting on Maryland waters, and will cause a loss of markets for our commercial fisheries harvest. There are three mechanisms for economic impacts to various Maryland industries. The first mechanism involves a general decline in the volume of sales because individual consumers choose not to buy seafoods at markets or restaurants. Seafood is generally considered a luxury item in these situations, and is very susceptible to replacement by other foods. The second mechanism involves the loss of wholesale customers for our commercial wholesalers. Maryland commercial wholesalers must compete with those from other areas, and they have found in the past that their competitors are willing to capitalize upon any unfavorable publicity that can be used to taint Maryland products in the minds of commercial buyers. The third mechanism involves the avoidance of the area itself by individual hunters and fishermen. This reduces the business of the sporting goods stores, boat captains and others catering to the sportsmen.

We have indications from past experiences that these impacts may not be trivial. However, we do not have the necessary quantification to support a cost/benefit comparison with other alternatives for handling the TMI decontaminated water.

Under these circumstances, we recommed that NRC proceed with its licensing of the Metropolitan Edison Company to decontaminate the accident-related water, and that the Company store all the processed water on-site, in the tanks now being constructed, until the necessary economic data has been made available by the NRC for public comment. The decision on ultimate disposal can thus be delayed without further cost or delay of the overall cleanup process.

The resin/zeolite type system, of which the Company's proposed Submerged Demineralizer System is an example, appears to be the best choice for treating the water. Our own sampling of the output from the EPICOR II system, another example of this type of decontamination process, assures us that such a system can be designed to adequately decontaminate the water. We consider the residual radioactivity levels in the draft documents to be good estimates of expected performance. However, because the actual performance of such decontamination systems depends as much upon the judgment and care of the operators as it does upon the system design, we still desire to check the actual levels in the processed water before taking a position on the suitability for discharge to the Susquehanna without further processing.

Our final comment has to do with the clarity of the draft document. It suffers from several editorial shortcomings that have caused serious misunderstandings in the public's perception of the issues. The principal problem is with the summaries; they are not informative enough. Such a large and necessarily redundant document needs a single comprehensive summary which is short enough to be read by everyone. The summary should include precise numerical information on such things as the actual volumes of water, total activities, residual activities, costs in dollars and the doses resulting from various alternative actions. The summary should also include the necessary information to provide context. Comparisons with values for normally operating reactors, license limitations, regulatory discharge standards drinking water standards and natural backgrounds should be made, as pertinent. The use of comparisons alone,

without providing the actual values, tends to destroy the readers' confidence by suggesting that the actual values are being kept from them unless they have the expertise to read the complete document.

The draft document also suffers from the computational and analytical errors noted, most of which appear in the summaries. Although many did not seriously affect the actual analyses, their correction will be necessary before the public can be expected to gain a realistic appreciation of the situation and the options for its resolution.

Another common failing throughout the draft document is the lack of explicit explanation of what was and what was not included in the analysis. For instance, many readers have apparently failed to recognize that bioaccumulation was included in the NRC's impact analysis. Also, the wording of several sections implies, incorrectly, that the output from a contaminated water processing system goes directly to the plant discharge at the rate of 30 gpm. The statement on page 3-15, that natural background should be interpreted to include the doses from fallout and other nuclear fuel cycle discharges, has been used to convince many readers that the NRC uses a floating standard for comparison with new dose increments, despite the fact that these man-made contributions are an insignificant increment to the natural levels being discussed.

In order for the public to have a valid basis for making input to the NRC's decision process, we believe it is necessary for the NRC to correct these errors and deficiencies, clarify these editorial misimplications, provide an adequate summary, and circulate the corrected document. The compilation of the basic information in the document is a positive accomplishment, providing confidence that the Three Mile Island Unit 2 can be decontaminated safely without significant environmental impacts. However, because of its shortcomings, combined with the NRC's overestimations of radiological impacts to the Chesapeake Bay, this draft of the PEIS has served to cause unnecessary worry for the public. This situation can only increase the potential economic impact on Maryland associated with any options involving discharges to the Susquehanna River. Circulation of the corrected document is one step towards diminishing this problem.

Sincerely,

Steven M. Long

Steven M. Long, Ph.D.
Director, Power Plant Siting Program

SML:ph

THE JOHNS HOPKINS MEDICAL INSTITUTIONS

DIVISIONS OF NUCLEAR MEDICINE AND RADIATION HEALTH SCIENCES

'5 NORTH WOLFE STREET
ALTIMORE, MARYLAND 21205

Telephone 301; 955-3350

November 14, 1980

The Honorable Harry R. Hughes
Governor, State of Maryland
Executive Department
Annapolis, Maryland 21404

Dear Governor Hughes:

The members of your Committee on Three Mile Island have examined the Draft of the Programmatic Environmental Impact Statement (PEIS), designated NUREG-0683, published July, 1980 by the Nuclear Regulatory Commission (NRC).

We have reviewed the data and conclusions of Dr. Steven Long and Mr. Richard McLean of the Maryland Power Plant Siting Program, described in their draft accompanying letter to the NRC and in two memoranda entitled: (1) Projecting effects of Three Mile Island discharges based on Peach Bottom's Measured Radiological Impacts, and (2) Briefing paper on the effects in Maryland from potential releases of decontaminated water at Three Mile Island.

We wish to emphasize our concurrence in your charge to our Committee that it is in the best interest of the citizens of Maryland to proceed expeditiously with the clean-up. It is unacceptable to take any course of action or inaction that would have the effect of making the Three Mile Island site a permanent or even a long-term radioactive waste storage facility.

The following are our conclusions with respect to the PEIS:

(1) A major deficiency of the statement is that it does not address the question of the ultimate disposal of the high level radioactive waste (chiefly but not exclusively the damaged fuel elements). We believe that this problem should be addressed now.

We recommend that the Department of Energy be instructed by the President to expedite the selection and utilization of a site for long-term storage of high level radioactive wastes from Three Mile Island, in order that the site be available for use within a period of seven years.

(2) We recommend that the approximately one million gallons of decontaminated water associated with the clean-up of Three Mile Island Unit #2 be stored initially in tanks to permit accurate assessment of its residual content of radioactivity prior to a decision regarding ultimate disposal. Our review of the projected levels of radioactivity in the processed water, as calculated by the NRC and by Dr. S. Long and Mr. R. McLean, indicates that, no significant hazards to either

public health or the biota of the Susquehanna River or the Bay would result from release of the decontaminated water under the conditions described in the PEIS. We believe that the socio-economic impact of the release of the decontaminated water on the seafood, recreational and other regional industries, which could be quite serious, has been inadequately addressed in the PEIS. Until studies of radioactivity content in stored water and the potential socio-economic impact of the release of decontaminated water are completed, we believe the NRC would have inadequate data on which to make an informed decision on the release of that water into the Susquehanna River. We believe that the decision should be delayed until completion of such studies and appropriate public review and comment. Deferral of the decision regarding ultimate disposal of the water for a period of approximately three years will not delay the decontamination process or itself result in any significant hazards. Storage tanks are now being prepared at the TMI site. With the help of their political leaders and scientific advisors, the public should again participate in the decision-making process at the time when a decision regarding the ultimate disposal of the water will need to be made.

(3) We agree with recent statements by the Chesapeake Bay Foundation that "the Chesapeake Bay is our nation's most productive body of water and its seafood resources are most important to this country."

Yours sincerely,

Henry N. Wagner, Jr.

Henry N. Wagner, Jr., M.D.
Chairman, Maryland Governor's
Committee on Three Mile Island

nlm

CC: Secretary Charles R. Buck, Jr.
Secretary James B. Coulter
Dr. Steven Long

APPENDIX B

Power Plant Siting Program Staff Review of

TMI Draft PEIS

Deficiencies

1. The level of planning in the document is not sufficent to ensure whether wastes will ever leave the island. High level waste disposal depends upon planned future federal actions on a repository. The Federal government has failed to make any progress in establishing a repository for 20 years, despite copious announcements and bureaucratic activity. Therefore, there must be established a mechanism for removing the high and low level wastes from the Island that is practical now. The Commission should set a date by which all accident related wastes will be removed from the island. A cut-off date should be established on which the aforementioned mechanism will be started if no other preferred mechanism has already been implemented.

2. The PEIS does not address the option of DOE storing TMI accident related wastes with defense wastes, as requested by Maryland during the scoping process. It is important that this option be protected, since it is the only currently viable one for promptly removing the wastes from the island. The NRC must be careful not to preclude this option by licensing a decontamination process which produces a solid waste form physically unsuitable for DOE's existing facilities or processes.

3. No costs are provided for any of the options considered. It is essential that costs be considered in selecting options, since the company is not endowed with limitless financial resources. Risks associated with each option must include the risk that the price of the option will contribute to the bankruptcy of Met. Ed. and the inability to complete the cleanup.

4. No attempt was made to quantify the socioeconomic impacts of various options. Release of decontaminated accident-generated water to the Susquehanna River is certain to be accompanied by press coverage of misleading and disturbing statements from some of the opposition groups. The public fear thus created will tend to cause a decrease in the marketability of Maryland's commercial seafood harvest, and an avoidance of the area thought to be affected by sport fishermen and waterfowl hunters. Past experience with other contamination scares suggests that these effects may cause significant economic penalties. The discussion of such effects on p. S-11 misses the point by assuming the public could "understand" the releases. The NRC's own study (Appendix E to the PEIS) demonstrated such aversion in resident fishermen in the Susquehanna near TMI at a time when the radioactivity levels had been reduced by the accident. The lessons learned in this study have been improperly extrapolated to an area that has many tourist fishermen and hunters. The NRC's study clearly shows aversion to eating fish caught, yet the document incorrectly concludes that marketability of commercial catch need not be impaired. These impacts must be properly addressed before there is sufficient basis for evaluating the discharge option.

Errors

1. Comparison of "water's edge" elevation of 280 ft. MSL on p. 3-1 with the "average elevation" of the island of 277 ft. MSL on p. 3-5 leads to the obvious conclusion that TMI is 3 ft. under water.

2. Table 3.1-1 (p. 3-4) The "Anions" listed are all cations and the "Cations" listed are all anions.

3. Section 4.5.3 (p. 4-5) states, "No accident having off-site consequences is postulated", but Section 4.4.2.2 (p. 4-4) states, "However, if overheating is assumed to occur and all the remaining Kr-85 and cesium were released to the reactor building, the total activity from this hypothetical release would be about the same as the activity inside the reactor building prior to purging". This means that the environmental effects would eventually be the same as the purge already conducted, since another purge would be required.

4. Correspondence between tables 6.5-2 and 6.5-5 and between tables 6.5-3 and 6.5-6 is unclear with regard to total release to the river for the entire process. From Appendix G, table 6.6-7 appears correct, and table 6.5-5 appears to be low by a factor of 1,667.

5. Table 10.1-2 is obviously in error for sump water releases. Apparently concentrations in table 6.3-5 were multiplied by the value at top of each column, neglecting the factor of 1200 ($\frac{3600 \text{ gpm}}{30 \text{ gpm}}$) dilution in the concentrations. Correct values can be obtained from tables in Appendix K, where both the volumes and the concentrations of effluents are given prior to dilution by blowdown.

6. Tables 5.2-6 p. 5-16 and all later tables have incorrect $\frac{\text{Cs-134}}{\text{Cs-137}}$ ratios. The decontamination process cannot change the cesium ratio from that shown in Table 5.2-5 for the unprocessed water.

Comments

1. p. 1-26 "Requiring that the numerical design objectives of Appendix I to 10CFR50 are met will assure that the radiation dose received by the public during the cleanup operation is equivalent to or below that of a normal operating reactor".

   Not true, especially if the NRC intends to interpret 10CFR50 App. I to mean 10 Ci/quarter or 40 Ci/year, instead of 1.25 Ci/quarter. The Commission should announce specific numerical limites for aqueous discharges applicable to TMI unit 2 cleanup, as requested by Maryland during the scoping process. The PEIS is ambiguous. Normal discharges from an operating reactor typically give doses on the order of several tenths of a millirem annually to a maximally exposed individual, while Appendix I sets 3 mrem/yr. as the "achievable" level for a single reactor.

2. p. 1-26 Stating that the doses from the whole TMI event come to less than 25 mrem/yr for the maximally exposed individual is simply another way of stating that the cleanup will last well over 4 years, since the NRC is assuming the maximum public dose during the first weeks of the accident was somewhat less than 100 mrem. It masks the doses that will result from future, controllable events. State clearly what the doses will be from now forward. As now stated, the public does not have any opportunity to comment on the criteria the NRC staff will use "to make an informed decision should it be necessary to terminate or modify an operation".

3. Two of the "major options" on p. 2-1 are unacceptable to Maryland. These are "(c) use of the TMI-2 buildings and site as permanent waste repositories" and "(d) use the TMI-2 building and site as temporary waste repositories until a final decision is made." We concur that the island could not be qualified as a waste disposal or storage site. We disagree that the site is suitable for "interim storage" because there will be no distinguishable difference between the NRC's use of the term "interim storage" and permanent storage, unless and until DOE actually implements a permanent disposal facility.

4. p. 2-2 Maryland concurs that options involving core fixation are unacceptable, as are any other measures that would significantly increase the effort necessary to remove any radioactive wastes from the island.

5. p. 2-2 Maryland concurs that "no action" is an unnacceptable alternative.

6. p. 2-4 Maryland concurs with the staff's criterion "that no unprocessed accident water should remain after cleanup activities have been terminated or suspended for an indefinite period of time".

7. p. 2-6 Maryland concurs that the decision between decommissioning and rebuilding need not be made prior to commencement of cleanup. The time lost in reaching such a decision is not justified by the savings in component decontamination that could be obtained by scrapping instead of salvaging equipment.

8. Section 2.1.3.1 For the core fixation option, stating the weight and diameter of the "fixed" core plus the necessary shielding for transportation through public areas would make a stronger argument against this option in a lay person's mind.

9. p. 2-14 Section 2.2.2 indicates that many "low level wastes" will be peculiar to TMI and not necessarily suitable for existing commercial waste disposal mechanisms. These should have a specific mechanism for disposal or off-site storage ready before they are created. p. 3-28 states that some high specific activity, "low-level" wastes other than fuel are not acceptable at Richland.

10. p. 2-14 "Interim" storage of "several months" is recognized as necessary to cleanup operations. However, "long-term" storage of "10 to 20 years" on site is recognized as evasion of the issue and is unacceptable to Maryland.

11. p. 3-13 did not include Perryville, Havre de Grace and Port Deposit water intakes in Maryland. Why stop at "50 miles" when the river flows just 10 more miles and passes 3 more public water supply intakes before entering the brackish water regime? (These intakes are shown on Fig. 3.1-6.)

12. p. 3-15 "'Natural background' should be interpreted to mean normal background, including the effects of fallout from past nuclear weapons detonations and from the nuclear fuel cycle".

There is no reason to call fallout and nuclear fuel cycle emissions "natural". To do so may cause the public to believe the NRC is attempting to inflate the basis of comparison for TMI created doses so as to make the TMI doses appear less significant. Since the dose rates from fallout and normal fuel cycle emissions are less than the local variations in the natural dose rate, there is no need to use them for comparisons.

13. p. 3-32 states "Present DOE policy does not allow disposal of TMI-2 low-level wastes at government facilities". Such a policy should not stop evaluation of this alternative, since DOE can be commanded by the President. The PEIS should evaluate the technical feasibility of DOE's immediate acceptance of the TMI wastes when they are ready for shipment. DOE could store TMI wastes with those from the military nuclear programs until its disposal facilities are completed. A fee could be charged, if necessary.

14. p. 5-13 The statement that solidification of processed water requires TMI to be classified as a low-level repository is a semantic delusion. If the processed water is acceptable for discharge in a fixed period of time, and could not leach from the block in a shorter time, then this argument is useless to a logical technical analysis. Is there a legal barrier to this option? Must the island be licensed for storage of other radioactive wastes in order to pursue this option?

15. p. 5-14 "Local Release to the River" compares the process flow rate of EPICOR II with the cooling tower blow-down rate and calculates a dilution factor, implying direct discharge to the river after processing. This procedure is unacceptable to Maryland. All materials to be discharged must be held on site for batch sampling and approval prior to any discharge. Continuous stream discharges are too susceptible to accidental spillage. We believe that the implication was not intended, but feel it must be corrected.

16. Forced evaporation options are not adequately addressed. Heated ponds leave some of the cesium isotopes behind in the mud, eventually to wash off site. Sprays in ponds cause drift, as do cooling towers, carrying some cesium off-site. Other option should be addressed. Forced evaporation in a container, with filtered vapor venting, would allow release of essentially nothing but tritium, and would allow non-volatiles in the bottom water to be solidified in a physically small volume.

17. p. 5-37 The first paragraph indicates that accident sludges will be packed in 55 gallon drums and held, pending a decision on how to handle them. Since this is high specific activity waste (65 Ci/ft^3), it appeas that this material may be contemplated for "long-term storage" at the site. Dewatered sludge of such high activity in steel drums is not acceptable for indefinite storage. A fixation process must be settled upon now.

18. Section 6.3.2 p. 6-14 The arguments presented against direct solidification of sump water with cement seem weak. Transport in 600 or 1,200 truckloads is not an insurmountable task. (How many truckloads of cement were brought to TMI during construction?) The necessity for shielding should have been calculated. The acceptability of the resulting drums for disposal at Richland and the available space at Richland should have been checked in further consideration of this option. Specific activity would be $\sim$ 15 Ci/drum. Is this acceptable for low level disposal sites?

19. p. 6-15 Indefinite storage of the "high activity, coreosive filtrate" at TMI is unacceptable to Maryland.

20. p. 6-19 The "staff analysis", referred to in Section 6.3.4.2 for effects of a leak to the river, should have been included for review in the draft PEIS. Assuming the whole 700,000 gallons (500,000 Ci) leaks to the river in "one to two days", and using the previously applied river flow rate of 1700 cfs, the concentration downstream would be .00012 Ci/l = 0.12 μ Ci/ml. The staff analysis showing only 2.8 x 10^{-16} μCi/ml Cs-137 and 2.3 x 10^{-8} μCi/ml Sr-90 downstream thus has a very large mitigating factor in ion-exchange with the soil plus additional dilution due to the protracted release period from the soil to the river. Given the statements on p.3-5 regarding drilling water loss and the suggestion of open fractures in the underlying geologic structure, and given the statements on p.3-1 that stratified sand and gravel with some "clean sand" underlie the site, such mitigating assumptions seem unsupportable with present knowledge. The idea that the water could even be lost in "one or two days" would require an undergroung flow channel to be feasible, which is inconsistent with the postulated 1.6 yr. soil retention time. We therefore feel that the effects of the maximum possible leak have been drastically understated. This tends to improperly lend support to the "no action" options and detract from the immediacy of the present problem.

21. p. 6-22 Tables 6.3-7 and 8 show release of 75 mCi of cesium isotopes due to the loss of a HEPA filter. p. 6-21 states "HEPA filter failures not related to fire are assumed to occur". If this means that such failures are expected during cleanup operations, then redundant filters, with detection devices between them, should be employed, and testing of the outer filter should be conducted to be sure it does not fail first. p. 6-26 gives 1.1 mrem/accident, mainly due to ingestion. This assumes 6.7 x 10^{-6} m/sec^2 for X/Q. Dispersion could be much worse. This is not adequate for accident analysis. p. 6-26 states hourly X/Q values may be within a factor of 500 times this value. That means possibly 4.4 mrem inhalation and 550 mrem ingestion doses. The latter figure indicates that farm crops may be lost, rather then that somebody would actually suffer the dose.

22. p. 6-24 Loss of sump water to the river through soil gives 59 mrem/yr. This seems entirely too low. See comment #18.

23. p. 6-28 states "... it is probable that some residual radioactivity from TMI-2 could be found as far south as the mouth of the Potomac River". This conclusion by the NRC staff is based upon faulty analysis of the literature, and is contradicted by Maryland's radiological sampling of the Bay to determine the distribution of the same radionuclides that are released from the Peach Bottom Atomic Generating Station during normal operations. The NRC analysis rests upon a paper in Estuarine and Coastal Marine Science by Eaton, Grant and Gross (Oct. 1980) purporting to shown that sediment in the Bay as far south as the mouth of the Potomac is principally derived from the Susquehanna River. Even if this is true, and it is disputed by many, the sediment has had at least tens of thousands of years to get this far. Maryland's radiological monitoring data from the head of the Bay indicates that Peach Bottom discharges give maximum concentrations of Cs-137 in fish in the vicinity of Conowingo Dam, and maximum concentrations in sediments at the river mouth. Concentrations in all media have declined by two orders of magnitude by the mouth of the Sassafrass River, becoming undetectable beyond. Since Peach Bottom releases about 10 times more Cs-137 annually than is contemplated for the entire TMI cleanup, release of the treated TMI water over an extended period makes detection of the TMI effects unlikely at any location in Maryland waters, and dubious in the Holtwood Reservoir, the first upstream station unaffected by Peach Bottom.

24. p. 6-28 also states, "Once in the flats, the radionuclides will be diluted by a factor of one thousand within 30 days, and more rapidly further into the Bay". This statement is obviously false for a continuous discharge situation, including any discharge with a duration approaching the flushing time of the Bay, which is about 1 year. Virtually all the fresh water on the flats comes from the Susquehanna River. The Susquehanna provides about 80% of the freshwater input to the Bay above the confluence with the Potomac River. Consequently, dilution is principally by the seawater transported up the estuary, and steady state dilution can be estimated from the local salinity. In the steady state, even a factor of 2 dilution will not occur until a salinity of 15 ppt is reached (down near Calvert Cliffs). For short term releases, the dilution will depend upon the duration of release, the volume of water on the flats, and the extant mixing conditions on the flats, which are strongly affected by river flow rate, astronomical tides and wind patterns. Consequently, the analysis of the behavior of radionuclides in the upper Bay cannot be treated in the same manner for controlled releases and accidental releases, as was done in the PEIS. The physical mechanisms for removal of radionuclides from the water column to the sediments appear to be much more important factors than dillution in determining the distribution of any isotope but tritium.

25. Section 9.1.1 (p. 9-1) states that EPICOR I wastes will be stored at the on-site interim storage facility. Why aren't EPICOR I resins shipped off-site as in normal operation? This system should not be used for creating such high specific activity wastes that they aren't acceptable at the operating repositories.

26. Section 9.5.1.2 (p. 9-15) states, "... maximum radiation levels at the fence surrounding the facility from the interim storage and staging facility will be less than 0.5 mR/hr". We assume this is at the fence surrounding the storage facility, not the site boundary. What is the maximum off-site (boundary) dose rate?

27. Section 10.5.3 neglects to discuss the integrity of the interim storage facility and the concrete storage facility during the probable maximum flood. Has this been investigated? Were the buoyant forces of the cells, the side forces of any currents and the relationship of the center of gravity to the center of buoyancy for individual modules evaluated? What were the conclusions? The analysis presented in the PEIS assumes structural integrity, but this could be questioned, expecially for the interim storage facility, which is mostly dirt fill.

28. The PEIS sections and appendices all treat the various cleanup systems for sump water, primary loop water and decontamination water as if they are deterministic devices whose performances do not depend upon the care and judgment of their operators. In fact, the effluent numbers for the various options are only the NRC staff's assessment of how these systems might perform; the Metropolitan Edison Company is currently free to do better or worse. Given the existing operating license, the Company could conceivably do about 160 times worse and still be considered by the NRC to have complied with their limit of 10 curies/quarter/reactor for the discharge of bioaccumulatable radionuclides to the river for one year. The statement should, with proper consideration of cost, determine what performance is "practicable" with each of these systems to meet the criterion of 10CFR50 App. I that radioactivity releases to the environment be kept "as low as practicable". These performance standards, for the system implemented, should then be made binding upon the Company. If the NRC does not chose to proceed in this manner, then the PEIS is deficient in that there is no consideration of the probable range of performance of each system (as was done for volumes of solid waste), and those following environmental impact analyses are improperly founded.

STATE OF MARYLAND
EXECUTIVE DEPARTMENT
ANNAPOLIS, MARYLAND 21404

HARRY HUGHES
GOVERNOR

October 3, 1980

The President
The White House
Washington, D. C. 20500

Dear Mr. President:

I am writing to request your assistance in a matter of great concern to the State of Maryland. The Nuclear Regulatory Commission's draft Programmatic Environmental Impact Statement for the Three Mile Island clean-up has failed to address any alternatives which provide assurance that the radioactive wastes will be removed from the island without decades of delay. All plans addressed require that the Department of Energy first establish a storage facility or repository for commercial high level radioactive wastes and high specific activity wastes. However, the lack of progress towards establishment of such facilities over the last 25 years renders any current schedules subject to skepticism.

There is one option which can guarantee the capability for timely removal from the island of the high level wastes, transuranic wastes, and those high specific activity wastes unacceptable at existing commercial repositories. This is for DOE to accept these wastes for storage with the similar wastes that DOE now handles from the defense-related nuclear projects. Although Maryland formally suggested during the scoping process that NRC consider this alternative, it was dismissed in the draft statement with the simple declarations that DOE policy does not allow for disposal of TMI low-level wastes at government facilities, and that DOE is studying the high-level waste problems.

I am therefore requesting that you use your authority as President to direct DOE and NRC to explicitly consider the technical feasibility of this option, and to direct DOE to make an exception to its policy by accepting these TMI clean-up wastes for which there is no available off-site storage facility.

The unusual nature of the accident derived wastes is reason enough for such an exception. The recent decision by the Pennsylvania Public Utilities Commission prohibiting use of revenue from ratepayers for the TMI clean-up, has created a situation of institutional instability for the Metropolitan Edison Company. This makes it imperative to identify and confirm at this time a location to which the wastes can be removed. The clean-up activities should be planned and conducted in a manner that will insure that disposal with defense related nuclear waste remains a viable option.

The draft environmental impact statement reveals that federal agencies are following a course of action that will make Three Mile Island a long-term storage dump for radioactive waste. Nothing could be more dangerous to Chesapeake Bay and the people of Maryland. No responsible agency would locate a dump for radioactive waste on an island in a flood plain above the water supply of a major metropolitan area, and poised at the head of Chesapeake Bay. Yet, because of refusal to consider any other realistic alternative, that will be the result of actions described in the draft environmental impact statement.

Because this is an unusual situation and because of the unusual threat to people in Maryland and Chesapeake Bay, I am making this unusual request that you intervene with the Departments of Defense and Energy and insist that all of the radioactive waste be removed from Three Mile Island as quickly as safety will permit--even if it means disposing of them for some extended period with waste from defense operations.

I would appreciate your response at your earliest convenience.

Sincerely,

Governor

APPENDIX D

JAMES B. COULTER
SECRETARY

BUREAU OF MINES
ENERGY OFFICE
POWER PLANT SITING PROGRAM

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

October 14, 1980

MEMORANDUM

TO: Steve Long

FROM: Richard McLean

SUBJ: Projecting Effects of TMI Discharges Based on Peach Bottom's Calculated Radiological Impact

Our assessment of Peach Bottom radioecological impact has provided extensive data on radionuclide concentrations in biota and sediments of the Susquehanna River and Upper Chesapeake Bay. Both Peach Bottom and weapons-testing fallout have contributed Cs-137 to the ecosystem, a fact which complicates the process of estimating the power plant increment to environmental Cs-137 levels. Cs-134 concentrations are, however, attributable solely to Peach Bottom effluents. For this reason I have used Cs-134 environmental values and Peach Bottom Cs-134 release data to estimate radiocesium concentration increments in finfish and sediments which would result from a controlled release of processed water at Three Mile Island. Also provided are estimates of radiocesium and tritium concentrations in Conowingo Pond which would result from a controlled release of processed water assuming a mean river flow of 34,000 cfs. Estimated dose commitments to adult individuals consuming the finfish and water are included. These estimates are based on the following assumptions:

1. The radiological effects seen in the Conowingo Pond, Susquehanna River and Chesapeake Bay resulting from a controlled release from Three Mile Island are equivalent to the radiological effects resulting from a controlled release of the same amount of radioactivity from Peach Bottom.

2. The environmental concentrations of Cs-134 in our sediment and finfish samples are effected solely by the 1.62 Ci of that isotope discharged from Peach Bottom during the second quarter of 1979.

3. Similarly, the activity from TMI which results in the estimated concentrations in finfish and sediments is released over a period of one quarter.

4. Quantities of radionuclides (activity) released from TMI correspond to those given in PEIS Table 5.2-11 for EPICOR processed water and those derived from PEIS Table 6.3-5 for Submerged Demineralizer System (SDS) processed water.

5. The decay of Cs-134 is not considered.

6. The behavior and ratios of release activity to sample concentrations are the same for Cs-137 and Cs-134.

The values used in these calculations are the maximum detected concentrations in our finfish and sediment samples. The estimates of concentrations resulting from a release at TMI therefore represent upper bounds based upon our sampling program. Additionally, assumptions 1 and 2 provide some measure of overestimation by not accounting for some loss of radioactivity above Conowingo Pond (1), and assuming that Cs-134 environmental concentrations result from only the previous quarter's discharge (2).

To provide some perspective on the TMI-related concentration estimates, fallout-derived levels (based upon our analysis of remote Chesapeake Bay samples), and Peach Bottom associated concentrations are included.

RIM:ldn
attachments

RESULTS:

A. Finfish

This table gives estimates of the Cs-137 and Cs-134 concentration increments in finfish flesh and the dose commitment to an adult consuming 21 kg of such fish for TMI processed water releases. Fallout and Peach Bottom-derived concentrations are included for perspective.

	Radionuclide	Activity Released (Ci)	Concentration in Finfish (pCi/kg)	Total Body Dose (mrem)
1. TMI Discharges				
EPICOR[a]	Cs-137	.0079	1.1	.00165
	Cs-134	.0013	0.2	.00047
				.00212
SDS[b]	Cs-137	.215	30.5	.0457
	Cs-134	.037	5.3	.0135
				.0592
2. Fallout[c]	Cs-137	--	~12.0	.018
	Cs-134	--	0.0	0.0
				.018
3. Peach Bottom[c]	Cs-137	1.3	~300.0[d]	.45
	Cs-134	1.62	230.0	.59
				1.04

[a]Table 5.2-11

[b]Table 6.3-5

[c]PPSP Data

[d]Median Cs-137 concentrations in finfish within the influence of Peach Bottom effluents are essentially indistinguishable from fallout-attributable levels, although the presence of Cs-134 in many indicates a Peach Bottom supplied Cs-137 increment as well. This sample of White Crappie which contained the maximum detected Cs-134 concentration represents the only finfish collection where a Peach Bottom Cs-137 increment is assignable.

B. Sediments

This table gives estimates of the Cs-137 and Cs-134 concentration increments in sediments which would result from the release of TMI processed water. Fallout and Peach Bottom-derived concentrations are included for perspective.

	Radionuclide	Activity Released (Ci)	Concentrations in Sediment (pCi/dry kg) Conowingo Pond	River Mouth	Susq. Flats	Upper Bay
1. TMI Discharges						
EPICOR[a]	Cs-137	.0079	1	3	< 1	< 1
	Cs-134	.0013	< 1	< 1	< 1	< 1
SDS[b]	Cs-137	.215	< 27	85	< 27	< 27
	Cs-134	.037	4	15	3	< 1
2. Fallout[c]	Cs-137	--	e	e	e	e
	Cs-134	0	0	0	0	0
3. Peach Bottom[c]	Cs-137	1.3	d	d	d	d
	Cs-134	1.62	165	640	134	28

[a]Table 5.2-11

[b]Table 6.3-5

[c]PPSP Data

[d]Peach Bottom increment to Cs-137 in sediments unassessable due to fallout contributions.

[e]Concentrations range from < 27 pCi/kg (in sand) to ~700 pCi/kg (in clay).

C. Water

Because radionuclide concentrations are generally undetectable in Conowingo Pond, estimates of concentrations relative to Peach Bottom discharges are not possible. The calculations are for an integrated discharge of one year's duration and assume a mean river flow of 34,000 cfs. Dose commitments and amounts of activity ingested are annual and calculated assuming a water consumption rate of 2ℓ/day.

	Radionuclide	Activity Released (Ci)	Activity Ingested from Water Consumption (pCi)	Total Body Dose to Adult (mrem)
1. TMI Discharges				
EPICOR[a]	H-3	347	8345	.00088
	Cs-137	.0079	0.19	1.4×10^{-5}
	Cs-134	.0013	0.03	3.6×10^{-6}
				.00089
SDS[b]	H-3	3697	88900	.0093
	Cs-137	.215	5.17	.0004
	Cs-134	0.37	0.91	.0001
				.0098
2. Fallout[c]	H-3	d	219000	.022

[a]Table 5.2-11

[b]Table 6.3-3

[c]PPSP Data

[d]Tritium concentration in water is ~0.3 nCi/ℓ

THE PENNSYLVANIA STATE UNIVERSITY

UNIVERSITY PARK, PENNSYLVANIA 16802

College of Engineering
Breazeale Nucleur Reactor

Area Code 814
865-6351

11 November 1980

U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTENTION: Director, TMI Program Office

SUBJECT: Comments on Draft PEIS (NUREG-0683)

Gentlemen:

I am pleased to note that NUREG-0683 has made an attempt to study the activities necessary to decontaminate and manage the wastes from the accident at Three Mile Island-Unit 2 Nuclear Station. While there are many positive aspects to this document, I wish to point out here some of the areas which I consider as the deficiencies of the document, with the hope that these comments would help improve the overall approach to the problems of decontamination and waste management at TMI-2.

1. Several of the scenarios considered for the interim and long-term management of wastes resulting from TMI-2 cleanup operations are over optimistic. First of all, it is rather unrealistic to expect that all the wastes from TMI-2 can be shipped to the State of Washington. Recent responses to a referendum must have convinced the futility of such planning. Second, transportation of wastes from one end of the country to the other is not the best approach to the problem because accident probabilities in waste management are a maximum in the transportation phase.

2. This attempted study (NUREG-0683) does not seem to have the benefit of good safety analyses especially in the interim management of wastes. Specifically, the document does not address the consequences of chemical and radiolytic effects on waste forms during the interim management period and during subsequent handling and processing. The waste "staging area" at TMI is bound to be in business for a very long time and the hazards of interim storage need to be assessed immediately and corrective and preventive actions need to be instituted.

3. It is too simplistic to consider the wastes from TMI-2 cleanup operations as "low level wastes" and to consider shallow land burial of the ion exchange beds as a viable alternate.

4. The waste loadings of ion exchange liners considered (and some of them already performed) are far in excess of the quantities with which there is process experience. However, this document does not give adequate consideration to the problems and consequences of radiation damages to ion exchangers. There is an almost apologetic passing reference to the problem and no serious discussions. It

seems that some of the well known publications on this topic have not been identified by the group preparing this document. Furthermore, there is no mention anywhere in the document about the generic nature of process materials used in waste consolidation and management. This makes the task of predicting potential problems extremely difficult, if not impossible. There is considerable experience in the U.S. and adequate knowledge internationally to recognize that radiation damages to ion exchangers can have catastrophic consequences if the wastes are not properly managed using well established scientific principles.

5. The PEIS often refers to "proprietory" and secret formulas for waste removal techniques and materials used in waste processing. It is very important to recognize that the peddlers of these remedies know nothing about the overall consequences of the use of these materials in the waste management system. It is also necessary that responsible scientists and regulatory agencies should have the full benefit of the generic nature of the materials and processes used in waste management at TMI-2. If this cannot be achieved very soon serious consequences can result from the misuse of these materials and techniques in the decontamination efforts at TMI-2.

6. There is a distinct lack of participation by the Commonwealth of Pennsylvania in developing pragmatic solutions to the TMI waste management problems. The wishful thinking on the part of the Commonwealth that all these wastes generated in Pennsylvania can be dumped in someone's backyard is a bit naive. It is time for the responsible agencies of the Commonwealth to wake up to the situation and develop sound programs to manage the wastes in the interim period and to seriously consider the necessity to dispose of some of these wastes within the boundaries of the Commonwealth.

7. The schedules proposed in the document are often unrealistic and some pragmatists ought to get involved in revising this document.

It is my considered opinion that there are significant gaps in our understanding of many areas of waste management efforts proposed in NUREG-0683. The recognition of these uncertainties would be a major step in solving the overall problem of decontamination and waste management. Parallel efforts should be directed at developing, verifying and confirming technological uncertainties. While an ideal solution to the decontamination and waste management problems at TMI-2 is not achievable in the near term, present knowledge can be used to develop acceptable solutions for the decontamination and waste management at the Three Mile Island Nuclear Station, Unit 2.

If I can elaborate on any of the points made, please let me hear from you.

Sincerely yours,

K.K.S. Pillay

KKSP/r

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 80/899

OCT 8 1980

Mr. 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 Mr. Snyder:

The Department of the Interior has reviewed the draft programmatic environmental statement on the decontamination and disposal of radioactive wastes at Three Mile Island Nuclear Station, Unit 2, Pennsylvania. We have the following comments.

We concur with the staff position expressed in the Conclusions that "long-term or prominent storage of high-level waste is not appropriate at the TMI site" (p. 12-2, par. 10). Elsewhere in the statement, however, the possibility of long-term onsite storage of damaged irradiated fuel is not ruled out if long-term offsite facilities are not available (p. 9-11, par. 3). We recommend that plans for appropriate offsite storage facilities be coordinated with decontamination plans for Three Mile Island to ensure that long-term storage of the damaged core on the island can be precluded.

Staff analyses of leakage of water into the ground from the auxiliary fuel-handling building (p. 5-17, par. 2) and the reactor building (p. 6-19, par. 3 and 4) are referred to, but only results in terms of time to reach the river and concentrations in the river at the nearest water supply intake are given. The assumptions and data used in this analysis are not given except for the assumption that for the reactor building all the sump water would leak out in one or two days (p. 6-19, par. 3). No indication is given as to how probable such an accident would be, but the impression is left that even without mitigating measures the consequences would not be serious. However, in the absence of the details of the staff analysis, this impression must be questioned. If there is a significant probability for the occurrence of such leaks involving very large quantities of radionuclides, a very rigorous analysis of consequences is warranted.

The consideration of a potential accident such as dropping a contaminated demineralizer liner from the monorail system (p. D-8, col. 1, par. 3) did not take into account the possibility of this occurring during rainfall. If this transfer operation would be taking place within an enclosure we foresee no problems. However, if it is occurring outside with rainfall, a potential new source of contaminated runoff is created.

We hope these comments will be of assistance to you.

Sincerely,

James H. Rathlesberger

Special Assistant to
Assistant SECRETARY

cc: Secretary's File Copy
Secretary's Reading File (2)
PEP
AS/PBA (2)
OPA/Mr. Kallman
REO-BOS
HCRS/ FWS/ NPS/ GS/ BM
PEP/Martin

PEP:TMartin:sjm:10/3/80:X6128

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 2063
Harrisburg, PA 17120

Secretary

November 13, 1980

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

Dear Dr. Snyder:

The Pennsylvania Department of Environmental Resources appreciates this opportunity to comment on NUREG 0683, "Draft Programmatic Environmental Impact Statement relating to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station Unit II". Our comments on this report are first of a general nature followed by specific comments prepared by William Dornsife of our staff. Mr. Dornsife's comments are attached.

Due in part to the nature of the subject, the document was very lengthy and difficult to review, especially for the lay public. However, the subject matter could have been better organized to allow for a more fluent and, therefore, useful review. As examples, much of the information that is repeated in each chapter could have been covered in one chapter or moved to an appendix, and more of the background technical information which is contained in the chapters should be included as an appendix.

We again appreciate the opportunity to comment on this Programmatic Environmental Impact Statement and trust that our comments will be given due consideration. We would, furthermore, expect that we would be consulted for our input prior to a final decision being made on the implementation of the various alternatives.

Sincerely,

Clifford L. Jones

CLIFFORD L. JONES

Attachment

NUREG 0683, "Draft Programmatic Environmental Impact Statement Relating to Decontamination and Disposal of Radioactive Wastes Resulting from the March 28, 1979 Accident at Three Mile Island Nuclear Station Unit II"

The specific comments on the Draft Programmatic Environmental Impact Statement by indicated sections are as follows:

Section S.2 - The statement concerning accidental recriticality of the core leading to a release of additional radioactivity does not appear justified by or consistent with the detailed discussion which is contained in Section 4.

Page S-9 - Any mention of disposal alternatives for the waste appears to be absent from the summary discussion. Disposal is an integral and very important part of the clean-up process and should be discussed in detail in the Final Environmental Impact Statement.

Page S-12 - It should be indicated that gross alpha measurements are periodically taken on certain selected samples.

Section 1.6.3.1 - No mention is made of NRC's on-going development of a waste classification system. This waste classification system is a very important part of determining the final disposition of and management requirements for TMI wastes.

Section 1.6.3.1 (page 1.25 at the bottom) - The paragraph does not appear to be complete.

Section 1.6.3.2 - The paragraph, which places into perspective the public exposures by comparing them with natural background exposures and is restated in each section dealing with that subject, is important from a public perspective standpoint and should be expanded. A much more complete and descriptive discussion of natural background and other comparative exposures should be included in the document, such as was included in the Final Environmental Assessment for Reactor Building Atmosphere Clean-up.

Section 2.0 - The statements concerning the importance of an early decision on decommissioning versus reuse of the plant needs to be expanded and clarified. In this context, a summary discussion should be given of the possible effects on the health and safety of the public and effects on the alternatives for clean-up between an early decision on decommissioning or reuse of the plant. For example, from a waste disposal standpoint, it would appear to make more sense to decontaminate the plant rather than dispose of plant materials prior to this decontamination effort.

Section 2.1 - The statement that it is the staff's position that TMI should not become a permanent waste repository site is indeed a very important conclusion and should be given much more prominence than an isolated sentence in this particular paragraph.

Section 2.1.1.2 - The motor operators on the two valves that are discussed in this section must remain operative to provide for long-term forced cooling of the core, rather than to maintain the present safe cooling mode of the reactor.

Section 2.1.3.1 - The statement is made that a dry core could become physically unstable in some regions and criticality might occur. This statement appears to be inaccurate, since the low enrichment of the TMI core in a dry state prevents criticality regardless of the configuration. It has been determined that enrichment in excess of 6% would be required for criticality to occur in any dry configuration, even if a reflector were surrounding the configuration.

Section 2.2 - The title of this section should more appropriately be Management of Radioactive Wastes since disposal appears to receive very little mention.

Figure 3.2-2 - It is understood that the route for radioactive waste shipments in the vicinity of the TMI site is in error in this figure. The correct route should be north on Interstate 81 rather than south and then north on Route 15.

Section 4.3.1 - It is stated that the mini-decay removal system will be used to spare the normal in-plant decay heat system from becoming grossly contaminated. A more important reason for not using the normal decay heat removal system appears to be the fact that it has a relatively high design leak rate and, therefore, could cause additional contamination of the auxiliary building with a potential for small additional releases of radioactive material to the environment.

Section 5.1.4.1 - NRC Regulatory Guide 1.140 is stated to have a conservative factor of about $1 \times 10^{+5}$ above more realistic assumptions. This amount of conservatism appears to be excessive and requires an explanation of the assumptions.

Section 5.1.5.2 - The location for the largest average annual dispersion factor is assumed to be in a west-northwest sector at 0.37 miles from the plant. This location appears to be on an island in the Susquehanna River which is not occupied year round. A more appropriate dispersion factor which is used in the reference may be 1.4×10^{-6} sec/m^3.

Section 5.1.5.3 - (This comment applies to all supplemental accident analyses.) An annual average dispersion factor is assumed for this particular accident. This and most subsequently assumed accident releases appear to occur over a very short period of time; and, therefore, it would appear to be more appropriate to use a short-term dispersion factor to get a realistic dose assessment for accident analysis. The disclaimer that states that the dose will be 500 times greater or smaller is not very reassuring and could be eliminated for most of the subsequent analysis.

Section 5.2.4.1 - It is stated the amount of airborne particulate activity from the various processing alternatives has been estimated based on experience with the more complex chemical reprocessing operations. Has experience with processing at TMI using EPICOR II been included in this estimate, and how would this affect the estimates which are used for all succeeding dose assessments?

In the description of Table 5.2-4 and all subsequent similar discussions, it should be stressed that the factor of conservatism only applies to particulates and not to tritium. Therefore, all except the tritium values would be increased by a factor of 10^5 if regulatory guide assumptions were used.

Section 5.2.5.2 - The doses which were calculated for the consumption of drinking water appear unduly conservative. Rather than assume the low flow of record for dilution in the river, the more appropriate assumption should be the average river flow, since discharge would occur for a long period of time and, in most cases, the discharge is controllable. This comment also applies to other dose estimates using similar assumptions.

Section 6.3.3.1 - It is stated that small quantities of dissolved radioactive gases would be released during the processing, but existing processing equipment could readily handle this gas. What existing processing equipment justifies this statement?

Section 6.3.4.1. - The assumption that 0.1% of the amount of radioactive material process could become airborne appears to be conservative in this particular example because the system, as designed, will be an underwater system and, therefore, particulate releases should be minimized. A potential problem with this assumption appears in Table 6.6.3. Using the concentrations which are given in this table, it appears that the maximum concentration in the building could be as high as 40 times the maximum permissible concentration for Cs^{137}. In addition, no discussion is given of the possibility of dissolved Krypton in the reactor building sump water which could be released as gas during processing.

In the same section, under liquid releases, it is assumed that a 30-gallon per minute discharge occurs into the cooling tower blowdown. This is inconsistent with the previous assumption of AFHB liquid releases in Section 5.2.3.2 which indicates that the allowable discharge rates would be limited by boron concentrations to a much lower value.

Section 6.3.4.2 - The accident analysis for leakage of reactor building sump water should state the assumed river flow which will give this particular concentration at the nearest potable water supply intake. In general, there is a need for a better description of the assumptions that are used for all the various accident scenarios, which could be included as an appendix.

Section 6.3.5.4 - The discussion of behavior of radionuclides in the Susquehanna River and Chesapeake Bay should include an estimated radiation exposure to the public from eating the shellfish and fish from these waters.

Section 6.6.3.1 - It appears that only cement and vinyl ester styrene are assumed to be immobilization agents for the zeolite/resins systems. One of the more promising possibilities for solidification that should be discussed is vitification in glass.

Section 7.2.2.1 - The EPICOR I system is listed as an alternative for initial processing of primary system water. It should be noted that no environmental assessment was done for this sytem and, therefore, prior to use an environmental assessment would be necessary.

Section 8.1.4.2 - It is stated that the inventory of Krypton-85 in a single fuel element is about 1.5 curies. This appears to be a misstatement since total core inventory of Krypton-85 is estimated to be about 10^5 curies. This would give about 565 curies per element.

Section 9 - This discussion concerning temporary storage and transportation of fuel and solid waste appears to be adequate. However, the discussion concerning disposal of these materials is totally inadequate. A discussion is needed of the alternatives for off-site storage and disposal of the radioactive wastes along with possible contingency plans which may be necessary if disposal sites are not immediately available. This discussion should include an analysis of environmental, public and occupational health impacts.

In addition, this section should include a discussion of the treatment and disposal of non-radioactive wastes such as water treatment sludges. This would provide information to the public as to the existence of these wastes and alleviate concerns when these wastes are disposed of at acceptable facilities.

Section 9.5.2 - An analysis should be made for potential accidents during storage of radioactive material which could be caused by tornados or floods which may impact buildings which are not qualified for these particular design basis events.

Section 9.5.2.2 - An accident dispersion factor of 5×10^{-3} sec/m^3 is used for this particular accident. A similar dispersion factor should be used for all accident analyses which involve short-term releases.

Table 10.1-2 - The amounts of radionuclides which are summarized as being released to the river (if approved) appear to be very low for the processing of a reactor building sump water.

Table 10.3-1 - All doses, in this table and in the supporting sections, appear to be total body doses to the maximum exposed individual. There needs to be a discussion of total body doses and how individual organ doses are taken into account. If individual organ doses are taken into account in the definition

of total body dose, a discussion should be given of how this is reflected in the calculation of probability of cancer death over the lifetime of the individual, since individual organ doses have a lower potential for causing cancer fatalities than whole body doses.

Section 10.4.5 - A hypothetical two-inch diameter hole in the bottom of the pressure vessel appears to be an incredible accident. A more likely accident which should be discussed is a small break in the reactor coolant system without makeup. In any event, it appears that the approximately 115 kilowatts of thermal energy which is being generated by the core at this time is insufficient to cause a melting of the fuel using reasonable assumptions.

The following comments are related to NUREG 0698 entitled, "NRC Plan for Clean-Up Operations at Three Mile Island Unit II."

Page 3 - It is not discussed how the TMI-2 Advisory Panel, which is mentioned in the footnote, will interact with the Three Mile Island Program Office. In order to provide a significant role they should have early and continuing involvement in the process.

Page 6 - A discussion is given of the decision-making process which is followed for alternatives which are within the scope of the PEIS and also those not covered by the PEIS. However, it is not indicated what, if any, input the public and State will have in the final decision-making process of determining which alternative is the most appropriate.

LEAGUE OF WOMEN VOTERS OF PENNSYLVANIA

STRAWBRIDGE & CLOTHIER • *8th & Market Streets* • *Philadelphia, Pennsylvania 19105* • *(215) 627-7937*

November 10, 1980

STATEMENT TO THE NUCLEAR REGULATORY COMMISSION ON THE PROGRAMMATIC ENVIRONMENTAL STATEMENT FOR DECONTAMINATION OF THREE MILE ISLAND II

I am Anne Valsing of the League of Women Voters of Pennsylvania representing 66 local Leagues throughout the state. The League of Women Voters of Maryland concurs in this statement. Thank you for this opportunity to comment on the Environmental Impact Statement for the decontamination and clean-up procedures of Three Mile Island Unit II nuclear power plant. The League, on the national, state and local levels, has watched developments at TMI with great concern since the accident there in March 1979.

The League of Women Voters commends the Nuclear Regulatory Commission (NRC) for creating the citizen advisory committee of government officials and concerned ctiziens, for the purpose of following carefully and commenting on the Environmental Impact Statement (EIS) and clean-up procedures. The participation of this committee in the ongoing process of considering the best methods for clean-up and the possible effects of the alternatives appears to be a concrete step toward allaying the fears of the population surrounding Three Mile Island. Because of concern for the health and safety of the citizens and environment of central Pennsylvania and parts of Maryland, it is very important that the people of the region know about the problems engendered by the accident and understand the pros and cons of available options as the clean-up proceeds.

The League of Women Voters strongly believes that citizens have a basic right to know about governmental actions and decisions that will affect them. We think that governmental bodies must protect the citizens' right to know by giving adequate notice of proposed action, holding open meetings and making public records accessible. Citizens must be able to fully participate in and truly influence the decision-making process.

The League believes that the advisory committee must have access to all relevant information concerning the clean-up process, with freedom to express to the public and those involved in the clean-up the results of their investigations. The committee must also have adequate funding for clerical work and for the hiring of experts in order to understand the extremely technical data which may be the key to making wise decisions. Because of the unknown conditions which may be encountered during the clean-up process, and because statements in the EIS have indicated that supplements to this original statement will be issued when more information becomes

available or if operations need significant change, it is vital that the committee remain in place during the entire projected five to seven year clean-up period.

The League is critically concerned about the storing of nuclear and hazardous waste material on Three Mile Island because the island is a fragile land area and the Susquehanna River a drinkin water source. During this period of temporary waste storage, the League believes that it is of utmost importance to maintain vigilant on and off site monitoring for contamination of the soil and ground and surface water. Regular inspections of the storage containers for leakage should be a part of the monitoring. Citizens should continue to be part of this monitoring process.

The decisions being made by the NRC during the clean-up of TMI are of precedent-setting nature. Citizens around other nuclear plants and in other countries are watching the degree of concern shown by the NRC to the clean-up process. Public health and environmental issues here have world wide ramifications. We urge the NRC to monitor not only for immediate safety reasons but also to continue long range monitoring and evaluation programs which include study of human, water, animal, and aquatic life and of vegetation. Studies designed and carried out during the process of the decontamination of TMI should be beneficial to future generations. The League urges the NRC to do no less.

501 Vine Street
Middletown, PA 17057
November 15, 1980

Director
TMI Program Office
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Director:

I'm writing in response to the draft PEIS on TMI #2 clean-up. Most of my comments are on record at a November 10, 1980 meeting held in Harrisburg with the NRC.

There is no doubt that all citizens of the area want TMI #2 cleaned as safely as possible in terms of worker and off-site population radiation exposures and "disposal" of wastes.

I feel my comments will be more helpful in the future as various specific stages of the clean-up are publicized and open to public comment.

It is my hope that EPA will be able to assemble a reasonable array of "independent" specialists to be utilized throughout the clean-up.

I'm encouraged by the formation of the Citizen Advisory Committee. The meeting on November 12 was a very positive and open session. My main concern is that all those on the committee really care about this clean-up and affected populations. Those that are not committed or have poor attendence should be replaced by consulting directly with the leadership of local organizations.

Sincerely,

Donald E. Hossler
Donald E. Hossler

Dr. Bernard J. Snyder,
Program Director, TMI Program Office,
Office of Nuclear Reactor Regulation

32 Valley Drive, RD3,
Annville, PA, 17003,
November 15, 1980.

The Commissioners,
The Nuclear Regulatory Commission,
Washington, D.C. 20555

Re: Comment on NUREG 0683
TMI 2 PEIS

This letter is written to give the commission some reactions to the NUREG-0683, Draft Progeammatic Environmental Statement, Docket No. 50-320. I am a retired physicist and electronics engineer living 12 miles form TMI. We are customers of electric power delivered by the Met-Ed system. We were here on the day of the accident and almost every day since that event.

This comment is primarily about the disposal of the treated liquid wastes resulting from this accident. I have read the first 5 sections of NUREG-0683 and some of the later summary sections. It looks like a good job.

It appears to me that it could be improved by generating a table which directly compares the present nuclides concentrations in the Susquehannariver water with the expected concentrations in the decontaminated liquids to be discharged into the river. You can dig that out of NUREG-0683, but it is not easy.

If it has not already done so, the NRC should set a policy about the concentrations of the nuclides in the decontaminated water. As a knowledgable customer for electrical power, I would object to carrying out procedures which will reduce the concentration of all the nuclides to values less than that in the upstream river water, say at Harrisburg. If the concentrations of all the nuclides in the decontaminated TMI accident water are reduced to values less than the upstream river water, this would amount to trying to dilute the contaminated river water flow immediately upstream of TMI by adding the less concentrated TMI accident water. It would be unconscionable to expect customers and taxpayers to have to support such a procedure.

Tritium is the most difficult nuclide in this situation, I know. However, if a supply of water having tritium content less than the upstream river water can be found locally, it would be possible to finish the dilution with that. This procedure should not be carried much past the point where the tritium concentration is equal to that in the upstream river. Then the purified TMI accident water should be put into the river, with an explanation to the public, no equivocation on the matter, and no apologies to anyone.

Carrying this approach one step farther, have you investigated the availability of low tritium water from nearby wells to perform the final dilution. Suppose low tritium water can be withdrawn from an aquifer which would not be utilized in the period of ten half lives of tritium, about 120 years. This could then be used to complete the dilution of the TMI accident water to the river water concentrations. If necessary, some higher tritium level water could be pumped back into the slow turnover aquifer for remote storage while it is decaying. In this way the radioactive exposure of living things at the surface could be held close to the present value.

In short, I ask you to confine the accident water clean-up to reach the upstream river water values and no further. The electric power industry and its customers should not be saddled with the job of diluting the already radioactive Susquehanna river water.

Sincerely yours,

Henry H. Grimm

Henry H. Grimm

Nov. 11, 1980.

Dear Mr. Snyder,

I have read much of the P.E.I.S and these are my feelings on it.

First, I must say that it is quite incomplete. The NRC seems to be engrossed with the idea of segmenting the clean-up process. It is to our (the public) advantage to know what comes later even though the whole scheme of nuclear power doesn't seem to deal with later problems such as disposal of various levels of waste, spent fuel and other hazards to the future of the human race. I know that there is a bottleneck at the Department of Energy about high level/high activity waste disposal; we all realize that the problem should have been addressed 25 years ago or not create the damn stuff. Even the low-level waste must be dealt with later by our descendants.

All of the pages of the P.E.I.S. dealing with doses seem quite redundant. I've seen these types of estimations and mathematical extrapolations many times before. They cannot be very comforting because the human error involved in the operation or clean-up of a reactor throws all of these imaginary odds out the window. A mistake during critical clean up stages could be more disastrous than the accident itself and we were told that the chances of a reactor accident were almost nonexistent.

Many important considerations which, in my opinion, cannot be separated from the clean-up were conveniently omitted from the draft P.E.I.S.

I think that the lack of resources of the licensee and the uncertainty of it's future has a direct bearing on every aspect of the decontamination. This has the effect of invalidating or severely limiting all of the information contained in the P.E.I.S.

The fact that the licensee is building a submerged de-mineralizer system without NRC approval is quite disconcerting

How about nothing being mentioned in the P.E.I.S. about the fact that the carbon steel liners that contain the high activity resin bed filters from Epicor II being corroded away with no apparent contingency plans for dealing with the situation. Lack of hard scientific data on the effects of mass low level exposures of C_s, S_R and H_3 on living organisms point clearly to not using us as experimental animals any longer.

The psychological effects of TMI are, to this day, severe on myself and my family. The P.E.I.S. really discounts this completely. I know tens of families, hundreds of people who have had tremendous mental and emotional trauma, but not one was contacted with relation to compiling findings for the stress section of the P.E.I.S. Where did the N.R.C. get their findings? I could gather 200 people right now whose presence alone could show you that the long term stress to residents is a relentless pressure that no one should have to endure and the existence of the pressure is all but totally overlooked by the people who worked on the P.E.I.S.

Now, about the amount of risk there is to each of us from the clean-up. Who has the choice on how much risk each of us wants to take? According to the U. S. Constitution, the individual does. In the P.E.I.S., however, someone has made the judgment that the clean-up poses small hazard to living things. I didn't choose to subject my family to this hazard, small or large. All that seems to matter in NRC documents are phrases like "as low as reasonably achievable" which was conveniently written to make a money judgment versus public safety an easy

choice for the people with the money invested. Even the National Environmental Policy Act has a clause that makes investing more money to insure the health and safety of citizens unnecessary in order for industry to be in compliance with this act. Another thing is that all of the people who have attempted to establish the premise for the safety of nuclear power and the clean-up at TMI are employed in occupations that depend on the continued viability of nuclear power for their very profitable livelihood. Why should any of them say that they would not like to keep their job?

R. D. #5
York, Pa. 17402
November 15, 1980

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, Docket No. 50-320
Draft Programmatic Environmental
Impact Statement

Dear Mr. Snyder:

Once again you are asking the public for comments on the decontamination and disposal of radioactive wastes from Three Mile Island.

The public made their comments on the disposal of the krypton gas and, in spite of the fact that the majority of the comments opposed the venting of the krypton, the NRC allowed the venting to be done.

The majority of the meetings held in the area to discuss the PEIS were with groups having financial interests, not with the general public who has a more important interest -- health effects!

Both NRC and TMI officials have repeatedly said that they do not intend to turn TMI into a high level radioactive waste dump. There is no such thing as an interim storage facility. An interim storage facility turns into a permanent storage facility.

To suggest the storage of radioactive waste on an island on <u>any</u> river is an irresponsible suggestion.

We now have a severely damaged reactor and an <u>unanticipated</u> amount of nuclear waste in our area, along with an <u>idling, fully</u> fueled reactor. During the cleanup (with an admitted possibility of a serious accident) it is not a good policy to have the fuel in Unit 1. The fuel MUST be removed from Unit 1 while it is still possible to remove it safely.

Concerning the accident water, you have stated that the NRC will not base its evaluation of the SDS on cost considerations to the utility. The "cheaper" method of disposing of the krypton gas was used even though releasing more radiation into the atmosphere is detrimental to the environment.

Money really talks in this nuclear field and even though I have very little money, no amount will ever keep me from speaking out about the truth.

Sincerely Yours,
Vincent R. [illegible] + family

Bernard J. Snyder, Program Director
November 15, 1980
Page 2.

You have stated that other methods of treating the water were considered by the NRC, and that diluting and releasing it into the Susquehanna River would have no adverse health effects, according to staff conclusions. Why are you minimizing the seriousness of the effects of the radiation that we, who live nearby the plant, have received already and will be exposed to during this cleanup operation?

Paragraph 10.7.3 of the PEIS concerning water and air resources is not valid because of unknown factors. Time has shown that calculations by self-proclaimed experts on the effects of radiation hazards to the environment being "insignificant" are <u>false</u>.

We can't see the effects of the radiation right away -- that will take time. But we can see the effects of the psychological stress NOW!

You will have to admit that no one (not even the NRC) knows just how much radiation has been released from Three Mile Island since the accident occurred on March 28, 1979.

The studies cover a fifty mile radius from the plant with a large population. That makes the average dose received much smaller. You can't average radiation!

NUREG-0683 mentions the large number of truck shipments (660 to 1700) carrying waste to disposal sites will be made over a long period of time and should cause little traffic congestion. I am not worried about traffic congestion, but I am worried that there could be accidents involving these shipments and that radiation would be released. If something can happen -- it will!

The whole PEIS is slanted toward the eventual restart of Unit 2 and not toward the most important factor -- minimizing the total amount of radiation exposure to the public.

Sincerely,

Alice A. Herman

Alice A. Herman

cc: John F. Ahearne, Chairman
cc: Peter A. Bradford, Commissioner
cc: Victor Gilinsky, Commissioner
cc: Joseph W. Hendrie, Commissioner
cc: The Honorable H. John Heinz III
cc: Congressman Bill Goodling
cc: Congressman Allen E. Ertel

Susan Shetrom
Box 629 RD 1
Etters, PA 17319

Bernard J. Snyder, Program Director
Three Mile Island Program Office
Nuclear Regulatory Commission
Washington, DC 20555

Dear Dr. Snyder:

Some basic flaws in the Programmatic Environmental Impact Statement that will require further study and evaluation are:

1. The evaluation of psychological stress is inadequate and faulty. Current stress is not caused by perceived stress but by the reality of a cleanup delayed by the incompetence of Metropolitan Edison and the Nuclear Regulatory Commission. The stress is further heightened by increased rates and the possibility of the insane restart of Unit 1. High levels of stress continue for some members of the community and long-term psychological effects on the great majority of the people can be expected for many years.

2. The problem of how and where to dispose of the wastes resulting from the accident and cleanup process is inadequately considered. There is no assurance that any waste site will accept the low-level waste in the amount postulated by the NRC staff and ultimate disposal of high-level waste remains an unresolved question.

3. The NRC staff dismisses the question of whether TMI Unit 2 will be decommissioned or prepared for restart by stating that it is not within the scope of the PEIS. In reality the methods of cleanup are very dependent on the decision to restart or to decommission the unit. Certain processes could severely damage the equipment, making the final disposition question essential in selecting the proper methods to be used. Thus the question of restart or decommissioning of the plant must be considered in depth within the PEIS.

-1-

4. There is a total lack of cost estimates in this evaluation phase of the PEIS. The NRC staff has promised that the cost factors will be provided in the final PEIS (after the period for public comment has passed). In view of the precarious financial condition of Metropolitan Edison, the NRC's assertions that costs are not a limiting factor can hardly be viewed as realistic.

5. In the PEIS the NRC makes the assumption that cesium and strontium from the planned release of processed water (which will contaminate Chesapeake Bay seafood as far south as the Potomac River) will not effect the marketability of the seafood. A separate EIS that includes market research data on radioactivity in Chesapeake Bay seafood must be performed prior to making determinations as to the effects of radioactive contamination of Bay seafood on the seafood industry.

Very concerned

Susan Shetrom

Susan Shetrom

Nov. 18, 1980

Dear Mr. Synder,

Concerning the clean-up of T.M.I. –

I have been to the meetings in Annapolis and Baltimore Maryland and wonder how the dumping of ANY water at all is still being considered as a possible clean up solution. I'm the mother of four children and pay close attention to matters of health and pollution. There are various causes of pollution in our world today and if you have any influence on the NRC Comissioners at all, I ask you to please ask them do not release any contaminated water from the T.M.I. plant into anyone's water supply.

Even if the ~~changes~~ chances of ill effects are very small, that reason enough. Put it somewhere else.

Sincerly, Peggy Jone

RPF Ecological Associates
727 Reba Place
Evanston, Illinois 60202

November 12, 1980

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 Sir:

I have reviewed the Draft Programmatic EIS relating to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident Three Mile Island Nuclear Station, Unit 2. I have only one comment which is summarized below.

Page 3-18 suggests that the bald eagle and osprey are likely to take food from the Susquehanna River below Three Mile Island. The bald eagle is an endangered species. The analysis on pages 6-26 to 6-30 should include an analysis of radionuclide concentration and absorbed radiation dose in bald eagles or ospreys that might feed on fish for several months in the Susquehanna River or Chesapeake Bay following controlled or accidental releases of processed water. Because compounds such as cesium or strontium become concentrated many-fold times more in fish-eating birds, would such concentrations harm individual birds or affect their reproduction in the following year(s)?

Thank you for the opportunity to comment on this EIS. Please send me a copy of the Final EIS when it becomes available.

Respectfully yours,

Robert W. Guth, Ph.D.
Ecologist

NIRS
Nuclear Information and Resource Service
1536 Sixteenth Street NW, Washington, D.C. 20036 (202) 483-0045

November 14, 1980

Matthew Bills
Environmental Protection Agency
Associate Deputy, Assistant Administrator
For Office of Monitoring and
Technical Support
401 M. St. S.W.
Washington, D.C. 20460

Dear Mr. Bills:

We are very pleased that Environmental Protection Agency (EPA) is sponsoring an independent scientific review of the Draft PEIS on TMI-2. We are looking forward to the information it will supply to answer questions raised by unresolved problems identified in the Draft.

Some processes described in the Draft PEIS which are greatly deficient and need more research done, in order to be useful for decision making are:

Need to identify current restrictions as set out by present license requirements in order to determine what other radiation standards are needed to be set for the clean-up process itself.

Need a description of costs for all suggested processes to be used in the cleanup.

Need a definition of high-level waste.

Need to identify disposal methods suggested for high specific activity wastes and resins.

Need a description of on-site wastes and eventual disposal of that waste.

Need more alternative processes described especially for disposal of high level wastes and water.

Need to do a study on the marketability of fish in the Chesapeake Bay if radioactive water is dumped into the Susquehanna River.

Need to monitor river water in light of expected variation in the amount of radio-nuclide charged clays suspended in the river at any one time. The amount of suspended material will vary widely due to variation in river turbulence. Please see the comments by Steven Sylvester which are attached.

Need to monitor worker exposure to radiation by recording cumulative doses from medical and ocupational exposure. Need to keep records for 20 to 30 years on all workers involved in the accident and the cleanup (regular and transient workers).

Need to monitor health effects as a part of the cleanup process. It will provide valuable documentation in studying the effects of low-level radiation from a nuclear power plant accident rather than extrapolating information from nuclear weapons testing.

Monitor infants born during and after the accident within 30 miles of TMI to evaluate respiratory diseases, immunological defects, congenital defects, genetic defects, Down's Syndrome, Leukemia and other cancers.

Select a population of young children who were within 30 miles of TMI at the time of the accident and follow them for health effects for 20 to 30 years.

Do case studies on women who were pregnant at the time of the accident March 28, 1979, and women who become pregnant throughout the cleanup process.

Do case studies on a random population of women of child-bearing age, who live within a 30 mile range of TMI. This study should be carried out over the entire cleanup years. It should be done to study reproductive history such as: ability to conceive, irregularities of menstrual cycle, miscarriage, still births, labor and delivery, C-section, genetic defects and births resulting in congenital defects.

Do extensive follow-up on infants with hypothyroidism (including the Amish population) within a 30 mile range of TMI. Infants should be studied who were in utero at the time of the accident.

Do studies in great depth and over a long period of time studying the effects of radiation on the animals. Cows should be especially studied because of their rate of reproduction and ability to study the genetic effects on generation to generation. Animals should be studied for miscarriages, still births, c-sections, and delivery of offspring with congenital defects.

Due to the deficiencies that we have noted, cost factors omitted and alternatives yet to be presented, we request that a Revised Draft PEIS be issued at this time in place of a Final PEIS. It is imperative that the public have an opportunity to review the new information to be presented.

We are in hopes that EPA will also make these recommendations to the Nuclear Regulatory Commission.

Attached also are comments made by Nancy Kelly, Senior Staff Biologist for the Chesapeake Bay Foundation. Please also refer to comment being submitted in conjunction with these comments by Judith Johnsrud and Chauncey Kepford.

We are pleased for your attention to these matters of grave importance to the public in the cleanup of Three Mile Island.

Respectfully,
Coral Ryan
Coral Ryan
For the Nuclear Information and Resource Service, Staff

STEVEN SYLVESTER'S COMMENTS TO THE E.P.A. AT NOVEMBER 6, 1980 MEETING

RE: DRAFT P.E.I.S. FOR THREE MILE ISLAND UNIT 2

Models presented for the behavior of radionuclides discharged via plant effluents into the Susquehanna River and upper Chesapeake Bay are not supported by existing scientific data. Estimates of resulting radionuclide buildup in river sediments (6.3.5.4.) are unreasonably low.

NUREG-0638 (p.6-27) recognizes that isotopes of cesium have an appreciable tendency to combine with clay particles suspended in river water. Based on an estimate of 10 to 20 mg/l suspended clays during normal flow and 40 mg/l during storms, NUREG-0638 concludes the bulk of the cesium (75 to 100%) will remain attached to the suspended clays and only a small percentage will be deposited in river sediment (Gross, et. al.(1978) is cited, reference 13, by the document.)

These predictions are wrong for the following reasons:

(1) Gross et. al. (1978) found that under normal circumstances between one-half and two-thirds of the suspended material that passes Harrisburg, PA is deposited before Conowingo, MD.

(2) Schubel (1968, Fig. 1B) provides data showing the suspended load at Conowingo, MD to be less than 10 mg/l 65% of the year. These data indicate that the bulk of the cesium (as well as other radionuclides that tend to attach to clay particles) will be deposited in the Susquehanna River sediments. Since clays settle out of river water only in areas of calm or still water, most of the cesium charged clays will be deposited in select areas, resulting in appreciable reconcentration of radionuclides.

(3) Predictions for the behavior of cesium charged clays reaching the upper Chesapeake Bay do not consider that the clays will undergo flocculation when encountering salt water. Flocculation results in rapid deposition

of clays, suggesting that the remaining cesium loaded clays will be deposited and reconcentrated in a select area of the Bay.

NUREG-0683's Environmental Radiological Monitoring Plan is inadequate for the following reasons:

(1) Most monitoring efforts involve air sampling while most remaining clean up activities involve the clean up of liquid effluent.

(2) The monitoring consists of six different plans with differing goals and areas of concern. A single, coherent plan using the resources of the six monitoring groups in a coordinated manner should be developed.

(3) Monitoring of the Susquehanna River's bottom sediments and invertebrates is not detailed or extensive enough to detect any reconcentration of radionuclides in select areas. Analysis of bottom samples should include the physical characteristics of the sediments to determine if the sample includes recently deposited clays.

(4) Monitoring of river water is not detailed or extensive enough in light of expected variation in the amount of radionuclide charged clays suspended in the river at any one time. The amount of suspended material will vary widely due to variation in river turbulence.

(5) Contingency Surveillance Procedures (11.8) are inadequate to monitor the dispersion of radiation resulting from any uncontrolled releases. The maximum two hour response time for a mobile laboratory and six hours for airborne monitoring do little to monitor a short, intense airborne release. Four mobile laboratories should be positioned around the plant (two on each side of the river) at all times. The monitoring aircraft should be hangered locally.

Using composite sample analysis for monitoring uncontrolled releases in the Susquehanna River results in as much as a week's delay since that is

the period over which that samples are composited. Contaminated samples should not be composited with any samples collected prior to any uncontrolled releases.

References

M.G. Gross, et. al., "Suspended Sediment Discharge of the Susquehanna River to Northern Chesapeake Bay, 1966-76". Estuaries 1(2): 106-110, 1978.

J.R. Schubel, "Suspended-Sediment Discharges of the Susquehanna River at Havre de Grace, Md." Chesapeake Science, 13(1), 52-58.

Steven Sylvester
Department of Geology
Franklin and Marshall College
Lancaster, PA 17604

ENVIRONMENTAL COALITION ON NUCLEAR POWER

Co-Directors: Mr. George Boomsma—R.D. #1, Peach Bottom, Pa. 17563 717-548-2836
Dr. Judith Johnsrud—433 Orlando Avenue, State College, Pa. 16801 814-237-3900

14 November 1980

Dear Matt:

Herewith the comments on the TMI PEIS. They are much more general than we'd prefer, since there are so many specific wrongs and so little right with the PEIS, but perhaps this will give the Commissioners the flavor of our concerns.

Your efforts in this matter are very much appreciated. I hope we'll be able to stay in touch for the duration —

Regards,

Judy Johnsrud

hastily —
Oh, for a full-time typist!

ADDITIONAL SUMMARY CITIZENS' COMMENTS ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT RELATED TO DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES RESULTING FROM THE MARCH 28, 1979, ACCIDENT AT THREE MILE ISLAND NUCLEAR STATION, UNIT 2 (NUREG-0683)

General Comments on Format and Content:

The flaws, errors, and omissions in NUREG-0683 are sufficiently fundamental and pervasive to mandate the withdrawal of this draft document and a complete revision of its contents. The information included in the draft, while voluminous, is so poorly organized and presented as to render the document virtually unreadable for anyone of reasonable intelligence. In order for proper and meaningful comments to be submitted, the incomplete and erroneous data must be fully supplemented and corrected, units of measure brought into conformance to allow for accurate assessment, and the entire text rewritten in intelligible, logical, coherent language and order.

Although many "public meetings" have taken place and the time for public comment extended from 45 to 90 days, the Nuclear Regulatory Commission has failed to provide for proper and full hearings to fulfill the spirit and purpose of the National Environmental Policy Act of 1969 and the NEPA Regulations of the President's Council on Environmental Quality.

Under no circumstances should the NRC Staff be allowed by the Commissioners to issue a Final PEIS accompanied merely by the Staff's promises to produce subsequent Supplements in which any still-unresolved issues might be addressed. All inadequacies identified by commenters must be addressed in a revised draft, and the Commission must require its Staff to correct all errors and deficiencies prior to issuance of the Final PEIS and the Commission's approval of the decontamination plans and procedures.

Major Deficiencies of the Draft and Recommendations:

1. The Draft PEIS fails to address appropriately the long-term disposal of TMI-2 accident-generated high-level radioactive waste. We draw the Commissioners' attention to the fact that the NRC in its supposedly generic rulemaking proceeding on the Reassessment of Confidence

in the *Availability of Radioactive Waste Disposal and Spent Fuel* Storage (Docket PR 50, 51) has failed totally to consider these TMI-2 wastes. Because of the propensity of the Susquehanna River to flood, interim storage of radioactive wastes on this island until the Year 2000 and beyond, the time period being considered in the Waste Confidence proceeding, is not acceptable. Hence, the PEIS fails utterly to fulfill its basic purpose under NEPA.

2. The fundamental decision of whether TMI-2 is to be decommissioned or ultimately restarted must be addressed and resolved before a properly developed programmatic cleanup plan can be approved by the Commission and before realistic cost estimates are available. The Draft PEIS fails to do so.

3. The Draft PEIS does not fully address the management and disposition of all radioactive wastes generated by the TMI accident and associated with the decontamination and repair or decommissioning of the plant. The condition of the Epicor-II resins, for example, has deteriorated markedly since the publication of this document. Mitigation strategies for unsuccessful or inadequate cleanup activities must be fully examined. The passage of the referendum in the state of Washington on November 4, 1980, may prohibit the use of low-level waste facilities at Hanford; delays in approval of either regional or intrastate low-level waste disposal sites must be reckoned with. These issues and attendant costs must be more fully considered.

4. The Draft PEIS fails to provide a believable mass balance accounting for isotopes originally in the core. NRC Staff must revise the mass balance to provide a complete and credible accounting.

5. The Draft PEIS lacks a proper discussion of how TMI-2 reached its present condition and lacks adequate current factual information on the actual, as opposed to theorized or assumed, status of the plant. The Revised Draft PEIS must include a locational inventory of all radioactive materials, identifying clearly where all isotopes are presently on the site. This discussion should also account fully and in detail for all shipments of contaminated materials and their disposition upon arrival at destination. Concern has been expressed in the TMI area that some wastes are being illegally removed from the island and disposed of.

6. The Revised Draft PEIS must contain full analysis of the multiple options for decontamination for the entirety of the cleanup. Where uncertainties or lack of operating experience with techniques exist, they should be clearly identified as unknowns. No optimistic assumptions that experimental methods will succeed should be permitted in the Revised Draft. The present Draft lacks sufficient depth of information and analysis of alternative methods for cleanup. This deficiency must be corrected, and the methodological equivalent of event tree analysis applied to all options. From the revised and expanded discussion of decontamination options the Staff must develop and clearly delineate a full programmatic plan; such a plan is missing from the Draft.

7. The discussion and quantification of health effects must be revised in accordance with the state of knowledge on the health and genetic consequences of radiation exposure, rather than policy. This section must reflect the fact that there is a substantial controversy concerning the effects of low dose and low dose rate irradiation, as well as large areas of ignorance, as was elucidated by the National Institutes of Health, March, 1980. The Revised Draft PEIS must include the full range of views of scientists who are independent of governmental and nuclear industry programs and policies and who reach different, more conservative conclusions concerning the health and genetic consequences of radiation exposure. Again, the revision should clearly state the uncertainties.

8. Long-term studies of health and other impacts on the affected populations of the TMI area and animal studies must be designed to include control populations that are indisputably beyond the range of the effects of the accident in question. The Revised Draft PEIS must address the plans for such studies.

9. The socio-economic impacts of the decontamination and waste disposal are inadequately addressed. The escalation of TMI-2 cleanup costs to the one billion dollar level during the four months since release of NUREG-0683 is indicative of the total inadequacy of the discussion of this issue in the present Draft. The Revised Draft PEIS must include a fuller discussion of the comparative costs of all alternative means

of plant decontamination and disposal of all accident- and cleanup-generated radioactive, and other, wastes. The costs and benefits of strategies of fully decommissioning TMI-2 and of substituting conservation must be incorporated into the Revised Draft PEIS.

10. Those costs which are less amenable to strict quantification but nonetheless are real costs to the social, economic, and psychological well-being of the residents of the TMI area, the lower reaches of the Susquehanna River, and Chesapeake Bay must be fully assessed for the entire period of cleanup activities.

Conclusion:

The Draft Programmatic Environmental Impact Statement does not satisfy NEPA requirements. It should be withdrawn. A fully revised Draft PEIS must be produced to respond to the deficiencies identified by public and agency commenters and the Revised Draft PEIS must go through a complete public review procedure, culminating in NEPA public hearings.

1974 Duella Ct.
York Pa 17404

Rep. Bill Goodling — Oct. 17, 1980

Dear Sir,

OCT 20 1980

The TMI enviromental impact report is seriously flawed. The NRC makes several assumptions that violate the basic principles of chemistry and physics. It does not even give the correct physical properties of beta radiation.

In my opinion this report as well as the report on decontamination represent a NRC coverup of the seriousness of the three mile island accident and decontamination. The potential for serious health effects is in the thousands But the NRC insists this was a minor accident and juggles the laws of physics to prove it.

During the accident fifteen million curies of Xenon and other deadly radionuecleotides were released over a populated area. Xenon is heavier than Air and is a gas only at room temperature or above. The beta particle is the principle particle emitted at the rate of 3.6 x the rate of release of gamma rays.

Met Ed had a limited number of dosimeters in place that measure only gamma radiation. The bulk of the radiation was not recorded. The NRC assumed that the Xenon rose to the upper atmosphere and that no citizen inhaled or came in contact with it. Therefore, the NRC based their human and environmental health effects assessment on limited readings of gamma radiation.

Prior to the venting of TMI II, the NRC reports about twenty thousand curies of Krypton in the world's atmosphere. Venting released another forty four thousand curies, more than double the world figure. Yet the NRC felt the public health impact would be minimal even in areas near the reactor.

The NRC told residents that Krypton would not get into their bodies or stay there if it did. However the NRC report states that Krypton has an affinity for fatty tissue such as the breasts... It is assumed that Krypton levels of the body will recede and stabilize at world atmospheric levels.

Krypton is heavier than air and a gas at room temperature. The NRC assumes that it will rise to the upper atmosphere and remain there. The laws of physics state that it will fall to the lower atmosphere. Yet the NRC did not include this factor in its assessment of human and enviromental health effects.

The health department did not conduct a thorough investigation of health effects. They say that limited finances restricted them. This is the worst nuclear accident in this country and funds are not available to study it. The news media has issued several reports that they are limited in access to information about this accident. They also report a coverup and false reports to the media during the crucial days of the accident.

Residents were not warned of the danger to their health. The NRC and Met Ed forced over one hundred thousand people to be involuntary guinea pigs. Physicist Berndt Franke, from the Heidleberg, pleaded with the NRC and government to restrict further releses of radiation on an unsuspecting public.

Sincerely Yours

Geraldine Trust

Comments Received at September 30, 1980, Meeting with Maryland Citizens in Annapolis, Maryland

JOHN CAMPBELL (Tr 25): What happens if you decide to dump the water into the Susquehanna River but the river flow is lower than you are now anticipating?

JOHN KABLER (Tr 29): My feeling is that you are making a mockery of the NEPA process by your intention not to hold a public hearing designed to maximize public participation in Baltimore and Harrisburg as was requested by many groups. I don't believe that NRC does have a real interest in conforming to those NEPA regulations and considering the public concern in getting the best solutions to the cleanup, and hearing from independent scientists, requesting the claculations and assurances that you give us. I feel you can reverse that problem by having the public hearings that so many people want, by funding independent scientists as you promised to do, chosen by a citizen advisory committee, or at least talking to us about it, taking no more cleanup actions until these questions have been resolved, and by not dumping water into the Susquehanna River until the scientific controversy about the possible effects of that have been resolved and until you can prove that the marketability of the seafood downstream won't be affected.

CORAL RYAN (Tr 40): What input is this draft going to have in the actual decisionmaking? How does the public get involved in those specific decisions on the cleanup process? When you ask a government agency such as EPA to evaluate the document, their scientists are being paid. When an independent scientist has to evaluate this draft, he is working fulltime at some other job and we as citizens have no funds to pay them to look at this issue.

STEVE SORRELL (Tr 51): I think that there should not be any tritium dumping at all under any circumstances for two reasons. The first being that the effects of tritium have not been fully evaluated and, secondly, even if after evaluations tritium is believed to be safe, which I find highly unlikely, it is going to be the EPICOR II system or ion exchange resin or whatever you decide to use in undoubtedly going to let some radioisotopes get released into the environment which was addressed to earlier as far as cesium and strontium and I don't want to denounce the value of these machines and using them, but I think that we should respect their limitations and that no system is going to be 100% effective. And no matter how many times we recycle the water through these machines, there is still going to be some radioactive material that gets released, other than tritium. And this is if the EPICOR II system or whatever we use is operated properly. The nuclear industry and its regulatory agencies have had a long history of turning valves the wrong way, of turning off systems that should have been left on, and claiming malfunctions when, in fact, radiation leaks were occurring. I think that we need some kind of assurances that only trained, highly skilled workers are going to handle this cleanup and not just any person that comes along that's willing to get irradiated to make a couple of bucks. And finally I think that we should use the best available technology throughout this cleanup and assure the best possible implementation of it. I think that we should try to come about bringing economic cost of nuclear power that starts to approximate its social cost. And what I mean by the social cost is, to really understand the magnitude of it I think we have to be aware that as sophisticated and complex as this environmental impact statement is that it is only dealing with the tip of an iceberg and that the radioactive poisons that we have here are

going to be deadly for a quarter of a million years and we have no feasible, foreseeable technology to contain this waste, and we don't really have any guarantee that it's going to be contained and it just appears to me that we have inadequate technology and inadequate guarantees that deal with the whole situation. And I think in light of this, the best possible thing to do is to shut down all nuclear power plants and employ the best available technology to get out of the mess we have now and realize that even employing the best available technology, whatever it costs, it's not going to be satisfactory but it's the only alternative that we have.

DEBBIE GEORGE (Tr 53): First of all, I would just like to say that the document is very poorly done as far as assuring the public that there is no problem. There are things that are said in the document about the seafood industry, that it is taken into account. One thing in particular, there is a statement that there will be low, but measurable, amounts of cesium-137 that will be detectable for some amount of time, approximately 18 to 24 months in the Upper Bay. That is a really critical consideration. The Upper Bay is in a very critical condition. The finfish in the Upper Bay have been decreasing. There are no shellfish up there so we don't have to be concerned about that, but the Department of Natural Resources reached the conclusion in a report that's used as reference in the EIS that there is "something wrong with the water" and they don't know what it is. So, that is one thing that we are concerned about, that the EIS says that is the public is properly informed there should be no problem. But this is not an example of properly informing the public. And I don't think 25 meetings in the area of the Chesapeake Bay and Susquehanna River is properly informing the public. I don't think you are letting us do that. I think that so far everyone is saying that the Susquehanna River alternative is just an alternative -- you are open to other alternatives. And yet, the Susquehanna River alternative is constantly brought up. There were graphs and charts and maps on in tonight and I have heard people say that it is just going to get dumped sometime. They talk about accidental releases in the EIS. There is going to be a big accidental release, so we are very suspicious and very unwary. We also feel that there needs to be independent scientific review. And again, to reassure the public, our efforts at seafood marketing which have really just begun to pay off will be just annihilated if the public is not properly informed and, again, this is not an example of that. So, I guess really I can sum up my whole statement in saying that in order for me to really represent Watermen just to say that we could not at all support in any way, shape, or form any kind of dumping or dilution of any kind of wastes into the headwaters of the Chesapeake Bay or into the Susquehanna River.

LOUISE BEAUREGARD (Tr 57): I am dismayed that anything as acute as this would be kept on the level of printing and meetings and meetings and printings. And I am wondering if it's because you are not educating us as to how this really affects us in an acute way. The concern of the route that you showed on your map, that's not because of the Army-Navy game that we're a logical nuclear target, it is because the President takes that route to Camp David, that heavy trucking route from Washington to that point of Maryland where Camp David is, and it would jeopardize our first family of our country and the countries that are our enemies would certainly make that a natural target area with the heavy trucks, and I think that has not been brought out. The second thing is the cold war psychology and the repercussions from the nuclear blast in 1940 to the country of Japan. And I think it's time, while the first thing on Three Mile Island may have been an accident, and we praise the Lord that it was an accident, but only four weeks ago they showed clams one inch to an inch and a half growing inside of nuclear pipes. Now those clams had to be placed as seeds, so how long ago did that frame take place? And, therefore, I have a right to ask you, with the generation coming up, if we are being done to because someone did it to them? Will you alert us and why should we stop at Congress from keeping you from protecting us if infiltration of enemy sources are there now? I think that should be taken to the President of our country. Our ducks on Route 2 now have thyroid goiters from the chemicals that are in the water and the tomatoes that are grown cannot be eaten. You are not eating the crabs that come from Maryland waters; they taste of kerosene gasoline and other chemicals.

EDITH MAY (Tr 59): I've noticed this evening and also in the environmental impact statement that economics has been left out pretty much. There is very little cost-benefit analysis. You talk about the benefits of the cleanup being so great over the risks of environmental factors, what could happen to the environment, and I don't see any economic analysis going on. I know that the Department of Energy has economists; I assume that the NRC has economists on your staff also. I also would like to know why only the headwaters of the Chesapeake Bay are being considered. Has anyone considered the economic impact on the thousands of fishermen in the Chesapeake Bay, the fishing industry? Has anyone considered what the economic impact is on Metropolitan Edison? I have heard a lot of talk in these meetings before about the EPICOR system and how Metropolitan Edison went ahead and spent millions of dollars and now the NRC of going to bail Metropolitan Edison out. Has anyone analyzed what are the various net present values of Metropolitan Edison's investments in the various techniques of processing the water, of cleaning up the plant? What is the impact on Metropolitan Edison's current stock price? What will the stockholders want to do? What will the Board want to do? Are you people bailing them out? My question is not, is the NRC going to spend the money, but is the NRC going to make it the easiest and the cheapest way for Metropolitan Edison to spend its money? How long will it take you to put out the final? You said it took you 8 months to put out the preliminary -- from the end of November to the end of March is 4 months. If you couldn't come up with costs in 8 months, how are you going to do it in 4 months?

PATRICIA CLAGGETT (Tr 72): I'd like to address my concerns to the alternative of disposing of the waters underground. Some of the people here tonight may be aware that the House Government Operations Committee today released a report that is concerned with toxic waste residues in our drinking water supplies in this country — that they are very seriously in trouble and if we don't address that concern immediately, we are not going to have enough water by the end of the century. The whole debate of nuclear waste disposal has been going on for some time and some of the most capable minds in the country have been addressing the issue and it has not been resolved. I'd hate to think that we are going to attempt to resolve it at Three Mile Island with the Chesapeake Bay and the surrounding communities as a recipient of that resolution, in whatever form, sometime in the next year or two, because I just don't think that we are capable of

doing it. And I don't think that the underground water supply, maybe it is out of sight and out of taste a little more than dumping it in the river, but I don't think that is any safer at all, and I am particularly concerned about it.

PHILIP CAHROOM (Tr 73): I would like to raise three basic questions that are on my mind. The first one and most specific is to agree with Miss Kelly and some other speakers that we really can hardly accept as any kind of environmental evaluation the statements which appear a couple of places, such as, page 10-29 and page S-11 in the statement as it now stands to the effect that if the effects of radioactive releases in the Susquehanna are properly understood by consumers that the marketability of fishery products from the affected body of waters would not suffer. I have seen, in attempting to do a thorough reading of the EIS, no form of study whatsoever as to public acceptance of supposedly low levels of radioactivity, particularly in light of scientific controversy as to what those levels may be and what the effects of those levels, particularly if there were bioaccumulation or certain hot spots which might cause limited variances in contamination of seafood, what kind of public reaction there really would be. I don't know, if I had not seen any comparison to the actual reaction to agricultural problems in the TMI area at the time of the accident. I haven't seen any comparison with other seafood contamination scares in the actual history of the Bay. There is no foundation whatsoever which I have seen for that support. And I don't think it's a fair statement lacking any support, it's just someone's opinion. Second, I would like to agree with some other speakers and point out that the regulations as to the EIS 10 CFR Section 51.23 specifically require that there be a cost-benefit analysis which to the fullest extent practicable, should quantify the various factors considered. I think that it is also a disservice to the public that no effort was made or at least no effort was made to include even provisional dollar figures in the EIS. I think that the cost of the cleanup itself is an environmental impact because I don't think anyone could deny that the full cost of that is going to be passed down to the consumers in this area, whether exclusively limited to the Harrisburg area of whether passed along by the utilities consortium to consumers up and down the east coast, so that the dollar figure is something that should be included and I would hope that a supplemental draft EIS would include dollar figures so that that might be considered. Related to that, the third and final point I have is that I suspect an assumption is being made here or that there are underlying assumptions which depending on how they go, would affect the cleanup decision of whether or not TMI-2 would ever be restarted or whether it is to be permanently shut down and the kind of costs that would result from those decisions are things that should be considered also. It's those decisions as to whether it should be permanently shut down or whether a full cleanup would result in starting up or salvaging any of the plant should be fully disclosed and the public should not be made to pay more either economically or environmentally to maximize the salvage value of that plant in any way.

KENNETH MAHAN (Tr 76): I have a prepared statement which I will excerpt later, but there is one point that I would like to bring out and get clarified, perhaps which came up tonight. When Dr. Snyder was asked about the economic impact and why we don't have cost figures now, he said that the cost of the various cleanup methods is "of secondary importance." I attended a meeting similar to this in York, Pennsylvania, on September 18, 1980, and John Collins filled the same role that Dr. Snyder does here and when he was asked the same question he said that it was of no import at all, that the only consideration would be to do it in a manner which is the lowest possible radiation exposure and I think that deserves a clarification somewhere along the line as to which is the real considerations, the secondary or no consideration at all. Let me just read a little bit from my statement in the interest of time, I will cut it off. I would like to comment also on the prospect of Metropolitan Edison running this cleanup. As I understand it, the NRC will not choose the method of cleanup but only has a veto over the method Met Ed chooses. We Marylanders who may drink the water possibly released from Three Mile Island, or eat the seafood that lives in it, need assurances that the NRC will require Met Ed to use the safest method for the cleanup. Metropolitan Edison is in bad shape financially. Two weeks ago, it laid off a large number of workers, including 500 working on the cleanup. The NRC should devise plans to continue the cleanup should Met Ed go bankrupt and should devise plans to determine if Met Ed is scrimping on cleanup to save money in a manner which could jeopardize the health and safety of our citizens. The cleanup is a unique and difficult technical problem. Met Ed does not have a reputation for technical excellence. Saturday's Baltimore Sun notes that NRC's study found 37 serious deficiencies at the TMI-1 control room and 50 less serious deficiencies. This leaves the observer with the fear that Met Ed will not do the excellent job required to make the cleanup safe. The NRC should develop plans to monitor the cleanup to see that it is being done correctly. Finally, the NRC must realize that the public does not have great faith in it and Met Ed. There must be some assurance for the public that this process is being done correctly. It should be a truly independent, knowledgeable, well-financed body to monitor the cleanup so that we Marylanders who drink Susquehanna River water are not having our health jeopardized and we Marylanders who make their living from the Chesapeake Bay are not having our livelihoods jeopardized.

JOHN ECHENROAD (Tr 78): I would like to, as a member of the Chesapeake Energy Alliance, endorse the view that has been taked by Marylanders here tonight — that the radioactive discharges into the Susquehanna, into our waterways would be considered unacceptable.

CATHY RILEY (Tr 80): I am a delegate representing Harford County and chair the Joint Energy Commi-tee in Annapolis. I am getting the impression from what you all have said and from some of the comments and questions that have been directed to you that this is our bite at the apple. That we're talking about a 5- to 7-year process of the cleanup and maybe I am incorrect and maybe I have been misled but it seems to me that I am hearing that this is our one chance as public officials and as citizens to have an input, and I find the statement deficient for a lot of reasons, some of which have already been pointed out. And I would like to clarify whether or not when it comes time to make the various decisions and to determine alternative after alternative, whether or not you are going to have public hearings, whether or not you are going to give the people and the elected officials the opportunity to comment at that time. I think it's terribly important. You said earlier that in a decision that the NRC was trying to make that they were breaking new ground. And I think we've all broken new ground with the whole TMI issue. The track record of NRC in the last 18 months has not been one to be terribly proud of as far as I am concerned and I think we are all in the process right now of trying to expand credibility and to expand public knowledge and I would hope that you are going to give us the opportunity to comment piece by piece.

BILL AMOS (Tr 82): I am a delegate that represents the area that is most affected in Harford County. That is a single member district so it just leaves it up to me as that delegate to express how the citizens of that district feel about the possibility of dumping. I want to thank you for the "seem-like" decision to say it needs to be cleaned up. I believe that is necessary and I appreciate that very much. However, you can see how I would strongly object to the dumping and I think we that live there realize a few other things about the river, and I can't help but what you said about the flow in the area of Three Mile Island — it just doesn't exist at the Conowingo Dam. You probably are privy to all the Susquehanna River Basin information. That information will lead you to the conclusion that they have been worried about the flow in the dam ever since the last dry spell. And, here we come into another dry area, and this summer we had a fish kill below the dam which meant, in the end, it proved that they had it shut off for almost 72 hours. Now, they can shut the dam down for 72 hours, can you imagine what that does to the flushing effect of the Conowingo reservoir. In taking dumping into consideration, you've stated what that would do to the environment if that amount of water there was dumped. However, you remember that, just remember that, something could happen to Peach Bottom, and if it did, you would have no alternatives if you don't, what I call, clean up completely and get it away from the river — this strong possibility of something else happening. Not only do you have that at the upper end of the Bay, you have Calvert Cliffs to the bottom. Of course, flushing effect is much more there because the ocean's a lot closer. But a combination of two accidents or even of a large spill at Peach Bottom could aggravate the problem if you go towards dumping. We also, in Harford County, depend of course upon the water supply. I'm not sure that anybody sits there and drinks two liters each day of water and I'm not sure that a lot of it wouldn't be filtered out. However, there is a bottling plant there for Coca Cola, and there's other industries there that would be affected because that whole corridor of Route 40 is hoped to be supplied from the Havre de Grace water works. You go across the river and you have Perryville which can have the same problem, especially if any of these expand commercially. I guess the final thing I'd like to say is that in this final proposal, I feel that there should be some more input. You're going to make a decision. I find input no problem. Evidently several regulatory agencies of the U.S. government do. One is the one in charge of licensing the Conowingo Dam. In that process, it's been very difficult to put input into it. I find the more input you get, the better off you are.

CRISTIE FIEDLER (Tr 85): Several months ago I received the NRC Draft Programmatic EIS related to the decontamination and disposal of radioactive waste generated from TMI accident. Accompanying the document were six pages of corrections, including Section 10.3, "Offiste Doses and Health Effects from Normal Operation." I would point out with strongest emphasis that the qualifying word in this phase is "normal." Section 10.3 contains tables and descriptions correlating expected releases of radiation during transportation of wastes to the probability of cancer or genetic damage in the general population. As an example I cite the conjecture that a person exposed for 3 minutes at an average distance of 3 feet from a truck loaded with radwaste as at a highway facility might receive up to 1.3 millirems. The risk of cancer from that dose is 1.7×10^{-7}. The risk of genetic damage, about 3.4×7^{-7}. What this data and all similar conjectures that the NRC failed to account for is the likelihood of a major accident during radwaste shipments — a likelihood that must be considered as possible as a likelihood of similar TMI-type accidents at other nuclear plants. A worst-case accident would result in exposures during shipment that would exceed those of a person at 3 feet for 3 minutes. Furthermore, this Section 10.3 is merely an example of what is missing from the entire PEIS -- an overall failure on the part of the NRC to consider the factor of human failure inherent in the nuclear program as a whole. The NRC is to be credited for the clarity of their tables, research, data, statistics, and other raw information made available to the public. However, it is a discredit to the NRC and a disgrace to the public that the Commission does not regard the public health, welfare, and safety above all other considerations. In order to restore public trust in the NRC's decisionmaking you must demand the highest safety standards possible from Metropolitan Edison and all other of these licensees regardless of economic impact.

Comments made by NANCY KELLY appear as comment number 13 in this appendix.

Comments made by DR. IRVING STILLMAN appear as comment number 14 in this appendix.

Comments Received at October 6, 1980, Meeting with Susquehanna Valley Alliance at Lancaster, Pennsylvania

MRS. HYATT (Tr 25): My home is near Three Mile Island, but because of psychological trauma I have had to leave there a year ago and cannot make myself go back. Now what I want to know is, I have been through a lot of traumatic experience and know some facts on TMI that haven't been told by the NRC or Met Ed. What I want to know is, I'd like to go back to my home; but if the course of cleanup is going to be as bad as what I think it is, and have found out it to be a fact, I would like the panel to come right out tonight and be honest about it. I have a home and a husband back there at Three Mile Island that I cannot force myself to go back there. And if you could just be honest about the cleanup and say how much radiation I am going to be exposed to if I go back, and the constant release of the Krypton. I know for a fact it's a heavy noble gas, and depending upon and wind, which way I'm going to get it directly. So what I would like to know is, just exactly how harmful will it be if I go back -- not counting the psychological stress that I'm under.

VINCENT R. LUDER (Tr 29): I have one comment before I ask my questions. Pertaining to the woman that was just up, the answers that she received implied that the radiation from the artificial elements that are created in nuclear plants are identical in effect on human beings as are natural background radiation levels, assuming that we consume and ingest all the natural background levels in the same way -- which I'm not really certain of, from my background, being able to discern that that is actually true, but I'll continue with my question. On one of the very first slides that was shown, one of the purposes of the EIS was to focus on environmental issues and alternatives before commitments to specific choices were made to cleanup. To that sentence, I would like to ask why Metropolitan Edison is squandering the limited resources they have in building a submerged demineralizer system which has had no okay at all, and could potentially be actually not okayed for use. This could be a tremendous waste of the new small resources they have.

TOM SMITHFALL (Tr 34): It states in there that you will focus on environmental issues and alternatives before commitments to specific cleanup choices are made. It appears that EPICORE-II, the SDS system, and the construction of the rad waste staging facilities are not "specific cleanup choices." My question is: I think there is a discrepancy in your introduction and what is actually occurring at the plant. Section 1.3 of the PEIS states a summary of Metropolitan Edison's objectives, proposed actions, and schedule. When the licensee presented their schedule for Phase I and II, which are containment entry and decontamination and fuel removal and coolant decontamination, did they at that time present to you a third phase which would, I presume, have dealt with the reconstruction for operation at that time? How can the NRC approve Phases I and II without knowing the ultimate disposition of the plant?

WALDEN RANDALL (Tr 39): Before I begin, I would like to comment. I have been to many meetings with the Nuclear Regulatory Commission, and I appreciate you being here this evening. However, I am becoming increasingly concerned that these meetings are an opportunity for us to ask questions, but if we do not feel that a full explanation has been offered, or if we still have more questions -- such as this crowd which has now grown to probably over 300 -- it's not a satisfactory way to allow the public to comment. My first question would be to Mayor Morris: Mr. Collins says the decision has not been made whether or not to dump the water into the river. All the way through the document is "if approved." Lancaster City under Mayor Wolten (phonetic) has an agreement that no water that is accident-generated or cleanup water will be allowed to enter the river -- God help us -- from an accident or a mistake, be allowed to enter the river until the Final Environmental Impact Statement is completed. That will be March, 1981. Am I correct. I had one other question which I wanted to raise on Section 10 which deals with the desilting basin at the site which will be used to store the cannisters containing the resins from the EPICORE procedure and, if approved, I assume the SDS resins. Is that correct? The high-activity waste in the canisters in the shallow burial site in the desilting basin are projected, according to your document, to be covered by a probable maximum flood for only four days. Could you please tell me where you get the figure that if there is to be another Agnes, or another flood on the Susquehanna River, that your high-level activity wastes inside the canisters would only be exposed to a continuous water path for four days? It is now 1980, and every official government document -- the National Flood Insurance, Watershed Basin Studies, Pennsylvania Act 282, Storm Water Management, passed by the legislature last year -- the volume of a flood on this river is increasing yearly. It will continue to increase as various areas are paved over and become impermeable, which means that as the rain falls, the water hits the river faster; it doesn't have time to be absorbed by the ground because the ground is covered by asphalt. I question the storage of any high radioactive waste on an island based on a design-basis flood which was prior to the probable maximum flood, and then a probable maximum flood that is eight years old. I think that you may in fact be placing the canisters of high-level waste -- high-activity waste in a shallow burial site where there could be an extremely serious flooding problem. Those canisters could then be -- the contamination within the canisters would then be spread all the way down the river and into the Bay. I think that is terribly alarming, and I would like your reaction. Is there no burial site available in the country that can take those canisters, other than leaving them on the island at this time? If they were solidified, is there a site available in the United States to which they can be sent? Or must we await the development of a deep geological repository somewhere else in the country, approved by the Department of Energy, which no one has been able to find since 1941?

JOHN ADAMS (Tr 46): The Clean Water Act prohibits discharge of radioactive waste into navigable waters causing further dilution and dispersal of radioactivity into the environment. Would any proposed dilution of radioactive processed waste -- accident or cleanup -- conforming to NRC standards discharged into the Susquehanna violate the intent of the Clean Water Act? I feel it is somewhat contradictory to call the workers, or mention that they're "apart from the general public"; yet, their genetic effects are increased over the general public, and they will continue to father and mother the children that will become part of the "general public." Now I feel that that is an erroneous statement to claim that they're "apart from the general public."

DAVID DOBBINS (Tr 49): This PEIS Statement gives alternatives to the disposal of the radioactive water -- or processed radioactive water. Who is responsible for choosing the alterantive to be used of the many that are listed in this document? Secondly, once that choice has been made, will the public be allowed to have comment and review on that? Will the comments given at this meeting and the meetings like this, along with the comments that are requested by November 20th -- How will these comments be incorporated into the final draft, or the final copy of the draft? I was interested in actually if the public would have a comment on the choice of the alternative chosen. What kind of forum, as you mentioned. Or would there be public input? In other words, do we have any kind of commentary on the choice chosen? Because one of the choices is dumping the water into the River.

DEBORAH THOMPSON (Tr 54): The scope of the Programmatic Environmental Impact Statement, as it stands, is inadequate. Before any cleanup actions proceed, the following factors should be more fully addressed by the NRC. First, the decision whether to commission or decommission Unit 2 must be fully addressed to make an intelligent cleanup decision and, by doing as little cleanup as is necessary, forestall the possibility of more environmental contamination. Secondly, the disposition of high-level wastes must be fully addressed before a decision to produce more wastes is made. TMI cannot function as a waste repository without endangering the health of our community. Thirdly, public safety and health factors are not adequately considered in the PEIS. Stress will not be alleviated by the speed of cleanup as is suggested in the Environmental Impact Statement; but, rather, by competent decisions based on concern for health and safety of the community in proportion to concerns for Metropolitan Edison's financial viability. Fourthly, radiological effluent criteria for the community during the cleanup process must consider the accident-generated releases. Only in this way would the total effects of TMI and the accident on the community be accurately addressed. In setting these radiological effluent criteria, the accident releases must be honestly and openly reflected. Fifthly, the dilution of contaminated water to Federal Drinking Water Standards is not an acceptable method of cleanup for persons who drink, bathe in, and use the Susquehanna River for recreational purposes. In conclusion, I would urge the NRC to be more responsive to the public comments you hear tonight and you will receive in writing than you were vis-a-vis the public comments you received concerning the venting of krypton-85.

DONALD CRYDER (Tr 62): The first conclusion that was in the slide stated that total whole-body dose to individuals offsite should not exceed 1.6 millirem. Now what does that mean? Does that mean, as a result of the proposed cleanup the offsite exposure to the radioactivity? Is this the projected from any method of cleanup and disposition of the waste? Then further in that same conclusion you state: The risk of cancer, death cancer, is -- 2.2 in 10 million -- Do you mean that a certain number of people exposed to that amount of 1.6 millirems of 1.6 millirems of radiation, 2.2 in 10 million of those -- if there were 10 million there -- will get cancer as a result? Now let's say that this projection is wrong. Suppose, instead of 1.6 millirems, people just offsite of the reactor building are exposed to 3.2 millirems. Now would the risk of cancer increase linear to that? Would it double if the exposure is doubled? Or would it be exponential? In other words, like 10 percent -- that there is a 10 percent risk of cancer?

BEVERLY HESS (Tr 68): Is NRC operating under National Environmental Policy Act considerations in the cleanup process as outlined in the EIS? I read that the National Environmental Policy Act does not require that an agency select the most environmentally beneficial alternative; but only that it understand the environmental consequences of its actions and consider them in its decision-making. An agency may proceed with an action that involves environmental damage if it is convinced that there are economic and technical benefits that override the environmental drawbacks. I am very concerned, as I understand what is being said here today, that there will not be an opportunity for the public to do anything more than comment on what we consider to be the environmental consequences of the alternatives that are being outlined, and which will be chosen. At the time of the elections in the spring, President Carter said that he would make the health and safety of the people of the Three Mile Island area the primary consideration in the cleanup. As I understand these regulations, that is not being said; that that primary consideration has to be the overriding concern. And I would like to know, what -- I mean, other than the public comments, and I understand that this is being reported, and I understand that there will be opportunities for public comment to be taken again -- but since the Staff recommends to the Commission, and the licensee recommends what shall be done, at what point -- or does, or will -- the public ever have an opportunity to say what they consider must be done in this instance that affects our lives? Is there anything short of the legal route, where citizens have to sue the NRC to see to it that the water doesn't get dumped into the river. Is there anything short of that legal procedure by which citizens can have a real effect other than just public comment?

STEPHEN SYLVESTER (Tr 71): I have read almost all of the statement, and I have listened here tonight, and I must say that you've gone into a good more detail in the past. This both puzzles me and concerns me. I think what most people in this room really wnat to hear is: When is the cleanup going to be finished? And what are you going to do with the waste? When are you going to truck them out of south central Pennsylvania? And despite

the fact that you've answered every question here in a great detail of detail, and you've told us over and over: We know what we're doing. We have experience. It seems that tonight what I hear more and more is: The cleanup process is becoming, time-wise, more open-ended. All of a sudden you're telling us: Well, it may take longer now. Met Ed said three years; now we think it's seven; we think it may even be longer. If you want to settle this thing with the public, if you want to somehow win the public over, to cooperate with you and to listen to you, you'd better come up with these answers, fast. And if you tell me you don't know, you shouldn't be sitting up there. You should be sitting down here and somebody with the answers should be sitting up there. I have read in the newspapers that Met Ed is asking for money, or is about to ask for money, or is looking around for money from the Federal Government to help with the cleanup. Part of their rationale is that the regulatory process didn't protect them from this accident. Could you, in your position working for the NRC, comment on this? Did the NRC do a good job? Was there any malfeasance? Is there any sort of, in your mind, liability that the NRC has from this accident and thereby committing the public Treasury to clean this up?

KENNETH MAY (Tr 74): One of the thing that was striking to me, as a lawyer, about this PEIS was that there were no cost figures, financial figures as to the cost of the various alternatives which I thought would have been in the PEIS. On September 18th in a meeting in York, you, Mr. Collins, said that the only criteria is something along the line of "as low as reasonably achievable," and the costs of the various methods would not be a consideration. Now on September 30th at a meeting in Annapolis, the same question was asked of Dr. Bernard Snyder, and he said that cost would be a "secondary consideration," which seems to be different. I was wondering if the two of you have discussed which one of you is right?

MARCIA WEISS (Tr 76): One of the concerns that I have -- or a comment, is that, if you would, to talk to the local water companies and find out what their sales were before the accident, and what their sales were after the accident. I think you would be quite surprised. I know many people through employment and through my church activities, and I think that most people switched over, or a lot of people have switched over to the Diamond Springs Water. Now if a survey went out to those people, I think that an underlying reason would be fear of the drinking water. We can't get away from it. Our children brush their teeth in it, and they take their baths, and we wash our clothes in it. I know you have good scientific reasons as to why we are safe, but there are a lot of people that are still afraid; and there are people that just cannot forget it. We don't have a packed house tonight, but there are people here who care and people who read the papers. And there are many more people that care about it than I think you people realize, and that is one way of showing it. Now one of my questions is: In your statements concerning the low-level dose rate, the rems that a person can receive per year, that safe average, are people included in the statistic?

JOYCE NETKE (Tr 80): One experiences a considerable amount of psychological stress just sitting here and listening to what you say, and reading your slides.

STAN KOHLER (Tr 86): I have some questions pertinent to Section 6. These relate to some of the biological concentrations that you're indicating in the report. There are a couple of things I would like to make clear, first. Number one is that, when you talk about 1.6 -- 1.7 cancers in 10 million due to exposure to the 1.2 to 1.3 millirems, these are whole-body exposures that these are based on; correct? So this is assuming that the 1.2 to 1.3 millirems are exposed over the whole body. Now two of the more potent radioisotopes that we're talking about, or radionuclides, are cesium-137 and strontium-90. Both of these are fairly strong bioaccumulators, and not just bioaccumulators but also ecosystem concentrators -- which means that they concentrate as they move up the food chain. You said a number of different things in your report. You said that if there was an accident, that somebody who consumes a grand total of, I believe it was, 2 liters of water a day and 21 kilograms of fish could get a total of 31 millirems and 21 millirems respectively. And if you total that up, if somebody happens to be somebody who likes to drink a lot of water and they drink 2 liters of water a day and they also eat a lot of fish, that means a total of 58 millirems. Does this include the overall effects of accumulation and concentration in the body? In other words, does that include the fact that it is going to stay there for awhile? Or does it mean a one-time-only deal? My last comment, though, is that the standards are being contested. In the interest of everyone concerned, I would vote that the water not be released. And it seems to me that solidifcation on-site has a very, very good potential. I think that it can be done in such a way that worke-s are not exposed, and I think that having it there onsite -- and I'm talking about fairly low concentrations, as you indicate they are here -- in cement are going to stay there for a long time. And if they build a wall around it, so much the better.

JIM BRESFLOWER (Tr 96): My question to you is: Do you have any plans to do so? To involve the Union of Concerned Scientists and other independent, nongovernmental and nonindustry groups in the decision-making process?

LUCILLE WRIGHT (Tr 99): First of all I would like to say that I really do feel as though the Nuclear Regulatory Commission has a pretty big job. So I think it is healthy that the opinions and views of people who have expertise -- local people -- should be expressed. But I also feel that -- this is the first time I have ever attended a meeting like this, and there are not many of us here from the area. I feel as though we need to have some kind of an expression. And I am wondering if there are any plans or any consideration of a local referendum that would include the people in the counties here that are directly involved in this issue. I feel as though we should have something to say, a chance to say how we feel about the release of water into the Susquehanna. I feel as though we ought to be able to say something about how we feel about the disposal of the solid waste. And I also feel as though the general public ought to have some input into the reopening of Three Mile Island.

RICHARD DRENNEN (Tr 103): What I am worried about, more than this low-level radiation and so forth, God has a way of doing things with the earth. You can have earthquakes, typhoons, floods bigger than you have ever seen or I have ever seen. What happens to my home? What happens to all our homes when this place is under water, when the rock splits because of earth problems and this radiation goes down this river? Can you guarantee me that in my lifetime I can come back to my home and drink my water because you have permitted something like that to be this close to this many people in a waterflow area?

SYLVIA BUYAN (Tr 106): From the way I understand your Environmental Impact Statement, these environmental impacts would occur over a period of what you now estimate to be five to seven years. However, you mentioned tonight that this may have to be extended out. Now my question is, because you have no control over how quickly this will be done because it's a question of money, time, and all this other kind of things, that there is a possibility that this could go on for 10 or 15 years. However, if this were to drag on for whatever reason, how would this change the Environmental Impact Statement? Would you then have to do another survey? Would it change these statistics? Because I understand the plant is, I don't know, decomposing, or it has a life --.

BYRON CORE (Tr 109): I read in the EIS, Section 10.1, "The processed water would be diluted and then discharged to the river at controlled rates. Such concentration of radionuclides in the river would be well below the threshold level for deleterious effects in aquatic species of humans." Now this suggests to me that there is some sort of threshold level that is also being considered. What is that threshold level, if there is one?

CARL HUIER (Tr 111): I, too, am opposed to the dumping of the water into the Susquehanna River, because I live right on the Bay. I'm a little closer to the Bay than I am to Bel Air. I used to like crabs. I don't eat crabs and shellfish from the Bay anymore. I do have some questions. One of them refers back to Mr. Congel, and he opened it up by what he said there. The amount of radiation that's taken into the body as a child, the infant at one year, no matter what level we're talking about, is considerably growth-related to the child. Not that the child gets older from the time of one year to fifty years, that way. But if the child is there in an area where there is radiation, year two, how much radiation does that child receive as whole-body radiation, and how much does it retain, year three, year four, year five? The cumulative effects on that infant, or unborn fetus, or fetus, will continue to grow as a cancer if the cancer is there. Now getting back to this BEIR Report, as expected over a year, what period of time are we talking about in the experiments or the data that was extrapolated on giving doses of radiation to mice at 100 millirems, or to hampsters or guinea pigs are we considering that you extrapolate to a year? Is it a day? Was it five hours? Did you observe the animal through its lifetime, as we're doing with human beings? The other thing, why does cesium or strontium have to be released? Why can't it be superfiltered, or continually heavily filtered to get it out of the contaminated water?

BARNEY EPSTEIN (Tr 119): You mentioned the fact that the scientific community has been searching for a burial ground for years for the high-level waste. I would like to know what constitutes "temporary"? Because in your statement, you mentioned the fact that the waste will be left on the Island "temporarily." Also in conjunction with that: How long after the time limit "temporary," does it become a waste ground, a permanent waste ground?

KITTY LOVINGSHANK (Tr 122): Now my question is: Sitting here tonight, I am really confused about how much authority the Nuclear Regulatory Commission has over the decisions that are made by Metropolitan Edison. If I understood you correctly, you very early this evening talked about an installation that is being put in at TMI that you people do not agree with; and that it's costing $35 million, but you told them to go ahead, that it's their problem. And on top of the fact that the lack of Nuclear Regulatory inspections of these plants is what made this accident possible in the first place. Now I would like some clarification about just what kind of a watchdog you really are.

BETTY TOMPKINS (Tr 124): On what basis did you make the statement that there will be no long-term psychological effects from Three Mile Island? I would like you to revise your estimate at least to say that it's "99 percent sure," because here is one person -- and I've told you before, at the time of TMI, that my grandson was two weeks old. He's now a year-and-a-half old, and we will have psychological concerns about him, and we will suffer stress as long as I live, and until at least 20 years from now. So I don't know how you can say that there will be no long-term psychological stress.

Comments Received on October 7, 1980, Meeting with Pa. Farmers' Assoc.
Camp Hill, Pennslyvania

WAYNE BESHORE (Tr 27): The material which you're going to be disposing of, is that a solid matter? Or what is it? You've talked about water, which I can understand; but what is this?

CHRIS ALLEN (Tr 29): Since that waste may be stored on there for some time, what sort of storage facility does Met Ed have?

WAYNE BESHORE (Tr 35): Is there any economic data involved in this?

LOU WAMBAUGH (Tr 40): Going back even before the accident at TMI, your daily records had one reporter that had quite a series of writeups citing the faults of nuclear power, the dangers. That went on for a couple of weeks. Could this accident have been planned?

CHRIS ALLEN (Tr 44): *Two questions, really. At the beginning of the* slide show, you showed some conclusions that you reached about how possible doses from the cleanup would affect people, and they compared favorably with background doses. Have you ever made the same kind of judgments on livestock in the area? And I guess this may be a question for DER: Can farmers along that transportation route look forward to more frequent testing of milk for radiation and subsequent publicity of that?

CHRIS ALLEN (Tr 50): If accidents on the scale of TMI haven't happened, where does the training come from? Is it simulation training that these people have had?

WAYNE BESHORE (Tr 54): You infer that there is no possibility of contaminantion on the part of milk, and I guess you're saying other foods also. Has all sampling been discontinued?

MR. DEHOFF (Tr 58): Aren't some of the foreign countries reusing the wastes.

JIM HESS (Tr 67): Is there a danger that radiation would get in the crops, in the ground, and cause problems in the future? And is this danger actually -- does it really exist? And how serious is it? Okay, now let's explore the unforeseen. What happens? What is the probability? What is the cause? What does radiation do to crops, and animals, and so on?

MR. MUSSELLMAN (Tr 82): I would like to make one statement for the record. It appears to me, according to your presentation here, that there seems to be a procedure of experiment -- not "experiment," entirely -- but procedural arrangements here for cleanup that are not feasible from the standpoint of evaluating the cost of it. In other words, we don't know exactly how much it is going to cost to clean up the reactor, and everything else. The statement I would like to make is: I don't think the consumer is served, if Met Ed should be the sole persons to stand that expense. Since this information is going to be used by the NRC in other possible accidents which would occur, the procedures which you all are enacting will be to the benefit of future problems, and therefore I think the cost should be borne at a federal level, the expense of partially this cleanup.

Comments Received on October 8, 1980, Meeting with Steering Committee
Newberry Township, Pennsylvania

BRIAN MCKAY (Tr 36): You keep telling us about the water problem down there and every once in a while we understand that Met-Ed makes another test well and finds some more tritium and of course everybody keeps telling us we can't find out where it is coming from and that that is a process of nuclear fission. That stuff can't ever be filtered. What is going to be done to alleviate that problem and find out exactly where the tritium leaking from from damage due to No. 2 of Unit 1?

DIANA WELLS (Tr 38): One is that you stated that No. 3, the partial clean-up and defueling is not what you would consider a reasonable alterantive and I would like for you to elaborate on that, please, and give a little bit of your reasoning because it seemed to me that an awful lot of waste water is going to be generated in that clean-up process and it seemed to me that the study did indicate that it would be a lot lengthier process and a lot more closely process to deal with all this excess waste water and the other materials that would be involved in cleaning up the plant and the total clean-up versus just getting rid of the core. So if the core was out and if the waste water was solidified with cement or whatever alternative you have, are you saying that would eventually leak through the cement walls and into the environment? I think one of the things that concerns me is it seems the desire to toally clean it up which added several million dollars and the refueling, in the paper they listed the cost for the clean-up and in that cost was added the cost of the refueling the plant, and it seems to me that the big desire is to clean up that plant so that it can be refueled and reutilized rather than what would be the safest way of cleaning it up. They have added a lot of costs and a lot of time in there for completely washing down the walls with hundreds of thousand more gallons of waste water.

MR. MCHENRY (Tr 43): Just a question of interest. Have there ever been any plants in the United States decommissioned and the environment restored? I just wanted to further my I guess comment more than anything else, the fact that we seem to be doing a lot of experimentation on Unit II in terms of developing systems that can handle the larger commercial nuclear reactors and the fact that, you know, some possible alternatives might be to go so far and continue making some experimentation in other areas with another reactor and the decommissioning process, you know, that you at least know what you have to work with. The comments have been that work has been done with small systems, experimental reactors. From what I understand, you know, I don't think it is a matter of just taking a system and building the parts ten times larger and using that TMI-2. That is being oversimplistic.

MS. REHM (Tr 46): I would like to read you something that you have in your environmental impact statement. It says here "Commercial nuclear power plants are not designed with special considerations for large-scale contamination operations." So, in other words, this is an experiment? Also according to here it said you have had two major differences than they have had at any other accident or other plant. That is, one, the krypton, and then also the amount of containment in the water.

MS. STRICKHOUSER (Tr 53): I feel, like 90 percent of the people that the longer it takes to clean this up there might be more danger to it. There might be an unknown danger that might happen to the public the longer they hold off to clean it or decide how they are going to clean it. What I mean is you are pussyfooting around deciding what to do, how to do it and anything can happen in between until it is accomplished, the clean-up is accomplished. There is fear in the public. You would be surprised how much fear there is in the public where they won't talk up until this is cleaned up. It is really fear.

MS. UMHOLTZ (Tr 57): Throughout the 18 months I have been basically concerned about my exposure to this radiation but throughout these months I have been told by various people that it is either a comparison to an X-ray or it is within normal background levels or it is slightly above background levels which is not harmful or any cause for concern for public health. On the other hand, they are coming up with risks, 2.2 in 10 million and 4.2 in 10 million for genetic. If I am not getting affected in any way by this how can you come up with risks? It doesn't make any sense to me. There should be no risks then, but you are coming up with risks.

MR. MCKAY (Tr 68): You gave the example that you are reusing the water from the auxiliary building in the clean-up process. What I would like to know is if it is going to take five to seven years for the total decontamination of the plant what is it going to be the volume of waste produced that has to be stored on site or removed? Now, what about the high radioactive waste on the resins which are being stored down here on the island at the present time? What is the estimated time in effect for leaching to occur with the storage of that type of resin? What is the minimum time expected that damage will be incurred by the leaching effect of the type of resin storage that is contained at Three Mile Island?

MS. HERMAN (Tr 70): You asked for public comment on the venting of the krypton. Now you are asking for comments from the public again. I know before most of the comments opposed the venting and you went ahead and vented the krypton. What will these meetings and the comments made by the people, what effect do they have upon the decision that will be made?

Comments Received on October 20, 1980, Meeting with PANE
Middletown, Pennsylvania

JEAN CRUMLEY (Tr 32): I live in Summerdale, which is very near that Route 11 and 15, and I wondered, could you tell me if any radioactive waste has actually gone the 11 and 15 route? I'd like to put in a word for suggesting that it never be used again, because it has some of the most dangerous driving in the whole area, and there is a place where it is just impossible to widen the highway, and they do all the corrections they can, but it is extremely dangerous for the residents who live there. They take their lives in their hands to get out and make a right-hand turn, and certainly to -- I would like to make that a very strong recommendation.

MS. THOMPSON (Tr 33): Has the disposal site in Washington been closed?

DORIS ROBB (Tr 35): Are the wastes from the EPICOR system are low level wastes? I have another question. There is a possibility that the submerged demineralization system will be put into effect. I understand that's the same type of system as the EPICOR. What do you plan to do with the wastes from that, should that indeed be implemented?

MS. LIGHT (Tr 60): I wanted to respond or to ask -- well, I suppose because I live here, I'm a resident here, I was particularly sensitive to some of the descriptive terms used in the PEIS. I was interested in the way the terms were used. I was interested in the way the term "exception" was used, and I am interested in the way the term "phobic" is used.

MR. PEFFLEY (Tr 70): My concern is the disposal of hazardous waste materials. I do not represent opposition to progress, but to progress predicated on calculated risks primarily satisfying ones in lieu of needed services or products or natural resources. Man is an overspecialized beast by reason of his brain. It adds overspecialization that leads to his ultimate doom. In my 58 years on this earth, I have learned one thing: These people, and people in general, are neither for you nor against you. We are all for ourselves. It's a matter of survival. And you hear of people -- I mean because of various factors. But they themselves are protective of their party, the same as you are. I am subject to the hammer. I may, you know, be looking for a job or be jobless as a result of standing up and speaking out, as I have in the past, but it doesn't make any difference at this point. There are apparent safety measures built into all regulated industry. I work in the construction industry. I worked on the power plant down here at Peach Bottom, and various others. I understand a little bit about a lot of things, but not a hell of a lot about anything. I am familiar with acid fallout due to working on coal-fired plants. I am a little bit familiar with the disposal of waste in emergency situations, having worked under those situations. On these plants that have fuel storage tanks, in case there is a spill, they have safety valves and pressure systems. When they generate steam, regardless of the source of energy, they generate the steam from the water that they use, and the whole system is no safer than the human element. The human element is often times subject to the direc-

tion of engineers and technicians. In other words, if they don't do what they're told, they don't have a job tomorrow morning. I'm a human scientist, I'm allergic to tradition, superstition, and diplomacy, the ability to change the subject if you can't change the people's minds. Now the question I have is this: Number one, what is the capacity of the spent fuel storage cells on Three Mile Island, number one? And number two, to what degree of contamination is the emergency waste landfill, nonoperational at TMI, the onsite landfill, dangerous, concerning the leach chain and toxic emissions of the material that's disposed there into the soil, and eventually into the water, as far as the water is concerned?

KEN CHASTAIN (Tr 78): My comment is, we don't trust you. You have made mistakes in the past, you are going to make them in the future. In your corrected version, on page 24, you have Three Mile Island in another county, instead of Dauphin County, and if you don't even know what it's at, how are you going to clean it up?

JOHN GOFLICK (Tr 79): I'd like to make a comment and finish up with a three-part question. The nuclear industry and the NRC have yet to learn the thrust of the people in this area, because the safety of the people is not their primary concern. In 1979, I predicted that Three Mile Island was our greatest tragedy. Subsequent event have confirmed that. There is an established historical pattern of deceit and concealment of information from the people, based on the pretext that the truth would only cause panic. When a chemical-filled truck or train accident occurs, the local populace is warned and/or evacuated upwind from the scene of the accident. When a nuclear plant accident occurs, North Carolina, Three Mile Island, Florida, anywhere you can find one, the plant personnel try to conceal its existence. But when the outside news sources pry, the plant spokesman and/or the NRC will minimize the incident, such as TMI, such as the experience at TMI, and give false assurances that the radiation levels are far below background or NRC limits. And the disturbing assurance that NRC provides is that only two of our neighbors will get cancer. This occurs with each accidental release of radiation and/or krypton gas. We have a cumulative effect on this area, because 365 days a year, 24 hours a day, we have a byproduct while TMI was operating that produced electric, radiation and cancer. It is not producing electric today, but it is still producing radiation and cancer. The clean-up at TMI will pose continual radiation releases, and I believe your rates are minimal. I would also like to raise the question, the PEIS does not address the formation of zirconium hydrites in the core. Why was not the NRC aware of the fact of the chemical reaction of zirconium and zircaloy 204 combined with oxygen, nitrogen, hydrogen and steam could cause an explosion when exposed to air? Will the NRC warn the people of this possibility before the reactor core is removed? Will the area be evacuated as a precaution?

BARBARA PYLON (Tr 87): I wanted to refer to the entry, not the most recent entry of the five men, but the planned entry before, which happened to coincide with the PUC decision on the ratepayers not being held liable for the clean-up costs. And as I remember at that point in time, the licensee said, "Hey, we need the money to go in there. If you can't give us the money, we can't go in there." But what I have seen is a very slow process of getting in there. Now I don't have the technical expertise to know why you can't get in there, and for what reason 18 months later you've only been in there a few times. I'd like to know why it has taken so long. When you go in there, are you doing other than the usual things and checking out of the principal containment? What are you doing to get closer to the clean-up process? Because I don't want that sitting there for another 10 years. I want it cleaned up as soon as possible.

VOICE (Tr 91): On page 125 in the PEIS, there has obviously been something omitted, because my page 125 ends with a period at the end of a sentence, and the start of page 126 starts in the middle of a sentence, and there is nothing in between. I noticed in the presentation you gave earlier, talking about total exposure from the clean-up over a seven-year period of 1.6 millirem, and then later in the presentation you talk about transportation of waste, and if somebody was to be three feet from a certain given shipment for three minutes, they could get 1.3 millirem, and I'm sure you're aware that Met Ed or whoever the contractor is that does their hauling, already had one truck come undone coming out of Middletown. I'm sure it took them longer than three minutes to hook it back up. So how can you say 1.6 millirem, when -- in 1700 shipments of waste you have a tremendous potential for 1.3 millirem exposure for three minutes. These are just a few observations. Page 112, reference of the building interior surface. Quote. Experience is limited. Page 114, dealing with significant core damage. Quote. Experience is limited. As are as chemical decontamination, experience to remove fuel, quote, very limited experience. That's on page 114. Removing fuel debris from reactors. Quote. Little experience. That's on page 114. Removing damaged fuel and core components. Quote. Experience rather limited. Much experience not directly applicable to TMI 2. That's on page 116. On page 117, TMI fuel, quote, quite different, more susceptible to oxidation and embrittlement. Page 119, there are many uncertainties regarding characteristics of TMI 2 waste. Large scale decontamination activities -- this is quote -- much less -- this is on page 126, in dealing with the waste, as far as fuel centers are concerned, the word "unique," that is on page 210. Structural hardware, as far as waste is concerned, how do you deal with them. Unique. That's on page 210. Filter cartridge assemblies. Quote, Unit contaminant. That's on page 212. Accidents, large, quote, not directly comparable to specific activity -- loaded ion exchange materials. Quote. Waste well above those normally generated by light water reactors. Unique to TMI 2. That's on page 213. Quote. It was never anticipated that such wastes would be created. That's on page 213. In view of all these things, how can you tell us that you are going to clean that place up safely and with minimal exposure to the public? Back in January, the outside that was handed out for the hearings, it was pretty clear that the PEIS was expected to take positions on various clean-up alternatives somewhere between January and August. There was a fundamental change there to the point where now we are not talking about specific alternatives. When can we expect the Staff to take a position on any given alternative?

Can I ask one more question? The other question I have is in the PEIS, there aren't any indications of the economic costs of a lot of these steps, so I understand that will come out in the EIS. In answer to questions about clean-up, you say No. 24, will any clean-up alternatives be chosen solely on the basis of cost? And you said reviews will be based on the safety and environmental impacts, which isn't -- it's a little deceptive because, as you said, in the past, costs will be a secondary consideration. My question is, will there be any opportunity for the public to comment on your estimates?

JAN EMERICK (Tr 105): I have several short questions. Page 715 and page G-4, among other places, mentioned evaporation and it says only minute amounts of gas are released -- radioactivity are released as gas. How is this controlled? That's the first question. So how do you make sure that only this small amount stated there is given off? On page 843, Table 8.4.1, plus incineration of combustible wastes. What do they mean by this? How is this incineration -- how is this burning going to be done?

ELIZABETH CHEVAIN (Tr 107): What I would like to know, since the NRC did not have the wisdom to foresee the need for a large scale monitoring before the accident, and since you do not know the level of radiation to which we were exposed during the accident, since there was no monitoring, how can you possibly sit there and give us such precise figures on the cancer rate statistics, when you do not know the initial dosage of radiation received? That is our big hang-up.

VOICE (Tr 109): Will there be any political considerations given in the final report that you give to the NRC Commissioners when they make their final decision? In the sense that if it's politically expedient to do it in a way other than you recommend it should be done, that there could be some changing of decision-making or decisions that would affect how the clean-up would be done, and whether or not it would be to our advantage, to the people who are living here, to be done one way or the other. Is there any consideration given to that?

Comments Received on October 23, 1980, Meeting with Pa. Medical Society
Lancaster, Pennsylvania

JOHN RANDALL (Tr 22): The first comment I would make is that it is very difficult to get an overall picture of what the occupational hazards are to the workers. As you know, the occupational is broken up into many settings, and you clearly have a hazard to your workers. It is very hard to get an idea of what the overall hazard is, as I am sure it is for you. The second is that I think you led off with the cost question. What I would be very interested to know is, when you did your EIS for the krypton venting there was a cost analysis, and I didn't see anywhere where you really broke down the costs and what the public can expect as far as Met Ed's physical survival. What I was saying is that a breakdown of each operation and then the potential hazard for a worker, the bottom line, and then the top line for each operation that is to be performed. That is what I was saying. Frankly, after reading it, I will tell you why I am interested in the occupational health, because with the low level stuff that we are dealing with, we are dealing with a controversy that can't even be solved by the National Academy of Sciencies. We can sit here all night and discuss the low level stuff. As far as I can see in the document, there are two real health hazards. One is to the workers that are going in there, and the second is this business of storing the high level waste on site and not having or being able to process through DOE or anyone that will accept the waste. As long as you have the cleanup, you are going to have to accept some occupational risk, I suspect. I want to deal with this high level waste question a little more. I saw a report from Brookhaven Laboratories which I think was done for your office in May, which had to deal specifically with the canisters in which you are storing the resins. There are two things that give me a little heartburn. One is that it looks like the resins themselves hold the isotopes for a period of a month and then leach out. Is that your understanding of how these resins function? What will the heat be in these canisters? The only other question I have is, you know, you derived your water levels from the Agnes flood, I assume, and --. You estimated it to be a four-day maximum flood period over these canisters?

DR. WHITELY (Tr 33): First of all, could you give some indication as to why the very long period of time for this cleanup operation, five to seven years? My second question is why have you decided to keep the other reactor inactive?

DR. DEARDOFF (Tr 37): In your opening statement you said, of course we are not satisfied with this, we want to move this out of here someday because the middle of the river is not a good place to have this bunker. That is my next question. Let's say we are stuck. Let's say nobody can take our stuff. Let's say we have got this stuff for 50 years. How safe is your bunker over the years? My last question. Is there anywhere else in this eastern megopolis that has a dump or a bunker like this, not stuff in action, disposal solid waste stuff buried in a bunker near cities like that? I am working my way slowly to understand this, so bear with me a little bit. I have got the

water in my mind, I've got the scrubbed resins and the bunker down. Now you have got damaged fuel rods. How did you report? What are you saying you are going to do with the damaged fuel rods? Do they do in the bunker too?

DR. RANDALL (Tr 46): I have a couple more comments to make. I am very pleased to see how you dealt with the psychological question in the EIS because I think that is very important, and in your small statement that commented about the fears people are going to have in terms of productivity, of wine, which is about three miles, of corn, chocolate, and then lower down the Chesapeake, the fish and the oyster industry. Regarldess of what the facts are about the low level releases, there is still a lot of angst regarding release into the river. You know, you may have the scientific facts that you feel that it is safe, but there is still a marketing question of produce and there is still the same kind of angst that generated a law suit a year ago from the City of Lancaster. I am not sure that there is the physical basis for that anymore, but I have a feeling that when February comes and that agreement -- or whenever it is -- that agreement expires, I think you are going to feel more community pressure regarding the low level releases into the Susquehanna. So I would urge you strongly to consider other ways, not on a scientific basis but more on the psycho-social basis. The question I had which is a technical one has to deal with the water and its effects on the cement in the building itself. I understand there was a cleanup up in Canada somewhere. Chalk River, okay. And they had to go in with jackhammers and take about three feet of cement out all the way around. Do you anticipate that occurring here? Apparently they didn't have a liner in this unit that would prevent that.

Comments Received at October 29, 1980, Meeting with Maryland Citizens in Harve De Grace, Maryland

CONGRESSMAN BAUMAN (Tr 38): I am a member of Congress representing the First Congressional District of Maryland, including Hanford and Cecil Counties which border on the Bay and the Susquehanna, as well as eleven other counties, nine of which border on the Chesapeake Bay. I appreciate the Nuclear Regulatory Commission's public hearing or public informational meeting tonight so that not only public citizenry but those of the official governments involved, both municipal and county, can have a chance to have an explanation of the information that you have made available to us in the past. As a member of the Subcommittee on Energy and the Environment of the Interior Committee for five years until two years ago, I served on the subcommittee that had jurisdiction over nuclear power when the Joint Committee on Atomic Energy was abolished, and some 18 months ago at the time of the TMI incident, I had contacted then Acting Chairman of the NRC, Joseph Hendrie, when I read reports of the intention to possibly dispose of waste water that was contaminated into the Susquehanna River. Of course, we have come a long way since then in both knowledge of the incident, its scope and the need for cleanup, and I feel very strongly that we must indeed meet soon the disposal problem because of the many problems that it presents, even so great that a layman like myself can understand them. I would also say a word of praise for Delegate Katherine Riley and the others in the delegation who have consistently been in contact with your agency on behalf of these public meetings which I think go a long way to dispel the concerns that exist in the public mind. For my own part as one who has worked with my staff members who are particularly interested in this, I would say that I would oppose any alternative that would result in the disposal of waste water dumping into the Susquehanna River. There are other alternatives, and I can tell you that those of us who live on the lower end of that great river have a great deal of apprehension about what incidents or what impact this might have, and I am sure that you know that no matter how much scientific explanation is provided, it certainly will not allay the fears that exist, and if there are other alternatives that can be pursued, as you indicate there may, I would hope you would look at those various alternatives. Lastly, I would like to request of the agency that you allow at least another public hearing at a time when a final decision is made so that comment can be made by governmental officials and private citizens and interested groups on whatever decision is finally made; and I thank you very much for hearing me tonight.

LOUISE MASSINGER (Tr 41): What I would ask this agency is that you really no longer ignore the lessons of history and the problems that are already written on the face of the earth. Historically one of the greatest tragedies of modern times has been brought about by just the kind of process you are proposing, and I am talking about the destruction, the pollution and the death of some of greatest rivers. The tragic flaw for

each one was just that little bit of contaminant that each operation added to it. It was just a little bit each time, and that is what they died of. I do not think we can keep our rivers or our bay healthful and clean by adding any of those. I think we can do it by only removing whatever contaminants are there insofar as we possibly can, not by starting that deadly snowball going again, adding anything at all. I feel it is an unconscionable act and a grave offense to the human race to justify any degradation of human life or of the natural world by the juggling of statistics or by making such rash unverifiable statements as the psychological stress occasioned by such an operation will have no long-term effects. There is no way anybody can possibly know that, and all indications would be to the contrary. To put it in a positive way, I feel there is a moral imperative to dispose of the poison already created there in a way that does not further poison our environment in any way at all.

HOWARD SEXTON (Tr 45): You come up here, you run a whole lot of stuff under the bridge, you run all this stuff by about the drinking water and how many thousands of millimeters are supposed to be in the water and all this and that, and yet you show us on the chart where it is going to show up on our bay and on our flats, clean down to the Sassafras River. Well, see, you are showing stuff right there where a lot of people around this community are trying to make a living, are trying to make a go of commercial work around here. This upper bay has been shut off from the lower bay for years, which is a lot of guys around here like me now are striving to make this bay and our community around here more of a place to go for seafood and stuff like that, like the lower bay. We don't need this contamination. We already have enough problems. I have been cleaning the bay for 25 years and I have had junk that you would not believe, from all the way up from upstate New York. We don't need no more headaches. And as far as you coming out with these figures that this water would be so pure and everything, I want to see him drink some of it and then I will be ready to drink some of it or turn it loose into the Susquehanna River. But until then, I say tomb it up just like they did the nuclear bomb down in the Pacific, down there where they could not get those islands cleaned up, tomb it up and leave it there. Who needs that island. All it is is a rock pile. Why put our life and our kids and our citizens and health in danger for a rockpile?

JEFF KATZ (Tr 47): I have two questions. One is, assuming that the radioactive materials are released either to the air or to the river, can you absolutely indicate at what threshold of activity we could see a biological effect on plants, fish or man? That is the first question. The second question is, if acceptance of the licensee's cleanup proposals will be based on their safety and environmental impacts instead of solely on cost, and since NRC agrees that solidifying the waste in Portland cement is the simplest method for disposing of the waste, why does NRC label this not a valid alternative? Specifically, why is the alternative invalid? Assuming that the activity is released to the air or to the water, to the Susquehanna or through some evaporation technology, can you absolutely indicate at what threshold of activity we could expect the biological effect in fish, plants or man?

ANNA MCMULLEN (Tr 55): If you would add up the radiation released from the China bomb, Peachbottom, Calvert Cliffs, accidental exhaust and other recent X-rays for medical reasons, the drinking water at the present time that there was probably or still will be, and accidental releases that we don't know about that is in our water at the present time, in our seafood consumption -- I would like to know if these were added to the statistics that you have given us tonight -- will we still be as safe as you try to make us believe we will be?

LEWIS FOSTER (Tr 57): I think there is a problem, and my request, my plea to members of the Commission is to really look into this matter completely and look into your own hearts and find out within yourself like what you really think is going on. Do you really believe what you see? Do you really think it is true? If you have any doubts as all deep inside, you should really look into it much more closely. We should completely discover what is going on before we dump anything into the river and subsequently into the Bay. There are a lot of other problems, but this is one I want to address to this particular Commission.

STANLEY KEENE (Tr 62): In the slide presentation I noticed you made reference to a truck route of 2600 miles. I think this was to the State of Washington. I also noticed that you had some time limits for people that would be exposed to those truckloads of material. Now, I do not think we should endanger all of the people from here all the way across the country to exposure to this type of thing. Now, I know this has nothing to do with the water that is here. In the gentleman's presentation about the amounts of material in the fish, in a controlled release, which I believe is 30 gallons per minute, the amount of material in that compared to the amounts of material in an uncontrolled accidental release, which would have been 500,000 gallons, in only 2 to 1. Now, it is not going to take the people at Three Mile Island long to figure out the same thing I did. If you are only going to double it and you are talking about it being very small to start off with, they are going to get the same idea and they are going to let it go. Now, is there a way to decompose your water into your hydrogen and oxygen? I am not a chemist. I don't know what you would have left, whether it would be more dangerous or not. We speak about how much we get from normal living, how much radiation we get from it. We want to add more to it now. Something else will come along, we will want to add some more to it again. You are just going to bust the camel's back by doing these type of things. This you consider to be a week small bit. Someone else is going to add a wee small bit and a wee small bit, and they are not going to take into consideration the whole thing that we get. So it is all cumulative.

MS. RANDALL (Tr 64): There is a definition that reads as follows: Natural background should be interpreted to mean normal background including the effects of fallout from past nuclear weapons destination and from the nuclear field cycle. The observed radioactivity in the Susquehanna River and so forth and so forth and so forth, exactly what the gentleman said, that now this is called natural background. If natural background is what

we get from the granite and the rocks and the rest plus the bombs plus the actions that have been licensed by the Nuclear Regulatory Commission, then clean is dirty. That is no more natural than flying down the road in a helicopter is natural. I wish you would take the first word out and say background radiation, because I think to call that natural is stretching the truth, and it proves what some of the people have been saying here tonight, that you are going to keep saying that now we have natural background for 1980, then we have natural background for 1990, then we have natural background for the year 2000, and at each point with no safe threshold, and even Dr. Upton from the National Cancer Institute saying there is no safe threshold. This natural background with all of the additions of the nuclear industry is going to keep being quoted as being this background level, which it is not, not with the interference of man. My question basically has to do with why did the NRC approve the installation of the EPICORE system without requiring solidifcation of the resins before that system was alloed to operate if you now have a hassle with trying to solidify the waste so you can get it off-site? Why did you license them to go ahead and run a system when you did not have the solidifcation procedure in place which would allow those wastes to then be removed and taken to a storage dump? When the resins that are now in the canister that are going into the desilting basin are taken from the site, where are they going?

GEORGIA ANN GAITH (Tr 69): I received a letter that the writer wishes to have read into the record. "I am opposed to the dumping of any waste into the Susquehanna River. Thank you for your help and cooperation in this matter. Very truly yours, William Menloav, Cecil County Commissioners." I also have a question of my own, and that is: If solidification of the waste can be maintained on the island in the form of a concrete slab, then why are we even here talking about biological impact in the Bay? Is it an economical factor? That is not addressed in the environmental impact statement. Is it cheapter, or course, to dump it than it is to solidify it and maintain it?

ROBERTA SCOVILLE (TR 72): I am speaking on behalf of the League of Women Voters of Maryland and with concurrence of the League of Women Voters of Pennsylvania. I will give you my written comments, but I would just like to point out one thing that has not been addressed, and that is that the cleanup process will take five to seven years. It is an experimental process even though you say that most of the procedures are technically known and all decisions about how to adequately decontaminate the facility and dispose of the waste will not and cannot be made at this time. Therefore, we feel it is extremely important that the formal public hearing process not be limited to this preliminary EIS. There should be public information and comment at all stages of the process. We realize that this is not normal procedure; however, there should be public information and comment at all stages because this is the only way people will ever accept any exposure that proves necessary during the cleanup period.

The importance of this cannot be overstated. In addition, I will just summarize by saying that the League is very concerned about designating off-site waste disposal facilities as soon as possible, about very strict and adequate regulations on the transportation of materials from Three Mile Island, and finally, we suggest very strongly that you consider not releasing the water simply because there are many, many people who are deeply opposed to releasing the water. It is very difficult for non-scientifically trained people to evaluate the risks involved in low level exposure when there is disagreement among scientific personnel on the effects of such low level radiation exposure. Therefore, we hope that you will avoid dumping if you can.

STAN KOHLER (Tr 73): I am concerned about the dumping of the water. I would prefer that it not be dumped for a number of reasons, among them the isotopes of strontium and cesium, which are known bioaccumulators, which is not addressed in this, although bioconcentration is. I think that does need to be addressed. In addition to that, the levels of tritium that you are releasing are in the neighborhood, I believe, of six to seven times what a normally operating nuclear power plant would discharge. I would like to speak in solidification in concrete, though not necessarily the way you have addressed it in here. The way you have addressed solidification in concrete is by saying that you are going to take all of the waste water and solidify it en masse rather than subjecting it to the demineralization or SDS process first. Can you tell me, please, why you would not consider doing something like demineralizing it first and then taking that water and, after it has been recycled a number of times in the plant, then subjecting it to concretion and then that would be basically low level waste which could potentially be made into very large blocks and placed on the island rather than being transported. Can you tell me what section you address that in, please, specifically, because what I saw was what some of the other people have alluded to. A few other things I would like to point out. In Table 6.5-7 you have a summary of helath effects for each decontamination, liquids, processing, alternative, and you have probability of occurrence for maximum-exposed individuals. That is probability of occurrence for cancers and genetic defects, and in that you have solidifcation in concrete, evaporated resin system, and bituminization system. According to that, you have solidification in concrete as by far posing the minimal risk to the maximally-exposed individual. That would account for anybody in the general public as opposed to any worker, is that correct? I would also like to speak against evaporation because evaporation is going to do essentially the same thing that dumping in the river is going to do. It is going to disperse it out amongst the general population. It is going to exposure people to levels above background. Now, one thing that I always come here prepared to say is something which is more or less intelligible and something that is scientifically based, at least according to a report here, but I cannot help but get angry at some of the erroneous statements made, such as a fish living in normal background radiation is not suffering any ill effects whatsoever. I don't see how you can make that statement because

I don't think that there are -- there is anybody around that is willing to say that background radiation causes no cancers, no genetic effects because radiation, because of the type of animal it is, it does break chromosomes, it does cause damage, it does cause cancer, it does cause genetic effects, whether it is natural background or whether it is induced from fallout or whatever the reason. So even a natural background, it is known, does cause some problems. And the point is no radiation is good radiation, and the more you keep it to a minimum, the safer the levels are. I would hate to see the straw that breaks the camel's back in this case. It may or may not be, but we should never let ourselves get to the point where we even approximate that kind of situation. I fear that we are, from things like fallout, things like nuclear power plants, from Peachbottom, from Calvert Cliffs, all accumulating more and more of the dose to the individual. And it is true we do have a high cancer rate and it is getting higher, and it is because of things like this that should be controlled more strictly than they are.

SIMON GRAYSON (Tr 78): My daughter has leukemia, whether she got it from natural causes or from something else. But I have seen here - thanks be to God, she is with us and thanks also to Johns Hopkins and to the doctors. She was hospitalized for four months, and during that time I saw her drowning in her own blood for almost 48 hours while they looked for where she was bleeding. We prayed for every breath that she took for 24 hours. Again, thanks be to God she is still with us. So when you take these figures of two in 10 million or four in 10 million, I want you to think of you son or your daughter.

CONNIE BINES (Tr 79): I am opposed as a private citizen to the dumping of this water in any form into the Bay, into the Susqheanna River and into the Bay, I should say.

JOHN MCNALLY (Tr 81): I have a brief question. It centers around the fact that the NRC seems to be very reliant upon EPA's drinking water standards in concluding that this discharge into the river would lead to minor -- if detectable at all -- health problems at the North Haven intake and below. I would like to point out or ask you if you have taken into account the fact that there are numerous experts that feel that the current standards are far too weak. I guess the comment I want to conclude with is that the drinking water standards under the Safe Drinking Water Act that EPA is now trying to enforce, the standards are basically a political compromise in many cases. EPA wanted to go for something harder. It was not possible because they got flack from different industries or different interests that are trying to post the standards as weak as possible, and basically what they have is the best they could get. That does not mean it is safe. That does not mean they do not want something stronger in the future. This is what they were able to achieve in the political comment from 1974 onwards.

JOHN PEGINAY, JR. (Tr 83): I would advise you to try and save your continental shelf very much, and you may look at infrared radiation photography in a $15 book that would give you some pollution records from 1973 on at the area around the capital and here, and for your own home you might be able to purchase for $8 to $15 a photograph on a daily or monthly basis for each one, pictures that have a capability of heat sensitivity. Programs that should be included are some kind of free legal aid system to make sure the citizens get what they want in the event that federal funding for cleanup is a difficulty. There should be some children's medical monitoring program and adult coverage program, a job loss medical compensation program. These are all very long-range programs. So that the information does not die out from the nation, there should be some kind of forced national media coverage, monthly for a few years after the completion of the disposal operation. And there should be long-range environmental tests and there should be published and announced wind patterns and other local area safety precautions, and there should also be microscopic photography, cell structure change information offered to the people. There should be some awareness that if the waste is dumped onto the eastern continental shelf, large industries may use this as a precedent to enforce and allow their advances there.

KENNETH MAY (Tr 85): Also, one related statement or question. The PEIS does not include any economic figures. The Baltimore Sun on October 21, 1980 said that, "It is estimated by state officials that the dockside value of the fish and shellfish extracted from the Bay each year exceeds $35 million, and that the industry generates total business activity of $150 million annually." The PEIS claims that possible dumping of radioactive waste water should have no effect on the marketability of seafood products if the public is properly educated. I have attended meetings of this kind in Annapolis, Maryland, York, Lancaster and Middletown, Pennsylvania. Many of the people at these meetings read the PEIS, and some, like Nancy Kelly of the Chesapeake Bay Foundation have very well reasoned out the accuracy of the documentq I have yet to meet an opponent of nuclear power who has been convinced by that PEIS and the NRC briefings that dumping of the waste water is safe. If the NRC cannot convince nuclear opponents with whom it can communicate in public meetings of the safety of possible water dumping, how can it convince nuclear opponents outside the affected area, with whom it has never communicated, that dumping is safe. I cannot predict how many people will quit eating Maryland seafood if the radioactive waste water is dumped. If there is only a drop of 2 percent, I would think a very conservative estimate, that will be $3 million a year. Further, it may take years to win back these consumers' confidence, so the figures should at least be doubled or tripled. In fact, I believe the economic damage would be much greater, I hope you include these figures when you calculate the economic cost-benefit relationship of various alternatives. Finally, let me ask you one question. Will there be an opportunity for the public to comment on the economic figures in the final EIS?

BILL TOWNSEND (Tr 90): You are going to make the decision whether to dump this water or not into the river. You have a lot of impressive figures it is not going to hurt us, but how come ever since this has happened, there has not been one single person that has anything to do with the nuclear industry say that low level radiation long term isn't going to hurt you? You are talking about 400,000 to 500,000 gallons plus approximately another 90,000 gallons of water. That works out to 80 more truckloads in tank trucks, 5 to 12 percent increase in transporting stuff to a suitable disposal site. The alternative is dumping it in the river. We've got enough stuff in there already. We know what is up there now. How do we know how much they have let loose already that they have no told us about? Are you going to aggravate the problem by letting more out? It does not make sense. Eighty truckloads. It is going to cost a bundle to move the rest of the stuff. You are talking 660 to 1700 truckloads. That was the figure you used for solid waste. What is another 80?

RONALD SWATHKE (Tr 95): I would like to know if some people have made reference to this before. The electrolytic enrichment of tritium is used on a laboratory scale for low-level analysis of tritium, and I wondered if that was considered and whether that process could be scaled up to concentrate the tritiated water and then solidify it. Let me ask another question. Maybe my questions are too technical. If you don't want to address them here -- there was a lot of krypton gas up there, and another question I had was it seemed like you have a public relations problem as well as a technical problem up there. I could not understand why -- had the thought been given to instead of releasing it as a gas into the air and creating a fear factor among all the people, whether that gas could have been liquefied and removed off site and then released. That is technically feasible. If you do release this water into the river and that is in a fresh water environment, and then it goes into the bay, which is a saline environment, do you anticipate very large concentration effects there, precipitation effects, concentration in the sediment of the cesium and strontium? As far as concentration in fish and organisms, I have seen conflicting reports as to whether fish and organisms concentrate isotopes like cesium and strontium and as to what degree they do. Could you give me a number: fish is how much -- how much cesium it would concentrate over what it is in the water? Would it be a like a factor of 10 or --

JOHN MONOHAN (Tr 100): My question is: what gives you the right to take risks with our lives? You know, I take risks every day. You know, I cross the street. That is a risk. But I get angry if someone were to stand in back of me and calculate that that risk was so small that he could push me into the street. How do you get the right to take risk with the seven lives -- rather the three lives of the workers who might get cancer due to the cleanup? How can you take risk like that?

GWYNNETH HOWARD (Tr 102): First of all, I know that Three Mile Island is a big problem, particularly for those people who live around it in Pennsylvania. I have had the feeling over the last couple of months that the people in Pennsylvania have had difficulty realizing that people in Maryland are also concerned about this problem, and sort of discovered Maryland down the river with some trepidation and started asking questions. I have to make a couple of points. We live already in Harford County in the vicinity of Peach B ottom, which was rated in the New York Times as one of the worst plants on the East Coast, and it has accidents on a regular basis and there is no way you can deny that since it has been in the Aegis. Secondly, we live in the vicinity of Three Mile Island, and the difficulties and dangers of cleaning that up are already being suggested as being more than the public knows already and will probably come out more than that. We have one reactor already on the our flats, and that is Peach Bottom, which is enough of a curse, I suppose, for most of us to live with. In addition, our bay is exposed to Calvert Cliffs Nuclear Power Plant, a plant that already has stored on its premises waste well beyond the legal level -- limit. Now, I realize that Three Mils Island creates a tremendous difficulty in cleaning it up, and it seems to me that if, as you said, we are in a safe shutdown situation, the only thing I could do is urge you to take your time and consider the human element as well as the economic and other elements that you are considering. I would also like to observe a couple of things, specifically about the Susquehanna Flats. You have spoken in your statistics of the probabilities and the generalizations, and I have a couple of things to say about the flats because of my experience living on the flats. First of all, in a summer like this you have water levels that are tremendously low, which means you are going to have high concentrations of water and evaporation, which means you will have problems which they are already having with pesticides. That is, you have pockets of perhaps radiation that you had not counted on in your general statistics. The second thing is I am not sure how all this is being handled when it gets to the dam and is concentrated if we already have had a million gallons of water at the dam that had low levels of radioactivity. How is that going to be effected when the other half-million gallons come down the river as well? And I would like you to consider the effect of this and the other background radiation, specifically on the Susquehanna. They are going to have to think of ways of disposing of this waste that are not going to involve our economy and our health in some kind of jeopardizing way more than we are already being jeopardized by just breathing in and out.

JOHN KABLER (Tr 105): If I believed that everything was under control as you say it is, I would feel a lot better about this; but I really do not. My confidence is still shaky after all this time and all these hearings. I want to read into the record q auote from Governor Hughes, who is not confident either, in a letter that he sent to President Carter on October 3. Just one paragraph from this long, strong letter. He says this. "The draft

environmental impact statement reveals that federal agencies are following a course of action that will make Three Mile Island a long-term storage dump for radioactive waste. Nothing could be more dangerous to the Chesapeake Bay and the people of Maryland. No Responsible agency would locate a dump for radioactive waste on an island in a flood plain above the water supply for a major metropolitan area and poised at the head of Chesapeake Bay; yet, because of refusal to consider any other realistic alternative, that will be the result of actions described in a draft environmental impact statement." That is from Governor Hughes. So, now we have this environmental impact statement, and evidently people here tonight the ad hoc committee, feel that all is not well with the environmental impact statement. There are serious problems with it. I hope that in April or March when the final statement comes out, that I will be able to thank the NRC for listening to the problems, to concerns that the people of Maryland have so clearly delineated to you tonight and over the past year during the many hearings and meetings that have been scheduled. You have heard it all before. Everything that was said tonight so eloquently, you have heard before; and I would feel more confident if we were not saying the same thing a year later, over a year now. We are saying the same thing. We are hearing the same answers. It makes me wonder what is going to happen when the final impact statement comes out. I have a few questions maybe I can get an answer on. The first one, Dr. Snyder, I guess you would not recall because you were not involved in the March 20 hearing in Baltimore, but at that time we heard an agreement from NRC representatives to meet with us and look into funding for independent scientists to analyze this environmental impact statement when it came out, and prior to that to have input into it. I would like to know if you would consider reopening these negotiations at this time. The last thing. Would you develop a process other than the current method that allows the public to respond to decisions such as the decision to dump water into the Susquehanna if you should make that -- in the manner suggested by Roberta Scopes of the League of Women Voters just a few minutes ago? Do you recall what she said? She was saying she wanted an ongoing input as decisions were made. The thing that bothered me in your answer to Mr. Cawood's question as to what would happen when the final statement comes out, you said that you would review the EIS after it was completed and see if in your opinion you had dealt properly with the meat of the decision, and if you think you had dealt properly with it, you would go ahead, something like that.

EMILY JONES (Tr 114): I would like to ask some questions about an aspect that has not been touched on tonight. We are discussing the Three Mile Island situation as though it were static, and in fact it is my understanding that according to the NRC report, leakage from the reactor's primary cooling system adds 550 liters per day to the spill and the continuing rising water level now poses a hazard. Some instruments, electric cables have already been shorted out by the water, and a couple of motors that are necessary to keep the core from deteriorating any further are now at some hazard. My question is this. You proposed to continue this consideration of the phase of what will we do until the end of March; is that true?

SUSAN EWING (Tr 116): I have a comment and a question kind of all rolled up into one. In any of the cleanup processes that you are considering as far as the water goes, be it evaporation or bituminization or whatever, are the primary isotopes of the most concern tritium, strontium and cesium if they should be introduced into the environment, either accidently or in a controlled manner? Am I correct in assuming that: How are these isotopes assimilated in the body? And also, can you define what is a cumulative whole body dose as opposed to ingestion or inhalation? What is the difference between a cumulative whole body dose and a dose that you might ingest, which leads back to the beginning of the question: how is strontium, for example, assimilated in the human body? In the environmental impact statement, I do not recall it being mentioned that strontium, for example, will concentrate in your bones. I do not recall the fact that cesium will concentrate in muscle tissue. In fish maybe it was. At any rate, is it the same, then, as far as whole body dose goes with water? What would be the difference, swimming in the water or drinking the water? Would I get the same whole body dose if I took a swin in an area of water that was contaminated with detectable levels of, say, cesium? Would that dose to me be the same as if I drank two liters of that water?

A resolution by HARFORD COUNTY appears as comment number 42 in this appendix.

Comments by SENATOR PAUL SARBANES appear as comment number 39 in this appendix.

241 West 97th Street
New York, New York 10025

November 19, 1980

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:

Enclosed please find our comments on the draft 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, submitted to your office in accordance with the published invitation for such comments.

Yours truly,

Daniel M. Pisello, Ph.D.

Richard G. Piccioni, Ph.D.

DMP:lf

Enclosure

Critical Comment with Supporting Materials on Draft Programmatic 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)

Richard Piccioni, Ph.D.
Daniel Pisello, Ph.D.

This study conducted under the auspices of Accord Research and Educational Associates, Inc.

The proposed clean-up at the Three Mile Island Unit 2 nuclear plant (TMI) is potentially lethal to a large percentage of the population of the United States. The United States Nuclear Regulatory Commission, together with the utility (Met Edison) and the United States Environmental Protection Agency carefully underestimate the real damage to public health in a major agricultural area of the United States, and consistently underestimate the probability of catastrophic accidents resulting from existing core and structural damage in the reactor.

The Programmatic Environmental Impact Statement NUREG-0683[1] (PEIS) gives no indication at all of the harm that will be done to the health of the public as a result of the proposed clean-up of TMI. The PEIS specifically underestimates the quantity of toxic radionuclides that will be released to the environment in the various phases of the proposed clean-up. A false impression is created (by the NRC) that public health is protected by diluting and regulating the releases so as not to exceed certain maximum permissible concentrations set by federal law and thereby limiting the maximum dose per year to any single individual. In fact, the total number of induced cancer fatalities is determined by the total population dose which depends only on the total amount of radioactivity released, not on the rate at which it is released. The dose response factor, i.e. the induced cancer fatalities per person-rem, used in the PEIS is too small by a factor of about 200 or more. The possible accidents considered in the PEIS do not incorporate the real possibility of structural damage and the core condition which, taken into account, make the possible accidents both more numerous and more lethal than discussed by NUREG-0683. No attention was given to the special dangers associated with the large quantities of zirconium hydride formed in the core, when the hydrogen bubble was present in the reactor vessel. Finally, the monitoring program described in the PEIS is totally inadequate for detecting the release of significant quantities of radioactive toxins during clean-up.

Table I gives the total inventory of the TMI-Unit 2 reactor as of July 31, 1980, as calculated from the computer program ORIGEN for radionuclides with significant activity. For reference purposes we include the adult whole body dose conversion factor for ingestion and inhalation in rems per curie taken from the USNRC Regulatory Guide 1.109[2] and from Handbook of Laboratory Safety tables[3], and the potential population dose in person-rems to the whole body for each radionuclide present. In this way we can see at a glance which radionuclides have the greatest potential for harm. It should be noted that the dose conversion factors are higher for children and infants, resulting in larger potential doses to these age groups. For example, the whole body dose conversion factor for ingestion of strontium-90 is 1.86×10^6 rems per curie for adults and 4.71×10^6 for infants, i.e. 2.5 times greater. According to these figures the worst potential threats are strontium-90, 1.5×10^{12} person-rems to the whole body from ingestion, and plutonium-239 and 240, 1.26×10^{12} person-rems to the whole body from inhalation. Other isotopes having large potential population doses are the cesiums, cobalt-60, ruthenium-106,

antimony-125, nickel-63, americium-241, and iron 55.

The first step in making these toxic materials available to the environment is to destroy the integrity of the Zircaloy fuel cladding of the fuel rods. This was done in the metal-water reaction that occured in the reactor vessel resulting in the production of large amounts of hydrogen gas. According to NRC estimates 40% of the cladding was destroyed in this reaction. The combination of the produced hydrogen with unoxidized zirconium formed zirconium hydride destroying an additional 20% of the cladding. For a fuller discussion of this point see "The Zirconium Connection"[4] which is submitted as part of this comment.

Because of the destruction of the cladding much of the gaseous fission products have escaped from the core and the entire inventory of radionuclides in the spent fuel can be leached out by the primary coolant water, which has been leaking from the primary coolant system since the beginning of the accident. There are approximately 300,000 gallons of water in the Auxilliary and Fuel Handling Building (AFHB), 700,000 gallons in the reactor building sump, and 96,000 gallons in the primary coolant system. Table II gives the amounts of the principal radionuclides present in the water as dissolved and suspended material and as sludge. This adds up to a total of 619,000 curies representing a potential dose of 84 billion person rems. To this must be added the radioactivity that will be scrubbed from walls and surfaces in the decontamination of the AFHB and the reactor building, as well as the material that will be leached out of the core during the decontamination and flush of the primary coolant system. This may result in an additional 300,000 curies of cesium-137 becoming dissolved as well as unpredicted amounts of other substances. There is, for example, still in the core about 770,000 curies of strontium-90. If one tenth of this leached out during the flush of the core, that would add another 77,000 curies of strontium-90 representing an additional potential population dose of $1.4x10^{11}$ person-rems. Thus the total dissolved activity could easily reach nearly one million curies representing a total potential dose of $2.5x10^{11}$ or 250 billion person-rems.

All contaminated water is to be treated with one or another of the proposed decontamination systems that involve filters, and either inorganic (zeolite) or organic (resin) ion exchange media. According to NUREG-0683 these systems will have an overall decontamination factor of about 10^{-5}. Thus the final product will be water containing approximately one curie of strontium-90 and 9 curies of cesium 134 and 137 (10 curies in 10^{6} gallons = .003 microcuries per milliliter) representing a total potential dose of 2.5 million person-rems. If this was discharged into the Susquehanna River when the flow rate was 5000 cubic feet per second or 3.2 billion gallons per day, and water was taken for Lancaster at 8 million gallons per day, for the borough of Columbia at 2 million gallons per day, and for the city of Baltimore 250 million gallons per day, then 260 million gallons per day or 8% of the river would be taken into municipal water supplies, and 8% of the released strontium and cesium would also be taken in.

If only 1% of this amount were eventually ingested, this would result in a total population dose of 2000 person-rems to the people of these municipalities or to people who consumed food products produced with water from these supplies. It is important to point out how sensitive this calculation is to the assumed amount of strontium-90 that will be leached out of the core during primary coolant flush or any other phase of the clean-up for that matter. A leaching rate of 20% instead of 10% for strontium-90 would raise the population dose to 3120 person-rems. Also, we have not included the effect of other radionuclides beside strontium and cesium.

In calculating airborne releases occuring during water treatment, NUREG-0683 uses the figure .01% of the total activity processed to find the amount that becomes airborne. This figure is "based on experience with a more complex chemical operation associated with fuel processing." (6.3.4.1, p. 6-17) It is important to note that this value is quite arbitrary and is applied indiscriminately to a wide variety of operations involved in the clean-up. However, on the basis of this value we can expect a total of 100 curies to become airborne during the clean-up of the water. If the HEPA filters function perfectly for the entire time, then NUREG-0683 recommends the penetration factor $9x10^{-8}$ for the filters. Applying this factor one predicts 9 microcuries will be released to the air. However, if one applies the approach of NRC Regulatory Guide 1.140 as discussed in NUREG-0683, Section 5.1.4, then one predicts 1 curie of strontium and cesium will be released to the air during the water clean-up without any accidents. This represents a total dose of 2.75×10^{5} person-rems. If we consider that 40% of the land area in Dauphin, Lancaster and York counties is cropland and assume 100% deposition and an annual uptake of 1% of the undecayed isotopes we calculate that a total population dose of 1.6×10^{4} person-rems will eventually be delivered to the people eating food from this area.

According to NUREG-0683, 6.5.4.1, solidification or immobilization of the filters and resin beds resulting from water treatment will also yield airborne radioactivity amounting to .01% of the total activity processed. Thus the predictions of the preceding paragraph are simply doubled. Thus from processing the waterborne activity, the chief consequence will be a release of possibly 2 curies of activity, strontium-90 and cesium-137 and 134 as airborne particulate which will settle on the farmland in the area causing a maximum population dose of 32 thousand person-rems. This will be in addition to the dose to citizens downstream from release of the processed water, calculated to be 2000 person-rems, not including the incorporation of the radionuclides into the human food chain via fish.

Much larger releases with correspondingly more tragic consequences can result from accidents involving, for example, fires which destroy air filters, and fires which may involve spent resin beds or spent fuel. In this latter respect we must add our warning to the warning comment of Professor Earl Gulbransen of the University of Pittsburgh concerning the particular dangers

associated with the presence inside the reactor vessel of substantial quantities, perhaps 4 tons, of zirconium hydride, and unreacted zirconium. This material is present in the reactor vessel partly in the form of fine needles. It is capable of reacting with water explosively releasing hydrogen with a pressure of 10^{10} atmospheres. Zirconium and zirconium hydride also burn very hot in air and in the finely divided state they may ignite spontaneously. These problems were discussed in a USNRC memorandum[5] dated June 6, 1979, from Kris I. Parczewski of the Reactor Safety Branch, Division of Operating Reactors (DOR), through Carl H. Berlinger, Section Leader, Reactor Safety Branch, DOR, for Paul S. Check, Chief, Reactor Safety Branch, DOR, with copies to C. Berlinger, F. Coffman, S. Weiss and R. Vollmer. The memorandum duly notes the problems:

> In contact with water at lower pressures hydrogen gas can be released....Zirconium hydride in powdery form is pyrophoric and when exposed to air may ignite and produce violent reaction. The information from other sources shows that the auto-ignition temperature of zirconium hydride is 270° in air. It is, however, very much dependent on the physical form of the hydride.

The memorandum concludes with the recommendation to take the warning seriously and take the following precautions:

> (1) To monitor the presence of hydrogen in the primary coolant in order to establish if the decomposition of zirconium hydride takes place.

(2) When opening the reactor vessel for cleaning assure that the debris at the bottom of the vessel are not exposed to the oxidizing environment (e.g., dry air).

Although NRC staff is aware enough of this problem to discuss its dangers in internal NRC memos, no mention is made of it anywhere in the PEIS. Especially in 8.2.3.3, where reference is made to using underwater cutting tools on fuel assemblies and collection of debris from inside the vessel, some account should be given of how one will implement the above precautions. A copy of the memorandum is attached and submitted as part of this comment.

Next we take up the question of the dose-response parameters used in the PEIS. These are the factors used to convert population dose to predicted health effects, i.e., cancer fatalities, or individual dose to cancer risk. The numbers used in PEIS are taken from the National Academy of Sciences, Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR) report, November 1972,[6] and consistently underestimate the effects of ionizing radiation by a factor of 200 or more. Bross[7] has recently analyzed the question of dose response in light of the most recent epidemiological studies and arrives at a figure of 5 rads for the doubling dose for leukemia and somewhat higher value for solid cancers. We will use a figure of 10 rems for the doubling dose. This means that in a population like the one around TMI where 625,000 cancer fatalities are expected in the population of 2.2 million people (see Sec. 6.1.5.2 page 6-5), i.e., 28% cancer rate, a population dose of 1000 rad (rem) delivers 100 doubling doses and results in 100 x .28 = 28 cancer fatalities. Using the figure for the airborne releases associated with water treatment calculated

above (3.2×10^4 person-rems), we get 3.2×10^3 doubling doses causing 900 additional cancer deaths.

If we assume a better filter efficiency of 3×10^{-4} we predict air releases from clean-up of the water will cause 27 additional cancers in the general population. The projected release of contaminated water to the Susquehanna as calculated above resulted in a population dose of 2000 person-rems or 200 doubling doses and 56 excess cancers.

The maximum dose to workers in the clean-up is given as 30,000 person-rems in NUREG-0683. This is equivalent to 3000 doubling doses or 840 additional cancer deaths among the workers.

Using the 10 rem doubling dose, the observed cancer rate of .28, the deposition and annual uptake of 100% and 1% respectively and the 40% cropland figure for this area, for each millicurie of airborne strontium-90 released we predict 8.4 fatal cancers, and for each millicurie of airborne cesium-137 released we find .35 fatal cancers.

Children, infants and the unborn are much more vulnerable to radiation. The doubling dose for the unborn for example is one rem or less as determined by Stewart.[8] Thus, the predicted number of cancer deaths calculated above can be multiplied by 5 if one considers an affected population made up primarily of children, infants and the unborn. Thus, one millicurie of released strontium-90 could generate in the young and unborn 42 cancers and the entire cleanup might generate up to 4,5000 deaths.

This past summer during the two week TMI venting period, monitoring was done by Accord Research and Educational Associates (AREA), a private scientific environmental and public health research organization. Air particulate samples were collected and the krypton-85 activity in the plume from TMI II was measured. This short venting period allowed us to formulate a precedent. As a result of these measurements we calculated 7 millicuries of strontium-90 released, and estimated 20 millicuries of cesium-137 released. The total number of cancer fatalities resulting from these releases is predicted to be 50-300 (due to strontium-90). These results are discussed in detail in the paper attached that we submit as part of this comment, because the NRC's estimates of releases in this "minor" venting were calculated to be as inaccurate and of "no significance" as are the estimates in NUREG-0683.

Table III summarizes the proposed monitoring activities of state and federal agencies, as well as Met Edison, regarding the measurement of radioactive air particulates and milk contamination during the clean-up of TMI. Of the six agencies involved in environmental monitoring, only two even attempt to detect strontium-90, a pure beta emitter. Only the licensee, Met Edison, attempts to measure strontium-90 more frequently than four times a year. As pointed out above, this isotope represents the single greatest source of harm to human beings of any nuclide in the reactor.

A simple calculation based on the reported or likely detection limits for the procedures listed in Table III shows how these methods are very poor indicators of isotope release into the environment. The amount, A, of radioactivity released from the reactor is related to f, the amount collected on the filter, as follows:

$$A = \frac{t_r}{t_s}(X/Q)\ rf$$

We will assume that t_r, the duration of the release, and t_s, the duration of sampling, are equal. The air flow rate, r,

is typically 1.0×10^{-3} cubic meters per second. We will choose a disperson factor, $X/Q = 10^{-6}$ seconds per cubic meter, rather favorable for detection. We obtain:

$$A = 10^9 f$$

If the minimum amount of cesium-137 detectable using a Ge(Li) system is 25 picocuries (NUREG-0683, Appendix M) the minimum detectable release of cesium-137 from the plant is 25 millicuries. Typically, the threshold for detection of cesium-137 in a gross beta measurement is 2 picocuries, for detection of strontium-90, 1 picocurie. Radiochemical analyses for strontium-90 provide greater sensitivity, down to approximately 0.5 picocuries. These limits, the corresponding minimum detectable releases, and the numbers of fatal cancers expected on the basis of calculations described above, are shown in Table IV.

The maximum rates at which these dangerous quantities of radioactivity could be released yet remain undetected depend on the values in Table IV, and on the length of the sampling period. Minimum detectable release rates for each monitoring agency are presented in Table V, along with the mean response time, equal to one half the sampling period. The mean response time is the average time which could elapse before a release <u>of any magnitude</u> would be detected.

It is evident that improved sensitivity to low rates of release is purchased at the cost of delaying the response to a large release. In fact, practical sensitivities for long sampling periods would be less than those given in Table V because of higher background counts due to fallout collection (typically amounting to 2 picocuries of gross beta or .03 picocuries strontium-90 per day of sampling at 2 cubic feet per minute). This factor further points out the inadequacy of long sampling periods in protecting the public.

The value of X/Q chosen here (10^{-6} seconds per cubic meter) is also optimistic from the standpoint of detection; even with 18 fixed sampling stations, the chances of an EPA sampler being in the plume centerline (i.e., directly downwind) and at the distance of maximum ground level activity, are very small. This probability is negligible in the case of Met Ed's 8 and the State's 3 sampling stations. Even under weather conditions favorable for detection, it would not be unusual for X/Q to fall below 10^{-7} seconds per cubic meter, increasing the minimum detectable releases by 10-fold.

Some obvious measures could be taken to improve offsite monitoring of air particulates: shortening sampling periods; increasing sample size (i.e., flow rate); maintaining mobile units on the plume centerline at the distance of maximum ground level activity, etc. However, it is evident from the extreme toxicity of the materials released during this cleanup operation that onsite measurements of air- and waterborne radioactivity, including determinations of gross-beta and strontium-90 must be made on a daily basis. The results in absolute (curie) amounts for each nuclide should be made public without delay. It is also essential that these measurements be performed by an

independent entity responsive only to the welfare of the public rather than the prosperity of Met Edison.

In summary, the total quantity of lethal and toxic radionuclides that must be released to the air and water in the proposed clean-up of the damaged TMI Unit-2, either over time or in any single phase of the clean-up, is much greater than estimated by NUREG-0683 (PEIS). The NRC insists repeatedly that public health is protected by diluting and/or regulating releases to not exceed certain maximum permissible concentrations set by them and enacted into federal law. These laws apparently limit the maximum dose per year to any single individual. However, an individual is only aided by such manipulation of releases over time, if he is lucky enough to die of other causes before the next such planned release. In fact, the total number of additional cancer fatalities, illnesses, and genetic mutations depend only on the <u>total</u> amount of radioactivity released which determines the total population dose. The <u>rate</u> at which these releases are made is not a factor in the total number of additional cancers. Also, the induced cancer fatalities per person-rem used in the PEIS is too small by at least a factor of 200.

It has been determined by the NRC that 40% of the cladding of the fuel rods has been destroyed, potentially making available all of the radionuclides in the spent fuel to leaching out into the primary coolant water. The primary coolant system has been leaking this primary coolant water since the beginning of the accident, and to date, the water continues to leak. The total amount of principal radionuclides now present in the water, either dissolved, suspended or as sludge, can be calculated to be 619,000 curies, or 84 billion person-rems. More will be made available during clean-up procedures, calculated to be a possible 300,000 more curies. The treatment of contaminated water will reduce the contamination to an "acceptable" but alarming quantity of radionuclides to be finally released into the Susquehanna and taken up as drinking water. The final product figured here using the NUREG-0683 decontamination factor of about 10^{-5}, will be water containing approximately one curie of strontium-90 and 9 curies of cesium 137 and 134 (10 curies in 10^6 gallons = .003 microcuries per milliliter) representing a total potential population dose of 2.5 million person-rems. Air releases are also greater than proposed in this PEIS. The available air and water contamination will all enter the food chain as a factor for the next 5 to 10 generations of people eating the crops from the surrounding Pennsylvania farmlands.

Enormous possible dangers are associated with the existence of large quantities of zirconium hydride, originally formed in the core when the hydrogen bubble was present in the reactor vessel. This existing core damage has created an unstable and dangerous condition and must not be considered a predictable factor in the clean-up operation. The interaction of clean-up technologies with the core's unstable condition might be of catastrophic proportions. The PEIS makes no reference to the possibilities of this lethal situation, although the NRC

acknowledges these possibilities in the existence of interoffice memo dated June 6, 1979, Reactor Safety Branch, Division of Operating Reactors. It is thus clear that they are informed of these real scientific hazards of the proposed clean-up.

Releases from accidents due to zirconium fires and other hazardous and flammable materials (resins, spent fuel, etc.) are calculated to be of enormous proportions. For example, calculations show that a fire involving 1% of the spent resin beds could lead to millions of deaths from inhalation and ingestion of dispersed strontium-90 and other radionuclides. Direct gamma radiation from cesium-137 released from such a fire would be roughly equivalent to the radiation from the fallout of a one megaton nuclear bomb. Zirconium fires involving spent fuel would release long-lived alpha-emitting plutonium, and americium, as well as strontium, cesium and all the other radionuclides. This would cause immediate death to tens of thousands of people and would contaminate the land for hundreds of thousands of years.

In addition to the proclaimed ignorance regarding a major hazard, ignition of the zirconium hydride cladding, the NRC carries out four key deceptions in assessing risk. First, the value assumed for the fraction of radioactivity expected to become airborne is speculative and not based on experience with the operations proposed. Second, the efficiency of air filtration assumed exceeds the NRC's own maximum dependable value. Third, the radiation dose/effect relation employed by the NRC to estimate the effects of exposing large numbers of people to relatively low rates of irradiation are based on effects observed at high irradiation rates. These values underestimate effects by two orders of magnitude. Most significant, however, is the totally false assumption that distributing release of a given curie amount of radioactivity over an extended period of time in any way lessens its ultimate biological effect. In fact, because of the irradiation-rate phenomenon just mentioned, the radioactivity is likely to deliver a greater effect when exposure is prolonged.

We demand that no clean-up be made unless there is a substantial reduction in the probability of radioactive releases, and a major improvement in the intensity and scope of environmental monitoring; that the region around TMI be officially declared unsafe for human habitation; and that agricultural products from the area be declared unfit for human or livestock consumption.

REFERENCES

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2. U.S. NRC Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

3. N.V. Steere, ed., Handbook of Laboratory Safety, Second Edition, Chemical Rubber Co., 1971.

4. Daniel Pisello, "The Zirconium Connection", 1979.

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7. Bross, I.D.J., Ball, M., Falen, S.: "A dosage response curve for the one rad range: adult risks from diagnostic radiation." American Journal of Public Health 69, 130-136, 1979.

8. Bithell, J.F., Stewart, A.M.: "Prenatal irradiation and childhood malignancy: a review of British data from the Oxford survey." British Journal of Cancer 31, 271-287, 1975.

TABLE II. Radionuclides in water (curies)

	H-3	Cs-137	Cs-134	Sr-90	Sr-89
AFHB:					
Dissolved	190	33,000	5,600	520	124
Suspended	—	12,600	2,500	741	400
Sludge	—	9,000	1,800	2,600	1,600
REACTOR BUILDING:					
Sump Water					
Dissolved	2,500	440,000	75,000	7,000	1,600
Suspended		9.4	1.7	20	10
PRIMARY WATER SYSTEM:					
Dissolved	58	14,000	2,400	9,500	3,000
TOTAL IN WATER:	2,748	508,609	87,300	20,381	6,734

TABLE I. Radionuclide inventory of TMI-2 on July 31, 1980

nuclide	half-life (years)	inventory (curies)	ingestion: dose conversion factor (rems/curie)	ingestion: potential population dose (person-rems)	inhalation: dose conversion factor (rems/curie)	inhalation: potential population dose (person-rems)
H-3	12.3	3,800	1.26×10^{2}	4.8×10^{5}	1.26×10^{2}	4.8×10^{5}
Fe-55	2.7	29,000	4.43×10^{2}	1.1×10^{7}	4.93×10^{2}	1.43×10^{7}
Co-60	5.3	300,000	4.72×10^{3}	1.4×10^{9}	1.85×10^{3}	5.6×10^{8}
Ni-63	100.	10,000	4.36×10^{3}	4.4×10^{7}	1.81×10^{3}	1.81×10^{7}
Sr-90	28.1	790,000	1.86×10^{6}	1.5×10^{12}	7.62×10^{5}	6.0×10^{11}
Sr-89	.14	90,000	8.84×10^{3}	7.9×10^{8}	1.09×10^{3}	9.8×10^{7}
Ru-106	1.	1,300,000	3.48×10^{2}	4.5×10^{8}	1.09×10^{3}	1.4×10^{9}
Sb-125	2.7	42,000	4.05×10^{2}	1.6×10^{4}	3.65×10^{3}	1.5×10^{8}
Cs-134	2.1	220,000	1.21×10^{5}	2.6×10^{10}	9.10×10^{4}	2.0×10^{10}
Cs-137	30.	880,000	7.14×10^{4}	6.3×10^{10}	5.35×10^{4}	4.7×10^{10}
U-235	7×10^{8}	3.3	4.86×10^{2}	1.6×10^{3}	1.21×10^{6}	$4. \times 10^{6}$
U-236	2.3×10^{7}	4.1	4.96×10^{2}	2.0×10^{3}	1.24×10^{6}	$5. \times 10^{6}$
Np-237	2.1×10^{6}	1	5.57×10^{4}	5.57×10^{4}	1.39×10^{8}	1.4×10^{8}
U-238	4.5×10^{9}	18	4.5×10^{2}	8.1×10^{3}	1.1×10^{6}	$2. \times 10^{7}$
Pu-239	24,390	7,900	6.4×10^{4}	$5. \times 10^{8}$	1.6×10^{8}	1.3×10^{12}
Pu-240	6,537	2,200	6.39×10^{4}	1.4×10^{8}	1.59×10^{8}	$.3 \times 10^{12}$
Am-241	433	220	5.46×10^{4}	1.2×10^{7}	1.36×10^{8}	$.03 \times 10^{12}$

TABLE III. Summary of air particulate and milk monitoring activities near TMI*

agency	no. stations	air particulate sampling periods (days) method: Ge(Li)	gross-beta	Sr-89&90**	milk samp. period method Ge(Li)	Sr-89&90**
Met Edison	8	7***	7	90	7	90
USEPA	18	2-3	-	-	-	-
Comm of PA	3	7	-	90	30	-
USDOE	7	-	-	-	-	-
USNRC	1	-	-	-	-	-
State of MD	-	-	-	-	-	-

*reference NUREG-0683, Appendix M (USEPA "Long-term environmental radiation surveillance plan for Three Mile Island" March 17, 1980).

**Sr-89&90 measurement by radiological analysis.

***performed only when gross-beta result is positive.

TABLE IV. Minimum detectable releases of strontium-90 and cesium-137 from TMI under proposed monitoring program*

isotope	method	minimum detectable amount (pCi)	minimum detectable release (mCi)*	cancers due to ingestion***
Cs-137	Ge(Li)	25**	25	8.8
Cs-137	gross beta	2	2	0.7
Sr-90	gross beta	1	1	8.4
Sr-90	radiochem.	0.5	0.5	4.2

*based on sampling rate of 1.0×10^{-3} m^3sec^{-1} (2 CFM) and atmospheric dispersion (X/Q) of $10^{-6} sec\, m^{-3}$.

**reference: NUREG-0683 Appendix M (USEPA "Long-term environmental radiation surveillance plan for Three Mile Island" March 17, 1980).

***see text page 9.

TABLE V. Minimum detectable release rates and mean response times under proposed monitoring program

agency	isotope	method	min. detectable release rate (mCi/day)	mean response time* (days)
Met Edison	Cs-137	Ge(Li)	3.6	3-4
		gross-beta	0.3	3-4
	Sr-90	gross-beta	0.2	7**
		radiochem.	0.011	45
USEPA	Cs-137	Ge(Li)	8-12	1-2
Comm of PA	Cs-137	Ge(Li)	3.6	3-4
	Sr-90	radiochem.	0.011	45

*mean response time is equal to one half the sampling period stated in NUREG-0683, Appendix M (USEPA "Long-term environmental radiation surveillance plan for Three Mile Island" March 17, 1980).

**allows for approximately 10-day yttrium ingrowth.

Measurement of Strontium-90 Released in Venting of the TMI Unit 2 Containment Atmosphere: June 28 - July 11, 1980

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This study was conducted under the auspices of Accord Research and Educational Associates, Inc.

Between June 28 and July 11, 1980, Metropolitan Edison (Met Ed) vented the containment building of their Three Mile Island (TMI) Unit 2 nuclear reactor. Prior to the venting Met Ed reported[1] that the building atmosphere contained approximately 57,000 curies of krypton-85, a few curies of tritium, and far smaller amounts of other isotopes present as suspended particulates, e.g. radioactive cesium and strontium. The utility claimed that the amount of suspended particulate radioactivity was very small and that the exhaust stack filtration system was good enough to keep emission of radioactive particulates below detectable limits. The NRC decided to waive the "required" environmental impact statement for the venting. The NRC further compromised public health by temporarily suspending the federal regulations that limit the concentration of airborne isotopes that may result offsite from plant releases. Finally, the releases were made without the NRC requiring immediate check on the amount of beta activity that was being released in the form of suspended particulates, specifically leaving them blind to strontium-90, one of the most abundant and lethal isotopes in the reactor.

Accord Research and Education Associates (AREA) set up 24 hour monitoring in the field during this entire two week period, to measure radiation levels and collect air particulate samples in the vicinity of TMI. AREA detected the released krypton as far away as two miles from the plant and often observed ground level concentrations of krypton-85 substantially greater than the maximum permissible concentration (MPC) of 300,000 picocuries per cubic meter. In addition, AREA sampling of air particulates yielded a positive result for strontium-90, indicating that the release of this hazardous isotope was at least one million times greater than what the utility had estimated as possible.

Radiation levels were measured with a thin window Geiger-Mueller "pancake" probe connected to a Victoreen "Thyac III" portable rate meter. The audio output of the rate meter was fed into a digital accumulator-timer. This arrangement detects changes in the count rate of 10 counts per minute (cpm), using a one minute counting period. The background count rate in the Three Mile Island area consistently averaged around 30 cpm. We converted our excess counts above background to krypton concentration using a calibration factor determined from laboratory experiments with a similar detector performed at Pennsylvania State University. These experiments yielded 310 cpm above background per microcurie of krypton-85 per cubic meter.[2] In addition, comparison of measurements made in the field by this Penn State group with measurements made by the AREA group at the same time and location confirmed our use of this calibration factor.

Air particulate samples were collected on one-inch diameter Millipore membrane filters (pore size 0.45 microns), at a flow rate of 10 liters per minute. After aging for several weeks, each filter was counted for gross beta activity using a low background thin plastic phosphor scintillation detector. Subsequently, all filters were combined and analyzed for gamma emissions using a Ge(Li) detector. Finally the combined filters were subjected to radiochemical analysis for strontium-90 and strontium-89, yielding the positive result discussed below.

Twenty-four hours daily throughout the TMI venting, two-man teams in the field tried to locate the point of maximum ground level activity. This point is found directly downwind from the exhaust stack and somewhat further from the plant than the point at which the spreading cloud or "plume" of effluent gas and aerosol first reaches the ground. Low-lift helium balloons were released frequently both up- and downwind of the stack in order to study the local wind patterns and locate the plume center-line. Air particulate samples were collected in the plume at the point of maximum ground level activity, and that activity was recorded continuously. While one two-man team tended the air sampling pump and recorded radiation levels during sample collection, a second team continued to survey the surrounding area with another radiation detector to verify that the pump had indeed been set up at the point of maximum ground level activity and to detect, as quickly as possible, any shift in the location of this maximum.

Figure 1 shows the measured ground level activity averaged over one hour intervals for the entire monitoring period. Gaps in the graph indicate periods during which no data was recorded, e.g. on July 2 there were no AREA monitors in the field. The NRC-specified maximum permissible concentration for krypton-85 was exceeded for several hours around midnight June 30, July 3 and July 5 and for ten daylight hours on July 8.

Our ground level measurements of krypton-85 concentration provided an estimate of the rate and pattern of releases from the reactor. Using a simple atmospheric dispersion model[3] we calculated a release rate of 100-150 curies per hour for most of the daylight hours of June 30 – July 7. This value is consistent with the utility's data for that period, available through the NRC.[4] However, for late night and early morning hours during this period and for the daylight hours of July 8 we calculated release rates 3 to 4 times higher. These higher release rates were acknowledged only for the daytime releases on July 8. No release-rate data has been made available by the utility or the NRC for nighttime venting.

The high rate of nighttime venting is evidenced by the peaks of activity observed around midnight on June 30, July 3 and July 5. The absence of such midnight peaks on other nights is probably due to a high degree of atmospheric stability and low wind speed. On those nights these conditions caused the plume to rise very high resulting in low ground-level activity. Other periods of low activity in Figure 1 may be due to the occurrence of similar atmospheric conditions, interruptions in the venting, or the fact that the monitoring teams were not in the centerline of the plume. For example, it was impossible to reach this line when the wind was blowing down the river.

Figure 1 also shows the time periods during which air particulate samples were taken. The volume of air sampled and the amount of krypton-85 in each sample is shown in Table I for each filter. A total of 6.3 microcuries of krypton-85 in a sampling volume of

51 cubic meters passed through the set of 12 filters. No filter disc showed gross beta activity above the detection limit of 1.2 picocuries. The average gross beta background in the Harrisburg area is 0.02 picocuries per cubic meter, reported as cesium-137.[5] Thus background gross beta activity deposited on each filter is well below the detection limit.

The gamma scan of the combined filters showed no radionuclides above the detection limits shown in Table II. However, radiochemical analysis of the combined filters for strontium-90 yielded 0.95±0.36 picocuries or .018 picocuries per cubic meter of sampled air. This value is 18 to 50 times larger than the local background concentration from global fallout.[6] This result indicates an average strontium-90 to krypton-85 activity ratio in the effluent of 1.6×10^{-7}. According to Met Ed's reported containment atmosphere inventory given in Table III, the maximum ratio of strontium-90 to krypton-85 in the plume, assuming no filtration at all, is 2.1×10^{-10}, approximately 760 times less than our result. Assuming the claimed particulate filtration efficiency of 99.98%, AREA calculates that Met Ed released 3.8 million times as much strontium-90 as they had originally predicted possible.

Measured gross beta activity for individual filter discs is consistent with the result of the strontium analysis and provides an upper limit to the ratio of gross beta activity to krypton-85 activity of 2.0×10^{-6} in the filtered air. This limit is consistent with the gamma analysis in Table II.

On the basis of our field observations we conclude that an individual located on the plume centerline and at the distance of

maximum ground level activity throughout the entire venting received a krypton-85 skin dose of approximately 6 millirems. Doses due to inhalation and direct exposure to other components of the plume are apparently negligible. However, the long term health effects of particulate radionuclides released to the surrounding farmlands are much more serious.

Using Met Ed's post-venting estimate of 43,000 curies of krypton-85 released and our measured ratio of strontium-90 to krypton-85 activity, we calculate a total of 7 millicuries of strontium-90 released. A reasonable estimate of cesium-137 released is approximately 20 millicuries. This estimate is consistent with our strontium, gamma emission and gross beta measurements and with the higher volatility of cesium. We further estimate about 1.5 millicuries of strontium-89 was also released. We calculate here only the effect of strontium-90, the most important isotope.

About 40% of the land in the TMI area is cropland including pastureland for milk cows. We assumed therefore that 40% of the released isotopes are deposited on crops or pasture, and of this amount, 1% is ingested by humans each year. Allowing for the radioactive decay, the result is a total of 1.1 millicuries of strontium-90 eventually ingested by humans, resulting in a population dose of 2000 person-rems to the whole body from the ingested strontium-90.[7] Using a doubling dose of 10 rems for adults for all forms of cancer derived from the results of the Tri-State Survey[8], we find 200 doubling doses delivered to the population. In a population with a fatal cancer rate of 28%[9], this much radiation will yield 56 additional cancer deaths. Children, infants and the unborn are much more vulnerable to the effects of radiation. Studies by Stewart[10] on the carcinogenic effect of x-rays indicate a doubling dose for the unborn of approximately 1 rem. Thus, the additional risk of cancer or other radiation-induced effect is ten times greater in the young and unborn. Therefore, as many as 560 or more additional cancer deaths could result from this release of strontium-90 if the contaminated food was consumed principally by infants and pregnant women.

AREA's results show that a significant amount of strontium-90 was released to the environment from TMI during the June 28 - July 11 venting period. Significant releases of strontium-89 and cesium-137 must also be inferred. As AREA wished to know the ratio of strontium-90 to krypton-85 in the TMI releases, and to measure specifically the amount of strontium-90 in those releases, we drew air samples from the plume centerline and at a distance of maximum ground level activity wherever possible. In this way, the background strontium-90 from global fallout was only a small fraction (less than .05 picocuries) of the reactor effluent strontium-90. Therefore, the background strontium-90 did not limit the sensitivity of our measurement, and we were able to measure the strontium-90 activity to krypton-85 activity ratio in the reactor effluent to be 1.6 parts in 10 million.

The United States Environmental Protection Agency (USEPA), using their fixed air samplers, relied on chance to blow the narrow plume their way. This design also increased the volume of air ratio to the reactor effluent strontium-90, and also resulted

in significant and variable amounts of background strontium-90 from fallout.[6] This background deposit substantially reduced the sensitivity of their measurement of the crucial strontium-90 to krypton-85 activity ratio. The significant and remarkable quantity of strontium-90, released to this agricultural region and measured by AREA, was not reported by the USEPA.

In summary, AREA's findings showed toxic radionuclides including significant amounts of strontium-90 were released in the two week venting period (June 28 – July 11) of the containment building of the damaged TMI Unit 2 reactor in quantities that are 4 million times greater than the published predictions of Met Ed that were accepted by the NRC at the time. The airborne toxic radionuclides patterned themselves in a pie shaped wedge called a plume, with the highest readings seen downwind of the reactor and at a distance of maximum ground level activity. The long term health effects of strontium-90 released as particulates onto the farmlands were calculated to yield 56 additional fatal cases of cancer to adult humans eventually ingesting food from this area. Future generations ingesting crops from this area, because they will be children, are more vulnerable to the effects of radiation. Thus, AREA calculates 50 to 300 additional fatal cancers and other genetic health effects will appear in the next five to ten generations. No reports of deposits of strontium-90 or other particulate radionuclides have been made by Met Ed or the USEPA to date.

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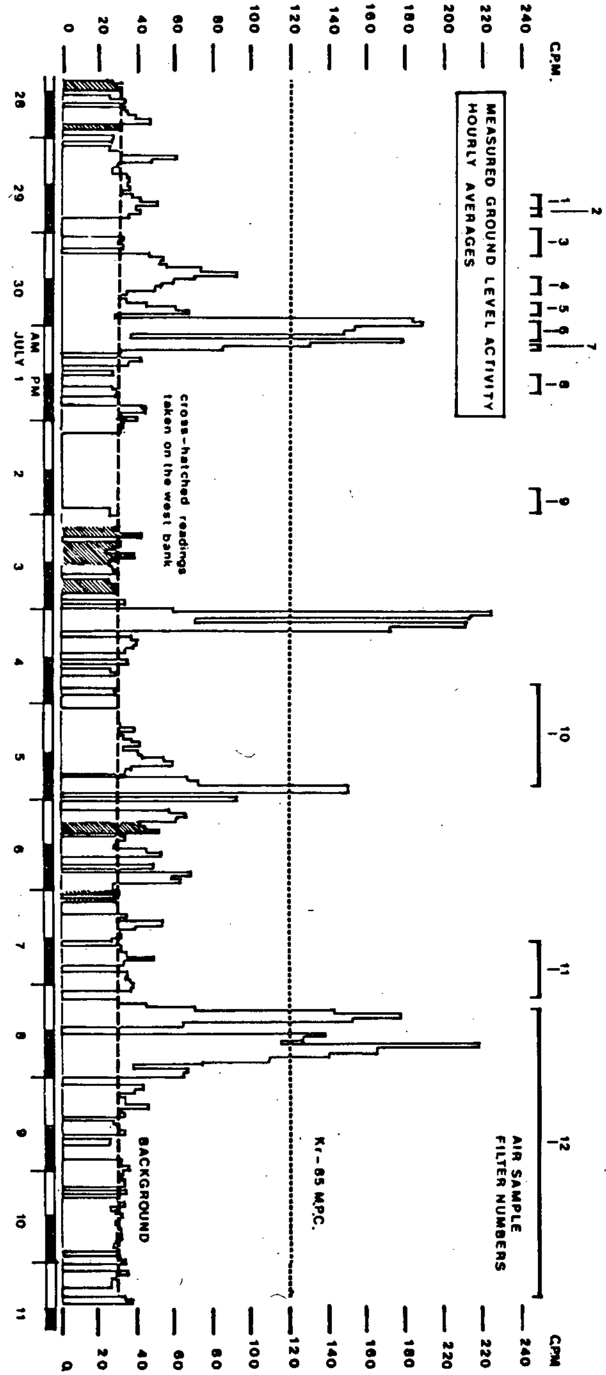

FIGURE 1
Measured Ground Level Activity at TMI During Venting of Unit 2 Containment June 28 to July 11, 1980

TABLE I

Sample volumes and krypton-85 activity

for each air particulate sample

Filter No.	Volume Filtered (cubic meters)	Krypton-85 Filtered (nanocuries)
1	2.1	97
2	0.9	16
3	4.3	nd*
4	2.7	180
5	1.9	130
6	3.2	830
7	14	290
8	1.6	nd
9	4.2	710
10	12	1,700
11	5.0	50
12	16	2,900
TOTAL:	51	6,300

*no data

TABLE II

Results from combined filters*

Gamma-ray emission Ge(Li) Spectroscopy**	Total activity (picocuries)
beryllium-7	LT 30
potassium-40	LT 60
manganese-54	LT 2
cobalt-58	LT 2
cobalt-60	LT 3
zirconium-95	LT 3
ruthenium-103	LT 20
iodine-131	LT 6
cesium-134	LT 3
cesium-137	LT 3
barium-140	LT 4
cerium-141	LT 4
cerium-144	LT 20
radium-226	LT 50
thorium-228	LT 5
Radiochemical analysis**	
strontium-89	LT 2
strontium-90	0.95 ± 0.36

*Total filtered volume of 51 cubic meters containing 6.3 microcuries Krypton-85. LT = less than.

**Measurements performed by Teledyne Isotope, Westwood, New Jersey.

TABLE III

Reactor building air sample results (Met Ed)

Nuclide	Half-Life	Concentration (Curies per cubic meter)
Hydrogen - 3	12.26y	$5\pm1 \times 10^{-5}$
Carbon - 14	5730y	$4\pm1 \times 10^{-7}$
Iron - 55	2.6y	$< 6 \times 10^{-11}$
Cobalt - 58	71.3d	$< 1 \times 10^{-11}$
Cobalt - 66	5.26y	$< 1 \times 10^{-11}$
Kryton - 85	10.76y	$0.93\pm.07$
Strontium - 89	52d	$1.1\pm.5 \times 10^{-10}$
Strontium - 90	28.1y	$2.2\pm.2 \times 10^{-10}$
Ruthenium - 103	39.6d	$< 2 \times 10^{-9}$
Ruthenium - 106	367d	$< 2 \times 10^{-10}$
Silver - 110m	253d	$< 2.5 \times 10^{-11}$
Iodine - 129	1.7×10^7y	$6\pm2 \times 10^{-11}$
Cesium - 134	2.05y	$1.7\pm.1 \times 10^{-10}$
Cesium - 137	30.23y	$9.3\pm.3 \times 10^{-10}$
Uranium - 235	7.1×10^8y	$< 5 \times 10^{-12}$
Uranium - 238	4.51×10^9y	$< 2 \times 10^{-11}$
Plutonium - 238	86y	$< 2 \times 10^{-12}$
Plutonium - 239,240	24,400y & 6580y	$< 2 \times 10^{-12}$

All nuclide concentrations listed with a less than symbol indicate that those nulcides are below the listed instrumentation sensitivity for those nuclides.

Note: Sample taken April 1980 through containment penetration R-626. Approximate inventories can be calculated by multiplying the concentration by the free volume of the containment building, 5×10^4 cubic meters.

The Zirconium Connection

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The Zirconium Connection

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The vast majority of nuclear power reactors in the world are operating with a fatal design flaw. The flaw is that no material exists which can safely clad the uranium fuel. Yet cladding is necessary to contain the radioactive products of fission in the fuel rods, and to maintain the integrity of the fuel. The cladding material must be a good conductor of heat and it must be relatively transparent to thermal neutrons. In addition it must resist corrosion under the extreme conditions obtaining in a reactor core. The material currently used as cladding in all water-cooled reactors is an alloy of the metal zirconium. This alloy called Zircaloy has the dangerous property of reacting explosively with water under a variety of conditions likely to occur in water-cooled reactors. The danger we face is inevitable nuclear disaster. Because of the zirconium cladding each of these reactors runs a high risk of violent chemical explosion and subsequent release of radioactivity on a catastrophic scale. There is, however, no material which can be used to replace the zirconium effectively.

This problem has been deliberately concealed from the public by the American nuclear industry and the United States Nuclear Regulatory Commission (NRC). The recent accident at the Three Mile Island reactor in Harrisburg Pennsylvania has brought to light both the design flaw and the extent of the coverup. All water-cooled reactors, both heavy water and light water, are affected by this flaw. According to the World List of Nuclear Power Plants published by Nuclear News, February 1979, all but one of the 68 plants in the United States are light water reactors.[1]

The same source indicates that 95% of the nuclear power plants in the world outside of Great Britain are water-cooled reactors.[2] Great Britain has currently no water-cooled reactors, since the British Government has thus far resisted the world-wide marketing efforts of the American manufacturers of these power reactors.[3] The Three Mile Island reactor is a pressurized water reactor, one of several types having the fatal design flaw. The lies told by the NRC concerning the hazards of these reactors emerge as all the more hideous as the real dangers become evident.

The dangers of zirconium are well illustrated by the events at Three Mile Island. Mechanical difficulties, the details of which are not of crucial importance here, led to a partial loss of coolant, and a partial meltdown of the reactor core. As an emergency measure, reserve cooling water was sprayed onto the dangerously exposed and overheated core. Hydrogen explosions occurred in the containment and later it was reported that a hugh bubble of flammable hydrogen gas had formed unexpectedly inside the reactor vessel. This bubble not only interfered with efficient cooling of the damaged core but also presented the frightening possibility of a hydrogen explosion inside the reactor vessel. The likelihood of such an explosion increased hourly as the oxygen concentration in the bubble approached a critical level. Such an explosion would precipitate a meltdown and result in large scale and long term contamination of the atmosphere and the Susquehanna River valley. Spokesmen for the utility company and the NRC claimed ignorance on the subject of the origin of the hydrogen bubble, referring to it as a "new twist" and "something that had not been foreseen when the reactor was designed."[4] The next day the bubble shrank and disappeared. The

American media carried the story of the disappearance but gave no explanation indicating only that its disappearance had been more rapid than expected.[5]

The claims of ignorance and the pretension of mystery on the part of the utility company, and federal experts in regard to the appearance and disappearance of the hydrogen gas are lies. Explanations for these occurrences are commonly available in the literature on nuclear engineering and safety, and center around the use of zirconium alloy cladding.[6] Experts within the American nuclear establishment agree privately that the hydrogen was produced by the reaction of tons of zirconium cladding with steam formed in the reactor vessel during the early stages of the accident. But weeks after the event the only public reference to the role of zirconium in the production of the hydrogen bubble was in the British press. (Recall that of all the major nuclear powers only the United Kingdom has no water-cooled reactors.) The April 12 issue of Nature magazine quoted from a letter to The Guardian, by Sir Martin Ryle of the Cavendish Laboratory in Cambridge. He stated in the letter that a highly dangerous hydrogen bubble should have been predicted as a matter of "A-level textbook knowledge."[7] The following excerpt is taken from a standard text on reactor safety and is part of a report dated February 1969:

> The chemical reaction of the cladding with steam, which is supplied by the water remaining in the bottom of the primary vessel after the blowdown or introduced by the operation of the ECCS, has three important effects. First, it furnishes energy, which can increase the heating rate of the core. Second, hydrogen, a reaction product is released to the containment structure. Third, the reaction also changes the character of the cladding (i.e., the metal cladding is converted to an oxide), which can effect its behavior on quenching.[8]

The water-zirconium reaction

$$Zr + 2H_2O \longrightarrow ZrO_2 + 2H_2$$

is exothermic, releasing about 129 kcal per mol of metal compared to the analogous water-sodium reaction

$$Na + H_2O \longrightarrow NaOH + \frac{1}{2}H_2$$

familiar from high school chemistry which releases about 43 kcal per mol.[9] While sodium metal combines vigorously with water at room temperature, the zirconium catches fire in steam at about 2000°F, well below the 5000°F achieved in a meltdown.[10] (Melting can occur in the core at much lower temperatures since the zirconium cladding melts at 3900°F. Also, eutectics and intermetallic compounds which melt at about 2550°F can form between the zirconium and supporting materials.)

We cannot accept the statements of ignorance by the nuclear industry and the NRC. These men know full-well the hazards of zirconium fuel cladding. But they also know that there is no safe alternative to zirconium in water-cooled reactors, and for this reason they have concealed the truth concerning the catastrophic events at the Pennsylvania reactor. In an effort to protect the nuclear industry as a whole, the NRC is putting the blame on individual operators, faulty procedures and insufficient regulations. The power company (Metropolitan Edison) and the reactor manufacturer (Babcock and Wilcox) are to be the scapegoats. The entire American nuclear power industry is committed to the light water reactor concept. The fact that an accident in these reactors can lead to zirconium-steam fires in the core, releasing enormous quantities of flammable hydrogen and heat and causing extensive damage to the cladding and fuel has been known for a long time and is now proven by the Three Mile Island disaster. The suppression of this information has been going on for a number of years prior to this accident, since it is clear that public awareness of the use of explosive materials in the construction of nuclear power plants presents an intolerable challenge to their continued existence.

At the time of this writing the only public protest by a qualified scientist against the use of zirconium in power reactors was made by Earl A. Gulbransen, a materials scientist at the University of Pittsburg. Soon after his retirement from Westinghouse, where he had worked as a research scientist for 35 years, Professor Gulbransen wrote a letter which was published in Bulletin of the Atomic Scientists. The following are excerpts:

> After 25 years of research and development work on the chemical and metallurgical properties of metals and alloys used in nuclear power plants, I have come to the conclusion that the current design and materials cannot give us a safe and well-engineered nuclear power plant.
>
> The use of zirconium alloys as cladding material for the hot uranium oxide fuel pellets is a very hazardous design concept since zirconium is one of our most reactive metals chemically.
>
> At the operating temperature of nuclear power reactors zirconium cladding alloys react with oxygen in water to form an oxide layer which partially dissolves in the metal embrittling and weakening the metal tubing. Part of the hydrogen formed in the zirconium metal reaction dissolves in the metal and may precipitate as a hydride phase also embrittling and weakening the metal tubing.
>
> At temperatures above 1,100° Celsius (1980° Fahrenheit) zirconium reacts rapidly with steam with a large evolution of heat and the formation of free hydrogen, with most metals to form intermetallic compounds and with other metallic oxides to form its own oxide. Once zirconium is heated to 1,100° Celsius, which could occur in loss of coolant accidents, it is difficult to prevent further reaction, failure of the tubing and of the reactor.

> There appears to be no way to overcome the inherent material problems associated with zirconium alloys and the current design of the reactor.
>
> Greater wall thickness for cladding and lower operating temperatures of the fuel may help but the chemical and metallurgical behavior of zirconium alloys cannot be overcome. No backup or alternative design is available if the present design and materials prove unreliable.[11]

His warnings went unheeded by industry and government. The controversy was kept from the public.

This writer made calculations based on the quantity of hydrogen reported and concluded that about 43% of the approximately 20 tons of zirconium cladding in the core of the Three Mile Island reactor had been oxidized in the steam-zirconium reaction.[12] (The damage done to a group of four zirconium clad fuel rods after exposure to steam in a laboratory experiment is shown in a photograph on page 504 of Thompson and Beckerly. An unreacted fuel rod is shown for comparison.) The enormous amount of heat released by this reaction adds to the fission product decay heat and increases the likelihood of meltdown.

Another matter which needs discussion is the disappearance of the hydrogen bubble. The uptake of hydrogen by the coolant water, even under the high pressure prevailing in the reactor vessel, can account for only a small fraction of the bubble. On the other hand, there is more than enough unoxidized zirconium cladding left in the core to take up all the hydrogen in the form of zirconium hydride $ZrH_{1.4}$. The dissociation pressure of the hydride is a fraction of a millimeter of mercury at the reported temperatures,[13] so that the formation of hydride is thermodynamically favored. Hydrogen is known to go into the zirconium through grain boundaries and edge defects of the oxide film.[14] (This reference contains a photograph showing how formation of hydride leads to disintegration of Zircaloy cladding material.) If all the hydrogen in the bubble were taken up by the zirconium, another 25% of the cladding would be chemically consumed. A total of 68% of the zirconium in the core has been converted to oxide or hydride. The NRC describes the cladding as having been "devastated".[15] The formation of oxide and hydride leads to severe crumbling of both cladding and fuel pellets. The resulting massive exposure of fuel to coolant water drastically increases the rate at which radioactive contaminants are leeched out of the core and multiplies greatly the amount of radioactivity released to the environment. The extensive damage and crumbling in the core has also altered and inhibited the flow of coolant through the core resulting in local hot spots. In addition the danger of hydrogen explosion will not be over as long as there is hydrogen in the reactor. The slow reaction of zirconium and zirconium hydride with the coolant water continues to release hydrogen from the hydride and also to produce additional hydrogen. Unless this hydrogen is constantly monitored and removed new bubbles will accumulate and possibly explode. The process of removing the hydrogen is slow and dangerous involving the release of more radioactivity to the atmosphere unless costly liquid hydrogen or liquid helium traps are employed to remove inert gases like krypton and xenon. The complete removal of hydrogen from the reactor may take up to two years.

Currently cooling water is being circulated through the damaged core by convective flow which operates with about 1% or less of the pumping force of the normal operating system.[16] The switchover to convective cooling from active pumping by one of the main coolant pumps means a greater likelihood that hot spots will develop in blocked portions of the damaged core or in the crumbled debris piling up on the bottom of

the vessel. Such local heating could achieve the temperature necessary to rekindle the exothermic steam-zirconium reaction releasing hydrogen rapidly, resulting in an explosion and the rupture of the containment vessel. It must also be borne in mind that the steel containment lining and reactor vessel as well as all the piping have been weakened by the absorption of hydrogen from the saturated coolant which has been circulating through the system for several weeks resulting in extensive leaking of primary coolant. It is fortunate that the core was only three months old at the time of the accident since a mature core would yield even greater amounts of long-lived contaminants such as deadly plutonium. Furthermore, convective cooling means lower flow-through of water and therefore a slower rate of dissipation of hydrogen and heat. Both effects increase the chance that new bubbles of dangerous hydrogen will form.

It becomes painfully clear why there has been a systematic censorship of information available to the general public concerning the behavior of zirconium in nuclear reactors. Zirconium cladding is the Achilles heel of water-cooled nuclear reactors. Ironically, the application of emergency cooling water to an overheated core can result in a violent chemical reaction of the water with the zirconium metal cladding, producing large amounts of heat and explosive hydrogen gas, massive destruction of the cladding and core, weakening of the reactor vessel and piping from hydridation, hydrogen explosions and large scale releases of radioactivity to the environment. No safe material exists which satisfies the requirements for coating nuclear fuel in water-cooled reactors. Thus the plan of the nuclear industry is to obscure the knowledge that these reactors have a major design flaw. All water-cooled reactors present the imminent and inevitable danger of nuclear disaster and we must insist on the immediate shutdown of all such reactors in the United States and elsewhere. In addition we must stop the sale of these reactors to foreign countries.

Finally we must face the grim reality of the storage of spent fuel rods. Each of these big power reactors produces waste in the form of spent fuel rods, thin zirconium tubes filled with radioactive substances including deadly plutonium. These rods are stored on the plant site under water in circulating pools designed to carry off the decay heat. A typical pool may contain a ton or more of relatively volatile plutonium oxide. Only a few feet of water separates the flammable zirconium from air in which it may ignite at around 1400°F. A zirconium fire in a spent fuel rod storage pool is one of the worst conceivable disasters because tons of plutonium would be smoked out into the atmosphere. Every year the power reactors in the United States produce ten tons of deadly plutonium packaged in a thin cladding of flammable zirconium.

Footnotes

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2. Ibid.

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4. The New York Times, April 1, 1979, p. A32.

5. The Wall Street Journal, April 3, 1979, p. 2; and also: "Now we are kind of surprised at the rate at which it has moved out." Joseph Hendrie, Chairman of the NRC, USNRC Discussion of the Three Mile Island Incident, Chairman's Conference Room, 1717 H Street, N.W. Washington, D.C. April 2, 1979.

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7. Joe Schwartz, "Harrisburg: Counting the Cost." Nature, April 12, 1979, p. 589.

8. Thompson and Beckerly, p. 502.

9. Charles R. Russell, Reactor Safe Guards (New York: MacMillan, 1962), p. 107.

10. Thompson and Beckerly, p. 485.

11. Letter by Professor Gulbransen, Bulletin of the Atomic Scientists, June 1975, p. 5.

12. These calculations are based on the following figures given by the NRC in a memorandum for Roger Mattson from R.O. Meyer, dated April 13, 1979, "Core Damage Assessment for the TMI-2" p. 8.
Hydrogen consumed in explosions: 226 lb mol.
Hydrogen remaining in containment: 80 lb mol.
Hydrogen in the primary system bubble: 76 lb mol (corrected for radiolysis).
The total 382 requires the oxidation of 382 x 91.2 x 1/2 = 17,420 lb zirconium.
The absorption of hydrogen in the bubble by zirconium to form the hydride $ZrH_{1.4}$ consumes 76 x 2 x 1/1.4 x 91.2 = 9,900 lb of zirconium.

13. Warren B. Blumenthal, The Chemical Behaviour of Zirconium (Princeton: Van Nostrand, 1958), p. 77.

14. Earl A. Gulbransen and Kenneth F. Andrew, "Reaction of Hydrogen with Preoxidized Zircaloy-2 at 300° to 400°C," Journal of the Electrochemical Society, 104 (1957), 12, 709-712.

15. Radio News Report WQXR-AM, New York, New York. April 15, 1979

16. In preparation of this portion, the author benefitted from discussions with Richard E. Webb, author of The Accident Hazards of Nuclear Power Plants (Amherst: University of Massachusetts Press. 1976).

17. Thompson and Beckerly, p. 455.

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

JUN 06 1979

MEMORANDUM FOR: Paul S. Check, Chief, Reactor Safety Branch, DOR

THRU: Carl H. Berlinger, Section Leader, Reactor Safety Branch, DOR

FROM: Kris I. Parczewski Reactor Safety Branch, DOR

SUBJECT: FORMATION OF ZIRCONIUM HYDRIDES IN THE THREE MILE ISLAND-2 INCIDENT

Introduction

The Secretary of the Department of Environmental Resources, Commonwealth of Pennsylvania transmitted to us a letter from Professor W. E. Wallace of the University of Pittsburgh in which he draws attention to the fact that during the TMI-2 accident large amount of generated hydrogen may have caused formation of zirconium hydrides which, if not handled properly, can under certain circumstances cause a violent reaction. Prof. Wallace quoted the work of Professor E. Gulbransen, also from the University of Pittsburgh, who for the last 25 years was studying the kinetics of formation and decomposition of zirconium hydrides.

The purpose of this memo is to evaluate, in light of the presently available information, the concerns brought by Prof. Wallace.

Available Information

The information used in evaluating the problem of zirconium hydrides came from the following sources:

(1) Telephone conversation with Prof. Gulbransen (06/04/79).

(2) Conversations with several members of the NRC Staff (F. D. Coffman, M. L. Picklesimer, D. A. Powers).

(3) "The Metallurgy of Zirconium," by B. Lustman and F. Kerze, Jr., Mc Graw-Hill Book Company, Inc., 1955.

(4) "The Metallurgy of Zirconium," by D. L. Douglass, IAEA, Vienna, 1971.

(5) "The Encyclopedia of the Chemical Elements," by C. A. Hampel, Reinhold Book Corporation, 1968.

(6) "Dangerous Properties of Industrial Materials," by N. I. Sax, Van Nostrand Reinhold Company, 1975.

Evaluation of the Problem

Prof. Gulbransen (Source 1) had indicated that when Zr comes in contact with hydrogen at certain pressures two types of zirconium hydride are formed: Zr H1.4 and Zr H1.9. At about 500°C the equilibrium hydrogen pressures for these compounds are few hundreth of mm Hg and few mm Hg, respectively. These hydrides are formed despite the existence of protective ZrO_2 because, according to Prof. Gulbransen, ZrO_2 cannot stop completely penetration of hydrogen into metallic Zr. This is a controversial point since in the opinion of other people (Source 2) ZrO_2 could completely prevent hydrogen from coming in contact with metallic Zr. The information from the literature (Sources 2 and 3) also confirmed the view that ZrO_2 would very significantly limit hydrogen penetration.

Prof. Gulbransen pointed out that Zirconium hydride formed on Zr surfaces may spall off forming a highly divided mass at the bottom of the reactor vessel. This point was also challenged by other people (Source 2) who did not believe that Zr hydride could ever assume a highly divided form.

According to Prof. Gulbransen the presence of zirconium hydride in the reactor vessel in TMI-2 could cause two problems:

(1) In contact with water at lower pressures hydrogen gas can be released. Although the rate of release would be slow the existence of this source of hydrogen should be taken into consideration.

(2) Zirconium hydride in powdery form is pyrophoric and when exposed to air may ignite and produce violent reaction. The information obtained from other sources (Source 6) shows that the auto-ignition temperature of Zirconium hydride is 270°C in air. It is, however, very much dependent on the physical form of the hydride.

As a remedy Prof. Gulbransen has suggested a method for decomposing zirconium hydrides by circulating hydrogen free water at low pressure and preferably containing some oxidizing agent (e.g. dissolved air). The rate of decomposition will be slow because of a slow rate of reaction and it would take a long time to decompose all hydrides.

In order to determine the maximum amount of zirconium hydride which could theoretically be formed during the accident it was assumed that 30% of Zr in the core reacted with steam or water and that 30% of the hydrogen generated in this reaction formed hydrogen hydride. With these assumptions about 2500 lb of zirconium hydride would be formed in the reactor vessel during the accident. It should be realized however, that this is an upper theoretical limit and it is most unlikely that such large amount of zirconium hydride would ever be produced.

Conclusion

The existing information on formation and behavior of zirconium hydride are somewhat controversial, however, because of the possibility of existence of this hazardous material in the reactor vessel the following precautions are recommended:

(1) To monitor the presence of hydrogen in the primary coolant in order to establish if the decomposition of zirconium hydride takes place.

(2) When opening the reactor vessel for cleaning assure that the debris at the bottom of the vessel are not exposed to the oxidizing environment (e.g. dry air).

K. I. Parczewski

Kris I. Parczewski
Reactor Safety Branch
Division of Operating Reactors

cc: C. Berlinger
F. Coffman
S. Weiss
R. Vollmer

FRANKLIN and MARSHALL COLLEGE
LANCASTER, PENNSYLVANIA 17604

DEPARTMENT of GEOLOGY

November 19, 1980

Director
Three Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington DC 20555

Dear Sir:

This letter plus enclosed statement constitute our comments on the NRC's plans for the cleanup of the TMI-2 accident (NUREG 0683). As geologists familiar with the physical and chemical processes that influence the environment, we feel compelled to voice concern. The plan demonstrates a lack of understanding of how physical, chemical and biological processes will affect the radionuclides released to the environment. Existing scientific data suggest that radionuclides may be reconcentrated by some of these processes. The plans for off-site radiation monitoring are not adequate to determine the maximum doses to the individual or to detect any reconcentrating of radionuclides in the environment.

NUREG 0683 does not adequately discuss the interim storage and final disposition of nuclear waste generated by the cleanup. Significant problems which already exist with wastes generated to date are not addressed. Discussions of alternative methods for each step in the cleanup should include a description of the expected waste products and should consider the management, stability, and disposal of the waste products before choosing a preferred cleanup procedure.

Since NUREG 0683 mainly puts forth alternative cleanup schemes, without choosing a definite cleanup procedure, we strongly urge that a more finalized and definite plan be prepared and presented for public comment.

Yours truly,

Arthur H. Barabas, Ph.D.
Assistant Professor of Geology
Coordinator of Environmental Studies

Steven Sylvester, M. Sc.
Specialist in Geology

FRANKLIN and MARSHALL COLLEGE
LANCASTER, PENNSYLVANIA 17604

DEPARTMENT of GEOLOGY

COMMENTS ON NUREG-0683 DRAFT 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

1. Models presented for the behavior of radionuclides discharged in plant effluents into the Susquehanna River are not supported by existing scientific data. Estimates of radionuclide buildup in river sediments (6.3.5.4) are unrealistically low.

NUREG 0683 (p.6-27) recognizes that isotopes of cesium have an appreciable tendency to combine with clay particles suspended in river water. Based on an estimate of 10 to 20 mg/l suspended material during normal flow and 40 mg/l during storms, NUREG 0638 concludes that the bulk of the cesium (75 to 100%) will remain attached to suspended clay and only a small percentage will be deposited in river sediments (Gross, et. al., 1978, is cited by the document).

These predictions are in error for the following reasons:

(1) Gross et. al. (1978) found that under normal circumstances between 1/2 and 2/3 of the Susquehanna River's suspended load that passes Harrisburg, PA is deposited before reaching Conowingo, MD.

(2) Schubel (1968, Fig. 1B) provides data indicating that the suspended load at Conowingo, MD is less than 10 mg/l during 65% of the year.
(These data indicate that the bulk of the cesium, as well as the other radionuclides that attach to clay particles, will be deposited in the bottom sediments of the Susquehanna River. Since clays settle out of river water only in calm or still areas, most of the cesium-charged clays will be deposited in selected sites, producing appreciable reconcentration of radionuclides).

(3) Predictions of the behavior of cesium-charged clays reaching the upper Chesapeake Bay do not consider that the clays will undergo flocculation when encountering salt water. Flocculation results in rapid deposition of clays, suggesting that the remaining cesium-loaded clays will be deposited and reconcentrated in select areas of the Bay.

2. The NRC should be complimented for its efforts to assure that occupational radiation exposures and airborne and aqueous releases to the environment are within levels permitted by federal regulations. In some areas, however, its approach is rather short-sighted. We believe that in order to assure the public of the safety of the cleanup activities at TMI and of the nuclear industry in general, the NRC should undertake further scientific studies of offsite waste dispersion. Although the environmental monitoring program (Chapter 11) is heavily skewed toward detection of airborne releases, the airborne monitoring network cannot adequately determine the ultimate fate of a known amount of radioactive material released from the stack or from other sources at TMI. The NRC should be ready to track and make instantaneous measurements of both controlled and uncontrolled airborne releases. This would necessitate having mobile monitors on the ground on both sides of the river as well as aircraft with detection equipment hangared at local airfields. At present, the radiation dosages are only time averages at the fixed monitoring sites on the ground. At all other geographic positions the dosages are extrapolated from the fixed sites. The total dosage will almost certainly err on the low side since a plume of radiation is more likely to pass between the fixed monitoring sites than over them. Likewise, radiation dose received by an individual positioned between monitoring sites will be underestimated. Installation of a much larger number of stationary sensors would improve estimates, but tracking releases is preferable since it minimizes extrapolation and allows a more scientific understanding of the dispersion processes.

3. NUREG 0683's Environmental Radiological Monitoring Plan for ground and surface waters, sediment, and biota is inadequate for the following reasons:

(1) Most monitoring efforts involve air sampling while most of the remaining clean-up activities involve work with liquid effluent and solid wastes.

(2) The monitoring consists of six different monitoring plans drawn up by six different agencies with differing goals and areas of concern. A single, coherent plan using the resources of the six monitoring groups in a coordinated manner should be developed.

(3) Monitoring of the Susquehanna's bottom sediments and invertebrates is not detailed or extensive enough to detect the reconcentration of radionuclides in select areas. Analyses of bottom samples should include descriptions of the physical

characteristics of the sediments to determine if the samples contain recently deposited clays.

(4) Monitoring of river water is not detailed or extensive enough in light of expected variations of the amount of radionuclide-charged clays suspended in the river at any one time. The amount of suspended material will vary widely due to variations in river turbulence and velocity.

(5) Contingency Surveillance Procedures (11.8) are inadequate to monitor the dispersion of radiation resulting from any uncontrolled release. The maximum two hour response time for a mobile laboratory and 6 hours for airborne monitoring do little to monitor a short intense, airborne release. Composite sample analysis will delay the detection of uncontrolled release of liquids into the Susquehanna River by as much as a week since samples are composited on a weekly basis. Contaminated samples should not be composited with any samples collected before or after uncontrolled releases.

4. The use of organic resins to filter radioisotopes from contaminated water (e.g. EPICOR II) is highly questionable since the stability of the spent radioactive resins, either in the untreated formed or immobilized in some medium such as concrete, is poorly understood. In addition, the radioactivities of *EPICOR II* resins from TMI-2 (Cs-137 activities of approximately 40 Ci/ft^3) are considerably in excess of the limits proposed by the government for shallow land burial. Inspection of a report by the staff of the Nuclear Waste Management Division of Brookhaven National Laboratory (R. E. Barletta, et.al., May 1980, "Status Report on Leachability, Structural Integrity, and Radiation Stability of Organic Ion Exchange Resins Solidified in Cement and Cement with Additives"), available in the NRC Public Documents files, is particularly revealing about the lack of knowledge of the expected behavior of the TMI resin wastes and about the types of problems which will probably be encountered in attempts to immobilize and store these wastes.

Experience with organic resins containing much lower activities than those produced by *EPICOR II* and preliminary experiments with small quantities of resins loaded with higher concentrations of radionuclides suggest that resins and resin-cement mixtures are structurally and chemically unstable. Mechanical effects include swelling of resins, and disintegration in water, cracking, and general weakening of concrete. Significant radiation damage which is anticipated will undoubtedly produce chemical decomposition with generation of chemically active by-products including acids, oxidants, and gases (e.g. hydrogen, methane, and oxygen), as well as heat. Recently published news stories suggest decomposition of the resins has already converted them into a gel-like substance. The casks currently containing the TMI resins are also subject to chemical attack. The possibility of explosions due to buildup of gas pressure or ignition cannot be ruled out. Resins have been known to ignite at relatively low temperatures. In addition, small sample studies reveal that most of the cesium in resins is leached by water during mixing with cement.

This analysis led the Brookhaven staff to conclude that it was impossible at present to predict the extent to which leaching of the TMI wastes might take place or to assure the public that these wastes would be characterized by low release rates and low total releases when buried. The Brookhaven staff recommended that a more systematic investigation of the behavior of organic resins and resin/concrete mixtures be undertaken. They also recommended that "more stringent waste management procedures be applied to the TMI-2 first stage EPICOR-II resins" (p. 19). We concur with their conclusions and recommendations.

5. This information leads us to question the desirability of continued operation and use of EPICOR-II during TMI cleanup until a more informed choice among filtration systems can be made based on determination of the safest and most effective scheme for immobilizing and isolating the wastes from the environment. If this is not done we run the risk of having the solid wastes from water treatment in an undesirable, dangerous, and unstable form. In addition, NUREG-0683 does not adequately address the effectiveness of the EPICOR-II system in treating the waste water from the Auxiliary and Fuel Handling Buildings. Table 5.2-2 indicates that 96 filter liners will be used to process this water. NUREG-0591 predicted that 50 liners would be needed. This discrepancy should be addressed, given the proposed use of EPICOR-II for continuing cleanup activities.

We anticipate that serious problems are likely to be encountered in the future because filtration systems for the treatment of contaminated waste water are being constructed before Environmental Impact Statements have been prepared and before management of the wastes which they produce is well understood. EPICOR-II was built before an EIS studying the alternatives was prepared. Now we learn that

a Submerged Demineralizer System is under construction at TMI, again before the present document has received comment and formal approval. We wonder whether the alternatives to the systems, currently operational or under construction, can be fairly evaluated given the ex post facto nature of the EIS. The EIS does not choose between alternative filtrationsystems or clearly specify which wastes will be treated with which system. We believe that this ambiguity should be eliminated before the current document is approved. Otherwise, we fear that acceptance of NUREG-0683 will constitute a blanket approval for all of the filtration alternatives.

6. We believe that one could better understand the cleanup and waste disposal alternatives if the discussion were tied closely to an inventory of the radioactive materials at TMI-2. This inventory should consider the fuel in the TMI-2 reactor before fission began, the radioactive materials (including unburned fuel, transuranics, and fission products in the fuel rods and cooling water, and irradiated water and equipment) and their probable location just before the accident, and the best estimates and possible ranges (for "best" and "worst case" scenarios for each of the contaminated systems) for dispersion of radioactive material as a result of the accident, preliminary cleanup activities and/other occurrences up the present. Such a mass-balance approach should also be applied to each cleanup step, including calculations of the disposition of radioactive materials before cleanup and dispersion due to cleanup activities as well as to the solid, liquid, and gaseous waste-products of the cleanup and to the storage and disposal alternatives. Calculations should include estimates of changing nuclide abundances due to radioactive decay and nuclear reactions beginning with the accident and extending into the future until the wastes will no longer constitute a major source of radiation. For example, the worst and best case estimates for the contamination level of the primary coolant water, both in its present state and as a result of removing the fuel rods, could be compared with estimates of the total concentrations of radioisotopes (and their activity) presently contained in the fuel rods.

Adopting this approach would provide an organizational framework which would allow the reader to assess the importance and potential hazard of each step in the context of the whole cleanup. The choice among alternative cleanup procedures would be based on an assessment of the integrated effects of all cleanup activities, including those of the particular step under consideration. Choices based on the myopic view of only the short-term exposure and accident scenarios for a particular procedure, considered alone, would be avoided.

The inventory approach would also permit assessment of accidents and controlled and uncontrolled radiation releases during the cleanup and might permit a back-calculation to determine the total amount of airborne radiation released during the accident. One would gain valuable knowledge and insights into the steps in the accident, equipment performance, design criteria for reactors and safety systems, as well as scientific data about dispersion processes and mechanisms.

FRANKLIN and MARSHALL COLLEGE
LANCASTER, PENNSYLVANIA 17604

DEPARTMENT of GEOLOGY

November 24, 1980

Director
Three Mile Island Program Office
U.S. Nuclear Regulatory Commission
Washington DC 20555

Dear Sir:

The enclosed list of "References Cited" was inadvertently not included in comments concerning NUREG 0683 we submitted to your Middletown office, November 19, 1980. In the interest of completeness, we would appreciate your adding them to our comments.

Yours truly,

Arthur H. Barabas

Arthur H. Barabas

S. Sylvester

S. Sylvester

REFERENCES CITED

Gross, M. G., et. al. Suspended Sediment Discharge of the Susquehanna River to Northern Chesapeake Bay, 1966-76, Estuaries 1 (2): 106-110, 1978.

Schubel, J. R., Suspended Sediment Discharge of the Susquehanna River at Havre de Grace, MD. during the Period 1966-67, Chesapeake Science 9 (2) 131-135.

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DEPARTMENT of GEOLOGY

November 18, 1980

QUESTIONS ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL STATEMENT (P.E.I.S.)

Relating to decontamination and disposal of radioactive wastes resulting from March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2.

In compliance with the NEPA legislation allowing comment on P.E.I.S, the Environmental Problems Seminar (Geology 54) at Franklin and Marshall College wish to respond. We have chosen to organize our comments into three categories: Decontamination and Cleanup Plan, Waste Management and Transport, Environmental Effects and Monitoring. We feel as though these categories best depict the activity that is necessary in the decontamination of TMI-2. In our opinion this statement is deficient in several areas:

a) There is a lack of choice between alternatives proposed for cleanup operations.
b) There is a lack of knowledge about the status of the reactor core.
c) There is inadequate provision for waste disposal and storage.
d) There is a lack of chronological sequence in the sections of the statement.

Initially, our group approached this document with a degree of optimism. We were under the impression that we would be able to accept or reject particular sections of each chapter. However, as our criticisms accumulated, we discovered that there was not a single chapter left untouched. Consequently, we have decided to reject each chapter. Where criticisms are few, the chapter itself is vague. We do not intend these comments as an assault on the NRC, but as constructive criticisms or questions that can be posed as decontamination possibilities of TMI-2 are studied. We ask that the NRC be careful and judicious in selecting the correct procedure. Remember we are only human.

[signatures]

I. Decontamination and Cleanup Plans

Because of uncertainty about the extent of the radiological damage within the reactor building, the P.E.I.S. sections on decontamination of the reactor building and equipment are incomplete. More thought and work will have to go into a plan which should be:

(a) More definite in terms of which operations are the most effective.

(b) More definite in determining the sequential order of operations.

(c) More definite in estimating the timing, duration and integrated amounts of expected releases of radioactive material.

Criticism of specific sections include:

6.7 (1) The P.E.I.S. only puts forth a "plausible" sequence of the major decontamination steps for the reactor building. However, choices among specific cleanup procedures for each step are not made.

6.4.2.1 (1) The section asserts that the sump water could be removed in several ways. However, none of the alternatives described provide a satisfactory method of cleanup. No data is given on which alternatives provide lowest worker exposure.

(2) The procedures and alternatives for remote decontamination, semi-remote decontamination and hands-on decontamination described in this section are well thought-out and complete. Nevertheless, the statement offers several methods without choosing a preferred method as being less expensive, easier or safer than another. For example, the statement says that remote decontamination above the 347 ft. elevation could be accomplished either by the overhead spray system or by a low-elevation stream injection with pulsed overhead water spray. No decision is made as to which method will be used.

6.6.3.2 The N.R.C. states that because of the drum's surface radiation and the specific activity of the sludge, the packaging of the waste will have to be done "remotely or within a drum shield". Yet, the N.R.C. admits that there has been no decision as to the design of this drum packaging station. The N.R.C. offers no procedural conditions, burial constraints, environmental or health implications relevant to the decision of the packaging and packaging facilities.

6.6.2.2 The N.R.C. does not discuss adequately the final disposition of the high-specific-activity zeolites after they have been packaged in their dewatered state. In addition, the immobilization and dewatering of the organic resins were still being evaluated. Information about the present condition of organic resins generated by the EPICOR-II system to date is not taken into account in the evaluation of future wastes of this type.

6.6.2.3 and 6.6.4 The N.R.C. states that compaction and incineration will be "used to the extent practicable". There is no effort to define this statement. This is of considerable concern because compaction and incineration of trash can give off radioactive effluents directly to the environment. One would have to determine whether these are alternative techniques which would reduce the releases of radiation to the environment. A total estimated amount of radiation releases from this source has not been determined by the N.R.C.

Table 6.6-15 One of the casks containing the first stage zeolite liner is made to endure a 30' drop. However, transporting and handling requires the casks to be 60' above ground level. Since a 60' drop from a crane would be part of a worst case scenario, casks capable of surviving such a drop should be used.

7. The N.R.C. has issued a Draft Programmatic Environmental Impact Statement on Reactor System inspection and has requested comment, after inspection has already begun. Section 1506.1 of the National Environmental Policy Act states, "that until an agency issues a record of a decision, no action concerning a proposal should be taken which would limit the choice of alternatives".

7.2.3.5 Section 7.2.3.5 states that the system needed for decontamination could be used in some combination with the manual plant system to process <u>primary</u> water and the associated waste. This "may" result in less than optimal facilities being used for some individual processes, in order to better optimize the use of all facilities in the decontamination process. This suggests selection of less than optimal clean-up procedure.

Table 8.4-1 The number of <u>Spent Filter Cartridges</u> which will be produced is not determined due to the uncertainty of constituents within the waste fluid.

8.4.3.3 Reactor coolant pumps and pump motors will be disassembled and transported out of the reactor building to an on-site decontamination area should in-place decontamination techniques prove unsuccessful. Transport and disassembly procedures lack details (i.e. package type, route of transport, size of disassembled mechanism). If decontamination is not possible off-site disposal, as the N.R.C. reports, is the only other alternative. Due to the large waste volumes (radioactivity around 5 R/hr with parameters of 712,000 pounds and 12,200 ft^3) and inherent potential hazards in handling, procedures for packaging, handling, and transporting must be developed.

8.2.1 This section states that trapped fission gas may be released during deleveling. The amount and final disposition of this gas remains unaddressed.

8.2.2 The best case conditions is "based on estimates of the most probable condition of the reactor core". No details of the analysis which identified this "most probable conditions" are given. The worst case condition reflects the impact of more severe damage conditions. Why is a more severely damaged condition considered a less probable one? Does a best case-worst case analysis provide an adequate model for reactor clean-up method?

8.2.3.4 One learns that "because of need for working with encumbrances (such as protective clothing) and because of the complexity of the cleanup operations, productivity factors are assumed to be 50% for best-case conditions and 40% for worst-case conditions". The reason given for the lower figure in the worst-case condition is due to the uncaused complexity of the operations. No details of how either of these figures was reached are given.

8.1.1.3 The N.R.C. staff states that high temperatures and changing pressures may have caused distortion in the reactor pressure vessel head (RPV) and various other components comprising the core structure. Until a more detailed analysis of the distortions in the RPV head is complete, no coherent plan can be put forth for the clean-up of the reactor or estimate the environmental impact of such a clean-up.

8.1.2.1 The N.R.C. staff states that once the core structure has been dismantled, the huge pieces of radioactive metal will be temporarily stored behind a shield in the building. What effect would temporary storage have on other aspects of the clean-up?

II. Waste Management and Transport

9.1.1 (1) Certain phases of the cleanup, as well as construction of on-site storage facilities has commenced prior to the preparation of the P.E.I.S. Hopefully, the P.E.I.S. will not prove to be an ex post facto rationalization.
(2) The nature of "remedial activities" mentioned in this section are not defined or explained.
(3) This section states that the current phase of operations has no significant impact associated with it. No definition or explanation of the "current phase of operations" is provided.

9.1.3.3 (1) The length of time radioactive wastes are to be stored on-site and the location of ultimate disposal site is not discussed.
(2) Can the on-site facilities accommodate all wastes produced by the clean up?
(3) The time period over which the interim storage facility's integrity is assumed is not given. Over what period is the integrity of this facility assumed? Was an expected lifetime considered.
(4) What is the present condition of the existing waste? What provisions have been made to monitor its condition in the future?
(5) The potential hazards of on-site storage were not discussed in depth.
(6) A more comprehensive geologic survey should be undertaken to insure stability of the on-site storage facility.

9.1.3.1 (1) Will additional shipping casks become available, and, if so, when?
(2) What is planned if the casks cannot be acquired? Are other alternatives now being considered?
(3) What are the minimum number of casks needed?

9.1.3.3 Commercial LLW burial sites may soon refuse wastes from TMI. What contingency plans exist?

9.2.1.1 Section 9.2.1.1 makes no reference to the fate of the on-site low level wastes in the event of a natural disaster (i.e., severe storm, floods, etc).

9.5.1.1 Concerning the transportation of nuclear wastes, the study fails to present methods to deal with an enroute vehicle accident and possible subsequent radiation leakage.

III. Environmental Effects & Monitoring

2.1 The NRC plans to store high-specific activity and transuranic wastes for an unspecified time at TMI despite their acknowledgment that the site does not meet U. S. Government standards for such storage. This immediately creates an unacceptable situation, especially when no indication is made of how long this "interim storage" will last.

2.2.3 This section discusses alternatives for disposition of radioactive waste, but the descriptions lack detailed accounts of the advantages and disadvantages of each. The safety of each alternative is not discussed. This information is of primary importance to facilitate public understanding of the rationale for the actions taken. One alternative not mentioned in the PEIS deals with the disposal of Epicore II treated, tritiated water. The public has indicated concern over the possibility of disposal of the water into the Susquehanna River. It is apparently assumed that this water will end up in the Atlantic Ocean. Direct oceanic disposal is not considered as an alternative. Pollution of the Susquehanna River could thus be avoided.

3.1.6.2 (1) The criteria used for defining the impact study area are not given. The study area includes the counties of Dauphin, Lancaster, and York, "although impacts may also occur outside of this area". An impact statement should take into account all those areas which may be affected, but at the opening of this section, it is clearly stated that this is not the case. A list of the criteria used in defining the study area would be most informative.

(2) This portion of the P.E.I.S. is purely descriptive and provides the public with no information about the short and long term effects a clean up operation will have upon the land and its inhabitants.

3.1.2 To insure full examination of the possibility of water loss through fractures and faults in the bedrock of TMI, core boring should be closely spaced over the entire island. Furthermore, a monitoring device must be set up to record any contaminated water leaking into the Susquehanna River from the bedrock.

3.1.4.2 A projection of the cumulative expectations of increased radiation levels in the Susquehanna River is absolutely necessary.

The P.E.I.S. does not state what the damages the surrounding ecological community might incur. A worst case estimate is needed in Chapter Three.

A study must also be made of the future consequences of a radiation build-up in the plant-animal food chain. Only small amounts of radiation may be found in the river but over the years concentration may occur in plants and animals which are stages in the food chain. Chapter Three must include a case study of unexpected consequences.

11.1 (1) It is evident that a coherent plan insuring adequate and accurate radiologic monitoring of the environment in and around TMI has not been formulated. The P.E.I.S. fails to clarify how monitoring responsibilities, sites and monitoring techniques were determined. In addition, the weekly, monthly and quarterly sampling indicated by the vast majority of monitoring schedules is inadequate to assure accurate tracking of episodic radioisotope releases. These sampling intervals tend to obscure the actual dose from each release to specific areas. If large releases do occur, their magnitude and extent will be hidden by the long term averaging.

(2) The hydrology of the Susquehanna River and channel sediments is inadequately addressed. The adsorption of radioactive isotopes onto clay-rich sediments and the subsequent distribution patterns of these clays are hardly mentioned. These fine sediments, along with their adsorbed radionuclides will accumulate behind downstream dams and other sediment traps during times of low discharge and will subsequently be remobilized in effectively higher concentrations during periods of increased river discharge.

MILLERSVILLE STATE COLLEGE
MILLERSVILLE, PENNSYLVANIA 17551

November 14, 1980

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:

Attached are my comments on the draft Programmatic Environmental Impact Statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit 2.

My particular concerns are directed toward the steps in the clean-up that appear to result in the largest radiation doses to the public:

(1) Release of processed water into the Susquehanna River.

(2) Release of tritium to the atmosphere as a result of the removal of the RPV head and internals.

(3) Storage and disposal of the resins resulting from the decontamination of radioactive water.

The PEIS should address itself more fully to alternatives to the areas presently proposed.

Sincerely,

C. Byron Kohr

C. Byron Kohr, Ph.D.
Nuclear Physics
Department of Physics
Millersville State College

lms

Comments on the Draft Programmatic
Environmental Impact Statement
(Three Mile Island)

C. Byron Kohr, Ph.D.
Department of Physics
Millersville State College

The description of decontamination of the large quantities of water contained in the auxiliary and fuel handling buildings (AFHB) and in the reactor building (RB) is incomplete on several counts.

I. The (AFHB) water is presently being treated by an ion-exchange system (EPICOR II) resulting in highly radioactive resins, which are unstable and highly acidic. The properties of these resins indicate that they are probably not in a solid form, but in the form of a slurry.

A. As stated in the PEIS, "The relatively high specific activity and nature of the fission product contaminants on some wastes will make them unique to TMI-2." (Section 2.2.1.3) Furthermore, it states, "The standards applied to these unique wastes will be considered on a case-by-case basis and, where warranted, these wastes will be handled, packaged, and disposed of in accordance with special requirements." (Section 2.2.2)

Comments: The PEIS should state clearly the range of possible unique wastes anticipated, and the methods by which each such waste would be handled, packaged, and disposed of. It is disturbing to find that there is no consideration of potential characteristics prior to proceeding with the clean-up. Such considerations and analysis should be part of the PEIS.

B. The highly radioactive EPICOR II resins are presently in steel-lined containers stored onsite in a concrete matrix. It is suggested in the PEIS that these containers could be stored onsite for periods of up to 20 years or shipped to special facilities for either storage or treatment. (Section 2.2.3.3)

1

Comment: Due to the high acidity of the resins, the steel liners are expected to disintegrate at a very high rate (perhaps as much as a 2% loss of mass per week). At this rate the containers could start to leak in less than one year. The PEIS does not address this concern at all. Analysis of this problem and possible solutions should be incorporated into the PEIS.

Comment: Shipment to special facilities depends upon several considerations. What are the special facilities contemplated and where are they located? Shipment requires adherence to standards established by the NRC, one of which is solidification of these wastes. What method, or methods, are proposed for this solidification? What is the present state of the resins? How would the problem of disintegration of the container be handled while in transit? What route would be used for delivery to the disposal site?

These questions must be fully discussed and alternative methods of dealing with these problems must be presented in the PEIS.

II. The reactor building sump water is not yet being treated, although the plant operators are constructing, without NRC approval, an ion-exchange system (SDS) for decontamination of this water. Since this water is even more highly radioactive than the (AFHB) water, the problems encountered in its treatment and storage, and the ultimate disposal of the wastes, should parallel those of the (AFHB) water, but be more extreme.

Comment: A complete analysis and review of the treatment of this water and the disposal of the wastes should be contained in the PEIS, including consideration of those concerns expressed in Part I of this comment.

Comment: Operation of SDS will produce spent resins with radioactive loads comparable in activity and type of isotopes (except transuranics are not expected) to high-level military wastes. DOE has not agreed to accept this waste at military disposal sites and it will be much too "hot" for disposal at low-level waste sites. The problem of eventual disposition of these SDS wastes is not addressed in the PEIS. Clear, well-developed plans for disposal offsite should be made and approved before SDS can be considered an acceptable treatment alternative.

III. As stated in section 6.3.1, 3.9×10^6 liters of highly radioactive sump water are contained in the reactor building. Appendix K of the PEIS describes techniques for processing this water. Using the Zeolite/Resin Process the following concentrations of radionuclides in the liquid effluent (total volume of 3.9×10^6 liters) as given in Appendix K are listed in the column (2) of Table A. The total amounts of the principal radionuclides in the processed water from the reactor building are reported on Table 10.1-2, as corrected, and are reproduced in column (3) of Table A.

Table A

Principal Radionuclides in Processed Water from Reactor Building

(1)	(2) (From PEIS) Concentrations (μCi/ml)	(3) (From PEIS, Corrected Data) Total Activity Processed Water (μCi)
H-3	9.5×10^{-1}	3.7×10^{9}
Cs-137	5.56×10^{-5}	2.2×10^{5}
Cs-134	9.56×10^{-6}	3.7×10^{4}
Sr-90	1.78×10^{-5}	6.9×10^{4}
Sr-89	4.2×10^{-6}	1.6×10^{4}

Comment: If this processed water is released into the river, the doses as reported on Table 6.3-12 are too low by a factor of 1200. Incorporating the assumptions used in the PEIS calculations, the corrected values are listed in column (3) of Table B. Also listed in column (2) are the incorrect values appearing in Table 6.3-12 of the PEIS.

Table B

Total Body Doses for Exposed Individual for Reactor Building Sump Water (Zeolite/Resin Processing Method)

(1) Pathway	(2) Total Body Doses (mrem) (From PEIS)	(3) Total Body Doses (mrem) (Corrected Data)
Drinking Water	2.2×10^{-4}	2.7×10^{-1}
Fish Consumption	5.1×10^{-4}	6.1×10^{-1}

Comment: Using the probabilities for health effects as given in the PEIS (Table 4.5-1), the health effects as given in the PEIS (Table 6.3-13) and Table 10.3-1) should be recalculated. The correct values for the health effects due to the Zeolite/Resin Processing Method for the reactor building sump water, including discharging of the processed water into the Susquehanna River are given on Table C.

Table C

Health Effects

Pathway	Probability of Cancer Death over Lifetime of Exposed Individual	Probability of Genetic Effect over Next 5 Generations of Exposed Individual
Drinking Water	3.8×10^{-8}	7.0×10^{-8}
Fish Consumption	8.5×10^{-8}	1.6×10^{-7}

The discharge of the processed water into the Susquehanna River represents a health risk to the public significantly greater than any other step in the clean up process, with the possible exception of removal of the RPV head and should be avoided.

Comment: In all these calculations complete mixing of the discharge water with the river water was assumed. As stated in section 6.3.5.2, consumption of 21 kg/yr. of fish in the plume would lead to doses 20 times higher, that is, 12.2 mrem to an adult individual.

IV. As indicated on Table 10.3-1, the largest offsite total body dose to a maximum exposed individual is expected to occur as a result of the removal of the reactor pressure vessel head (RPVH) and internals. As described in section 8.1.5.2, the principal radionuclide contributing to this dose is tritium, the total amount to be released over a period of one year being estimated at 560 Ci.

Comment: Alternatives to release of this tritium to the atmosphere have not been considered. The PEIS should include the possibility of condensing the tritium (in the form of HTO) from the vessel atmosphere and disposing of it in another manner, such as solidification in concrete. In as much as the PEIS indicates that the offsite dose from this source, as well as that from release of processed water to the river (as corrected above), constitute, by several orders of magnitude, the largest doses to the public, greater attention should be given to alternative methods.

November 19, 1980

To: Student Government Association of Catonsville Comm. College

It is our responsibility to keep our bay and wildlife alive. For this reason we cannot allow the representatives from Three Mile Island to dump radioactive waste into the Susquehanna River. This waste will eventually filter into the Chesapeake Bay and it is not yet known what the final result will be. Can we afford to take this risk? Tonight, is the last of 32 hearings (for the public) to take place in Middletown, Pennsylvania in the town hall at 7:30 p.m. Unfortunately, this incident has not been very well publicized. The media does not seem to think these public hearings are of interest to the public. It is up to us to prove that the people of Catonsville Community College are concerned.

Your vote of support will be greatly appreciated .

Sincerely,

Robyn M. Sachs

Robyn M. Sachs (Sophomore at C.C.C.)

SAVE OUR BAY !

KEEP THE WILDLIFE ALIVE !

DO YOU WANT TO SEE RADIOACTIVE WATER WASTE DUMPED INTO THE SUSQUEHANNA WHICH WILL EVENTUALLY FILTER INTO THE CHESAPEAKE BAY?

– SHOULD WE TAKE THE CHANCE?

THIS IS YOUR CHANCE TO BE HEARD – SIGN NOW

HELP! THREE MILE ISLAND WAS THEIR MISTAKE – NOT OURS! PLEASE

1) Robyn Sachs
2) Dave Walsh
3) [illegible]
4) Jacquelyn Grant
5) Jaclyn Johnson
6) Leslie King
7) [illegible]
8) Adraine D. Harrell
9) Derrick McDonald
10) Antoinette Franklin
11) [illegible]
12) Barbara Bensel
13) Eddie Myers
14) [illegible] Pratt
15) Todd Outten
16) [illegible]
17) [illegible]
18) [illegible]
19) Alan W. [illegible]
23) Bobbette Owens
24) Carolyn Holmes
25) Charles [illegible]
26) George Carter
27) Elly Schoolnick
30) Tom Centeneo
31) [illegible]
32) [illegible]
33) [illegible]
34) Terry Phillips
35) [illegible]
36) [illegible]
37) Samuel Johnson
38) [illegible]
39) Karen Harris
40) Kimmie English
46) Andrew McCall
47) [illegible]
48) Shellie Shewell
49) Kim Gerald
50) Sharon Davis (188) [illegible]
51) Kenneth Simmons (189) [illegible]
52) Donna Taylor
53) Pete [illegible]
54) [illegible] Johnigan
55) Patricia Johnigan
56) Susan [illegible]
57) [illegible]
58) Tammy Meacham
59) Jack Snyder
60) Greg Johnigan
61) [illegible]
62) [illegible] Johnigan
63) Marie Johnigan
64) Mary [illegible]
65) Pam Reynolds

A-199

From: Jeane J. Crumley
P.O. Box 189
Summerdale, PA 17093

Comment on the Draft PEIS
on clean-up of Three Mile Island

"For as long as the sun shines and the river flows, and the grass grows..." so ran the phrases in early U.S. and Indian treaty agreements, and now we're the "Indians" at the mercy of big government and big industry, those of us who are privileged to live in the TMI area. With so many different phases in the proposed decontamination schedule, and so much of an "uncertain" nature in the ways of coping with this ghastly pile of radioactivity I can only echo my husband's thought that the NRC's public relations people really worked hard to reassure the innocent who still hold a belief in "the government's ability to solve anything.

It didn't take much reading of Met-Ed and NRC records concerning the March 28th accident, (as well as Kemeny Commission transcripts, etc.) to feel very uncomfortable and even a bit queasy that the very

(P.1) JJC

same people who brought us the problems at TMI (NRC and licensee) will be the ones who plan, execute, and oversee the (rather protracted) clean-up. Since D.O.E. is the governmental body with the most expertise one might hope for better conditions and more expeditious operations, but this apparently is not to be the case as far as decontamination is concerned. At least some D.O.E. experts should be involved in disposal of the rad-wastes, especially as regards the likelihood of an indefinite period of "interim" storage on that island. If one can believe that some of the European countries work rather hard to keep up with "the state of the art" of nuclear power generation and/or fuel reprocessing, etc. then perhaps something of value might be gained from some of their experience.

At least the public is to have some input by way of the newly-met and organized Citizens Advisory Board, and from the tone of the initial meeting it's clear that the NRC Commissioners would do well to listen well (and carefully) to their

(P.2) JJC

ideas and suggestions, and to weigh them judiciously. All too many are those who have stated that the NRC considers the health of the industry far above the health of the citizens. That's shown in the most flagrant disregard for human health and safety by hiding the very real (if consider remote) danger of plant accidents and their potentials for literally ruining the earth for miles around with radioactive fall-out. It's a common un-funny remark around here "With nukes like these, who needs enemy missiles?", as paraphrase of "With friends like these, who needs enemies?" It makes no sense to me to leave out the question of whether TMI-2 should be decommissioned, because there's no way that I could imagine its ever being allowed to re-open. (I am helping the public intervenors in the TMI-1 re-start hearings, as much as I can — for the same reason — It just seems so utterly foolish to propose that Unit One be allowed to operate as if that

(8.3)

source of radioactive pollution (Unit 2) weren't there, at all. Such are the ways of a pro-industry regulatory body, it seems. If the March 28th accident isn't enough to effect attitude changes and open the way to cutting back, eventually to abandon nuclear power generation in the U.S., then some truly cataclysmic event will have to occur. (Read Alexander Sidar's The Dorset Disaster, for clues as to what that end will be!) — It is not reassuring to have so painfully optimistic a view on the problems of getting Three Mile Island cleaned up — It's just not based on reality to expect things to fall in place so well. I want to hear more details of how in the world those low person-rems for the people in the "clean-up" crews were derived. And there's just no way the environment can be expected to escape pollution from particulate matter when the containment building's interior is cleaned. There is a wide variety of radioisotopes plated-out in there. The PEIS comparisons of "best" and "worst" case could be a lot more realistic;

(8.4)

with so great a degree of uncertainty as to how all the various chemicals will react and interfere with proposed waste solidification methods it does seem that a great deal of research and development work would be essential to making these great quantities of radwaste as stable as possible, at this time. If leaks occur and migration of radwaste liquids and gaseous products is an accepted part of storage at Hanford, Beatty, and the D.O.E. plants all over — that's one situation. But let's not forget that these treatment and storage facilities are rather carefully isolated, not in the midst of a residential, recreational, and farming area, or essentially at an international airport, as TMI is.

People such as I were rather naive in assuming that a nuclear plant had to be safe, or else state

(P.5) J.J.C

and federal agencies would prohibit their location any place other than extremely isolated areas. Also, our faith in scientists and engineers is shaken by revelations which have (thank Heaven!) come to light after TMI accident. There's nothing really professional (ethics-wise) in covering up and glossing over facts that, if known to the public earlier on, would never have allowed nuclear power generation to grow at so fast a rate, if at all! It's terribly disillusioning to learn that many really good, honest NRC people lose their jobs, get transfer to ineffective positions, and are just plain ignored when they try to act in the public's health and safety interests. I look forward to seeing more of a true ombudsman attitude, less of a bureaucratic postponement, procrastination, arrogant (We know best!) way of expressing ideas on so vital a subject!

(Temporary end) (P.6) (To be continued) J.J.C

If only I were an accomplished typist, there might be reams of material here, as I have certainly worked as hard as I could, over the past months, reading documents in state library, professional journals, books on the subject of nuclear power in all its ramifications, and have attended a good many public meetings. There is no very good reason to alarm the general public further, but some positive actions must be taken by government agencies with responsibility, as well as the industry itself —

Jeane J. Cumley
Nov. 15, 1980

4367 Americana Drive
Annandale, Va. 22003

November 18, 1980

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,

Please find enclosed a copy of my comments on Docket No. 50-320, the draft programmatic environmental impact statement related to decontamination and disposal of radioactive wastes resulting from March 28,1979, accident Three Mile Island Nuclaer Station, Unit 2. I hope that the commemts of myself and my fellow citizens are carefully read and considered in a most thoughtful manner.

I would like to make the general point, that due to the lack of cost and cost/benifit analysis, that the next edition of this EIS must be considered to be an additional draft, not a final EIS. This would allow the public to participate in a meaningful way in the process, for without the cost information, public participation in the process has been stimeed. Also, that a draft EIS should be produced for each decision in the clean-up process, again to allow publdc participation.

Thank you for your considerations.

Yours truly,

Ira May

Ira May
Environmental Geochemist

Comments of Ira May
Environmental Geochemist, Annandale, VA

In general, I felt that the hydrology of the Susquehanna River and of Three Mile Island, itself, and the impact of the disposal of radioactive liquids into those systems is incompletely addressed. Estimates of concentrations in the river assume complete mixing during low flow periods by the drinking water intakes of Lancaster, PA. Yet, there is no discussion as to how a complete mixing theory was arrived upon. What about thermal effects, both in a stratified river system and in the released water? Does the meeting of a safe drinking water standard at the intake point suggest no impact? I would suggest that an EPA drinking water standard is not an impact free level rather it is a level at which corrective action must be taken. If the water of Lancaster, PA. contained the drinking water standard for tritium, it would be time to investigate the use of that water not a safe point. Would the location of the several dams downstream aid or hinder the complete mixing assumed?These questions must be answered before a complete assessment of the potetial impacts of release of water to the River can be arrived at.

Sediment deposition with the Susquehanna River and Chesapeake Bay, and adsorbtion of radionucleides by clay minerals, is barely addressed in the Draft EIS. My studies of estuarine systems would suggest that much of the released radionuclides would adsorb to clay particles almost immediatly, and would be removed from the water column to the sediment layers. The work of Eddington and Robbins of the Argonne National Laboratory(i.e. Chapter 44, Environmental Biogeochemistry, ed. by J.O. Nriagu, Patterns of Deposition of Natural and Fallout Radionuclides in the Sedimetns of Lake Michigan and their relation to Limnological Processes)states that the residence time of ^{137}Cs in aquatic systems is less than 1 year with the result that 95% of that which enters the system is in the sediments.McHenry etal.(Accumulation of Fallout Cesium 137 in Soils and SEdiments in Selected Watersheds, Water Resources Research Vol.9, No. 3, P. 676, 1973) state that Cesium 137 is concentrated up to 24 times in the sediments than in the respective watershed. This information would suggest that Cs will be concentrated into the sediment layers to a great degree and that the could potentially lead to areas of the Bay bottom that would be heavily contaminated with radioactive elements.

I am disturbed by the lack of mention of the fact that oyster and clams and all other sheel building aquatic organisms will use Strontium in place of Calcium in their carbonate shell makeup. As a matter of fact, studies by Dr. Holland of Harvard and myself during my studies at Johns Hopkins University in Baltimore, suggest that the geochemistry of the strontiate-aragonite crystal building process in shells favors strontium use. Therefore it would appear that addition of Sr to the aquatic system would lead to concentrations of the element in the shells as well as the tissues of these organisms, and would lead to impacts greater than those postulated in the draft statement.

I felt that those three geological and geochemical points were in - adequatly addresssed in the statement and are of vital importance to someone of my technical background. The other major issues which disturbed me I have decided to present only in summary form as they are not areas of my immediate expertise. They are as follows:
1) I found that the document was poorly written, some sections did not appear to even have been proof-read.Technical figures often did not add up and even more often did not agree with other figures elsewhere in the statement.

2)I found no mention of the disposal of liquids wastes except for the water in the containment building. Are we to believe that that water is all the radioactive liquids on-site?

3)The proposed mass balances do not add up.

4)the use of tritiated water as a cleaning fluid was proposed in one section of the document, however, there is no mention of any occupational exposure from such a program.

5)There is no listing of the radioactive elements at the site. An inventory of the scope of the radioactive on site would be helpful for any clear understanding of the problem.

6)There is no discussion of the disposal of high-level wastes. And now that the Hanford Washington site has been closed by the citizens of Washington state to low level waste, where will those wastes now go?

7)There appeared to be no discussion of alternatives in the document for difference courses of action. Also it would appear that the statement"it is against regulations" is inappropiate in an impact statement. Such a statement by it self is not sufficient to limit a course of action.

8) Why was the relative merits of ocean dumping not assessed? It would appear that dilution with ocean water of liquid waste is an attractive alternative.

9)There is no mention in the document of what the license requirements are, although an impact is asessed often on the basis that it is within those requirements.

10) does the monitoring program match teh decontamination procedure or is it set up for general monitorring?

11) There is no mention of the training of the number of workers who will be required to complete the decontamination procedure. Although their occupational dose may be low, will they be prepared to cope with the situation in the containment building?

Thank you again for this oppurtunity to comment.

Atomic Industrial Forum, Inc.
7101 Wisconsin Avenue
Washington, D.C. 20014
Telephone: (301) 654-9260
TWX 7108249602 ATOMIC FOR DC

November 20, 1980

U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Director, Three Mile Island Program Office

The Atomic Industrial Forum's Committee on Three Mile Island 2 Recovery has reviewed the Nuclear Regulatory Commission's draft Programmatic Environmental Impact Statement (PEIS), NUREG-0683.

The Committee endorses the draft PEIS conclusion that clean-up operations will have minimal adverse effect on the public health and safety and the environment, and agrees that offsite radiation exposure would be much less than the design objectives of Appendix I of 10 CFR 50 for an operating power plant.

The following general comments are submitted for your consideration:

- The PEIS provides a thorough and accurate analysis of the risks to the public health and safety and environment. The analysis is supported by an overwhelming amount of technical information.

- The draft PEIS does not recognize, however, the risks to public health and safety and to the environment associated with delays in the clean-up. The risks associated with delay should be considered and this urgency should also be recognized in the approval process for the PEIS.

- Alternatives for disposal of radioactive waste not suitable for shallow land burial are not addressed. While it is recognized that the disposal of high level waste is an unresolved national issue and that such wastes should be removed from TMI as soon as possible, consideration needs to be given for the Department of Energy to provide interim storage at federal sites.

- While the PEIS points out some unacceptable clean-up alternatives (such as doing nothing), it does not indicate which of the clean-up alternatives are acceptable. Indicating acceptable alternatives can expedite clean-up activities and provide some degree of planning certainty in the process.

- Criteria for liquid and gaseous releases are not stated in the PEIS. Consideration should be given to permitting releases under the same criteria as required in the TMI-2 operating license.

- Potential conflicts between the NRC, other federal agencies, and the Pennsylvania State and local governments, are not discussed. Problems have occurred at Three Mile Island and are briefly addressed in the PEIS. Other problems are likely to occur during the clean-up activities and should be considered.

There is a real need in the view of the Committee for the clean-up to proceed expeditiously. Possible leaks and indecisions can lead to further public fears. Prompt action will minimize the risks and the possible psychological stress to those living in the vicinity of TMI.

Should you wish to contact AIF Committee members to obtain further information on the Committee's views for the clean-up of TMI-2, the Committee Secretary, Frank Graham, would be pleased to assist you in the arrangements. A Committee membership list is enclosed.

Sincerely,

Vincent S. Boyer

Vincent S. Boyer
Chairman
Committee on TMI-2
Recovery

ATOMIC INDUSTRIAL FORUM
COMMITTEE ON THREE MILE ISLAND TWO RECOVERY

Chairman: Vincent S. Boyer
Senior Vice President, Nuclear Power
Philadelphia Electric Company

Secretary: Frank W. Graham
Special Studies Manager
Atomic Industrial Forum, Inc.

A. Philip Bray
Vice President & General Manager
Nuclear Power Systems Division
General Electric Company

Robert Brooksbank
Section Head
Pilot Plant Section
Chemical Technology Division
Oak Ridge National Laboratory

James A. Buckham
Executive Vice President
Allied General Nuclear Services

John P. Cagnetta
Assistant Vice President
Nuclear and Environmental Engineering
Northeast Utilities Service Company

Deslonde R. deBoisblanc
Vice President
Advanced Technology
Ebasco Services, Inc.

David J. Fogarty
Senior Vice President
Southern California Edison Company

Robert J. Gary
Executive Vice President and
General Manager
Texas Utilities Generating Co.

D. Clark Gibbs
Vice President
Middle South Services, Inc.

Richard Jortberg
Director of Nuclear Safety
Commonwealth Edison Company

George H. Kimmons
Manager
Engineering and Construction
Tennessee Valley Authority

Herbert J. C. Kouts
Department Chairman
Brookhaven National Laboratory

Milton Levenson
Director
Nuclear Power
Electric Power Research Institute

Saul Levine
Vice President and General Manager
NUS Corporation

Warren Owen
Senior Vice President
Engineering and Construction
Duke Power Company

Nunzio J. Palladino
Dean, College of Engineering
Pennsylvania State University

William B. Reed
President
Southern Company Services, Inc.

Marcus Rowden, Esq.
Fried, Frank, Harris, Shriver
& Jacobson

Irwin Spickler
Partner
Dames & Moore Company

Fred M. Stern
Vice President
Engineering and Development
NSSS Projects and Licensing
Combustion Engineering, Inc.

John J. Taylor
Vice President and General Manager
Nuclear Energy Systems
Westinghouse Electric Corp.

Robert Uhrig
Vice President
Advanced Systems and Technology
Florida Power and Light Company

Russell Youngdahl
Executive Vice President
Consumers Power Company

Marvin I. Lewis 81
6504 Bradford Terrace
Phila. PA 19149
11-17-80.

Bernard Snyder
USNRC

SIR:

PLEASE ACCEPT THE FOLLOWING AS ADDITIONAL COMMENTS TO THE COMMENTS THAT I SUBMITTED PREVIOUSLY ON THE TMI#2 CLEANUP PEIS.

1. THE FEIS ON THE DRESDEN DECONTAMINATION HAS JUST RECENTLY BEEN ISSUED. (NUREG 0686 OCT. 80) THE PUBLIC COMMENTS THEREIN POINT UP MANY OF THE PROBLEMS THAT HAVE SURFACED IN THE TMI CLEANUP SUCH AS LEAKING DRUMS.
   DUE TO THE DIRECT APPROPRIATENESS OF MANY OF THE PUBLIC COMMENTS IN THE DRESDEN DECONTAMINATION FES TO THE PROBLEMS SURFACING AT THE TMI CLEANUP, I RESPECTFULLY REQUEST THAT THE PUBLIC COMMENTS IN NUREG 0686 BE INCORPORATED INTO THE PEIS FOR TMI#2.
2. IN NRC/TMI-80-145, COLLINS TO ARNOLD, 11-7-80, MR COLLINS STATES, "DIFFERENCES IN PERFORMANCE (OF THE SUBMERGED DEMINERALIZER SYSTEM) MAY BE AS HIGH AS 100."
   THE RANGE OF ACTUAL PERFORMANCE OF CLEANUP SYSTEMS TO PLANNED PERFORMANCE HAS NOT BEEN PROPERLY ASSESSED. THIS VARIANCE OF ACTUAL TO HOPED FOR PERFORMANCE WAS POINTED OUT IN MY PREVIOUS SUBMITTAL. THE PEIS CANNOT BE ACCEPTED BECAUSE IT is based on hoped-for, not actual, performance.

Respectfully submitted,

Marvin I. Lewis.

November 19, 1980

Dear Sir

This letter is in regard to the dumping of nuclear waste water from Three Mile Island into the Susquehanna River. As a resident of Baltimore County in Maryland I am totally opposed to this action. The Susquehanna is a source of drinking water for many people in Northern Balto. County and I do not feel that enough is known about the long term effects of nuclear waste on humans, animals or plant life to risk the possibility of harm to anyone or anything. The Susquehanna River empties into the Chesapeake Bay and any changes (such as the dumping of nuclear waste water) to this body of water would greatly affect the people and the economy of the state of Maryland, as the Bay is a major source of income & recreation to the state residents. This problem originated in Pennsylvania at T. M. I. and I do not feel that residents of Maryland should have to pay in any way for this near disaster. In fact I feel that nuclear power should be totally eliminated then there would be no problem of dumping hazardous wastes or threats to public health & safety.

Thank you very much
Mrs. William Richardson
7704 Wynbrook Rd.
Balto. Md. 21224

Nov. 17, 1980

To: NRC Commissioners

Re: PEIS

The format of the PEIS gives a very fractionated view. As a lay-person, it is difficult to get one's act together. Some of the puzzling information:

P2-13 No regulations developed for the "types of unique wastes" generated at TMI 2 "since it was never anticipated that such waste would be created".

P6-13 Estimated concentration of dissolved contaminants in sump water, March 31, 1980

	μCi/mL	μCi/gal.
Tritium	0.95	3800
Cs 137	163	652,000
Cs 134	28	112,000

P8-12 "Gas will be stored or vented to the atmosphere as deemed advisable."

P8-36 Tritium will be released by the evaporation of water from the spent fuel pool and fuel transfer canal.

How many gallons? How is this contained during cleanup? What will be the total release to atmosphere? To river?

COMPACTIBLE COMBUSTIBLE TRASH

P5-35	99,000 ft.^{3}	Auxillary & fuel handling bldg.
P 6-63	45,000 - 150,000 ft.^{3}	Reactor bldg.
P8-43	35,000 - 100,000 ft.^{3}	Defueling and primary system decontamination

(Assumes 75% of compactible trash can be burned)

P6-74 Table 6.1-13 Offsite total body doses (by inhalation and vegatable consumption) for trash compaction and trash incineration (reactor bldg. chapter) gives dose in mrem/drum.

Is this per drum BEFORE or AFTER burning??? 5700 drums direct trash compaction OR 430 drums after burning?

P10-27 10.7.3 "Because of the rapidly renewal nature of the Susquehanna River and the regenerative powers and vast dispersive capacity of the atmosphere, the use ofthese resources to dilute and disperse the effluents of chemicals and radioactive materials from the clean-up of TMI 2 is not considered to represent irreversible or irretrievable committments of these resources."

Will this be another March 28, 1979?

We have no easy solutions. We have serious concerns for our homes and children.

Sincerely,

Charles and Genevieve Emerick
489 Willow St.
Highspire, Pa. 17034

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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

19 November 1980

Dear Dr. Snyder,

Enclosed you will please find our comment to the draft PEIS on the TMI-2 cleanup.

If you or any of the NRC staff have any questions about this document, please do not hesitate to call either me or Judith A. Dorsey, Esq.

Yours sincerely,

Bruce Molholt, Ph.D.
Science Director

Enclosure

Comment to

DRAFT 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

Prepared by the
PUBLIC INTEREST LAW CENTER OF PHILADELPHIA
For the
SUSQUEHANNA VALLEY ALLIANCE

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COMMENT TO THE PEIS FOR TMI-2 CLEANUP

Susquehanna Valley Alliance

I. General Comments - Deficiencies of the PEIS

The draft Programmatic Environmental Impact Statement (PEIS) related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2 (NUREG-0683) is a seriously deficient document. This draft PEIS is so deficient as to render it useless in its present state for the purposes for which it is mandated - informing decision makers and protecting the public. The deficiencies of the draft PEIS include gross underestimation of the potential adverse impact of the release of radionuclides during many of the TMI-2 cleanup steps proposed upon the people of the Susquehanna Valley region.

The deficiencies of the draft PEIS for TMI-2 cleanup are substantive, procedural and organizational. The document is not a balanced impartial scientific analysis of the potential environmental impacts from the proposed steps. Where scientists disagree, it chooses those quantitative values most favorable for the licensee. The reader is never informed of other quantitative estimates or even that a range of disagreement exists. Ranges in quantitative risks from all radionuclides potentially released during TMI-2 cleanup are invaluable for the process of unbiased decision-making. The one-sided presentation of the draft PEIS has never been permissible when determining how many fatalities will result from narrowing the curb of a highway; it clearly is unacceptable when the risks involve health hazards to the people of the Susquehanna Valley.*

*Airborne releases potentially affect 2 million people within a 50 mile radius. Water discharges potentially affect the cities of Baltimore, Lancaster and other municipalities which derive their drinking water from the Susquehanna River.

The basic purpose of an impact statement is to permit decision makers to know the impacts and risks associated with any action - in this case with the cleanup of TMI-2. The first principle is comprehensiveness. All of the impacts must be included and discussed, however, in this draft PEIS some very important impacts are left unmentioned in their totality, such as possible releases of plutonium-241, uranium-235, uranium-238 and other actinides known to exist in large quantitites within the reactor core.

Secondly, an impact statement must fairly and completely include all information about potential risks. This draft PEIS has consistently ignored reports or evidences indicating greater risks, including reports which the NRC itself has commissioned. For example, Appendix H "*Engineering Considerations Related to Immobilization of Radioactive Wastes*," gives a detailed analysis of the alternatives for immobilization. Yet nowhere in that appendix is reference made to a report commissioned by the NRC entitled "*Status Report on Leachability, Structural Integrity, and Radiation Stability of Organic Ion Exchange Resins Solidified in Cement and Cement with Additives*." This report, compiled by Brookhaven National Laboratory, Nuclear Waste Management Division, outlines some of the potential problems with solidification by cement, yet it is never cited in the draft PEIS.

This problem is particularly important in the area of estimating biological dangers inherent in potential releases of radionuclides during the TMI-2 cleanup operation. The NRC is well aware of discrepancies covering several orders of magnitude in risk assessments from radionuclides, yet these ranges of values are not commented upon in this draft PEIS and decision makers are never informed of the range of human health risk.

Another aspect of the fair evaluation principle is that it must be based on real and actual conditions, not on a hypothetical or imaginary world. This means any health consequences must be evaluated in relation to the discharges already absorbed by the Susquehanna Valley population during the operation of the TMI

reactors, the accident and prior "cleanup" activities. The draft PEIS ignores this principle entirely, treating any proposed releases of tritium into the Susquehanna River as if these prior releases had never occurred and ignoring evidence that repeated discharges increase the impact upon human health.

The third requirement of a PEIS is that it must identify and evaluate alternatives so that a decision maker can know what choices are available to him or to her. This is particularly important in a highly technical area like the cleanup of TMI-2. The organization of the draft PEIS does not make clear the consequences of the choices which are being considered, nor the alternatives. Furthermore, because the cost of eliminating any particular hazard or impact may be either very great or relatively cheap, it is important to know some range of magnitude of comparative costs. 40 CFR Section 1502.23 requires that an EIS should include factors not related to environmental quality that "are likely to be relevant and important to a decision." Clearly the comparative costs of alternatives for each aspect of the cleanup fall within Section 1502.23's requirements. The absence of such cost information from the draft PEIS* renders meaningful evaluation difficult at this stage.

The most obvious example of alternative courses which must be evaluated is a cleanup where the end product is recommissioning the reactor (the chosen policy) or decommissioning. Although these are the end of the line differences, they produce differences even even in the early stages of cleanup. The draft PEIS does not even include a list of what different steps would be taken and how soon this choice would be reflected in differing types of work, differing environmental impacts and differing health risks.

While the agency apparently believes that the raising of this issue would be politically unwise, the fact that environmental impacts of the cleanup will be affected makes it impossible to avoid.

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*It has been promised for inclusion in the final PEIS.

While there is little if any disagreement with the agency's position that the reactor core must be removed from the containment vessel at some point, it is not nearly so clear that other portions of the cleanup of the containment building would have to be so thorough. If in fact the facility is never to be recommissioned (and it is the opinion of some scientists that it is ludicrous to even consider recommissioning, in light of the internal damage to the facility that has taken place as the result of the events between March 28th and April 7th, 1979), then it makes little sense to spend the scarce resources of the utility on making the facility "white-glove" clean. It would also change the problem of disposal of resins, with the containment building becoming a possible interior site. Nor does it make sense to generate more resin or other wastes than is absolutely necessary, in light of the tremendous problems of ultimate disposal of those wastes. The public has the right to detailed information regarding the alternative of decommissioning, even if that is not the alternative eventually chosen. It is a reasonable alternative, if not a politically comfortable one, and legally must be considered.

As another example, the agency has made no direct, clear comparison of two major alternatives in the cleanup - between the proposed quick processing of containment building water and storage of resulting radwastes on the island for an apparently indefinite period, or the alternative of keeping that water in the containment building, unprocessed, until it is clear that there is somewhere other than the island to store the wastes. Scattered throughout the document are bits and pieces of such a comparison. It is stated that under no circumstances should TMI become a permanent waste storage site, and yet, in the absence of any other steps, that is exactly what will occur. There is no attempt to directly balance the vague threats of leakage of containment building water against storage of concentrated waste in storage facilities that are constructed to withstand "design basis" flood, and not probable maximum flood; against the fact that the steel containers holding highly radioactive EPICOR-II resins may be almost useless as a second barrier to leakage of radioactive material.

(See comments of NRC staff reported in October 6, 1980, issue of Inside NRC, stating that the resins could degrade to give off gases and corrode the containers.) These considerations, along with the fact that there is significant decay of radioactive material as the water sits in the containment building (and thus less radioactivity to handle and dispose of, the longer it is retained), should be pulled together from the document and presented as a clear, reasonable alternative to rushing into further cleanup.*

In many instances throughout the draft PEIS (because of a stated policy in the document and in public meetings), the NRC staff have stated no preference for a particular alternative. Staff have indicated that the PEIS is not meant to be a decision-making document, and therefore neither the draft nor the final PEIS will contain preferences. While the PEIS need not, in fact should not, be a decision-making document, CEQ regulations do require that preferences be clearly stated. 40 CFR 1502.14(e). As submitted to the public for comment, the draft PEIS does not give the public any sense of how the cleanup might proceed. Rather, it consists of a confusing set of ifs, ands and buts, with no clear direction except to complete the cleanup in the shortest time possible. While it is recognized that the cleanup at TMI will not be a simple task and there are many unanswered questions concerning the conditions inside the containment building and reactor vessel, there appears to be no need to make the cleanup one big question mark, as the NRC has managed to do.

It is important to note that the NRC ignored its own policy of not stating preferences in those instances where it preferred

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*Again, important technical information necessary for evaluating these alternatives has been omitted from the draft PEIS in violation of the law. The report continues to allude to the terrible consequences of not maintaining certain operating equipment, without adding that a system is being developed for keeping the core in a permanent shutdown mode without the use of any mechanical components (see NRC Status Report of October 14, 1980, p. 3). This reflects the same scare tactics used in the Environmental Assessment for venting krypton-85, which impartial reviewers found badly overstating the need for immediate entry and the risks of mechanical breakdown.

not to consider a particular alternative. We strongly suggest that the staff include all reasonable alternatives, attempt to place alternatives in the context of particular scenarios where possible, and to explicity state staff evaluations of particular alternatives.

Finally, the draft PEIS attempts to urge a "quick and dirty" analysis and "get on with the job" approach in order to reduce stress (and just by coincidence to reduce the opportunity for critical review). It is now claimed, as it was during the krypton venting controversy, that the more quickly the cleanup occurs and is completed, the lower the stress levels in the surrounding community will be. Since the cleanup will take several years in any case, the difference between five years or seven years will make much less difference in the levels of stress than a well-planned procedure that takes into account the real fears and concerns of the public. Stress is caused to a significant degree by a lack of trust and understanding. Acceleration of the review and decision making processes only increases this lack of trust and fear of a cover-up.

II. Summary of Specific Comments

The remainder of this comment to the draft PEIS addresses specific failures and inadequacies of the document. Specific comments are contained in sections III-VIII of our reply which comprise the following points in summary:

1) No facility exists at present which will accept radioactive wastes generated by the various phases of the TMI-2 cleanup. The Richland, Washington site, mentioned in the PEIS has stopped taking TMI-2-generated radwastes. This problem must be solved before the cleanup operations generate additional radioactive wastes which must be stored on Three Mile Island.

2) Tritium releases are taken completely out of context. In addition to the potential airborne releases of 560 curies and water releases of 270 curies from the auxiliary building water, there previously have been excessive tritium releases into the

Susquehanna River prior to and during the accident in March 1979. Additional releases of tritium may be planned following the cleanup of containment building sump and primary coolant waters.

3) In evaluating intentional releases of tritium into air and water, the draft PEIS ignores the concerns and fears of the public while exaggerating the consequences of keeping tritium on-site. Costs of alternative methods of tritium disposal off-site, such as storage for 60 years in steel tank cars, are not discussed.

4) None of the release tables contain any information concerning actinides, this despite the existence of 150,000 curies of plutonium-241 and unknown quantities of plutonium-239, uranium, thorium, polonium and other actinides in the TMI-2 core in which 90 percent of the fuel rods have been broken. The adverse human health impact from these actinides during cleanup of the crumbled core must be accurately assessed. The entire problem of core disassembly is paid only the barest of attention, a problem of sufficient magnitude to require a PEIS of its own.

5) Human health hazards resulting from environmental contamination by the other radionuclides released during the TMI-2 cleanup have been underestimated due to low radioecological transfer factors and conservative estimates of resultant genotoxicity.

III. Radwastes

Although Nuclear Regulatory Commission regulations, the National Environmental Policy Act and Council on Environmental Quality guidelines all require preparation and filing of a programmatic Environmental Impact Statement prior to the initiation of any major actions which will significantly affect the quality of the human environment, the cleanup of the accident at Three Mile Island, Unit 2, has already begun. Three forms of radioactive wastes (radwastes) have already been generated by this cleanup operation:

1) Gaseous; the 43,000 curies of krypton-85 which were released into the environment during two weeks in June and July, 1980,

2) Liquid; the 475,000 gallons of tritium-contaminated water in the auxiliary and fuel handling buildings, and

3) Solid; the contaminated resins generated by the EPICOR-II filtration of radionuclides other than tritium from the auxiliary and fuel handling buildings' water.

Additional gaseous, liquid and solid wastes exist and will be further generated by the cleanup operation, including sump and primary coolant waters and any resins and zeolites generated by their cleanup, and, most importantly, 100 tons of the reactor core which resides in a highly disorganized and potentially irretrievable state. The radwastes generated by the core alone during cleanup will comprise some of the most highly contaminated material both in terms of volume and specific radioactivity ever generated in the history of the nuclear industry.

Generation of these volumes of radwastes presumes the existence of safe radwaste disposal sites. No such sites exist. The Hanford Reservation at Richland, Washington, which heretofore has accepted TMI-2-generated radwastes, has limited the number of shipments it will accept and may in July, 1981, cease acceptance of all TMI-2 radwastes. An immediate problem are the primary resins containing one-half million curies of radioactivity. Storage of these resins on Three Mile Island has not been certified by the NRC. The problem will only be exacerbated when the core, which contains over 35 million curies, is disassembled and packaged up for radwaste disposal. At the moment, the safest vestibule for these 35 million curies of radwastes, plus unknown millions of curies of uranium-235, uranium-23[illegible], plutonium-239 and other actinides, may well be the reactor vessel

itself, where they now reside. This location is surely the safest site on Three Mile Island at present. Until alternative off-site radwaste storage is available, the reactor vessel, complete with circulating boron-saturated water and steel and concrete walls represents a safe interim storage site.

No further phases of decontamination and disposal of radioactive wastes from Unit 2 of the Three Mile Island nuclear reactor should take place until the issue of radwaste disposal can be unambiguously resolved. The programmatic Environmental Impact Statement must address this issue before safety for the environment from any other aspects of the cleanup operation is addressed.

IV. Tritium Releases

Although the PEIS clearly states "The March 28, 1979, accident and its associated environmental impacts also are not within the scope of this PEIS," this approach is untenable from the standpoint of protection of human health, from which standpoint, presumably, the PEIS is being written. Obviously the PEIS can do nothing to abate the environmental insults incurred around Three Mile Island from March 28th until April 7th, 1979. However, failure to take these releases of radionuclides into account as a premise for the present PEIS is a failure to recognize the *cumulative nature of radionuclide damages to the human environment*.

Genotoxic insults to the human gene pool such as carcinogenic and mutagenic changes in the DNA of human chromosomes are not removed once they are trapped into replicating (viable) cells. Hence, sequential genotoxic insults accumulate in the human gene pool and a population's risk for cancer and birth defects increases each time it is exposed to further releases of genotoxic radionuclides. This is particularly true of the population residing around Three Mile Island who received the genotoxic insult from 24 million curies released at the time of the accident, 43,000 curies from the venting of krypton-85 gas thirteen months later and are imperiled by further releases of radionuclides during subsequent phases of the cleanup operation over the next five to seven years.

Specifically with regard to tritium, the population residing near Three Mile Island had received considerable exposure prior to the accident on March 28, 1979. Assuming that Unit 2 released tritium at a rate similar to Unit 1, area residents were receiving at least annual releases of 1,434 curies of tritium into their air and 378 curies of tritium into the Susquehanna River (1). The latter may be an underestimate since the technician at TMI-2 in charge of tritium-monitoring reported after the accident that his supervisor often rejected tritium sampling data from the Susquehanna River for three or four days because they were too high. Only values which fell within the NRC regulations were reported. On top of this normal tritium release into air and water, an unknown quantity was released into the environment between March 28th and April 7th, 1979. There were at least 200 curies of tritium in the 265,000 gallons of contaminated water released into the Susquehanna River on March 30th and 31st, 1979. When it is realized that the City of Lancaster water intake 17 miles downstream from TMI receives 8 million gallons of Susquehanna River water daily and that the Baltimore water intake, 49 miles downstream, may receive as much as 250 million gallons per day, it obtains that significant populations have received tritium contamination prior to any further planned releases as a result of the cleanup process.

A. Planned releases

Clearly NRC regulations and EPA guidelines regarding contamination of drinking water by tritium are designed to protect the health of the public, since this radioactive isotope of hydrogen is genotoxic. The total genotoxic effect of several hundred curies of tritium will be the same whether it is put into the Susquehanna River on one day or over the course of more than one year, as proposed in one alternative of the PEIS, however. The

reason is that genotoxic agents attack DNA in direct proportion to the total number of molecules. If 2,000 carcinogenic and mutagenic events were to be initiated by 200 curies of tritium in the water supply, it would not matter if these 200 curies were present during one single day or over 500 days, the same 2,000 total irreversible changes in DNA of human cells would take place. It has been conclusively proven that there is no lower threshold below which human carcinogens fail to act (2). If anything, small, persistent doses of a carcinogen are more damaging than one large dose. This has been shown by Baserga et al (3) for tritium in experimental induction of cancer in mice using tritiated thymidine. More tumors were induced by a 10 microcurie per gram dose given in six injections spread over eight days than as a single injection.

B. Tritiated water genotoxicity

Dobson (4) recently measured the biological effects from protracted exposure to low tritium concentrations in water. His biological endpoint was irreversible loss of female germ cells in both mice and monkeys. His conclusion: "Effects from tritium were observed at surprisingly low concentrations where tritium was found more damaging than previously thought." Since Dobson conducted similar experiments with cobalt-60, a gamma-emitter, he could compare the biological effects of the beta particles emitted from tritium and the gamma rays from cobalt-60. At low exposures, comparable to tritium concentrations in the auxiliary and fuel building contaminated water after EPICOR-II processing, the relative biological effectiveness was found to approach three, or three times the potency of the cobalt-60 gamma rays. Dobson also warned of possible special hazards to the fetus of both tritiated water and cobalt-60.

Tritiated water (THO) equilibrates with normal water (H_2O) remarkably quickly upon ingestion, beginning within 2 minutes and complete by 45 minutes (5). The biological half-life of THO in the human body is 11.5 days (5), which, considering the 12.26 year physical half-life, is enough time for disintegration of 0.2 percent of the ingested tritium atoms in the human body. Beta particles released from the tritium atom carry an average energy of 6,000 electron volts (18 kev maximum) and travel an average of 1.5 microns in tissue (8 μ maximum).

Although tritium-released beta particles have weak penetrating power and may be stopped by a piece of wood, thick clothing or layer of skin outside the body, this short track length becomes a deficit for tritium inside the body. The THO tritium atom freely exchanges with hydrogen atoms in the hydrogen bond of the DNA double helix, for example. Disintegrations here or anywhere within the nucleus of a human cell releases a beta particle which expends 90 percent of its energy within the nucleus, creating in the process about 200 ion pairs. The energy of a beta particle released from tritium decay within the nucleus of a human cell is so great that chromosomal breaks are initiated at a frequency of about one per beta decay (6). Only 1000 atoms of tritium in a cellular nucleus are sufficient to provide it with a radiation adsorbed dose of one millirad per hour (6). It is estimated that for every visible chromosomal break engendered by tritium decay, there are approximately 20 unrepaired genetic alterations in DNA.

C. Tritiated thymidine genotoxicity

Specific adverse biological effects of many radionuclides are enhanced several orders of magnitude if inorganic precursors are biologically converted to their organic form. For example, vitamin B12 containing the cobalt-60 nucleus is 5,700 times as detrimental radiologically as is an equivalent number of inorganic cobalt-60 atoms when ingested by the human organism (7). Similarly, atom for atom, tritiated thymidine is 1000 times more lethal than tritiated water as tested in human cell cultures (8). Tritiated thymidine may be created by all cells, whether microbial or mammalian, when exposed to tritiated water.

Tritiated thymidine is highly carcinogenic in mice. A single dose of 1 microcurie per gram induces tumors in half of the treated mice (lymphomas and carcinomas of salivary gland,

skin, lung and liver; ref. 9). Tritiated thymidine similarly causes increased cancer frequencies in mice whose mothers were treated with the radioactive compound while they were in utero, a specific type of teratogenic effect (3). In addition, tritiated thymidine causes birth defects in offspring of treated males (10). In these experiments it was estimated that the number of DNA mutations was over four times the number of tritium disintegrations, a fact again attributed to the high release of tritium's beta energy within the nucleus (10).

In summary, tritiated thymidine is 1000 times as genotoxic as tritiated water and has been shown to induce carcinogenesis, teratogenesis and mutagenesis in treated mice.

D. Summary of genotoxic effects

If the NRC is to maximally protect the health of persons residing in and around the area of TMI, then for each radionuclide which has been released or will be released as a result of the cleanup operation, the NRC must err on the side of caution. The draft PEIS does not do this, erring on the contrary far in favor of the licensee. Specifically with regard to tritium, since tritiated water itself, and even more so tritiated thymidine have been found to be carcinogenic, teratogenic and mutagenic, it would make sense to keep this radionuclide, to the extent possible, out of the environment in which it will come into human contact. This means abstinence from dumping tritiated water into the Susquehanna River and abstinence from dumping tritium itself into the air. Alternatively, retention of tritiated water in tanks for 60 years at TMI-2 would reduce its radioactivity by about 95 percent, sparing the population living around the island this much genotoxic insult, especially those who drink Susquehanna River water.

V. Actinide Releases

A. Lack of consideration in PEIS

Although by far they constitute the major health threat both in terms of radwaste disposal and potential contamination of the public during the cleanup operation, actinide or transuranic elements are scarcely mentioned in the PEIS. In only one place, Table 10.4-3. *TMI-2 Core Inventory*, is an actinic element mentioned, and there only one, plutonium-241, of which 150,000 curies were shown to be present as of June 30, 1980.

B. Estimated actinide inventory

The TMI-2 core when new consisted of 100 tons of uranium oxide, which was 97.04 percent uranium-238 and 2.96 percent uranium-235. Although the TMI-2 reactor was only functional for three months before the accident on March 28, 1979, sufficient neutron bombardment of uranium-238 atoms occurred to produce considerable plutonium-239. This radioisotope of plutonium is not only dangerous to health if breathed or consumed, but also in that only eight pounds are sufficient to create the nucleus of a nuclear bomb, which is the major reason that spent uranium fuels are no longer reprocessed in this country.

In addition to uranium-238, uranium-235 and plutonium-239, there should be trace amounts of thorium-230, radium-226, radon-222 and polonium-210 in the crumbled core and primary coolant water.

C. Actinide genotoxicity

No substances are known which are more carcinogenic than the actinides. A mere microgram of plutonium-239 in the lungs of a human is a 100 percent carcinogenic dose (11). What is worse, detection of these alpha-particle emitting compounds is impossible by whole body scanning, the alpha particles being unable to pass more than a fraction of a micron through human tissues.

The reason for acute genotoxicity of actinides can be understood in the light of modern carcinogenic theory. Initiation of carcinogenesis requires that two independent genetic

events occur within the same cell (12). In rare cases one of these genetic events is inherited from a parent (13), but in general both genetic changes are engendered by contact with an environmental carcinogen. Since the human is composed of 20 trillion cells, it is rare that one cell suffers two independent genetic changes in the same genes of homologous chromosomes, for most carcinogens act during a discreet period of time and then are eliminated from the body. Actinide particles, however, remain entrapped within the same group of cells for a lifetime, emitting alpha particles all the while. The probability of a given cell being hit in homologous cancer genes now increases dramatically, up to a probability of 1.00 (unity) in the case of 1 microgram of plutonium-239 (11).

Actinides spontaneously disintegrate by alpha decay. These alpha particles create tens of thousands of ion pairs for every micron they traverse in human tissue. The relative biological effectiveness of the alpha particle from americium-241 (5.5 Mev) was recently found to be 278 for 100 millirad or less (14). This is roughly 278 times as genotoxic as an equivalent number of gamma rays.

In addition to several convincing studies of actinide-induced experimental carcinogenesis in test animals, there have been numerous epidemiologic studies in humans which demonstrate higher cancer incidence as a function of low level actinide exposure. Among the first epidemiologic studies were those of uranium miners in Bohemia before the first of the century (15). Nuclear workers at the Hanford Reservation (16), Portsmouth Naval Shipyard (17) and Lawrence Livermore Laboratory (18) have all been shown to have a higher cancer incidence than closely matched control populations. Utah school children who lived downwind from the Yucca Flats nuclear test site developed two to three times the expected leukemia rate in the following decade (19). Three times as many of the cast and crew of The Conqueror developed cancer as anticipated after spending only a few months in the same area one year after 11 nuclear tests (20). Similar increases in cancer and birth defects have been seen among soldiers who witnessed nuclear weapons testing and their families (21). The actinides and other radionuclides released accidentally at munitions manufacturing sites or purposefully at nuclear weapons test sites are of approximately the same spectrum as now contained in the core of the TMI-2 reactor.

D. Summary of genotoxic effects

In addition to the dangers of tritium, whose deliberate release into the air and Susquehanna River is proposed, we have focussed on the actinides as the most dangerous genotoxic radionuclides to be encountered and potentially dispersed into the environment during the TMI-2 cleanup operation. Unlike most of the radionuclides contaminating the TMI-2 site, most of the actinides have half-lives in the millions of years, meaning that they may contaminate the environment for thousands of generations if released or improperly stored. This fact coupled with their high carcinogenic potential makes it imperative that a sanctioned high level radioactive disposal site is available before any part of the containment building cleanup; sump water, primary coolant water and especially the core itself; begins.

The draft PEIS is not reassuring when it comes to describing alternative methodologies for decontamination of that most critical source of actinides, the reactor core. Section 8.2 treats this operation almost as if it were the normal defueling process, moving fuel rod assemblies out through the fuel canal followed by "scavenging and vacuuming." This benign approach ignores the present condition of the core in which 90 percent of the fuel rods are broken and in which more than 50 percent of the fuel pellets may have melted and formed an uranium oxide lattice intermixed with fragmented cladding extending all the way to the bottom of the containment vessel. Described alternative methodologies are inadequate for sectioning and removal of this massive bulk, perhaps being a continuous solid weighing upward of 50 tons. Perhaps none of the fuel rod assemblies can be withdrawn without sectioning this lattice. Will torches be

employed to cut through the tangled network of uranium oxide, zirconium cladding and steel? Will hacksaws be employed? How many of the potentially required procedures can be mitigated by remote control? If not, what will be the exposure to workers? How much danger is there of drops, spills and inadvertant crumbling contaminating the environment as large, irregular chunks of the core are lifted out of the containment vessel? This section of the PEIS must be written as to address all potential scenarios encountered in the decontamination of the core, and may require a separate PEIS in itself. This decontamination procedure may unavoidably cause exposures in excess of those standards which the draft PEIS assumes otherwise will be met.

VI. Other Radionuclide Releases

This comment has emphasized health problems arising from potential contamination of the human environment with tritium and actinides originating from the TMI-2 cleanup operation. Of the approximately 170 other radionuclides created during the three months of TMI-2 operation, many, due to their prevalence, genotoxicity or both are also dangerous to human health. Almost 1 million curies of radioactive strontium and half a million curies of radioactive cesium remain in the core. There is sufficient iodine-129 remaining to still cause neonatal hypothyroidism if released into the environment. Even the remaining carbon-14 is more dangerous than realized considering its long half-life and that the EPA estimated that releases from reprocessing plants in the year 2000 could be responsible for 12,000 cases of cancer and birth defects (22).

Each of the 187 radionuclides created in a nuclear power reactor has its own series of transfer factors from air or water releases to man. Each of these radionuclides, if transferred to man, has its own inherent genotoxic potential as measured by its relative biological effectiveness.

VII. Summary of Adverse Human Health Effects

A. Radioecological transfer factors

In deciding what the ultimate biological damage to persons residing near TMI from the Unit 2 cleanup might be, the first in a series of calculations depends upon the radioecological transfer factors involved. In its draft PEIS, the NRC has utilized the same transfer factors for transfer of radionuclides from air and water to soil, soil to plants, plants to animals and plants and animals to man as they and the AEC before them used for the past two decades, this despite sound criticism of these transfer factor values by the Institute for Energy and the Environment in Heidelberg, West Germany. If the NRC as a regulatory body is to act on behalf of public health, then it must take the criticisms of this Heidelberg group seriously, and adjust its calculations accordingly in order to incorporate the wide range of transfer factors for each radionuclide dependent upon the type of soil, plant and animals involved, humidity, type of fertilization employed, biological activity of the soil, chemical form of the radionuclide and biological form of the radionuclide.

In its recent article entitled "Radiation Exposure to the Public from Radioactive Emissions of Nuclear Power Stations,"* the Heidelberg group has shown that transfer factor calculations of the NRC/AEC may be off by orders of magnitude. Citing the variation in biological dosage obtained from vitamin B-12 (co-60) as compared to inorganic cobalt-60, the Heidelberg group finds a 5,700-fold difference. Similarly they point out that transfer factors for water-borne plutonium-239 are based on the IV oxidation state of the radionuclide, whereas the predominant form in chlorinated drinking water, especially after heating is the VI oxidation state. The difference in intestinal absorption is 1000-fold, in favor of plutonium-239 (VI). In this comment we have pointed out that tritium as tritiated thymidine has 1000 times the biological effectiveness of tritium as tritiated water.

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*In that this paper (ref. 7) is unpublished and vital for the comments presented here, it is appended in its entirety.

Regarding the potential exposure to persons living within three miles of a normally operating nuclear power plant, or deriving all of his or her vegetation from within three miles of a normally operating nuclear power plant, the Heidelberg group concluded that a conservative estimate of exposure might be 720 millirem per annum as contrasted to the absolute minimal fraction of a millirem as calculated by the NRC. When there exists a wide range of transfer factors possible considering all the variables mentioned above, it is prudent to err on the side of caution with respect for human health. These same uncertainties in transfer factor variables exist for the transfer of radionuclides emitted from TMI-2 during the cleanup operation into the human environment, and a more conservative estimate on the side of human health should be central to the final Environmental Impact Statement.

Without considering contamination of the human environment by actinides, the draft PEIS concludes that a maximum of 2.5 millirem exposure will be suffered by any member of the public offsite. This maximal figure is already at odds with estimates of the PEIS of exposure from standing three feet away from a truck loaded with TMI-2 radwastes for six minutes, which would expose an individual to 2.6 millirem (or 26 millirem if exposure were for an hour). Worse, the 2.5 millirem exposure <u>maximum</u> is based on the same <u>minimal</u> transfer factor estimates criticized by the Heidelberg group as being at least three orders of magnitude lower than possible maximal transfer factors, that is, it is no maximum exposure limit at all. Considering all the variable soil, plant, chemical and biological conditions possible, a more likely maximum exposure level to a member of the public offsite is 2,500 millirem (2.5 rem).

Added to this 2.5 rem maximal exposure to the public estimate must be the risk of exposure to actinides released during the cleanup of containment building sump and primary coolant waters and the TMI-2 reactor core itself. Since the draft PEIS does not provide data on any of these actinides, other than plutonium-241, it is impossible to accurately estimate maximal exposure levels to the public from accidental actinide releases into air or water. The badly disintegrated state of the core makes actinide contamination of sump and primary coolant waters veritable certainties. Similarly, the fused lattice state of the core makes it physical removal difficult, which may raise the risk of accidental contamination of the human environment by actinide particles released from the core itself.

We shall consider the adverse human health effects from actinides and other radionuclides separately in the three sections below in which we describe potential genotoxic effects resulting from the TMI-2 cleanup.

B. Carcinogenicity

There is considerable disagreement in the scientific community as to what carcinogenic factor should be assigned radiation levels under 50 rads. Extrapolation from high level exposure values is difficult in that cell killing is imposed upon cell carcinogenicity, leading to an underestimate of carcinogenic dangers in low level exposure. Similarly it has been found that fragmented low level doses are more carcinogenic than one cumulative low level dose. Despite these differences within the scientific community, the NRC has chosen to use one interpretation, that of the 1972 BEIR report, to assign carcinogenic potential to millirems of exposure. More conservative estimates, by an order of magnitude, exist and would again allow the NRC to err on the side of caution concerning potential adverse health effects resulting from the TMI-2 cleanup (23, 24). These more conservative estimates of carcinogenic potential translate 1000 person-rems as one cancer.

As calculated above, the maximal offsite exposure from non-actinides may be 2,500 millirem (2.5 rem). Using the conservative carcinogenic factor above, the probability of this individual developing cancer over his or her lifetime 0.35 percent, that is, for every 300 persons so exposed, there would be one cancer. On the other hand, if 30,000 persons living around TMI were exposed to one-tenth the potential maximal non-actinide radionuclide release, there would be ten cancers.

The carcinogenic potential of accidental actinide release during the TMI-2 cleanup procedures is difficult to assess due to the number of unknowns. There are two knowns, however, that the core originally contained 100 tons of uranium-238 oxide pellets and as of June 30, 1980, was estimated to contain 150,000 curies of plutonium-241. Much of the uranium-238 and other actinides must now reside in the sump and primary coolant waters. Taking the weight of plutonium-239 which is 100 percent carcinogenic, 1 microgram, as a measuring stick, it is calculated that contamination of the environment by dust containing only 0.000000001 percent of the core could still initiate 500 cancers.

C. Mutagenicity

Utilizing conservative estimates of radionuclide-induced mutagenicity for non-actinide releases, 500 person-rems as one birth defect in five generations, it is calculated that the probability of the maximally exposed individual to bear progeny with birth defects is 0.7 percent. Hence, for every 150 persons so exposed, there would be one birth defect, or, if 30,000 persons living around TMI were exposed to one-tenth the potential maximal non-actinide radionuclide release, there would be 20 birth defects.

The mutagenic potential of actinides has not been as well studied as their carcinogenic potential, however, if delivered to germinal tissues, it is clear that actinides will have considerable mutagenic effect (25, 26).

D. Teratogenicity

The developing fetus is exquisitely more sensitive to radionuclide-induced detrimental effects than the adult. Potentially this was seen during the nine month period following the TMI accident when neonatal hypothyroid incidence in Lancaster County jumped to ten-fold the anticipated frequency and infant mortalities doubled within 10 miles of the TMI-2 reactor.

Some radionuclides, such as iodine-129, are more teratogenic than others. However, any radionuclide which is ingested or inhaled by the pregnant mother has the potential for crossing the placenta and entering the fetus, where it can exert teratogenic effects.

In general the developing fetus is 10 to 100 times more sensitive to the genotoxicity of ionizing radiation than the adult. Translating this as one teratogenic event per 100 fetus-rems, we would assign a probability of 3.5 percent teratogenicity if a pregnant mother happened to be the individual exposed to the maximal 2.5 rem exposure from the TMI-2 cleanup. If 3,000 such pregnant mothers were exposed to one-tenth the potential maximal non-actinide radionuclide release, there would be ten infant mortalities or birth defects.

The teratogenic potential of actinides has not been as well studied as their carcinogenic potential, however, if delivered to a pregnant mother and traversing the placental connection, it is clear that actinides have considerable teratogenic effect (25, 26).

It must be re-emphasized that the major failing of the draft PEIS with regard to all radionuclides potentially emitted into the human environment during the TMI-2 cleanup operations is not to provide the public with sufficient data regarding the range of possible health effects, especially genotoxic effects.

VIII. Miscellaneous Comments

A. Draft PEIS Authors

40 CRF 1502.17 requires that

> (T)he environmental impact statement shall list the names, together with their qualifications (expertise, experience, professional disciplines), of the persons who were primarily responsible for preparing the environmental impact statement or significant background papers, including basic components of the statement (1502.6 and 1502.3).

> Where possible the persons who are responsible for a particular analysis, including analyses in background papers, shall be identified. Normally the list will not exceed two pages.

The NRC in its draft PEIS has made no attempt to comply with this provision of the CEQ regulations. The final document should be in compliance.

B. Proprietary information

We request that there be no further use of proprietary methods in the cleanup procedures, as suggested in Appendix P, page 2. It is difficult to perceive of the need for proprietary information when a method which potential impacts on the human environment is involved. The fact that EPICOR-II is proprietary has hampered the progress of critical studies to determine the integrity of the resin containers. Unless the NRC is willing to take a stronger position on its right to obtain information quickly on such proprietary processes, the use of such processes during the cleanup could jeopardize the health and safety of the public.

C. Missing pages

Pages I-25, bottom, to I-26, top. A portion of the paragraph was left out. This portion of the draft PEIS makes no sense as it now stands.

D. Sump water tritium

Table 10.1-2, page 10-3. The figures for tritium concentration in the sump water of the containment building are low by more than three orders of magnitude.

E. Storage and transportation of tritium

We request a citation to the DOT regulations that would be violated my shipment of the tritiated water to some other site for disposal (such as the ocean). (See draft PEIS, page 5-13). We request an explanation of the fact that the NRC is willing to permit indefinite storage of radioactive resins on the island, but not solidified tritiated water. (See draft PEIS, page 5-13.) We request an explanation for the position that dumping tritiated water in the river is completely safe, but transporting it is not. (See draft PEIS, page 5-13.) Dilution of the tritium will not suffice as an explanation - total harm to the environment and to the human population will not decrease with dilution. The harm is simply spread so that it cannot be as easily detected.

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X. Appendix

RADIATION EXPOSURE TO THE PUBLIC FROM RADIOACTIVE EMISSIONS OF NUCLEAR POWER STATIONS

Critical Analysis of the Official Regulatory Guides

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Abstract

Current regulations for radiation protection involve determining dose limits for the exposure of the individual to radioactive emissions of nuclear power stations. Supposing that a known quantity of radioactivity is emitted, exact knowledge of the parameters for the abiotic dispersion and the transfer into foodchains including the behaviour of radioactivity in the human body is very important.

Comparison of the official regulatory guides of the USA and the Federal Republic of Germany (F.R.G.) for calculating annual human doses with the results reported in the international literature shows that the recommended factors for essential radionuc-

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lides (Cobalt 60, Strontium 90, Iodine 131, Caesium 137, Plutonium 239 etc.) for the transfer from soil into plants, from fodder into animal products, and from the gastro-intestinal tract into the blood are determined in some cases in a scientifically questionable way and that the factors are often located at the lower end of the range of realistic values. Thus, the potential radiation dose is substantially underestimated. A further reason for current underestimates is that the chemical form of the radionuclides in the foodchains is often neglected (e.g., Cobalt 60 bound in vitamin B 12). For conservative estimates of radiation doses, as required under the radiation protection regulations of the F.R.G. mainly for radiation exposures due to longterm accumulation of radionuclides in the environment, potential exposures must be taken into account which could be more than two orders of magnitude higher than previous estimates. There is therefore no guarantee that even if the emission unit of 1 Ci aerosols/year is coupled with the dose would be within limits. A further problem is the population dose, which should also be taken into consideration because of its importance for the cumulative global health risk from emissions of radioactivity.

1.) Introduction

The radiation protection standards of many countries limit the exposure of the individual to radioactivity emitted from Nuclear Power Stations. These values, which are mainly derived from recommendations of the ICRP, for example, limit the exposure for the "worst case" in the F.R.G. to 30 mrem/year for the whole body, while for different organs special values exist (SSVO, 1976).

Usually, compliance of the dose limits with the discharge limits of nuclear facilities is proved by radioecological reviews, which try to describe the complex behaviour of radionuclides in the abiotic and biotic environment mathematically. A prediction is attempted of the maximum possible radiation dose within a period of several decades. The often stated value of 1 mrem/year radiation dose to the public from radioactive emissions from nuclear power stations is the result of calculations and not of measurements. Even in routine releases nuclear power reactors emit hundreds of radionuclides of which Table 1 gives a selection. There we find noble gases, products of fission, activated corrosion products, and others. Radionuclides which are discharged into the environment, undergo a great number of transport processes, where they are more or less diluted or enriched and can lead by many different ways to radiation exposure of the indivudual (figure 1). One of the most important exposure pathways is by ingestion of contaminated foodstuffs through aerosols, which accumulate in the soil. Points we have to consider include the atmospheric dispersion, the behaviour of radionuclides and the systems soil to plant, plant to animal, and foodstuff to man. Attempts have been made to calculate potential doses, using mathematical models and standard table values for transfer factors (Ng, 1968, Fletcher, 1971, USNRC 1976, SSK 1977). The main problem lies not so much in the calculation model but rather in the enormous variability of the different factors which is found in nature. This paper attempts to illustrate the problems by examples involving the main radioecological parameters.

TABLE 1 Selection of radionuclides emitted by nuclear facilities into the air ($t_{1/2} \geq 8$ d)

nuclide	$t_{1/2}$
P 32	14.3 d
P 33	25.3 d
Cr 51	27.7 d
Mn 54	312.2 d
Fe 55	2.7 a
Fe 59	44.6 d
Co 58	70.8 d
Co 60	5.3 a
Ni 63	100 a
Nb 92	10^8 a
Sn 117m	14 d
W 185	75.1 d
U 237	6.8 a
ACTIVATED CORROSION PRODUCTS	
Kr 85	10.8 a
Xe 129m	8.9 d
Xe 131m	12 d
Xe 133	5.3 a
NOBLE GASES	
I 129	$1.57 \cdot 10^7$ a
I 131	8 d
IODINE-ISOTOPES	

nuclide	$t_{1/2}$
Sr 89	50.5 d
Sr 90	28.5 a
Y 91	58.5 d
Zr 95	64.0 d
Nb 95	35.2 d
Ru 103	39.4 d
Ru 106	368 d
Te 127m	109 d
Te 129m	33.6 d
Cs 134	2.1 a
Cs 136	13 d
Cs 137	30.1 a
Ba 140	12.8 d
Ce 141	32.5 d
Ce 144	284.8 d
Nd 147	11 d
OTHER FISSION PRODUCTS	
Pu 239	24 000 a
Pu 240	6 600 a
Am 241	458 a
Cm 242	164 d
Cm 244	17.8 a
α - AEROSOLS	

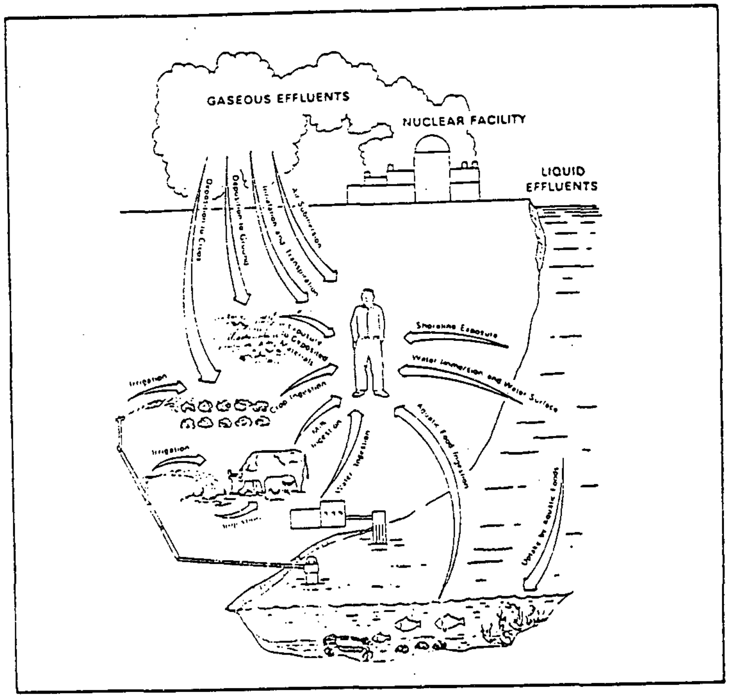

FIGURE 1 : Exposure pathways by effluents of radioactivity of nuclear facilities (from: Soldat, 1976)

2.) Transfer of Radionuclides from Soil into Plant

The transfer factor soil to plant (pCi/kg plant fresh weight: pCi/kg soil, dry) describing how much radioactivity taken up by plants depends on an enormous number of parameters, for example:

- elements
- plant species
- part of the plant
- chemical form of radionuclide
- type of soil
- fertilization
- humidity of soil
- temperature
- concentration of stable isotopes and similar elements in soil
- perhaps concentration of radionuclides in soil
- biological activity of the soil

The reason, why for example the transfer factor for caesium varies by four orders of magnitude can be found in these influences (figure 2). The Caesium isotopes Cs 134 and Cs 137 contribute to the radiation dose from ingestion of contaminated foodstuff in the vacinity of nuclear facilities. In figure 2 values for the transfer factor for Caesium (pCi/kg plant, dry: pCi/kg soil, dry) are correlated with the clay content of soil (in percent). The water content of plant is assumed to be 80 %. In all, 142 values of different experiments and measurements for grass-plants by different authors have been taken into account. For comparison, the officially recommended transfer factors

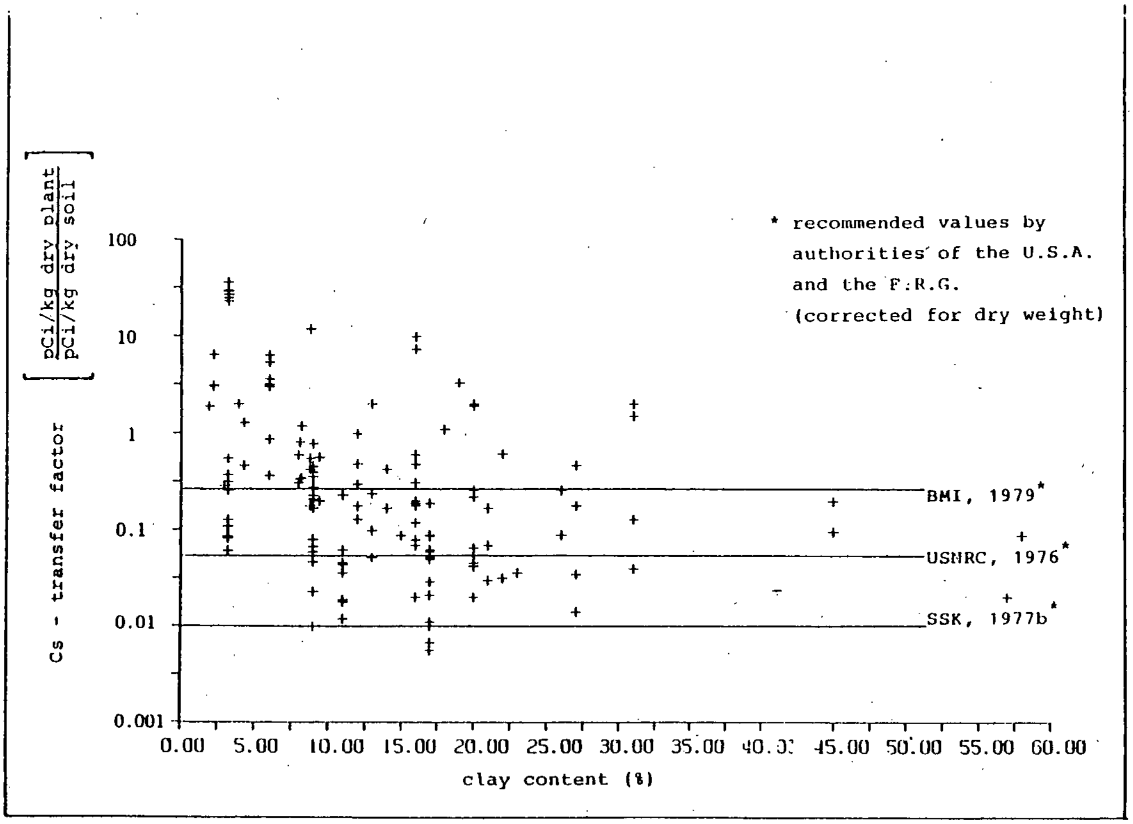

FIGURE 2 : Transfer factor plant/soil (pCi/kg dry plant : pCi/kg dry soil) for cesium against clay content in soil (%) (from: Franke,Ratka,van de Sand, 1978)

TABLE 2 : Variation of transfer factors plant/soil for cesium and strontium (pCi/fresh plant : pCi/kg dry soil) (from Franke, Ratka, van de Sand, 1978)

plant species	transfer factor Cs	transfer factor Sr
leafy vegetables	0.0075 - 0.9	0.08 - 7.8
grass	0.00068 - 14	0.01 - 9.8
potatoes	0.023 - 0.16	0.015 - 0.38
clover	0.004 - 33	0.22 - 7.4
root vegetables	0.0025 - 0.15	0.055 - 21
"vegetation"* or "vegetables"**	0.01	0.2

* as recommended in USNRC, 1977

** as recommended in SSK, 1977

for Caesium from American and German (F.R.G.) are indicated (plotted). Although the factor can vary by more than 4 orders of magnitude in most previous radioecological reviews, in the recommendations only 1 transfer factor for all plant species and soil types has been recommended. It is clear, that with such an instrument an accurate radioecological assessment is not possible. Analysis of the recommended transfer factors soil to plant showed that for most radionuclides the recommended values lie in the lower part of the range of realistic values. In table 2 the variation in transfer factors for Caesium and Strontium, derived from a great number of references, for different plant species is compared with the values recommended in the official handbooks. As may be seen, the recommended values may in special cases underestimate the transfer of radionuclides 10fold, 100fold, or even 1000fold.

How have the values in the official handbooks been derived? An analysis of the history of these values by Teufel et al., 1979, for Caesium is shown in figure 3. The references indicated for the recommended values and the references cited in those references had been analysed. The astonishing result was that the values recommended by the German Radiation Protection Commission are derived from a very poor study of references and that the cited values did not agree with the recommended values. The value of 0.002 (pCi/kg plant fresh: pCi/kg soil, dry) has been derived from a publication of Baker, 1976. Baker derived his values from a handbook by Fletcher, 1971, in which, for example, for leaf vegetables/soil the transfer factor of 0.019, 10fold the value in SSK 1977 is given. Fletcher cites five references and the values in those references are

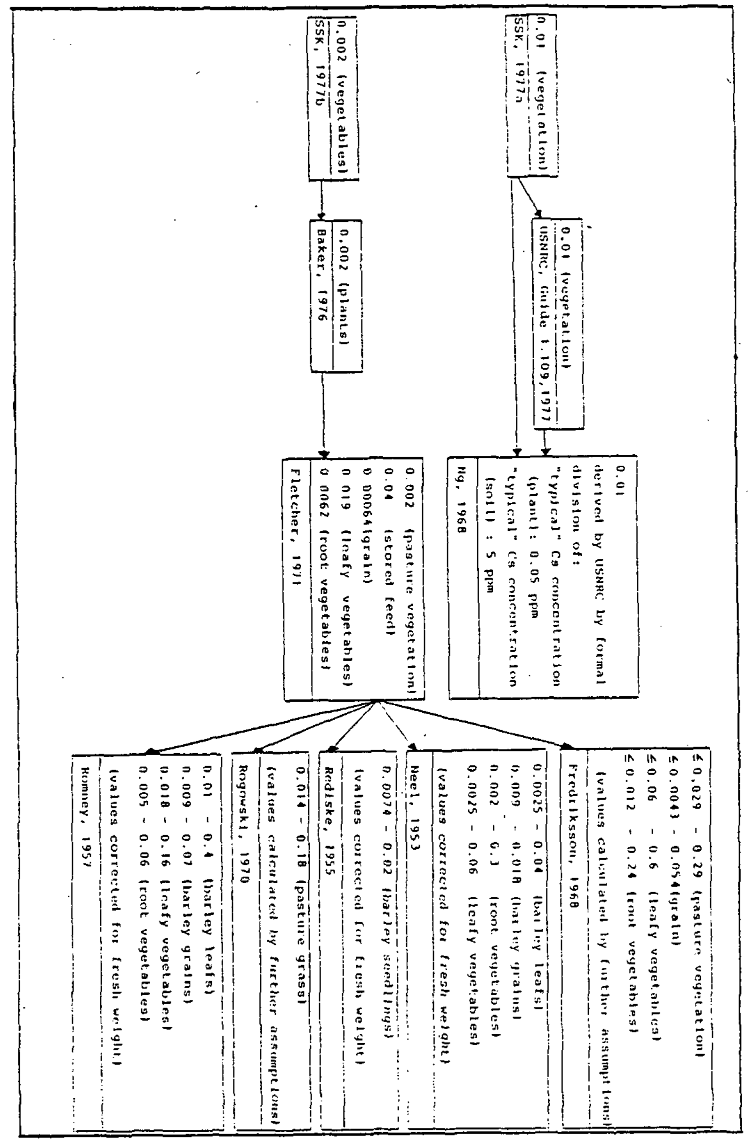

FIGURE 3 : References for Cs transfer factor plant/soil (dimension: pCi/kg plant, fresh weight / pCi/kg soil, dry weight)

1 to 2 orders of magnitude higher than the recommended values by SSK, 1977. The value recommended by the USNRC, 1976 has been derived by a formal division of stable element concentrations in plants (reference: english handbook) and soil (reference: russian handbook) in Ng, 1968. This method is more than questionable on scientific grounds.

Nevertheless, previous radioecological reviewers, administrations and members of radiation protection commissions, use these false values, to state that the values used would be conservative, meaning that real values would only be <u>less</u> than the ones used.

It should be clear, that in future instead of fixing on theoretical regulatory values, the transfer factor for soil for radionuclides in the surrounding of planned nuclear facilities should be measured to give a proper base for radiological assessments.

3.) Transfer of radionuclides from fodder into animal foodstuffs (meat)

Another problem is the transfer of radionuclides in meat. The transfer is indicated by a factor which gives the daily amount of the radioactivity ingested by the animal that is found in 1 kg of meat (dimension: pCi/kg meat : pCi/day intake). An analysis of the recommended values led to the result, that for important radionuclides these values are not suitable for a realistic or conservative assessment. Our research showed, that these recommended values also had been derived by a questionable method dividing non-corresponding con-

centrations of stable elements in meat and fodder (Franke, Höpfner, 1978b). Other American handbooks, for example the collection of data of Baker, 1976, and Fletcher, 1971, indicate transfer factors based on experimental results. Table 3 compares the values recommended by the USNRC, the West-German authcrities, with values in literature. A realistic value for the transfer of Caesium into beef must be taken as 0.075 ± 0.02 and a conservative value of 0.1. On the contrary, the recommended value for all sorts of meat is given as 0.004, lying below all experimental observations. Using such an inaccurate transfer factor, results in a linear underestimation of potential radiation dose. The ratic of conservative to offical values for beef is e.g. for Cs 25 : 1. for Sr 5 : 1, for I 7 : 1, for Pu 350 : 1. If, for example, a radiation dose by beef consumption of Cs 137 contaminated beef is calculated to be 1 mrem/year, a radiation dose of, for example, 25 mrem/year will result.

4.) Behaviour of radionuclides in human body

The 3rd important radioecological area is the system foodstuff to man. The behaviour of radionuclides in human body depends among other influences on

- the chemical form of radionuclides
- the amount of stable isotopes in the foodstuff
- the age of the individual
- state of health
- genetical constitution
- composition and amount of foodstuff

TABLE 3: Transfer factors meat/fodder (pCi/kg meat : pCi/d intake) for selected radionuclides (from Franke and Höpfner, 1978)

nuclide	animal species	BMI, 1979 USNRC, 1976	Fletcher, 1971	Baker, 1976	Franke and Höpfner, 1978 realistic	Franke and Höpfner, 1978 conservative
Cs	beef	0.004	0.03	0.03	0.075±0.02	0.1
	calf				0.42 ± ?	1.5
	pork		0.04	0.26	0.26 ± ?	0.26
Sr	beef	0.0006	0.002	0.0003*	0.002±0.001	0.003
	pork		0.008	0.0073	0.008	0.01
I	beef	0.0029	0.02	0.02	0.015±0.005	0.02
	pork		0.09	0.09	?	0.09
Pu	beef	0.000014	-	0.005	?	0.005
	pork		-	0.01	?	0.01

* apparently a printing error in Baker, 1976; correctly: 0.003

Because of the various influences the same amount of radioactivity can lead to very different radiation exposures for individual humans. Instead of reflecting this variation the recommended dose conversion factors vary only between adults and children. None of the other influences stated above are considered. Instead, it is often asserted that the recommended dose conversion factors, actually calculated for a "reference man" would be "conservative", implying that all potential radiation doses are considered. This is not right. As example the behaviour of zinc, plutonium, and cobalt show. Radioactive zinc can be emitted by nuclear power reactors as an activated corrosion product and thus contaminated foodstuffs. As these foodstuffs are consumed, it is very important to ask how much of the radioactive zinc in foodstuff will be resorbed in gastro-intestinal tract of humans. In previous recommendations of the US and F.R.G., using values from ICRP II, 1959, it is assumed that 10 % of the ingested radioactive zinc will be resorbed in the GI-tract. A literature review (Steinhilber-Schwab, Teufel, 1978) shows that the mean resorption rate for zinc actually lies at about 50 % with extreme values higher than 90 % (figure 4).

The differences are even more obvious in the case of the radiotoxic element plutonium. In previous recommendations the assumed resorption rate for plutonium from the GI-tract into blood is 0.0001 to 0.003 %. That means, that only from 1 of million parts up to 3 of 100 000 parts of the ingested plutonium by foodstuff will be resorbed. Our literature analyses showed, that the resorption rate of plutonium depends very much on its chemical form in the environment. The officially recommended resorption rates are only valid for poorly

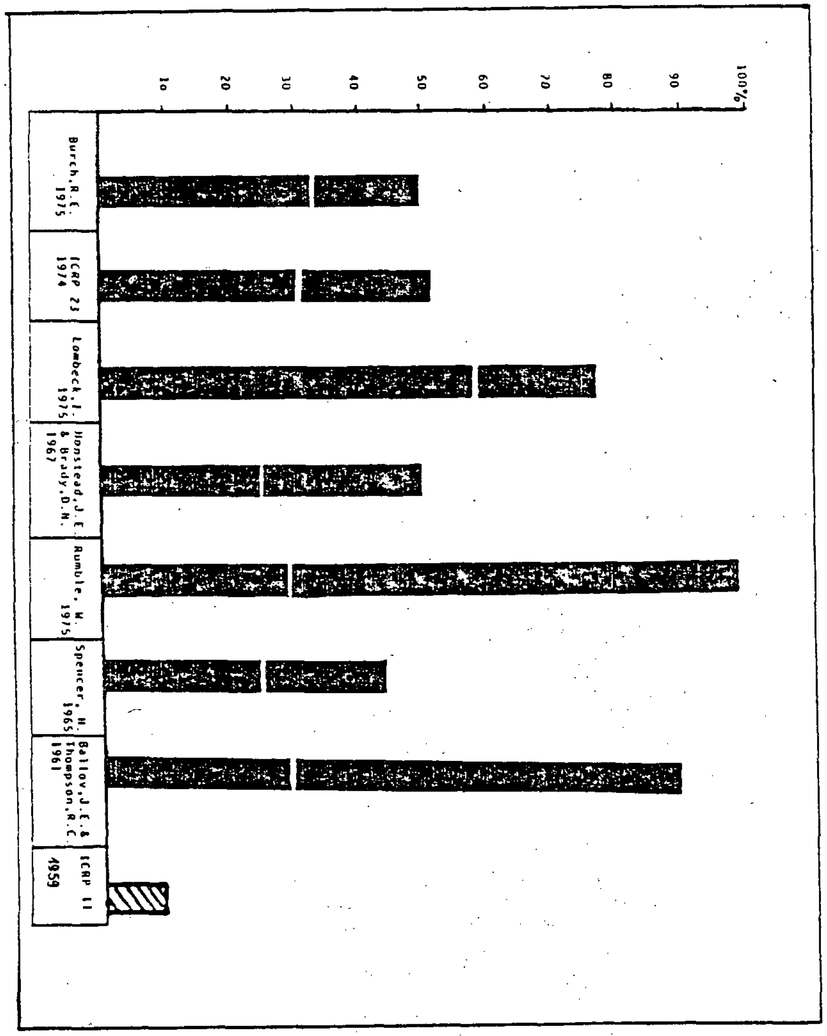

FIGURE 5: resorption of zinc in human GI-tract (% of ingested)
(from: Steinhilber-Schwab, Teufel, 1978)

soluble plutonium, however, for example, as Pu-nitrate or Pu-citrate or as Pu VI, plutonium is resorbed at a rate, 3 to 4 orders of magnitude higher than PuO_2 (figure 5). The potential hazard lies in the biological mechanisms that will complex PuO_2 which is emitted by nuclear facilities in the environment. Similar behaviour is known for other heavy metals, e.g., lead. Another problem is the changing oxidation state of plutonium under varying chemical conditions. Larson and Oldham (1978) found that plutonium which in oxidation state IV can be changed into Pu VI by chlorinated drinking water. Pu VI is resorbed in human GI-tract 1000fold better than Pu IV. Highest amounts of Pu VI were formed when drinking water had been heaten up, for instance, in preparation of food, tea or coffee. The resorption rate for plutonium is related linearly to the radiation dose to man. Therefore, it can happen, that the radiation dose from plutonium in drinking water or from plutonium taken up by plants can be up to 1000fold higher than calculated by official recommendations.

A third example is radioactive cobalt which is emitted by nuclear power stations as an activated corrosion product, similar to zinc. Cobalt is found naturally in soil and in plants in inorganic form. When taken up in this form by man, resorption and transfer rates in different organs as well as the biological halflife in the organism is relatively small (ICRP 1959). Cobalt is, however, an essential constituent of a biologically very important compound: vitamin B 12. In this case the physiological behaviour of cobalt is completely different from the inorganic forms: as vitamin B 12 is essential for the human organism and cannot be synthesized by the human body,

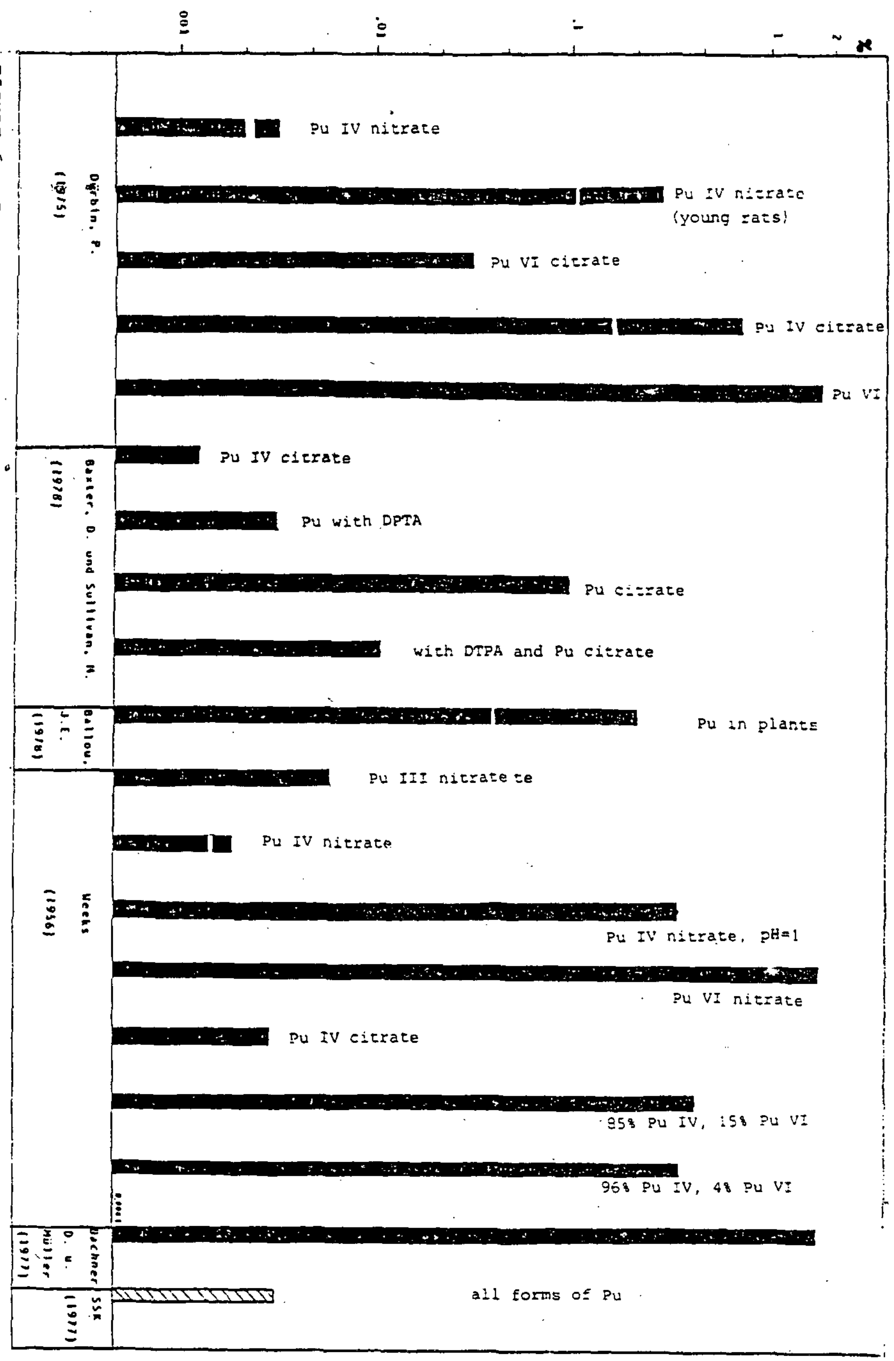

FIGURE 6 : Resorption of plutonium in GI-tract (% of ingested) (from: Steinhilber-Schwab, Teufel, 1978)

it is resorbed from food to a very high degree. Vitamin B 12 has a very long biological halflife (up to 750 days) in liver, which compares to the biological halflife of inorganic cobalt, assumed by ICRP II to be 9.5 days. The effective radiation dose from radioactive cobalt in the form of vitamin B 12 is up to 5 700 times higher than the radiation dose from inorganic cobalt. Although in many foodchains a proportion of the cobalt is built into vitamin B 12 (e.g. in beef 5 % and in milk 23 %), this problem has not been considered in previous radioecological assessments (Bruland et al., 1979).

The degree of underestimation of the radiation dose from Co 58 and Co 60 for the exposure pathways involving beef and milk consumption can be seen from table 4, in which the variation of potential values is given. In previous estimates the radiation dose from cobalt 60 contaminated milk is underestimated by a factor of 280 to 2300.

Because of the great uncertainties involved in making calculation models for radiation doses, it seems to be important to verify the model calculation by direct measurements. Hoffman et al. (1978) investigated the variation of the input-parameters for calculating the thyroid dose by I 131 (grass-cow-milk-child-pathway).

Although this pathway is one of the best investigated ones, the calculated dose for a given concentration of I 131 in air (in mrem/a : pCi/cm^2) varies in the range of 1800 to 50 000, a factor of 28.

TABLE 4: COMPARISON OF RADIATION DOSES TO LIVER BY ^{58}Co AND ^{60}Co AFTER CONSUMPTION OF CONTAMINATED ANIMAL FOODSTUFFS WITH AND WITHOUT CONSIDERATION OF THE TRANSFER INTO VITAMIN B_{12} (RELATIVE UNITS, ROUNDED)
(from: Bruland, Franke and Teufel, 1979)

exposure pathway	inorg. Co [1]	^{58}Co conside-ring vit. B_{12}	^{60}Co conside-ring vit. B_{12}
consumption of beef	1	5.4 - 77	22 - 480
consumption of milk	1	67 - 370	280 - 2300

Assuming the statistical variation of input-values to be logarithmic, the use of parameters, recommended by USNRC will lead in 30 % of the cases to an underestimation of potential radiation doses by I 131.

Parallel measurements by USNRC of I 131 emissions from nuclear power stations and I 131 concentrations in milk led to the result, that in 28 situations at 5 reactor sites milk concentrations have been underestimated 8 times. Four of the 20 overestimates were greater than 2 orders of magnitude (Hoffman et al. 1978). A considerable source of uncertainty can be referred to meteorological models.

5.) Radiation dose to individuals

Since the various parameters for radiation dose calculation for critical individuals are so uncertain, a conservative assessment of the potential radiation dose seems to be necessary. Compared to previous estimates, a radiation dose lying several orders of magnitude higher than previous estimates seems to be possible. A radioecological assessment for the Wyhl nuclear power plant from the "Tutorium Umweltschutz an der Universität Heidelberg" (department for environmental protection at the University of Heidelberg) led to the results in Table 5, assuming for the area of maximum concentration annual discharge limits for airborn effluents of

- 80 000 Ci noble gases
- 1 Ci aerosols (halflife greater 8 days)
- 0.3 Ci iodine 131.

The calculated whole body dose of 720 mrem is e.g. 24 times the whole body dose limit in F.R.G.

TABLE 5 : Radiation doses to individuals at area of maximum concentration by emissions of radioactivity by the Wyhl nuclear power plant into the atmosphere (from: Tutorium, 1978)

exposure pathway	radiation doses in mrem/a to:		
	whole body	bone	thyroid
noble gases	31	31	31
ground contamination	15	15	15
leaf vegetables	11	323	6.5
root vegetables	40	1 700	0.4
beef consumption	350	900	380
milk consumption	160	840	210
wine	110	940	96
sum	720	4 700	740
dose limit (F.R.G.)	30	180	90

TABLE 6 : Ratio of global collective dose (man-rem), integrated over 500 years and ∞ to collective dose caused by first exposure after emission (calculated from values of Hesel et al., 1978)

nuclide	organ	ratio global collective dose/dose at first exposure	
		$\int$ 500 years	$\int \infty$
H 3	whole body	0.05 : 1	0.05 : 1
C 14	whole body	23 : 1	190 : 1
Kr 85	skin	18 : 1	18 : 1
I 129	thyroid	0.013: 1	100 : 1

It can be concluded, that by conservative assessments compliance of discharge limits with the limits for radiation dose is not guaranteed. To minimize the uncertainties in the assessments, site-specific measurements of transfer-factors plant/soil , meat/fodder, milk/fodder etc. have to be undertaken. The radioecological parameters, used in previous estimates, are not suitable for conservative estimates.

Similar results have been obtained in the research by Krüger, 1978;, SAIU, 1978; Handge et al., 1978.

6.) The problem of collective doses

For the assessment of health risk from emissions by nuclear facilities, the collective dose seems to be as (when not more) important as the dose to individuals. The rise of emission height of a facility (e.g. 200 m instead of 100 m) will lead to a dilution of radioactivity in the vicinity of the plant and so to lower values but the collective dose (in man-rem) will be the same, nevertheless. Figure 6 shows how much the relative importance of various nuclides will change with time, for the collective dose from a single emssion of various radionuclides from a reprocessing plant. Integrating the collective dose over a long time period, the relative importance of C 14 and I 129 changes considerably. Considering only the first radiation exposure after emission, even if integrated globally, the collective dose in man-rem caused by this emission can be underestimated considerably, thus underestimating the health risk for the population as a whole. Considering, for example, only the first radiation exposure from Kr 85 emission, the radiation dose

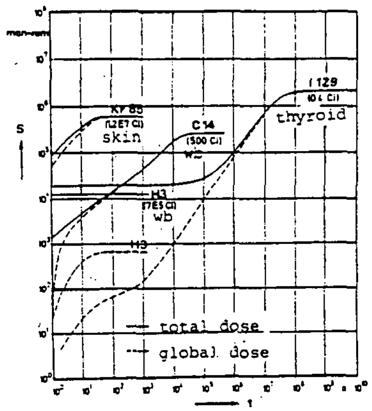

FIGURE 6 : Collective doses by one-year emission of H 3, C 14, Kr 85 and I 129 in dependence of integration time (world population $1 \cdot 10^{10}$) (from: HESEL et al., 1978)
wb=whole body

to the skin will thus be underestimated by a factor of 18. The collective dose which is of primarily importance for the potential health risk (cases of cancer a.s.o.) merits serious attention and should be reviewed worldwide in the interest of future generations.

7.) Conclusions

The following conclusions can be drawn:

1.) Recommendation and use of radioecological factors for calculating the behaviour of radionuclides in the environment should be limited. Fixing of factors, for example, in regulatory guides can lead to the neglect of the complexity existing in nature.

It is incorrect to represent the complexity and variation of nature by choosing such factors as are found in radioecological regulatory guides. An analysis of these guides shows on the contrary, that the assessment of many of the most important radioecological parameters is up to several orders of magnitude too optimistic. Thus, radiation doses calculated from these regulatory guides will be underestimated considerably.

2.) Major attention should be given to site-specific measurements of parameters for the transfer of radionuclides in the different ecological compartments, e.g. transfer factors plant/soil etc.

3.) Similar research is necessary in the field of physiological behaviour of most radionuclides, particularly for risk groups in population (the old and insane, the embryo etc.).

4.) Attention should also be given to nuclides not considered previously, e.g., Tc 99, Fe 55 etc. The longterm behaviour of radionuclides, e.g. Pu 239, which can be more easily taken up by plants owing to complexing in soil, should also be investigated.

5.) To evaluate the potential health risk for the world population by radioactive emissions from nuclear facilities, not only the individual radiation dose, but also the collective radiation dose should be reviewed.

"Aknowledgement

Important parts of this work could be realized by financial support of the ministry of economics and technology of the state of Hessen, F.R.G. Further aknowledgements are given to many people who are not personally named."

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 20 1980

OFFICE OF THE ADMINISTRATOR

Dr. Bernard J. Snyder, Progam Director
Three Mile Island Program Office
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 (EPA) has reviewed the Draft Programmatic Environmental Impact Statement (DPEIS) Related to Decontamination and Disposal of Radioactive Wastes Resulting from the March 28, 1979 Accident at Three Mile Island Nuclear Station, Unit 2 (NUREG 0683).

EPA has been involved in monitoring the impacts of this accident on the environment since March 30, 1979, so we are in a unique position to recognize the unusual nature of this action. We commend the Nuclear Regulatory Commission's determination to protect public health and the environment during the decontamination of Three Mile Island, Unit 2 (TMI-2) and the permanent disposal of the resulting radioactive wastes.

EPA's detailed comments are attached; our major concerns are described below. We hope they assist the Nuclear Regulatory Commission (NRC) in the selection of alternatives in authorizing and licensing utility actions during clean up and disposal. The final programmatic EIS (or a supplement to the DPEIS) should provide more information on:

(1) the amount, nature, and disposition of radioactive wastes from the TMI-2 decontamination;

(2) the health effects associated with various levels of exposure (public and occupational);

(3) the effects of possible transportation accidents;

(4) the cumulative effects on the public of all exposures suffered as a result of the accident (this would include the krypton-85 venting);

(5) the estimated costs of the clean up actions; and

(6) the psychological impacts of each alternative.

EPA believes that the FPEIS should be organized in such a fashion that all information pertaining to an alternative be contained in one section. The FPEIS should be written in plain language so that the public can readily understand it.

EPA recommends that the NRC issue a supplement to the DPEIS which satisfies the concerns which we have regarding the inadequacies in the DPEIS. EPA also recommends that NRC issue supplements to the FPEIS as additional data and information become available during the clean up operations.

Should you or your staff have any questions about our comments, please call: Mr. Jeremiah Manley (NEPA Matters, 755-0770) of my staff; Mr. Terrance McLaughlin (Technical Matters, 557-7604) of EPA's Office of Radiation Programs; or Mr. Matthew Bills, Senior EPA Coordinator for TMI, (Monitoring Matters, 426-4452) of EPA's Office of Research and Development.

Sincerely yours,

William N. Hedeman, Jr.
Director
Office of Environmental Review

Attachment

U. S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

DETAILED COMMENTS
ON THE
DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (DPEIS)
RELATED TO
DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES
RESULTING FROM THE
MARCH 28, 1979, ACCIDENT AT
THREE MILE ISLAND NUCLEAR STATION, UNIT 2
(DOCKET NO. 59-320, NUREG - 0683)

1. The FPEIS, or the supplement to the DPEIS, should clearly identify the type and amount of radioactive wastes as an inventory. This should include the high specific activity wastes, damaged fuel elements, decontamination liquids, and those of processed water anticipated during cleanup. It should also include those amounts that are estimated to have been inadvertently vented during the accident and intentionally vented during the bulk krypton-85 and weekly/monthly ventings.

2. The FPEIS or Supplement should detail the options available now and the best available estimates of options available in the future (i.e., the reasonable expectation of time to be considered for clean up operations) for the ultimate disposal of the radioactive wastes from the decontamination.

3. The FPEIS should clarify the statements made on the subject of transportation of radioactive liquids and should rigorously explore and evaluate all reasonable alternatives.

4. The FPEIS should address the technical feasibility of the off-site deep well injection as well as that of ocean disposal. We recognize that legislative, administrative, and other obstacles may currently prevent the use of some alternatives. But we urge the NRC to address all technically possible alternatives and their costs in the FPEIS. This would then allow the recommendation of changes in legislation and/or regulation to allow the selection of a technically superior alternative for waste disposal.

5. The FPEIS, regardless of preferred alternative for disposal of low specific activity processed water, should provide an assessment similar to that done for the krypton-85 venting. It would be beneficial in showing not only the worst case impacts but also the best controlled conditions for minimizing radiological exposure, psychological stress, and other impacts.

6. The FPEIS should eliminate the inconsistencies in waste and tritiated water inventories as well as clarify the occupational exposures should tritiated water be used in decontamination. Ventilation failure accidents could lead to significant exposures.

7. The DPEIS includes the alternative of releasing liquids into the Susquehanna River. Two alternatives for liquid disposal are permanent storage on site or evaporation. These liquids represent what is left after the 480,000 gallons of radioactive water has passed through a treatment phase which is likely to be an ion-exchange (EPICOR II). The resulting water would then be mixed with uncontaminated water so that it satisfies EPA's interim drinking water standards (40 CFR 41) at the plant discharge.

The plan to meet the drinking water standards calls for mixing the radioactive liquid and dilution water at the respective rates of 0.8 gpm and 36,000 gpm. It would take 416 days to discharge all this water to the river. To demonstrate that this procedure would work consider the data tabulated below:

Isotope	Input Concentration (pCi/)	Output Concentration* (pCi/l)	Concentration when mixed with Dilution Water (pCi/l)	Concentration that Gives a dose of 4 mrem/yr to a Critical Organ (pCi/l)
Cs-137	$8.4x10^9$	$8.4x10^5$	18	200
Cs-134	$1.4x10^9$	$1.4x10^5$	3.3	80
Sr-90	$1.4x10^8$	$1.4x10^4$	0.33	8
Sr-89	$3.2x10^7$	$3.2x10^3$	0.07	80

As can be seen from this analysis the concentration using the evaporation/resin process is at least an order of magnitude below the drinking water standards. However, a number of questions arise. The mixing ratio of 0.8/36,000 is a very large one. The FPEIS should indicate how this is to be achieved, whether it is possible to get reasonably complete and uniform mixing with this big a difference, and is range of the potential variations in concentration.

*Effluent from processing decontamination liquids by the evaporation/resin process.

The fate and transport characteristics of the liquid waste will depend on the properties of the radioactivity contained. The isotopes listed above are the main contaminants; however, others are present and comprise a wide variety of chemical elements. The different chemical elements would behave in different ways. For example, if the radioactivity was in ionic or particulate form, what would determine where it would go? If the radioactivity were part of the particulate fraction, it might sink to the river bottom and become part of the sediments. This would not be a permanent sink and could, for example, be stirred up in a dredging operation. Has the possible problem of a buildup of radioactive sediments been investigated?

In some cases, chemicals are more toxic to aquatic life than to humans. Is the radioactivity in this case more toxic to humans or aquatic life? Fish and other aquatic life are known to bioconcentrate metals and other toxic substances. What are the biocentration rates for these radioisotopes being ingested by aquatic life indigenous to the Susquehanna River? What is the resulting human exposure from eating such fish?

8. The FPEIS should correct the statements made in the DPEIS concerning EPA's activities in the following sections:

I. Section 11.3

(a) Effective 12/31/80, EPA will have 13 stations out to 5 miles.

(b) Analyses are done at EPA's TMI Field Station, Middletown. The Harrisburg setup was phased out in June 1980.

(c) Sample and analysis frequency is now once per week for the charcoal filters and 3 times per week for the particulate prefilters. Both will be changed to once per week as soon as telemetered gamma monitors are installed.

(d) The TLD dosimeter layout was changed the first week in October, 1980 to that given in Appendix D to EPA's Long Term Monitoring Plan, revision 2, to be provided to NRC shortly.

(e) Weekly continuous compressed gas samples are taken for Kr-84 analysis at Bainbridge, Goldsboro, Middletown, Hill Island, and the TMI Observation Center. The Hill Island Station was pulled October 3, 1980 because of pending shut down of the marina where the boat is kept. The Kr sampler at Bainbridge will be moved to Yorkhaven Jan 1, 1980 when the Bainbridge station is shut down.

(f) As soon as the samplers are built and analysis arranged (approximately Dec. 1980) tritium in air samples will be taken at the same stations as the Kr samples.

(g) EPA also collects and analyzes water samples as follows: (EPA does gamma spectroscopy, DER analyzes for tritium, gross alpha and gross beta; weekly composites are analyzed for Strontium 89 and 90 at the Eastern Environmental Radiation Facility, EPA, Montgomery, Ala.)

(1) TMI Outfall (All plant discharge, both units) - daily,

(2) Lancaster Water Works intake - daily,

(3) City Island - (upstream river water) - weekly, and

(4) Sediment pond, TMI (run off water) behind Unit 2 cooling tower.

There is a continuous gamma monitor on the 001 TMI outfall with a high-level alarm that automatically alerts EPA and DER to the presence of gamma activity in the water in excess of 1,000 pCi/l 137Cs (1/20 of permissible level).

(h) EPA Press releases are now on a weekly basis on Friday.

II Section 11.5.3

Community Monitoring Program. Most of the EPA recorders have been pulled back to the test site due to equipment shortages in the off-site monitoring program. Units remain at Newberry, Fairview and West Donegal. Reports are no longer issued on a daily basis.

III Appendix M

This Appendix has been substantially revised and will be made available to the NRC shortly.

9. The FPEIS should explain why, in spite of the fact that the decontamination is going to be done using processed water containing tritium at concentrations up to 0.98 uCi/cm^3, no mention is made of tritium as an occupational hazard. Perhaps this is factored into the doses given, but the specifics should be given more clearly. Tritium is both an inhalation and immersion hazard, but the occupational dose discussions appear to be limited to the external dose. Tritium is also omitted from several tables in Section 6 where it should appear (cf Tables 6.4-5, 6.4-6, 6.5-1 through 6).

10. The FPEIS should correct the following items with regard to Kr-85:

(a) Page 2-13, Sect 2.2.1.4. Not all of the Kr-85 has been removed. There is still potential for the release of more during water treatment and during the defueling operations.

(b) Sect 6.1. Kr-85 may still be coming from the primary coolant and the fuel rods. If so, this should be stated and factored into cumulative impacts and inventories.

(c) Sect 6.1.4 Should note the initial problems with the particulate alarm system, the cause thereof, and the resolution. The presence of the EPA Onsite Coordinator in the control room during purging should be noted.

(d) Table 6.1-2 and sect 6.1.6. Should include a comparison of the measured doses - EPA, Met Ed etc. - to the estimates presented. It may be reassuring to the public to show how conservative the estimates being made actually are.

(e) Sect 8.1.4.1 What about Kr-85 release?

(f) Sect 8.1.5.2, 3rd pp. line 6. If Kr-85 releases can vary by a factor of 500 from the estimated 100 Ci, we have a real problem. It is intended that the actual <u>doses</u> resulting from a given release will be <u>within</u> a factor of 500 of the prediction.

The entire question of the isotope balance for Kr-85 is unclear. It would be very helpful to state how much was present in the rods before the accident, how much was released in the accident and during the purging, and how much is left. Taking the number of fuel assemblies (177) and the 320 Ci of Kr-85 per 8.2.4.2 one could estimate about 56,000 Ci of Kr-85 in the reactor. This may represent the activity that was present with all rods intact. This should be clarified.

(g) Table 10.1-4. The 8.5×10^8 uCi. entry under Kr-85 may be in error. Should not it be 4.3×10^{10}?

11. The FPEIS should clarify the discussion of accident scenarios. The scenario on page 6-27 appears to indicate that the total exposure resulting from the accidental release of 500,000 gallons of water from storage over a two-hour period would be less than that from a planned release. Do you mean to imply that the alternative of rapid discharge to the river is preferable?

12. The FPEIS should clarify the statements in the DPEIS that there are 51,000 Ci of Krypton-85 in the core. There is no mention of it being in the primary coolant.

13. The FPEIS should include a discussion of the technical feasibility of ocean dumping of low-level radioactive wastes. The current Ocean Dumping Regulations can be found in the <u>Federal Register</u> of Jan 11, 1977 with the criteria for disposal in Section 227.11. We believe this is necessary to fulfill the mandate of NEPA for assessing all feasible alternatives, even though we recognize that, as a matter of policy, no permit has been issued by EPA to ocean dump radioactive waste at any level, and that there has been no ocean dumping of radioactive wastes since 1967. Neither the Marine Protection, Research, and Sanctuaries Act (MPRSA) nor the London Dumping Convention (LDC) preclude the dumping of low-level radioactive wastes; they prohibit the ocean dumping of high-level radioactive wastes. The designation of disposal sites requires an application to EPA with the applicant responsible for time consuming, expensive studies, and for monitoring to assure selection of an environmentally sound alternative.

352 Valley Road, Etters
Pennsylvania 17319
November 18, 1980

Commissioner Ahearne
NRC, Washington D.C. 20555

Dear Sir,

All points of view have not been presented in the body of the Programmatic Environmental Impact Statement, nor have all of the environmental consequences to all of the surrounding areas been adequately addressed. We feel a personal affront in that consideration of the impact on Cumberland County, with a population of more than one hundred thousand, was not included. The effects of the clean-up on the New Cumberland Army Depot, and on the Mechanicsburg Naval Supply Depot were not addressed. Such exclusions jeopardize the entire statement.

The safety of the routes chosen for transporting radioactive waste from Unit 2 could not have been carefully considered. I-80, for example, is in need of repair and is presently being repaired, section by section; a hazard in itself. The poor condition of this one route alone caused numerous accidents in the past. Those who prepared this statement could have commissioned a study to determine the numbers and severity of accidents on this route. If such a study was done, results were not reported in the statement.

We have a concern, to say the least, about evacuation. In the corridor between the Susquehanna River and Route 15 to the west, there are only two other routes running north-south: two-lane Route 111 and limited- access Route I-83, and 111 is the route giving access to I-83. Many of the secondary roads in this area are narrow with steeply-dropped shoulders, or none at all. We have been isolated for days after snow storms and have had to wait for special equipment to be brought in to have snow cleared. Accidents or weather conditions have resulted in miles of traffic jams effectively closing I-83. Another deeply disturbing aspect of evacuation is the fact that there are not enough school busses to transport children and others out of this area. Who will go first and who will have to stay behind and who makes that decision?

Difficulty in reading the statement is a universal complaint. The small print and the scattering of the many subjects throughout the entire body of the statement makes trying to follow a particular subject more complicated than it need be. Trying to enlarge on quotations from other sources has been expensive and aggravating. Being vastly overcharged for one small booklet seems to be just one other way to discourage the public from finding the information needed to comment constructively.

While it may be business as usual to the NRC, we are anguished by statements such as these:

"Almost all the risk(NRC genetic effect risk)would be borne by future descendants of workers at the plant."

"NRC intends to allow the disposal of TMI-2 wastes at existing disposal sites provided it can be demonstrated that these wastes have similar characteristics to wastes routinely generated and disposed of at these disposal sites."

"Regulations allow maximum individual occupational doses of 3 rem per quarter to the whole body, head and trunk and active blood-forming organs, lens of eyes, or gonads; 18-3/4 rem per quarter to the hands and forearms or feet and ankles; and 7-1/2 rem per quarter to the skin of the whole body."

"The use of these resources(Susquehanna River and the atmosphere)to dilute and disperse the effluents of chemicals and radioactive materials from the clean-up of TMI-2 is not considered to represent irreversible or irretrievable commitments of these resources."

If this environmental impact statement was supposed to address constructively our fears and concerns regarding the clean-up of Unit-2, it has failed to do so.

Sincerely yours,
Charles J. Hocker
[illegible] M. Hocker

JOHN J. KEARNEY, Senior Vice President

EDISON ELECTRIC INSTITUTE The association of electric companies

1111 19th Street, N.W.
Washington, D.C. 20036
Tel: (202) 828-7400

November 20, 1980

Nuclear Regulatory Commission
Washington, D.C. 20555

Attention: Director
Three Mile Island Program Office

Subject: Draft 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. NUREG-0683 (45 FR 54493)

Gentlemen:

The Edison Electric Institute (EEI) is the national association of the investor-owned electric utility industry whose members serve 99 percent of all customers of the investor-owned segment of the industry and 77.5 percent of all users of electricity in the United States. A number of EEI's members operate nuclear power reactors, have plants under construction and are considering possible future additional nuclear power plants.

We have reviewed the subject DRAFT PEIS and agree with the Staff's general conclusion that it has "... evaluated the environmental impacts of alternative methods ..." and that "... existing methods are adequate, or can be suitably modified, to perform all of the necessary operations ..." to decontaminate, defuel and dispose of the wastes from TMI-2. While we are not offering detailed comments on the report, we want to point out that the public health and safety is better served by expeditiously cleaning up TMI-2 rather than delaying the work. Therefore, the NRC is urged to proceed rapidly with the completion of the PEIS and with its safety review and approval of the necessary program elements. The clean up of the facility is essential and its early completion a standpoint of overall safety for the public.

Very truly yours,

John J. Kearney

John J. Kearney

JJK:skm

RE: Docket No.
50-320

2855 Croyden Road
Harrisburg, Pa., 17104
November 19, 1980

John Ahearne, Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Commissioners,

These comments are directed at the Draft PEIS relating to the decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2.

Over the last three months I have attended several public meetings in the Harrisburg area, heard presentations by the NRC staff and asked questions of Commissioner Victor Gilinsky, November 10, 1980.

I AM SCARED ! This huge clean-up operation is most frightening ! We (the area citizens) have very little faith in Met-Ed (including GPU) and their continued capability to adequately and safely follow proper procedures. Will the NRC and EPA staff be able to continue the vigilant, adversary, regulatory role?

The Draft PEIS is so involved and lengthy that most citizens are intimidated or unable to comment on the technical aspects. <u>It is crucial that policies and procedures for public input and reporting purposes for the duration of the clean-up be established as part of the final PEIS document</u>.

Citizens, business, government, medical professionals and other groups must have on going access to information presented at public meetings periodicly over the next ten years so there is opportunity for input to Met-Ed and NRC to affect decision making. I propose a quarterly reporting and input mechanism with government and utility officials in attendance.

It may be possible to develop such a plan in conjunction with the newly created Advisory Panel For The Decontamiation of TMI, Unit 2.

The media cannot and should not be depended upon to disseminate all the note worthy information, therefore, mailings to individuals must be continued (including all those who responded to the Draft PEIS). A network of openness on the part of Met-Ed (GPU) and all government agencies (NRC, EPA, DOE, and Pa. DER) is essential to reassure area residents for the life of the decontamination process and disposal of radioactive wastes at TMI-Unit 2.

Federal staff must be assigned to follow-up on reports of plant, animal and human health effects in the TMI area. A nurse in a local doctors office called Three Mile Island Alert in September because she was very concerned about the dramatic increase in thyroid problems. She said that within the last two months she had seen diagnosed the normal yearly number of "enlarged" thyroids (she used other medical terms). Her purpose in calling was to request information or direction to on going studies. She is very afraid there is a relationship to TMI but would not reveal her identity. Fears and rumors will continue if they are not openly and adequately researched and responded to.

Commissioner Ahearne, I just learned today that you plan to be in Middletown tonight for the final public meeting. Unfortunately I have other commitments and will not be able to attend. It is annoying to many of us that there was no notice of your visit prior to the day of the meeting.

Sincerely yours,
Kay Pickering
Kay Pickering

cc: Commissioner Vic[illegible]
Gus Speth, Allen [illegible]ing, Bernard Snyder,
John Heinz, A. S[illegible]

Rec'd 11/21.

The Earth Alliance
c/o Mrs. Johanna Ezell
Library
Mont Alto Campus, PSU
Mont Alto, PA 17237

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Dear Sirs:

We know the "Draft Environmental Impact Statement" proposed by the NRC intended to be the blueprint for cleanup of TMI Unit 2 to be insufficient in protecting our health and the health of the environment.

MET ED and the government have chosen their courses of action concerning the incident and cleanup at TMI since the very beginning with consideration towards saving money, not with consideration towards health and safety.

This "Draft Environmental Impact Statement" has glaring omissions, deficiencies and errors. As the ones who will suffer the effects of this whole incident, we demand that this DEIS not be used. We demand that a responsible and well-researched statement be used instead.

The use of the proposed DEIS would threaten our lives and this Earth we love. You are being held responsible for our future.

Signed by students of Mont Alto Campus,
Pennsylvania State University.

Duane E. Brunot
Chuck Hoak
Susan M. Finley
Paul Hemler
Johanna Ezell, faculty advisor
Mark Worrell
Matthew M. Corkery
Susan Spahr

Send to B Snyder

AMERICAN SOCIETY OF UTILITY INVESTORS

PRESIDENT
Dr. James R. Spang

P.O. BOX 605, CAMP HILL, PA 17011

November 18, 1980

The Commissioners
Nuclear Regulatory Commission
Box 311
Middletown, PA 17057

Gentlemen:

Staff of the American Society of Utility Investors has completely reviewed the draft Programmatic Environmental Impact Statement related to the decontamination and disposal or radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station, Unit #2, Docket # 50-320.

First, a word about the Society. The Society has a membership of more than 3,300 GPU shareholders. It was organized to provide a voice for the interests of the shareholders in all economic and related matters, including protection from the unfair attacks of local and national activists and their organizations.

We are pleased to report that in our judgment the draft is an intelligible, comprehensive and exhaustive model of responsible and objective commentary on a highly technical subject. Many alternatives are explored within each of the major parts of the report and feasible actions clearly identified.

We assume that any of the alternatives identified as feasible would be equally acceptable to the NRC and is the prerogative of the Company to implement. If this interpretation is not correct and that by some curious, circuitous reasoning another interpretation can be held, we would like to know about it. In our estimation, any other conclusion would be silly, because -- by definition-- it would, ipso facto, not be feasible.

In closing, we expect and recommend that the staff report be accepted and fully supported by the NRC.

Sincerely yours,
James R. Spang
James R. Spang

"INVESTMENT IS THE FOUNDATION OF GROWTH"

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

HARRY HUGHES
GOVERNOR

CONSTANCE LIEDER
SECRETARY

November 19, 1980

Mr. Bernard Snyder
United States Nuclear Regulatory Commission
1717 H Street
Washington, D. C. 20555

SUBJECT: ENVIRONMENTAL NRC IMPACT STATEMENT (EIS) REVIEW

Applicant: U. S. Nuclear Regulatory Commission

Project: Draft EIS - Decontamination of Three Mile Island Nuclear Station - Unit 2 NRC Docket #50-320

State Clearinghouse Control Number: 81-8-158

State Clearinghouse Contact: James McConnaughhay (383-2467)

Dear Mr. Snyder:

The State Clearinghouse has reviewed the above project. In accordance with the procedures established by the Office of Management and Budget Circular A-95, the State Clearinghouse received comments from the following:

Dept. of Public Safety & Correctional Services, Dept. of Health & Mental Hygiene, Office of Planning, Dept. of Economic and Community Development, including their Historical Trust section, Dept. of Transportation, and our staff, noted that the Statement appears to adequately cover those areas of interest to their agencies.

Cecil County provided detailed comments (attached) regarding the following concerns:

1. Three Mile Island Nuclear Station should be cleaned up as soon as possible.

2. The "local release" of processed nuclear waste water into the Susquehanna River is an inappropriate action and an unnecessary risk considering the alternative of storing the water in the two 500,000 gallon tanks that have already been installed.

3. Detailed safety precautions and backup systems should be outlined to maintain the boron concentration in the water circulating the core, thus ensuring that the reactor will be safely maintained.

4. High level radioactive waste should not be stored on TMI any longer than necessary.

TELEPHONE: 301-383-__________
OFFICE OF STATE CLEARINGHOUSE

Baltimore Regional Planning Council provided comments directly to the applicant by transmittal letter dated October 17, 1980.

Department of Natural Resources noted that they are the lead agency in the State regarding nuclear matters and are performing an in-depth analysis of the Statement. The Department hopes to have their review completed by the November 20 cut off date and will forward their comments directly to the applicant to conserve time. The Department will also send an information copy of such comments to the State Clearinghouse.

Dept. of Health and Mental Hygiene, Office of Environmental Programs was provided an ample opportunity to review and comment on the project within this review period but has not responded as of this date. If any substantive comments are received subsequent to this letter, the comments will be appropriately forwarded.

We appreciate this opportunity to review the draft EIS and anticipate that the review comments will be properly considered and addressed in the final document. Thank you for your attention to the A-95 review process.

Sincerely,

James W. McConnaughhay
Director, State Clearinghouse

JWM:BG:mmk

cc: G. Kamka/E. Pigo/S. O'Hara 80-364/M. Pugh/S. Long w-a/L. Frederick
C. Pyers/H. Silbermann/M. Eisenberg/N. Thompson

CECIL COUNTY, MARYLAND
OFFICE OF PLANNING AND ECONOMIC DEVELOPMENT
ROOM 210, COURT HOUSE BUILDING
ELKTON, MD 21921
TELEPHONE (301) 398-0200, EXT. 144

September 19, 1980

TO: Maryland Department of State Planning

FROM: Michael R. Pugh, Director

Re: Draft EIS - Decontamination of Three Mile Island Nuclear Station

After reviewing the draft environmental impact statement for the clean-up of three mile island, we have developed the list of the following concerns:

1. Three Mile Island Nuclear Station should be cleaned up as soon as possible.
2. The "local release" of processed nuclear waste water into the Susquehanna River is an inappropriate action and an unnecessary risk considering the alternative of storing the water in the two 500,000 gallon tanks that have already been installed.
3. Detailed safety precautions and backup systems should be outlined to maintain the boron concentration in the water circulating the core, thus ensuring that the reactor will be safely maintained.
4. High level radioactive waste should not be stored on TMI any longer than necessary.

We have enclosed further comments as requested.

1. Additional Effects

A. Additional effects of "local release" of the processed radioactive waste water into the Susquehanna River should be assessed. As the proposed alternative reads now "after on-site dilution and mixing in the river, the water would satisfy EPA's interim drinking water standards of the nearest potable water source". This allows for a higher concentration of radionuclides in the Susquehanna River between Three Mile Island and the nearest intake for drinking water. The radioecological consequences have been assessed after the effluent has completely mixed with the river. What are the radioecological effects at the point of discharge? There has not been enough study on the effects of low level radiation to set a definite standard. What may be a safe drinking water standard today may not be considered safe tommorrow. To complicate matters further, safe levels of radioactivity are relative. We are affected by the amounts of radiation we have been exposed to in a lifetime. For example, a person who has already been exposed to high level radiation, or someone who lives on the Florida Coast which has a high level of radiation, could safely be exposed to a much lower level of radiation than someone living in a low level radiation area. The EPA has deferred from setting standards in RCRA, Subtitle C for just such reasons. "Local release" of the processed water will hurt the fishing industry. Fish will be above the maximum radiation level. The bad publicity will effect the marketability of all seafood. The form of the radionuclide is not discussed in the EIS. Are the radionuclides in salt form which could lead to a high level of bio-accummulation from low level sources or are they in more insoluable forms. The chemical form of each type of radioactive material, and the effect of each should be included with the concentration level.

B. Additional effects of storing high level radio active waste if even for a short duration, should be considered. Three Mile Island is subject to floods and its proximity to the river makes the possibility of spills or leakage a particular concern.

3. Better or more appropriate measures

A. There isn't enough data on effects low level radiation to set definitive standards in order to evaluate possible effects.

4. Additional control measures to reduce adverse environmental effect.

A. If "local release" of processed radioactive waste water is chosen as an alternative, a maximum discharge level should be set, in addition to the maximum radiologic level at the nearest drinking water intake.

B. Periodic inspection of the clean-up process should be made to ensure that the procedures setforth are met. In addition, safety precautions and backup systems should be implemented throughout clean-up procedure.

TMIA: THREE MILE ISLAND ALERT, INC.
315 Peffer St., Harrisburg, Penna. 17102 (717) 233-7897

November 19, 1980

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

In re: NUREG-0683, Docket No. 50-320
Draft Programmatic Environmental
Impact Statement

Gentlemen:

We take this opportunity to present the comments of Three Mile Island Alert on the subject of the referenced DPEIS, in writing.

For weeks, members of this organization have been attending a number of the various public meetings held by the NRC to explain the DPEIS and to obtain public input and comments concerning it. Their questions, and comments, concerning the Statement are matters of public record and are contained in the transcripts of those several meetings. We commend their questions and comments to your attention and study. While they represent individuals' thoughts and opinions, TMIA in general both sympathizes with and agrees with their statements.

In addition, we would respectfully suggest that you pay special attention to the record of the first meeting of the Advisory Panel for the Decontamination of Three Mile Island, Unit 2, held in Harrisburg, Pa. on November 12, 1980. Most particularly we urge a careful reading of the questions and comments presented at that meeting by Dr. Thomas G. Cochran, physicist of the National Resources Defense Council and himself a member of the Advisory Panel.

We are aware that various agencies, including but by no means limited to, the Environmental Protection Agency and the Commonwealth of Pennsylvania, will also be reviewing and commenting on the DPEIS. While we cannot anticipate their specific concerns we are hopeful that they, together with those of others of whom we do have specific knowledge, will serve to emphasize

our concerns (and even our apprehensions) concerning the DPEIS in general and specific sections thereof in particular.

We have been privileged to receive copies of letters sent to the NRC regarding the DPEIS from the following persons: Ms. Kay Pickering and Ms. Mary Osborn, both of Harrisburg, Pa.; John F. Brougher, Carlisle, Pa.; Edwin and Mary Ann Charles, Mechanicsburg, Pa.; and George A. Herman, R.D., York, Pa. Any differences between their viewpoints and those of Three Mile Island Alert as regards the DPEIS would be in amounts too small to measure.

Three Mile Island Alert's concerns with the DPEIS are in four major areas: Alternatives, Costs, Emergency Planning, and Transportation and Disposition of Wastes. Our main points are as follows:

Alternatives

We find no mention of any consideration of what appears to us to be a viable, and the most preferable, alternative - namely, cleanup of Unit 2 to the degree necessary to insure no future radioactive releases therefrom (removal of contaminated water and of the core and no more, if that would suffice) to be followed by the permanent decommissioning and entombment of the reactor.

Costs

It is our understanding that costs of the several suggested alternatives will be included in the final PEIS. While we are interested in learning why this was not included in the Draft we are more concerned that, in this regard as in others, there will be no provision for meaningful public comment on the revised PEIS.

The ultimate solution to the pressing problems of who is to pay for the cleanup and what those costs ultimately will total remains as elusive as does the solution to the over-riding problem of what is to be done with the high-level radioactive wastes from TMI and the operating reactors in the United States.

To discuss alternatives without due regard to costs and how those costs will be met is an exercise in theory and little more.

Emergency Planning

Throughout, the DPEIS appears to have a fixation on the idea that decontamination will proceed without significant hazard, and the possibility of a major accident in the course of the cleanup appears to be treated as so remote a possibility that it rivals the once predicted impossibility of the accident that ultimately occurred at TMI Unit 2 on March 28, 1979.

The environmental impact of a major accident during the extended time now predicted for the cleanup is not only not admitted, it appears to have been completely blanked from the minds of the cleanup planners.

If emergency preparedness plans are required before licensing of new reactors, how much more should they be required in the case of a severely-damaged reactor, and should not the desirability of a practical emergency plan, including evacuation, be addressed in the PEIS?

Transportation and Disposition of Wastes

The very obvious error in the DPEIS of indicating that a crowded and dangerous highway route would be used for shipments of wastes from TMI between Middletown and Interstate 80 (an error now admitted by the NRC) is, we fear, symptomatic of the superficiality, haste and incompleteness which has already marred any claims for acceptability for the DPEIS.

Where the high-level wastes will find a resting place, particularly now that Washington State citizens have voted not to accept such wastes after July 1981 is a pressing problem.

Again we are presented with the recurring argument that theoretically there are solutions to the problem of ultimate disposition of such wastes. Gentlemen, please give us the relief of dealing with the practical world of what is, and do not compel us to deal interminably with the ethereal world of the theorists. If we believed them, then we would know that the bumble bee cannot fly, because theoretically it is aerodynamically impossible for them to do so. Fortunately, for the bumble bee and for us, the bumble bee is not bound by what is theoretically possible, or impossible.

Sincerely,

Mary Hartnett

Mary Hartnett
Chairman, TMIA
Steering Committee

cc: The Hon. John Heinz
Congressman Allen E. Ertel
Congressman Bill Goodling
Council on Environmental Quality

R.D.#1, Box 299,
Columbia, Pa. 17512
November 19, 1980

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

Dear Sir:

In the Federal Register of November 27, 1979, the Nuclear Regulatory Commission announced its decision to prepare a programmatic environmental impact statement on the Decontamination and Disposal of Radioactive Wastes resulting from the March 28, 1979 Accident at Three Mile Island, Unit 2.

It seems to me that the substance of the impact statement, as issued on August 15, 1980, is a cruel parody of what is required from the NRC to ensure that public health and safety will be of first concern during the long and unprecedented cleanup procedures that should result in removal and burial of radioactive residues from a flood-prone island in the middle of the Susquehanna River.

The paramount need unaddressed by this EIS, which is labeled a disposal statement, is to address the problem of disposal. As long as the government, whatever agency, or group of agencies, or legislative body that may need to be, does not find, or create, permanent, safe storage facilities which will accept TMI wastes, people who live in the Three Mile Island area will not be able to rest easy.

I know that the subject of segmentation regarding the cleanup has often been discussed before, sometimes far too lightly, in my judgment. This EIS does not contribute significantly to alleviating fears of the population, inasmuch as the accident, itself, with its doses to the public, and longterm onsite storage are not included as factors which must be considered for cumulative radiation dose, added on to the projected doses from the various cleanup procedures.

I am deeply concerned that the National Environmental Policy Act does not provide a clear mandate that NRC must choose the best environmental alternative for this cleanup, that economic and technical benefits may be permitted to override environmental needs. Cost analyses of cleanup alternatives are not discussed in the EIS. I am fearful because this does not provide information to the public which will assure us that go-ahead decisions are being given to the licensee that are clearly best for the health and safety of people, not primarily for the health and viability of Metropolitan Edison Company.

The fact that INSIDE NRC has pointed out the fact that the containers in which the resin filters from EPICOR II are stored, are now deteriorating, makes us who live in the area question whether NRC knows what to require of the licensee in the way of containers to contain, that can be moved from Three Mile Island if a storage site can be secured.

The fact that a maximum probable flood would inundate the concrete storage facility which is being used to store containers which could soon be leaking, necessitates a detailed analysis of the effects of radiation bombardment and heat on concrete. I have heard serious speculation about whether cesium 137 in the resins, if released from the canisters, could percolate through concrete. The EIS contains no indication that studies are needed, or are being done.

In the psychological stress sections to describe anxiety after an actual stressing event, as if all danger has passed from the unprecedented, untested cleanup procedures, as being phobic.. because it focusses on what-if, rather than what is, denies the rationality of area citizens. It is rational to be anxious in a situation that is fraught with danger. This EIS attempts to denigrate concern about the condition of what Clifford E. Jones, secretary of Pennsylvania's Department of Environmental Resources, has described as the "most unsafe radioactive site in the world."

It seems to me that a pinnacle of unconcern has been reached when the NRC holds hearings, as is presently being done in Harrisburg, on the restart of another nuclear reactor at this site where cleanup procedures must go on for most of the next decade. I would suppose that if restart is granted, there will be far better management and NRC oversight than was the case as the time of the accident, BUT to consider allowing "normal" releases from a "normally" operating reactor, in addition to the expectable, projected ones, and the possible unexpected ones from the cleanup is showing ultimate disregard for public opinion, and mental health, not to mention physical health.

These considerations, as well as a wide range of other public comments which have been sent to your office, call for NRC to issue another DRAFT of the EIS for comment, before a final draft can be issued to govern the cleanup.

Sincerely,

Beverly M. Hess

Beverly M. Hess

The Chesapeake Bay Foundation

"Citizen Representation · Environmental Education · Land Preservation"

162 PRINCE GEORGE STREET • "THE CHURCH" • ANNAPOLIS, MARYLAND 21401
301 268-8816 (Annapolis) 269-0481 (Balto.) 261-2350 (Wash., D.C.)

November 20, 1980

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

Dear Mr. Snyder:

The following comments are intended to supplement the comments which we submitted at the public hearing on September 30, 1980 regarding the draft PEIS on Three Mile Island.

We believe that there are serious deficiencies in the draft PEIS which will necessitate extensive revision of the document. Such deficiencies include the absence of cost estimates for the various alternatives, inadequate evaluation of the impact of the release of the processed water to the Susquehanna River on the Bay commercial and recreational fishing industry and an expanded discussion of the long-term radioactive waste disposal options, as well as numerous factual errors.

Agencies of the Federal government must prepare and circulate a revised draft environmental impact statement, if the original draft statement "is so inadequate as to preclude meaningful analysis "(40 CFR §1501.9(a)), or prepare a supplement to the orginial draft statement, which must also be circulated for public comment, if there is significant new information (40 CFR §1502.9(c)(1)(ii)). See also, I-291 Why? Ass'n v.Burns, 517 F.2d. 1077 (1st/Cir. 1975); Latham v.Brinegar, 506 F. 2d. 677 (9th/cir. 1974); and Cedar - Riverside Environmental Defense Fund v. Hills, 422 F. Supp. 294 (D. Minn. 1976). This requirement is binding on all Federal agencies (40 CFR §1500.3). "Federal agency" in this context is defined in 40 CFR §1508.12 to include "all

Page Two
Letter to
Mr. Bernard Snyder

agencies of the Federal government" excluding only the Congress, the Judiciary, the President and the President's Executive Office staff. Since no specific exception is made for independent regulatory commissions, there can be no question, but that the Commission should either prepare a revised draft preliminary environmental impact statement or a supplement to that statement and circulate the new material for public comment.

We therefore request that such a document be prepared and circulated for public comment prior to publication of the final PEIS.

We hope that you will seriously consider our request.

Sincerely,

Nancy G. Kelly
Senior Staff Biologist

Hope M. Babcock
Senior Staff Attorney

NGK-HMB/kaw

227 Townhouse Briarcrest
Hershey, Pa 17033
November 19, 1980

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

Dear Dr. Snyder:

In response to the request for public comment on the Draft 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), I am pleased to submit my comments on the report.

It is my feeling that the cleanup of Unit 2 must be done in an as expeditious manner as possible and in a manner that considers the health and safety of all concerned. I feel the draft PEIS is a reasonable evaluation of the effects resulting from the cleanup. I support the final issue of this report subject to being upgraded as information is now available that wasn't at the time of writing.

I would hope the result of the final issue will allow an expedited cleanup schedule to reduce the risks of an uncontrolled event that exists in the present protracted schedule. In my opinion an expedited cleanup is in the best interest of the public and personnel involved in the cleanup.

Please consider my comments in any decisions you make relating to the cleanup.

Yours truly,

Willet G. Juliano

617 Briarcliff Rd.
Middletown PA 17057
20 Nov, 1980

Dr. Bernard J. Snyder, Program Director
T.M.I. Program Office
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

The following comments pertain to the Draft P.E.I.S. on TMI unit #2 (NUREG-0683).

In chapters 1 and 2, discussion is presented on the decontamination of the damaged nuclear plant at Three Mile Island. It is very clear to me that the experience is very limited, and, therefore, the people of this area will be, like it or not, participants in an experiment of the grandest scale. The nuclear industry, through GPU at Three Mile Island, is embarking on its most dangerous task to date while 160,000 residents within ten miles of TMI sit on pins and needles. Carrying out the cleanup in the safest, most expedient manner receives unanimous support. However, I am deeply concerned that a truly safe cleanup is not possible; but, how can the NRC admit that to area residents? My reasons for feeling this way follow.

In Chapter 1, the other sites which are discussed as examples of previous decontamination experience are of questionable applicability. What was the size of those reactors compared to the 800+ megawatt reactor at TMI? I am sure that all of those cited were much smaller. Additionally, the scale of cleanup operations at those other facilities was miniscule by comparison. For example, at the Canadian NRC facility, the cleanup was one failed fuel element; at Enrico Fermi it was two fuel assemblies; at Canadian NRX it was 10% of the fuel rods; and at PRTR it was fuel element failure. At T.M.I., the estimates are that 90% of the fuel assemblies have been severely damaged. There is no comparison between the scale of cleanup at TMI, and that which has provided previous experience. The task at T.M.I will involve tremendous "scaling up" of equipment and procedures. This "scaling up" will not be easy. When the discussions took place in May 1979, about the possibility of scaling up a small cryogenic system at Oak Ridge, Tennessee, to be used at T.M.I, the NRC emphasized that the scaling up would be extremely difficult and involve questionable results. However, now the same NRC people attempt to convince area residents that the previous experience can be "scaled up" to accomplish the T.M.I. task. I question that confidence.

Specific cleanup steps are discussed further on in Chapter 1. In every procedure discussed, it is mentioned that experience is limited. Examples follow:

- on p. 1-12 relating to decontamination of building interior surfaces it states "experience is limited."
- on p. 1-14 relating to significant core damage it states "experience is limited"
- on p 1-14 relating to chemical decontamination to remove fuel failure debris it states "very limited experience."
- on p. 1-14 relating to removing fuel debris from large reactors it states "little experience."
- on p. 1-16 relating to removing damaged fuel and core components it states "experience rather limited" . . . "much experience is not directly applicable to TMI-2."
- on p 1-17 relating to the TMI-2 fuel it states "...quite different ... more susceptible to oxidation and embrittlement."
- on p. 1-19 it states "there are many uncertainties regarding the characteristics of TMI-2 wastes."
- on p 1-26 relating to large scale decontamination activities it states "much less experience."

The preceding statements convince me that the situation at TMI continues to be one of men "stumbling around in the dark."

The narrow scope of the psychological stress issue must be expanded. I hope the NRC will enlist the help of <u>independent</u> experts to fully develop an understanding this issue. The human design task force (or whatever you call it) has not provided adequate research of this issue. On October 20, 1980, at a meeting to discuss the PEIS in Middletown, I spoke with Dr. Struefert (sp?) from the Hershey Medical Center. He was introduced by Dr. Snyder as being one of the NRC's psychological experts and was in attendance to address any questions on the issue. In the one question that he attempted to answer, it was obvious that he was not familiar with the narrow view of the psych. issue as presented in the PEIS. After the meeting I spoke with him, and he stated that he had not read any of the PEIS sections dealing with psych. stress until that afternoon when he was visited by an NRC staff person and was provided with copies of the sections dealing with the issue. How worthwhile can the human design group be when one of its members, and most likely others, is not aware of what the NRC is doing in the psych. area? I suggest you get input from local mental health professionals and others from around the country to adequately scope this issue. I would be happy to supply you with the names of competent people.

The proposal to store radioactive wastes on the island, even for the "short term", is not acceptable. As the wastes (loaded resin filters, processed water, fuel debris, damaged fuel assemblies, and core components, etc.) are generated or removed from containment, they should be put into the safest shippable form and moved immediately. They should be moved to a remote government facility away from population centers. Certainly that is much safer than allowing them to accumulate on the island. I have lived in this area all of my life. In 1936, the Susquehanna River flooded, and the history books recorded it as a natural disaster of no equal for the towns along the river. From then until 1972, we heard about flood control dams and the improved river monitoring procedures that would make a reoccurrence of 1936 almost impossible. Well, 1972 disproved that theory; and who can say that the future does not hold worse? Because of the unknown potential for future flooding, it is absurd to even consider allowing wastes to sit on TMI while the political wrangling drags on about how and where to dispose of the wastes!!

I offer these comments/suggestions regarding NUREG-0683. It is my hope that the Commission considers them in preparation of the Final E.I.S.

Sincerely,

James Hurst

NIRS
Nuclear Information and Resource Service
1536 Sixteenth Street NW, Washington, D.C. 20036 (202) 483-0045

November 20, 1980

Bernard J. Snyder
Director of the
TMI - Program Office
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Dr. Snyder:

We are writing to comment on NUREG - 0683, the Draft 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.

We are requesting that a Revised Draft PEIS be prepared at this time. According to NEPA Regulation 1502.9 (a), a revised draft EIS must be prepared "if a draft statement is so inadequate as to preclude meaningful analysis, the agency shall prepare and circulate a revised draft of the appropriate portion".

It is our contention that the Draft PEIS for TMI-2 is so inadequately prepared and presented as to be meaningless in vital areas of cleanup such as waste disposal, where in-depth information is needed for decisions to be made. Attached are comments to that effect made by our organization to Matthew Bills at the U.S. Environmental Protection Agency on November 14, 1980. We wish to submit these comments to you, which will describe some of the areas which we have identified as inadequately developed for decision making and which document the need to prepare a Revised Draft PEIS.

Also attached are additional comments, which support the request that a Revised Draft PEIS be done, by Pennsylvania's state-wide group called the Environmental Coalition On Nuclear Power.

We will remain in contact with the Nuclear Regulatory Commission concerning our request that a Revised Draft PEIS be done and that these issues be addressed properly.

Respectfully,

Coral Ryan

Coral Ryan
For the NIRS Staff

cc: U.S. Nuclear Regulatory Commissioners

NOTE: Comments mentioned in the above letter as being attached are included in this appendix as comment number 64.

NS-TMA-2341

Westinghouse Electric Corporation
Water Reactor Divisions
Box 355
Pittsburgh Pennsylvania 15230

November 19, 1980

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:

We are pleased to provide the following comments on NUREG-0683, Draft Programmatic Environmental Impact Statement on the Three Mile Island cleanup activities.

The draft PEIS appears to be well written and technically accurate. Thorough analyses have been made, and an overwhelming amount of technical information is presented to provide the basis for the conclusions.

Based on our review, we believe the information contained fully supports the draft PEIS conclusion that recovery operations will have minimal adverse effect on the public health and safety and agree that maximum offsite radiation exposure would be "much less than the design objectives of Appendix I of 10 CFR 50 for operating nuclear power plants". (PEIS, page S-10, Section S.4.) We also support the draft PEIS conclusion that potential or postulated accidents are unlikely and do not have the potential to seriously threaten public health (except for psychological stress).

The draft PEIS correctly notes that the cleanup "should proceed in a timely manner . . . to complete those activities which can cause psychological stress for residents in the area. The sooner the cleanup is completed, the sooner the sources of concern will cease to exist". (PEIS, page S-3.) In addition, we point out that public fears are unnecessarily reinforced by the appearance of indecision. Thus, expeditious cleanup activities can provide public reassurance as soon as they begin.

As a corporate citizen of Pennsylvania, Westinghouse urges that public fears of TMI decontamination be minimized by prompt completion and approval of the PEIS.

Section 1.5 discusses some of the vast decontamination experience available from other sites, and properly notes that "The removal of unwanted radioactive contamination from materials and equipment is a familiar and routine operation in the nuclear field for reducing radiation levels".

In comparing TMI-2 with other experience, Section 1.5.6 of the draft PEIS notes that "At all the previous accidents, the workers began recovery operations immediately and got the job done quickly and effectively". Westinghouse observes that the most difficult and frustrating part of the TMI-2 cleanup appears to be obtaining authorization to proceed. We hope this situation will be corrected by prompt approval of the PEIS.

We are somewhat concerned about the consistent tendency throughout the draft PEIS to equate millirem or microrem public exposure to probability of cancer fatality or eventual genetic effect. Nowhere are the assumptions and probable conservatisms of the linear, non-threshold dose response model discussed. As noted in the 1980 BEIR-III report, "It is by no means clear whether dose rates of gamma or X radiation of about 100 mrads/yr are in any way detrimental to exposed people; any somatic effects would be masked by environmental or other factors" (BEIR-III, p. 187). We agree with the judgement of the draft PEIS, "On the basis of comparison of the doses calculated here to those of natural background radiation, it is suggested that the health effects are non-existent, especially in consideration of the fact that natural background radiation in the United States varies from one location to another within a range of about 70 to 310 mrem per year" (PEIS, Sections 4.5.2, 8.1.5.2, etc.). We also agree that it is appropriate in the PEIS to quantify the probability of cancer or genetic effect using an appropriate model. The result, however, should be presented as a calculated or theoretical result based on assumptions believed to be conservative, rather than as an actual probability. Also, an appendix, based on the new BEIR-III report, should be added to explain the linear, non-threshold model. We do not quarrel with the dose-response coefficients used in the draft PEIS, as noted in Table 4.5-1. While coefficients based on the new BEIR-III report recommendations would be somewhat lower, these recommendations came after the draft PEIS was generated and are not yet in common usage in environmental impact statements. Thus, we suggest that a discussion and comparison in an appendix would be appropriate.

Section 9 of the draft PEIS presents a detailed assessment of the impacts of transporting wastes to the Hanford disposal site, 2300 miles distant from the TMI site. This section should emphasize that this represents the bounding, or worst-case, assessment of transportation impact and does not imply that disposal at the Hanford site is the only acceptable alternative. As noted in the draft PEIS, "Onsite storage for an interim period prior to shipment is a viable and necessary option" (Section 9.2.1.1). Regardless of the duration of such interim storage, Westinghouse believes interim storage would be an improvement over existing conditions at TMI, both as to waste form and location. Thus, we urge that cleanup not be delayed pending selection of the ultimate disposal site.

Further, we believe additional efforts should be made to disseminate the information contained in the PEIS to the public.

Dr. Bernard J. Snyder - 3 - NS-TMA-2341
November 19, 1980

A descriptive document should be prepared for public distribution summarizing the PEIS in non-technical language, that clearly shows that the propose cleanup operation of TMI-2 will have negligible impact on the population with respect to health effects resulting from radiation exposures. The document should include, as a minimum, information on the following items covered in the PEIS:

a. No new technical advances are needed to successfully carry out the cleanup. Decontamination, radwaste handling and effluent control are "state-of-the-art" technologies.

b. There is a real need to get the job done as soon as possible to minimize the risks of uncontrolled leaks which would cause further public fears. Prompt action will minimize psychological stress.

c. Effluents (primarily liquids) that would be released are innocuous -- specific radioactivities should be compared to those in other common liquids, drinking water, etc., so the public can have a basis of comparison. Tritium activity should be placed in perspective.

d. The transportation impacts, volumes of low-level waste generated, and their significance, should be discussed.

e. The role of environmental radiological monitoring programs to assure that unacceptable radioactivity is not being released, merits emphasis. The role of the <u>community</u> monitoring program (pg. 11-2), whereby local communities can confirm that radiation levels are indeed negligible, should be stressed.

A means of getting this document broad coverage to the people located in the vicinity of the plant should be determined; i.e., through means such as newspaper inserts, regular press, electronic media.

Very truly yours,

[signature]

T. M. Anderson, Manager
Nuclear Safety Department

Dear NRC + Staff, 11-13-8[illegible]

Because you people approved the venting of Krypton - I don't think much of your environmental impact statements. It didn't matter to me or many other people what U.C.S. said about the safety of venting. As a member of T.M.I.A. who was present at a meeting to discuss venting - I want you to know this: the closer someone lived to TMI (especially those who had children or worked with children - women more so than men - even in our groups) the more they were opposed to venting! I also met with representatives of other groups to discuss our actions on venting. It was the closest thing I had come to seeing grown men cry. Quite frustrating, too. No one will ever forget those days.

The main reason I distrust the NRC + "staff" is because of what happened years ago, to the cows out west in the days of the A.E.C. It looks like things haven't changed much in the way of personnel or attitudes. I feel your standards are just not good enough.

see page S-7. Your methods for disposition of water are: one bad choice + three super bad choices. Bad choice is to store in tanks <u>on site</u> for a long time. Release to the river is totally unacceptable to me (even though I am not affected directly by this). The forced evaporation method would affect me + I'm opposed to this. Its like getting vented on again! To use processed water in clean-up seems to me would harm the workers involved. Like the lady said at the Forum - "you built a house without an outhouse."

(1)

page 3-11 You say agricultural families will be likely to be affected - I agree. I don't buy local produce or meat - I'm a bit paranoid now. Apparently I'm not the only one. Ask them at the farmers markets & local farms - sales are a bit off. (Be sure to put a "Pa." sticker on your produce. Penna. nuclearly - or - You've got a friendly atom in Pa.) There are alot of people that eat more than 50% or 60% of food from their own gardens or locally grown meat & produce.

As far as stress goes - the more you dump on me & my family - the worse it gets for me. When you get rid of krypton it is in my air - so I do worry.

XIV If it were not for the National Environmental Policy Act of 1969, you probably would have done the krypton without our knowledge & the water would already be in the river.

1-1 I think it would be wise for you to decide first if unit 2 should be decommissioned & then clean-up accordingly. You've got the horse before the cart on this one!

1-9 "The NRC should establish a CITIZENS' Advisory Committee." did congress pull rank on you? All we got was an advisory panel. (Is this to pacify us or will there be some teeth in this?)

1-16 Is it possible to get too much boric acid & sodium in the Unit 2 water? "Waste disposal requirements are much more restrictive & complex than for past experience." Looks like you did one thing right.

1-21 Emergency Plan - there is one on paper for some of the people - there is none for all the people in a 10 mile radius! If there is another accident like we had before - things would work out fairly well - weather permitting. But - if we ever had to get out in a few hours - you could just write us off as another statistic.

The radiation protection plan is at least 25 years outdated! The info. I got from Kevin Malloy (formerly with P.E.M.A.) is the same stuff I had in grade school. It wouldn't work then & it won't work now! If I had only known then (3/79) what I know now -- I wouldn't be so damn mad at the NRC - Met-Ed & State govt. Why didn't anyone say wash-off & wash your clothes - it can get rid of certain radioactives? Something little & easy as that. Where is all the potassium iodide? What dose does a 4yr old get? a 2yr old? You'd better get crack'n on this. if the Russian boy scouts know how to decontaminate themselves, why doesn't my C.D. Director or the fire dept. or the State police? You have the nerve to have hearings on Restart of Unit I & these questions haven't been resolved yet!

1-26 You mention calculations of accidental releases should be submitted to N.R.C. within 30 days. How many times prior to March 28, 79 were there accidental releases? I'll bet they were covered up whenever Met-Ed knew they could get away with it! (Ask Sen. Heinz.)

2-1 Why can't you just clean it up - get the core out & shut it down? I don't want any nuclear anything at TMI Units I & II.

2-3 (2.1.1.2) Water - It has been over 3 months now - has water leakage ended? What exactly does this mean: the present plant status may deteriorate?

2-5 Again = I think you must decide now wether reactor is to be dissassembled. This is an Environmental Impact Statement, not a Met-Ed go ahead statement. You people - like it or not - are supposed to protect us & the environment.

2-7 (2.1.3.1) Core Fixation (1) how do you "ensure" neutron absorbing material is distributed evenly so that criticality cannot occur? This entire paragraph is a bit scary. Can Met-Ed handle this? Pages 2-7 & 2-8 are something to worry about. Can you handle it?

3-12 Do you have data on York Haven Dam? How can you even think of putting tritium in river when complete mixing is assumed & the full flow of the river is used in determining dilution factors? Assumed!

3-21 Hospital Care - Do you have any intention of seeing that hospitals will be taught how to treat radiation exposure? It's the least you can do.

3-24 Stress - The continuing tensions seems to be related to two issues: future decontamination & distrust of you & Met-Ed & even state. This is true - but you must add to this all the stress from venting & the accident itself. The stress is still lingering & we are waiting for the next "event." As far as the

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media goes - they still have difficulty with all this nuclear talk. And they are being told to play it down. I think that is why there is minimum coverage locally. There is almost no coverage of Restart Hearings for Unit I. Talk about stress - add this to the list.

3-24 The paragraph concerning the peoples "feelings & their lack of control", etc. Is that why you made up advisory panel? If it is - you've got a lot of nerve! I will not let this panel be a pacifier. Get one thing straight "we" all know the place must be cleaned up. But don't lie to us anymore! Either tell us that you are going to dump the water & vent more of everything, or truly help us. If there are alternatives - use them! Since there is so much controversy over low level radiation - don't you think the least you can do is be on the safest side.

4-1 Any approach to recriticality can be detected? How? Do I have to worry that another human error can cause recriticality - there goes more stress (& no press is around).

4-5 Table 4.5-1. The BEIR. used is Nov. 1972. Isn't there one issued for 1979? It appears that some of your information is outdated. Especially about low-level radiation.

5-7 I don't know what your calculations mean on the dose a person would get if he ate 1/3 of his vegetable intake from his garden. I know a little about background radiation & radon

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gases. I don't feel like eating my own produce knowing there is a possibility of getting a little more of your #1 product at TMI = Radiation. I am hoping for a better environment next summer.

5-14 last sentence. Who are you trying to kid? "This could be minimized by operating only during "appropriate" meteorological conditions. Before you vented the Krypton - I asked NRC about 'meteorological conditions'. First you said 15 mph winds would be adequate - The next time I asked it was 5 mph." But they vented even when there barely was a breeze - in heavy - humid weather!

8-53 You say "compare" doses calc. to those of natural background - But I think you should be "ADDING" them together if that's the dose we are getting.

10-22 The Pa. Dept. of Agric. has concluded that as a whole - farmers living within 25 miles of TMI feel threatened or remain uncertain about their livelihood etc. Doesn't that mean anything to you? talk about stress!

10-27 One of my favorite statements in you E.I.S. is 10.7.3. So the mighty Susquehanna can handle it - what about the people & animals & vegetables that feed off the river? 10.7.4. Does TMI Qualify for this storage pool?

Mary Osborn
4951 Highland St.
Hbg, Pa. 17111
6½ miles N/W

Three Mile Island
Public Interest Resource Center
1037 Maclay Street • Harrisburg, Pa. 17103
717/233-4241

20 November 1980

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:

Pursuant to notice appearing in the Foreward to NUREG-0683, I am submitting to you the enclosed comments on the Draft PEIS on TMI-2 cleanup and disposal of radioactive wastes.

Your attention to the issues raised in these comments in the preparation of a Revised Draft PEIS and Draft Supplements to the Final PEIS will be appreciated.

I will gladly elaborate further on any of these matters with your staff if this will prove helpful.

I also expect that the Staff will take into account the comments which will be made by the Special Review Committee being established by the Environmental Protection Agency. This group of experts has been created to provide comments from an independent source.

Sincerely,

Steven C. Sholly

Steven C. Sholly
Project Director
TMI Public Interest
Resource Center

COMMENTS ON DRAFT NUREG-0683

submitted by:

STEVEN C. SHOLLY
Project Director
TMI Public Interest
Resource Center
Harrisburg, PA

19 November 1980

INTRODUCTION

These comments cover three general subject areas: (1) Editorial changes which should be made in the Final PEIS; (2) Technical, scientific, and policy comments on the Draft PEIS which should be addressed in the Final PEIS; and (3) Comments on the Draft PEIS regarding NEPA matters.

EDITORIAL CHANGES

1. The Draft PEIS is far too technical for the general public. I realize that the NRC has legal obligations to the NEPA process which require, as a practical matter, a highly technical and very lengthy document. I do believe that, especially in this matter, that the NRC has an additional and equal obligation to the public to produce a readable and complete discussion of the cleanup and alternatives.

The Commission has been criticized in the past by the Council on Environmental Quality on the nature of its EIS's (SEE "Environmental Quality--1979", the Tenth Annual Report of the CEQ to the President, pages 577-581). In the case of the Draft PEIS, this criticism seems to have fallen on deaf ears.

I can see two alternatives which would comport with the spirit of the new regulations adopted by CEQ on 30 July 1979. First, the NRC could publish the Final PEIS in two forms, one a less technical discussion which is much more readable than the Draft PEIS (SEE as an example Volume I of the Rogovin Report), and the other the typically voluminous, highly technical discussion which is commonly associated with NRC Environmental Impact Statements. The second alternative would be to produce a very tightly focused Final PEIS which meets the requirements of NEPA, but without the voluminous explanations with which the NRC seems to be the most comfortable. The more detailed explanations would then be included as appendices to which the reader could turn for more details.

2. The Final PEIS is greatly in need of much tighter editing than the Draft PEIS was given. There are some run-on sentences in the Draft that would give a junior high school English teacher a coronary.

3. The page numbering system used in the PEIS makes it very hard to use as a reference. I believe that it would make much more sense to number the pages sequentially in numerical order (e.g., 1, 2, 3, 4, etc., rather than 1-1, 1-2, 2-1, 2-2, 2-3, etc.). With a good table of contents, the sequential numbering system would make specific portions of the PEIS much simpler to locate, and thereby increase the utility of the document.

4. The reference citations appearing at the end of many sections of the Draft PEIS are totally inadequate. I suggest that the Staff envision an interested member of the public ernestly trying to locate any of the following (from page 1-17, Section 1.5):

"Nuclear Incident at SL-1 Reactor," IDO-19302.

J.M. Skarpelos and R.B. Lobsinger, "Decontamination of H Loop Following a Fuel Element Failure," HW-42081, March 23, 1956.

J.M. Lojek and W.T. Lindsay, "Attempted Decontamination of the Chalk River CR-VI Loop," WAPD, COA-AO-50, February 1959.

Obviously, these reference citations to not provide the reader with sufficient information to locate these papers. A full bibliographic citation (including name and address of publisher) is necessary.

Further, specific page references are missing entirely. Some of the referenced documents are hundreds of pages long; searching such documents for a specific fact or quotation without page citations (or even chapter citations) is impossible. In order for anyone to evaluate the PEIS, page citations to referenced documents is an absolute necessity. Such page citations must have been available to the Staff when the PEIS was prepared; therefore, there is no logical reason for not providing them to the general public.

5. The Draft PEIS is nearly devoid of visuals (photos, drawings, diagrams, etc.). Increased use of such visual aids would greatly enhance the public's understanding of the Final PEIS. Especially needed are drawings/photographs of the interior of the auxiliary, fuel handling, and reactor buildings at TMI-2.

6. The units of expression used throughout the Draft PEIS are inconsistently applied. In addition, while it is common to find both the concentration and volume of contaminated fluids, very seldom is the total activity calculated. It would be a service to the readers to include some basic appendices on units of expression and to expand the glossary to include such terms as shutdown margin.

TECHNICAL, SCIENTIFIC, AND POLICY COMMENTS

7. The Draft PEIS is flawed in major areas of concern due to a number of factors (incomplete information, incomplete discussion, artificially restricted scope, and artificially restricted assumptions about the feasibility and acceptability of alternatives). Revision of the Draft for Final form will result in very substantial changes. Some material will be included in the document for the first time in the Final PEIS if the Staff follows its present intentions (e.g., cost factors and the real transportation route to be used for waste shipments); this is clearly not acceptable procedure under NEPA.

It is necessary, therefore, that one of the following alternative pathways to a Final PEIS be followed. First (and the more desirable of the two), is to publish a Revised Draft PEIS for a thirty-day comment period. Second is to proceed with the Final to the extent that substantial revisions are not necessary. Where this is not the case, issue a Draft Supplement for public comment, then publish the Supplement in Final form. Either of these alternatives will provide the public with due process rights of comment on materials that are presented for the first time, while at the same time meeting the NRC's substantial obligations to the NEPA review process.

If it is necessary to proceed with a particular action before this process is completed (I would estimate that it would be complete by May 1981), an Environmental Assessment of that particular action could be performed. However, I do not foresee that this will be necessary (nor do I foresee that the Licensee would have sufficient funds to proceed until this time in any event).

8. The information presented in the Draft PEIS in Chapter 4 regarding the potential for recriticality does not fully address the problem. There are numerous studies related to the problem which are not even referenced in this section.

This is an extremely serious issue which merits a more detailed discussion in the Final PEIS. For instance, the Draft acknowledges that introduction of 1000 ppm borated water in the core (assuming the original configuration) could result in recriticality due to lack of control rod material. The fact that the geometry of the core was altered during the accident in a manner which will not be understood until the core can be examined visually makes this prediction very tenuous.

No mechanisms are postulated for the introduction of "underborated water" into the reactor, despite the seriousness of a recriticality accident. There two readily available mechanisms by which underboration could occur--sabotage and operator error. Neither is addressed in the Draft. Neither are the potential consequences on the environment and on the continued cooling of the TMI-2 core from a recriticality accident addressed.

9. The Draft PEIS is thoroughly slanted toward cleanup alternatives which would permit restoration of the plant to operating status. For instance, it is stated on page 2-1 that the "only" alternatives which would not affect a decision between rebuilding and decommissioning are those in the group labelled "full cleanup, salvage and decontaminate usable equipment." This is misleading and serves only the corporate interests of General Public Utilities and the image of the nuclear industry. Never in an Environmental Impact Statement from any agency have I seen alternatives rejected so out-of-hand and summarily.

It is clear, for instance, that full cleanup with equipment removal with minimal or no decontamination could be accomplished without precluding restoration or decommissioning. Decommissioning could follow directly (e.g., mothballing the facility); restoration could be accomplished simply by decontamination of the equipment.

The argument has been advanced by the NRC Staff during public meetings on the PEIS that the same level of decontamination would be necessary regardless of the future disposition of the facility. Nothing, other than the opinion of a limited number of NRC Staff personnel, has been advanced as providing a technical or scientific basis for this position. Why is it not conceivable, for instance, to decontaminate the containment sump water, construct shielding around the upper portion of the reactor, defuel the reactor, and mothball the facility until radiation levels decrease (when further decontamination could be accomplished with a much lesser exposure to cleanup workers)?

The "Tenative Outline for TMI-2 Programmatic EIS" dated 10 January 1980 and provided to the public during the "scoping" sessions, clearly indicates at section 2.2 that there was an intent to discuss the decommissioning/restoration issue, at least to a limited extent. Between 10 January 1980 and the issuance of the Draft PEIS, however, there appears to have been a change in intent and this issue was never fully developed. The issue of decommissioning/restoration is absolutely central to the entire cleanup. For the Staff to attempt to avoid its discussion is a clear violation of the spirit of NEPA.

The Staff's intent in attempting to avoid this issue is unclear--however, the obligations placed upon the NRC by NEPA are clear. The issue of decommissioning/restoration must be addressed in either a supplement (draft) or a Revised Draft PEIS. To do otherwise is to artificially restrict the scope of the PEIS, to eliminate from consideration a fundamental question regarding the cleanup, and to violate NEPA in the truest sense of the spirit and letter of that law.

10. A related concern to this issue, which also gets into the financial condition of Met-Ed/GPU, is the expenditure of funds by the company related to restoration activities while it is uncertain that there will be sufficient funding available to even complete the cleanup. The NRC should take a firm stand that until the contaminated water is removed from the reactor

building sump and until the reactor core is removed (the two main sources of potential releases of radioactivity to the environment) the Licensee should be prohibited from spending funds on activities related to restoration of TMI-2 to operating status. This will ensure that Licensee's unstable and limited funding base will be used toward its primary responsibility, which at this point in time is the decontamination of TMI-2 and the disposal of the radioactive wastes resulting from the accident and the cleanup. Absent such a stance by NRC, there is no guarantee whatsoever that the Licensee will not spend significant amounts of money on activities related to restoration. It is clear from public statements and from its own publication "TMI Today" that the Licensee fully intends to restore TMI-2 to an operating status; this should not be permitted in any form (including planning, engineering studies, expenditures for hardware, etc.) until the level of risk represented by Unit 2 is greatly reduced. In my opinion, this will only occur after the containment sump water has been processed, the core has been removed, and all high-specific-activity waste has been removed from the island.

11. The last sentence on page 2-8 states that it is possible that loose fuel debris could be present in large enough amounts in the Reactor Coolant System to present a criticality problem. This situation should be fully explored in the PEIS, including a description of how much fuel would be required to present a criticality problem, what the radiation doses to workers might be, and how the criticality problem could be mitigated once initiated. A simple one sentence description of this problem is insufficient for an EIS.

12. The PEIS should include discussions for each cleanup alternative of what potential impact the alternative could have on future options for the facility. There are at least three general possible futures for the facility:

   a. Restoration as a nuclear unit.
   b. Decommissioning alternatives.
   c. Conversion to another power source (e.g., fossil-fuel).

Blanket statements on this problem which are found in Chapter 1 of the Draft PEIS are totally inadequate.

13. The Draft PEIS fails utterly to deal with the eventuality of what could occur if the Licensee goes bankrupt during the cleanup, a possibility which certainly cannot be ruled out (in data submitted to the NRC at a meeting on 14 August 1980, Licensee notes an expected revenue shortfall to cover cleanup of over $500 million in excess of insurance coverage). This issue must be dealt with fully in a supplement or Revised Draft PEIS. It cannot simply be skipped because of Staff preference or the promise that it will be addressed in another report. The PEIS is <u>the</u> EIS for the cleanup, and as such should address all relevant issues, including the potential for bankruptcy of the Licensee and the

potential impacts on the environment and the schedule for the completion of cleanup.

14. In order that the cumulative impact of routine and accident-related releases of radioactivity can be placed in perspective, the PEIS should contain a section (perhaps an appendix) which describes the doses which have already occurred, both to the public and to the workers. This discussion should address the time period from the accident up until the period following the venting of the Krypton-85 from the reactor building. The following doses should be described as fully as possible (with ranges of uncertainty indicated for each):

   a. Average and maximum whole-body gamma doses for the workers and the public living within 20 miles of the plant (or out to whatever distance radiation doses due to the accident are indistinguishable from background doses).

   b. Beta radiation doses (whole body, skin, and inhalation) for the same persons.

   c. Alpha radiation doses for the same persons.

   d. Separation of total doses into component parts (i.e., whole body, inhalation, internal deposition, deposition on ground, immersion, etc.).

These doses and expected additional doses (as well as population doses in person-rems) should be compared both to existing standards, doses to the public from other similar reactors which are operating, and doses from the operating history of TMI-1. These discussions will permit the reader of the Final PEIS to place radiation doses from the cleanup into perspective.

15. The applicability of prior decontamination experiences at other nuclear facilities is very questionnable. These facilities were not located in populated areas, nor were they as large as TMI-2. The Draft PEIS contains many contradictory statements on this matter, so many so that a firm conclusion cannot, in my opinion, be drawn. The following statements conflict with the conclusion drawn in the Draft PEIS that "the basic technologies for decontamination are well established and that available techniques can be modified to suit the conditions at TMI-2":

   a. "experience is limited with high-level decontamination of building interior surfaces and equipment where the contamination has spread over large areas such as the entire interior surfaces of a reactor building." (page 1-12)

   b. "Applicable experience in removing damaged fuel and core components is limited, and development of techniques specific to TMI-2 will be required." (page 1-11)

   c. "Chemical decontamination experience to remove fuel failure debris, including fuel fragments, is very limited. Only one reactor, the Plutonium Recycle Test Reactor (PRTR), at Hanford, Washington, has undergone such a decontamination." (page 1-14)

d. "There has been little experience with removing fuel debris from large reactors . . ." (page 1-14)

e. "Experience at other nuclear facilities in removing damaged fuel and core components has been rather limited, and much of the existing experience is not directly applicable to TMI-2." (page 1-16)

f. "Other plants have had fuel removed after severe damage; generally these incidents have involved only a single or a few fuel assemblies. For the most part these fuel assemblies have been constructed of stainless steel-clad uranium metal fuel. The TMI-2 fuel is quite different in that the fuel is uranium dioxide pellets with zircaloy cladding, which is more susceptible to oxidation and embrittlement." (page 1-17)

g. "If significant fuel cladding has occurred, insoluble ZrO_2 could be distributed throughout the reactor coolant system. Hydrofluoric acid, one of the few ZrO_2 solvents, is too corrosive to be used as a general decontaminant; therefore, the ZrO_2 will h ave to be removed by mechanical means." (page 1-17)

h. "Commercial nuclear power plants are not designed with special considerations for large-scale decontamination operations." (page 1-17)

This issue requires much fuller explanation in the Final PEIS. More details should be given, and the applicability of each experience should be addressed.

16. In Section 1.6.1.2 (page 1-19), the Draft PEIS states that "to ensure reasonable radiation stability of the organic resin over ten half-lives, resins having specific activities greater than 10Ci/ft^3 will undergo specific evaluations to ensure that radionuclide migration and other impacts within the waste container are minimized over the hazardous lifetime of the wastes." When will these evaluations be done (after the contaminated resins are created?)? Who will do them? How will they be done? How can the physical, chemical, and radiological environmental conditions which will be present through 10 half-lives (Cs-137 or Sr-90) be simulated? What criteria will be used to perform the evaluations? What is the current condition of the EPICOR-II resins? Information available to me from outside sources indicates that the resins should be breaking down into caustic products which could destroy the resin liners. Further, this source postulates that the resins themselves are breaking down into a gelatinous mass in which the contaminants can migrate. This entire issue must be fully explored in a Revised Draft PEIS or a Draft Supplement.

17. It is stated on page 1-20 that the NRC Staff intends to address disposal criteria for "nonroutine wastes" on a case-by-case basis. This is not acceptable. Certainly general classifications of such wastes can be postulated and defined by contamination levels and by the specific isotopes which are most likely to be present. These wastes are some of the most significant in potential environmental impacts; to "pledge" to deal with them on a case-by-case basis is totally unacceptable. A thorough attempt to evaluate the environmental impact of the nonroutine wastes (and their storage and disposal) must be made. To the extent that this evaluation fails to cover specific waste forms proposed by the Licensee, supplements or environmental assessments should be issued in draft form.

18. The Staff is aware that the 11 February 1980 revised Technical Specifications are the subject of a pending litigation. It appears that disagreements between the Staff, the Licensee, and the Intervenors is possible in the near future. The Final PEIS should reflect any changes to the Technical Specifications. It would be advisable to include the revised Tech Specs as an appendix to the Final PEIS.

19. The Final PEIS should thoroughly address the status of the solidification of the EPICOR-II resins as required by Commission Order dated 12 March 1980 (Amendment 10 to License No. DPR-73). The discussion in the Draft fails to adequately address this important matter.

20. Section 1.6.3.2 addresses proposed criteria for radiological effluents from decontamination activities. The net effect of this discussion is to permit the Licensee, with Staff concurrence, to establish precedent-setting radiological effluent criteria which could be applied to future cleanup activities at this and other nuclear plants. The NRC should exercise its regulatory function and establish cleanup criteria, and then require the Licensee to meet these criteria. The criteria should be the subject of a rulemaking proceeding to commence as soon as possible.

21. Referring again to Section 1.6.3.2, I feel that it is totally inappropriate to use 10 CFR Part 50 Appendix I criteria in conjunction with cleanup. These criteria are intended for use with operating nuclear reactors, ones from which (presumably) the public receives at least some benefit. In the case of TMI-2, the Licensee's customers received the equivalent of 95 full-power days of electricity. Many of the residents in the 20-mile radius of the plant and most of the residents downstream from the plant received nearly zero benefit from the operation of TMI-2 since they are not customers of the Licensee (the only possible benefit would be power that was sold to their utility as replacement power from the Licensee). There is no positive benefit to be gained from radioactive releases from TMI-2 during cleanup, only the reduction in possible negative impacts. It is therefore inappropriate to use radiation release objectives designed for operating reactors in the case of TMI-2 cleanup.

Radiation releases from TMI-2 alone beginning with the accident have already far exceeded values given in the FES for both TMI-1 and -2. The following examples are given for your consideration:

a. Noble gas releases from the two units were not to exceed a combined total of about 4,000 curies per year. Estimates of the total noble gas releases during the Krypton-85 venting alone totalled at least 42,000 curies, or the equivalent of 10 years of operation (the venting took less than 2 weeks). Releases during the accident (as reported in NUREG-0600) were approximately 13 million curies (mainly isotopes of Xenon). The latter figure is equivalent to over 3,000 years of operation.

b. Iodine releases were to have been a fraction of one curie per year. Iodine releases during the accident are reported to have been around 14-15 curies. This is at least equivalent to 14-15 years of operation, and almost certainly much more.

22. Section 1.6.3.3 postulates the decontamination of TMI-2 to levels equivalent to those which are permitted for "unrestricted use." This will be necessary only if the plant is to be restored to operation. This is a continuing example of the bias of the PEIS toward restoration. The decontamination need only proceed to a level compatible with protection of the public health and safety, i.e., to the level necessary to permit decommissioning. If a decision is made to restore the plant, then and only then should additional decontamination be authorized. The worker exposure will be reduced by this policy, as will the quantities of contaminated water which will require processing. This bias reflected in Section 1.6.3.3 pervades the entire PEIS and should be eliminated in the Final PEIS.

23. Pages 2-1 and 2-2 discuss possible interim storage of high specific-activity and transuranic wastes at the island. There is no technical justification for this position contained in the Draft PEIS. Such justification must be included in a Draft Supplement or Revised Draft PEIS and must be fully explained, along with possible alternatives (including storage in containment at Units 1 and 2, storage at a location offsite, and storage at another facility away from a river location).

24. Section 2.1 of the Draft PEIS discusses in a cursory fashion the possible storage of radioactive materials on-site beyond the normal 30-year operating license period. Additional discussion on this matter is excluded from the Draft, according to the text, because the Staff considers that the PEIS should be restricted to alternatives that provide for complete removal of all radioactive materials from the site. While this is a laudable goal, keep in mind that this is the real world, and that there do not appear to be serious prospects for construction of a high-level waste repository in the next several decades due to political, regulatory, and institutional constraints.

Accordingly, the Revised Draft PEIS or a Draft Supplement should contain a thorough discussion of this situation, including all its ramifications. The discussion should include as a major focus the potential impacts of long-term storage of radioactive materials at the site. The attitude that "we'll cross that bridge if and when we come to it" is not sufficient in an Environmental Impact Statement. Long-term storage is a possibility which cannot be precluded simply because a portion of the current NRC Staff feels that such an action will not be permitted. The cleanup will last far beyond the 5-7 years so glibly predicted in the Draft PEIS; a completion date in the period of 1988-1995 is more likely. Long-term storage on-site of high level wastes should be evaluated for its environmental impact, not because it is a desirable alternative (which it certainly is not), but because given the current political, environmental, regulatory, and institutional climate, such storage cannot be precluded from becoming necessary. The impact should be evaluated now, not after it becomes a matter of fact.

25. Page 2-5 contains the statement that there are tanks and equipment in the Unit 2 Auxiliary Building which are needed for "maintaining the reactor in safe shutdown." This statement should be expanded upon to include a discussion of whether this equipment is safety-grade, and if not, what degree of reliance should be placed upon it in terms of preventing adverse environmental impacts related to safe shutdown loss. Further, the discussion should include possible impacts on that equipment (safety-grade or not) from cleanup activities which have already occurred or those that may occur from various cleanup activities. It is possible, for instance, that important pieces of equipment or systems may not be environmentally qualified for the environment which will be present during various cleanup activities.

26. Section 2.1.2.2 discusses, very briefly, the so-called "corridor concept" of selective decontamination. After a discussion of four sentences, this alternative is summarily dismissed. The brief discussion present in the Draft PEIS does not reflect any but the smallest consideration which may have been given to this alternative. The corridor concept of selective decontamination must be thoroughly explored, including costs, possible doses to workers involved in setting up the corridor, and environmental impacts as compared to other alternatives. It would appear that the corridor concept, if carefully planned and executed, could greatly reduce worker dose during cleanup.

27. Section 2.1.2.2 discusses destructive decontamination and scrapping of equipment rather than thoroughly decontaminating it. These two issues are again swept aside with the stroke of the pen, another obvious bias in the Draft PEIS in favor of preserving the restoration option. The consideration should be what method results in the lowest doses to the public and the workers, the least environmental impact, and the smallest amount of radioactive wastes. Both methods mentioned above are inadequately discussed, and must be further elaborated in a Revised Draft or Draft Supplement.

28. Page 2-7 contains a statement that "lack of knowledge of the reactor vessel integrity" increases uncertainty about core fixation alternatives. Lack of knowledge about reactor vessel integrity also increases possible environmental impacts from recriticality accidents, sudden pressure-temperature changes (getting possibly into nul-ductility problems), and other situations where loss of integrity of the reactor vessel could create unanalyzed problems. This entire issue must be fully explored in a Revised Draft or Draft Supplement.

29. Page 2-10 contains a statement that "It may not be possible to decontaminate some of the equipment contaminated during the accident and return it to service" (emphasis added). This again indicates a very heavy bias toward cleanup alternatives favoring restoration of TMI-2 as an operating reactor. The Staff should forthrightly deal with this issue.

30. Section 2.2.2 again raises the policy of "case-by-case" consideration by the Staff, outside of the NEPA review process, of the environmental impacts associated with specific waste forms. This is unacceptable. The potential environmental impacts from these wastes must be fully described in a Revised Draft EIS or a Draft Supplement.

31. There are several places in the Draft PEIS (for instance, Section 2.2.3.1) which discuss possible incineration of certain types of radioactive wastes. Incineration has supposedly been mentioned by Met-Ed officials as one possible means of disposing of the EPICOR-II resins (I find this rather difficult to believe). Nowhere in the Draft PEIS, however, are the environmental impacts from such incineration addressed. Are the radionuclides contained in the wastes released when incineration occurs? What types of filtration are available? What is the efficiency of the filter systems? This issue suggests quite a lengthy line of issues, yet none are discussed in the PEIS, or even mentioned for that matter. This issue must be fully explored in a Revised Draft PEIS or a Draft Supplement.

32. The discussion in Chapter 3 of the site geology and hydrology is insufficient when consideration is taken of the quantity of radionuclides available in solution at the damaged reactor. According to the State Geological Survey, there are no site-specific studies of the transfer characteristics of either the bedrock or soils found on the islands; therefore, any estimates of how fast leaking radioactive materials might reach the water table or the river are pure speculation. Site-specific studies should be conducted and reported in the Revised Draft PEIS or Draft Supplement. The question should also be addressed in terms of the continuing high levels of radioactive water (containing tritium) found in monitoring wells on the island.

33. Section 3.1.4.1 contains the assumption that complete mixing of TMI effluents with the full flow of the Susquehanna River is assumed below the York Haven Dam. The bases for this assumption should be fully explained in the Revised Draft PEIS or a Draft Supplement.

34. The Final PEIS should address the impact of water treatment on radionuclide concentrations present in river water. No information on this matter is found in the Draft PEIS.

35. The Draft PEIS fails to adequately address the impacts of release of treated but still radioactively-contaminated water into the Susquehanna River. Psychological impacts on downstream water users has been conveniently ignored. Further, there is no realistic consideration of possible impacts on the marketability of Chesapeake Bay seafood. I believe that if any contamination is detected in the seafood taken from the Bay, regardless of NRC claims as to its source, seafood eaters will take this as representing contamination from TMI, and, therefore, the seafood industry on the Bay will suffer irreparable harm. This is a very real impact which must be assessed with a fullscale market survey of both consumers and seafood industry sources. The survey must be carefully conducted and constructed so as not to prejudice the responses in any manner.

Similarly, the option of evaporation of such water through the plant's forced-draft cooling towers is inadequately assessed. Again, psychological impacts are ignored completely. No assessment is made over potential reconcentration of radionuclides released to the environment.

These issues must be fully developed in a Revised Draft PEIS of a Draft Supplement.

36. The statement in the Draft PEIS that the Susquehanna River is "not an attractive source of public water supply" (page 3-12) is pure nonsense. If this is so, why do the cities and towns of Lancaster, Baltimore, Columbia, Havre de Grace, Wrightsville, Conowingo, Chester, Safe Harbor, and Holtwood use it as a source of drinking water? How about some consistency and honesty?

37. In Section 3.1.6.2, it is noted that impacts may occur outside the so-called "study area." If this is so, these impacts should be investigated and quantified. NEPA reviews are not permitted to be limited in scope at the discretion of the NRC Staff. NEPA requires that environmental impacts be evaluated, not just those impacts and portions of impacts that the Staff "feels" like evaluating.

38. The section on psychological stress (Section 3.1.7) is pure fantasy. It was totally undermined by comments made by Dr. Siegfried Streufert (Human Design Group and Hershey Medical Center) during a public meeting in Middletown held during the Comment Period on this document. This section is nearly fascist in its orientation, placing anyone who does not accept the agency's version of the accident and its aftermath in the category of "phobic", implying that such persons are somehow mentally ill or incapacitated. This is fascism in its purest sense. It is high time that the NRC begin to deal realistically with this issue.

Why is it, for instance, that in the <u>first</u> attempt by NRC to address the problem of psychological stress that the NRC contracts with an organization whose lead staff member is also a professor at the Uniformed Services University of Health Sciences, which is associated with the Department of Defense?

NRC has an obligation under NEPA to fully and frankly assess psycholigical stress related to cleanup, and, given the utter failure to do so in the Draft PEIS, is now legally bound to do so in a Revised Draft PEIS or a Draft Supplement.

39. The Section 4.1 discussion on why the Krypton-85 was vented from the reactor building should explain why, after four months of waiting since the venting was completed, the fan coolers have not had any maintenance performed on them.

40. The Final PEIS should address how much longer so-called "mini-ventings" will be needed to continue to remove Kr-85 from the containment.

41. As a whole, in discussing possible accident scenarios, the PEIS fails to consider the possibility of sabotage. The Final PEIS should include this consideration in all accident assessments.

42. Comparison of radiation doses from cleanup with doses occurring from natural background radiation is misleading. First of all, natural background doses are unavoidable. Secondly, they are caused by different types of sources than the releases from the cleanup. The exposure pathways will be different in many cases, as will the specific type of radiation which is causing the exposure (i.e., gamma, beta or alpha). The practice of comparison of cleanup-related doses to natural background should be eliminated from the Final PEIS.

43. The assumption made in many instances throughout the Draft PEIS that all filter failures will be detected within 15 minutes is not justified by any material contained in the Draft. This assumption must be specifically justified in the Final PEIS.

44. What is the source of the Plutonium cited in Table 5.3-1? This could indicate fuel melting.

45. The discussion of waterborne releases in the Draft PEIS fails to deal in any way with bioaccumulation or any other means of reaccumulation of radionuclides following release from the plant. Simply looking at the concentration at release is not in itself sufficient to ensure minimal environmental impact. Possible means of reconcentration following release must also be examined.

46. In examining the radionuclide inventories listed in Section 6.4.1.1, if 99.99% containment of these radionuclides is assumed throughout cleanup, the following releases will occur:

a. 42 Ci of Cesium-137

b. 7 Ci of Cesium-134

c. .67 Ci of Strontium-90

d. .16 Ci of Strontium-89

This raises the question of how high a percentage of containment can be expected throughout cleanup. It would seem to be relevant to review the experiences of fuel reprocessing plants and other cleanup incidents in this regard.

47. The meteorological assumptions used in computing offsite radiation doses in the Draft PEIS (including dispersion and diffusion characteristics) should be fully justified in the Final PEIS, perhaps in an appendix.

48. Section 9.2.1.1 discusses possible radiation doses at the site boundary from a proposed onsite radiation storage area. The listed dose of 0.5 mr/hr works out to 4.4 Rads/year at the site boundary. What is the impact on site workers (person rems for the duration of occupation of the island? Further, what is the dose to the public? Even if attenuated by a factor of 100, this is significantly above regulatory criteria for the entire nuclear fuel cycle. If attenuated by a factor of 1000, it is still over two times higher than the total dose projected by the Staff for the entire cleanup.

<u>NEPA COMMENTS</u>

49. I believe that it is clear that the Draft PEIS as issued in August is so deficient as to not represent a sufficient basis for a Final PEIS without providing for public comment on the revisions to the Draft, which will be substantial. Therefore, I conclude that a Revised Draft PEIS or a series of Draft Supplements should be issued prior to the Final PEIS.

50. The Staff should acknowledge that the further one gets down the road for cleanup, the more likely it is that the Staff's projections will be in error, thus necessitating Draft Supplements on a variety of issues at some point during cleanup.

51. The practice of the Staff analyzing "best-case and worst-case" situations, rather than actual situations (even where known in the case of the Submerged Demineralizer System) is not permissible or acceptable procedure uncer NEPA. The public is entitled to know the environmental impact of specific proposals.

52. As I have made clear in letters to the Staff during the last several months, I believe that the law clearly calls for public hearings on the PEIS. The public meetings which have been held, while helpful, do not take the place of such hearings, since witnesses are not sworn, no cross-examination is possible, and no discovery can be had of the Staff or the Licensee on matters raised by the cleanup. I believe that it is a clear violation of NEPA not to hold such hearings on the PEIS. The NRC should expeditiously publish notice of availability for a public hearing on the PEIS and proceed with the adjudication of the matters raised as contentions so as not to delay cleanup while the proceeding is in progress.

November 19, 1980

555 Main Street
Bethlehem, PA 18018

Re: Docket No. 50320
NUREG E-0683

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

Dear Mr. Snyder,

The Draft Programmatic Envoronmental Impact Statement Related To The Decontamination and Disposal of Radioactive Wastes Resulting From March 28, 1979 Accident Three Mile Nuclear Station, Unit 2 is much to overwhelming and confusing for the average citizen who will be affected in the thousands by what is done with the accident's disastrous aftermath. Even lawyers and dedicated environmentalists have difficulty making sense of what is being proposed and how these proposals will really affect us. There must be a better, more comprehendable way to present material of such significant impact.

Living a little distance from Middletown (approx. 80 miles), the responses of citizens in that area are not immediately available to me. However, your assumptions that the Krypton-85 releases have increased feelings of safety and decreased psychological stress seem a little hasty and very shaky. Even at this distance the actual affect appears more to be a crushing of the human spirit -- increased feelings of helplessness and loss of control, a withdrawal to more mundane concerns, and respression of anxieties that appear to have no resolution.

The attitude of your entire document contributes to this destruction of the will to fight back, as has most official response to the accident. You continue to downplay how much people have suffered already and deny the extent of the problems facing the community in the future. You claim to have safe solutions when everyone knows there is a tremendous amount of bluff in the proposals you're trying to sell. You quietly describe your consistent uncertainty about so many of problems needing solutions, rather than delineating them clearly and seeking the wide range of support and input necessary to even begin to address these problems. Alarm by the community is appropriate, since only through that vigilant concern will these problems be faced and dealt with properly, if that is even possible. If you continue contributing to complacency, the next disaster at TMI may be assured.

To gain support your agency needs to admit the errors of past policies and separate itself from the present alliance with the Metropolitan Edison Company. Until Met-Ed's ambitions for profit at all expense are removed from planning for dealing with the accident aftermath, little hope exists for a truly community and worker safety orientation in that planning.

For your report to contain credibility you should immediately join arguments by citizen groups that TMI Unit 1 can never be reopend safely at what has now become a waste storage facility. All available resources from Unit 1 are certainly necessary to make the best possible attempt at dealing with the waste at Unit 2. Any possible uses for Unit 1 in this recovery plan seem to have been totally ignored by your report.

The cummulative doses faced by citizens due to the accidents multiple radioactives releases contaminating the public's environment to date (the initial stages, the Krypton-85 releases, the water dumpings, and other little puffs and spills here and there) should always be listed clearly and concurrently with the predictions you make for future radioactive releases, so that total impacts are readily determined.

A criticism noted early in your report seems to have been subsequently ignored. You fail to address in any clear fashion what happens if and when Met-Ed is no longer functioning as a utility. Their crippled status and lack of insight so far make them a very dangerous trustee of such an ominous situation. Perhaps, again, you should state this clearly and call for the removal of Met-Ed as a controlling interest in safety decisions and directions for the salvaging operation at TMI. Then you should present proposals for addressing the problems in that situation. (This should not absolve Met-Ed of financial responsibility, just as individual criminals are not absolved of responsibility for their deeds when hospital and health care professionals have taken over the mending of the human suffering the criminal caused.)

The citizen advisory committee established to address the TMI clean-up is certainly a beginning step, but lacks so much of the strength necessary for it to be meaningful. They should have power and funds to seek independent research, to demand the truth from officials and Met-Ed, and to function in a credible way informing and speaking for the community. The "clean-up" at TMI is such a long-term process that it will need strong input from many segments of the community for many years. That should be sought as often as possible. In fact there would seem to be no point at which a final plan could be laid out that would be so perfect as to preclude the necessity of further citizen questioning and advice.

Finally, a most serious flaw is the reality that you can really make no environmental impact statement because you do not know what to do with any of the waste. Even your "low-level" waste plans have been halted by the voters of Washington state. Again, this alarming situation has to be faced. This should be the issue of extreme concern to officials rather than the financial bail-out of Met-Ed that has Congress, the PUC and others enamored at the present. Why aren't you representing the public in seeking solutions to this enormous problem? And before responding that you are doing so, please note that any such response carries no credibility as long as you continue to promote and condone the continued production of these undisposalbe, deadly wastes.

Sincerely,

Nancy C. Tate

Nancy C. Tate

Joyce Cook
Box 70
RD #6
Hummelstown, PA. 17036

11-17-80

United States Nuclear
Regulatory Commission

E.I.S.

Comments, comments & more comments, are they really evaluated? Especially of nonproprietary nature. During the last comment period on venting, the main reasons given were: 1. Not enough time to implement the alternatives 2. Clean-up must continue without delay. 3 Met-Ed financial dilema. The monitor program was scrubbed on 11-13-80, yet only one monitor remains operating to measure core conditions. Still no major decontamination will begin until 1982.

Epicore II - The clean reprocessed water should be re-cycled & re used in future clean-up procedures. Instead of contaminating more water & creating more problems. Remember, there is a drought. Where will all this water come from.

Why would the N.R.C. allow Met Ed to spend eight million dollars, if they weren't going to approve the S.D.S. Why aren't there any NRC officials on duty from 12 midnight to 8 AM in the morning? Remember the accident took place in the morning, & consider that a violation against the public's health & well being. Accidents continue to happen delayed information is on & on. What lessons have been learned? Still the government bodies continue to play politics at the public's expense! How Sad!

The E.I.S. is nothing more than a calculated hypothesis. Conditions in the future will warrant many changes in the future, so its impossible to comment & make judgements on the outcome. The clean-up itself is very iffy.

Page 2
11-17-80

Is the restart of Unit I included in E.I.S.? Are problems & accidental releases included in the E.I.S? What about the low water level of the Susquehanna River? That will effect dilution of radionuclides.

Waste - What if DOE is eliminated? Will TMI become a permanent nuclear dump? After all is said & done, I believe it will. President elect Ragan made the statement that all waste generated for a year would fit under a desk. I suggest President elect Ragan put it under his desk.

Controlled or uncontrolled releases, no differance the end results are the same. The allowable public dose is false security for the public. If we perish, I know a good excuse will be given, such as a learning experience, benefit versus risk, progress must move forward & etc. The nuclear industry will have to deal with emotions. We are people with emotions (Justifiably so) otherwise we would be like (controlled robots.) I do get the impression that we are suppose to be & act like controlled robots unfeeling & unthinking society. Society has not reached that point yet! Thank God Phase Out nuclear power before it phases us out. The end does not justify the means.

The Bible's perditions are surely comming to pass.

Joyce Look

Union of
CONCERNED SCIENTISTS

November 20, 1980

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

Attention: Mr. Bernard J. Snyder
Program Director

Dear Sir:

I should like, on behalf of the Union of Concerned Scientists, to submit some brief comments on the NRC's Draft Programmatic Environmental Impact Statement (NUREG-0683) concerning the cleanup of Three Mile Island Unit #2 nuclear plant.

We concur with the NRC staff's view that there are no acceptable alternatives to full decontamination of the reactor and associated facilities and complete removal of the fuel. Further, we concur with the NRC's position that waste should not be shipped off-site in liquid form.

The suitability of solid waste forms for final disposal has not been sufficiently considered in this EIS. Associated with this deficiency is a lack of consideration of options for interim storage of waste, as a solid, in a manner which does not preclude eventual processing into a new solid form.

The safety of on-site storage and handling of both liquid and solid waste forms has not been sufficiently demonstrated in this EIS. For example:

(1) Section 10.5, "Potential Releases due to Flooding," does not give sufficient assurance of the integrity of the Interim Storage Facility, especially in view of that facility's reliance on compacted earth fill.

(2) Section 10.4.4, "Leakage of Reactor Building Sump Water", does not give sufficient assurance regarding retention of radionuclides in the ground. Further, as for other accidents postulated in this EIS, no person-rem dose is estimated.

If an adequate range of options regarding interim solid waste forms and storage and treatment facilities is to be examined in the final EIS, then included should be a thorough examination of the potential for off-site storage and processing.

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The limited scope of the above comments does not preclude further interest by UCS in the TMI-2 cleanup issue.

Sincerely,

Carla B. Johnston

Carla B. Johnston
Deputy Executive Director

CBJ:abc

cc: Dr. Gordon Thompson

November 19, 1980

Director
Three Mile Island Program Office
Nuclear Regulatory Commission
Washington, D.C. 20555

Comment on Draft Programmatic Environmental Impact Statement Relating to Decontamination and Disposal of Radioactive Wastes at Unit 2 of the Three Mile Island Nuclear Power Station, NUREG-0683

I respectfully suggest that the Nuclear Regulatory Commission agree to prepare and issue a revised draft Programmatic Environmental Impact Statement (PEIS) on the decontamination and disposal of radioactive wastes at Unit 2 of the Three Mile Island Nuclear Power Station -- rather than a final document at this time -- in order to include consideration of a number of options and issues which have been raised at some of the 30 or more public meetings held to date on this matter, and to include consideration of the following suggestion on decontamination and disposal of radioactive wastes, using the Unit 2 containment building as the primary structure for safe long-term storage of nuclear waste from the accident.

I suggest that a revised draft PEIS include serious consideration of the feasibility, and of the reduced radiation doses that would result from long-term use of the Unit 2 containment building to store the core and other radioactive waste from the damaged plant.

This is a reasonable option to consider because of the fact that there currently are no disposal sites to accept the Unit 2 wastes and core, and there is no reasonable expectation that such sites will be available during the foreseeable future.

The advantage of storing the core material and other wastes inside the containment building is that this structure, with its 4-foot thick walls and other safeguards, offers far more protection to the public, and less worker exposure, than would the use of the far-more fragile structures that might be constructed on Three Mile Island for "temporary" storage of the core and other wastes for the many, many years that will pass before possible sites for permanent storage are secured.

- more -

Comment on NUREG-0683
Frank D. Davis
November 19, 1980 -- Page 2

Under present conditions, it would be a fiction to contend that the TMI-2 site is not now and will not continue to be a long-term waste depository. Therefore, it would be prudent to use the existing containment building as a structure to house these wastes more safely and with less risk to the public than would be true if the core fuel and other wastes were removed to structures that would not provide nearly as much safety.

Very truly yours,

Frank D. Davis
200 Gettysburg Pike
Mechanicsburg, PA 17055

HOUSE OF DELEGATES
ANNAPOLIS, MARYLAND 21401

CATHERINE I. RILEY
HARFORD COUNTY
SIXTH LEGISLATIVE DISTRICT

COMMITTEES:
ENVIRONMENTAL MATTERS
JOINT COMMITTEE ON ENERGY
CHAIRMAN
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November 18, 1980

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

Dear Dr. Snyder:

I had indicated to you at both the Annapolis and Havre de Grace hearings on the Three Mile Island Cleanup that the Harford County Delegation would submit its comments on the Draft Programmatic Environmental Impact Statement in writing. The following remarks constitute our formal opinion.

We believe the draft PEIS is deficient in many ways. While much discussion is directed toward the eventual dumping of decontaminated water into the Susquehanna River, other alternatives are not explored to the degree necessary. The environmental impact of dumping in the River, as well as the potential impact of air evaporation are not addressed as thoroughly as we had expected. We are concerned that dumping will release not only tritium but strontium-80 and 90 and cesium-134 and 137 into the River.

The PEIS does not adequately delineate the constant need for monitoring of the contained water so as to assure the maintenance of minimum levels of contamination. Should the water be released in anyway to the environment, and even if long-term storage on site is undertaken, careful, regular on site and downstream monitoring should be standard practice.

We believe that the PEIS should contain some cost benefit analysis, which it does not. Also, we feel that the NRC must make a definitive statement to the Department of Energy, Congress and the President as to the absolute necessity to provide for a long term, permanent storage facility for the high level waste presently at the site. There is no question in our minds that waste must be removed from the island as quickly as practical and safe.

We believe that both dumping of the water into the River and air evaporation will have substantial environmental impact. The PEIS does not allay our fears in any significant way. We are concerned about any impact on our citizenry and our Bay. As the water source for Havre de Grace, Harford County and Baltimore City and a source of livelihood and recreation for so many people, we can not afford to jeopardize the Susquehanna and the Chesapeake Bay. Thus, we, the Harford County Delegation to the Maryland General Assembly must oppose any dumping of Three Mile Island water. We also must express equally serious concern about any proposed release to the atmosphere via air evaporation. Both approaches will release radionuclides into the environment at levels which have, as yet, undetermined long-range effects.

We appreciate your response to our hearing request. We feel our citizens made their point well, and we hope you fully comprehend the intensity of our concern.

Thank you very much.

Sincerely,

Catherine I. Riley, Chairman
Harford County Delegation

George B. Adams, Jr., Delegate

William H. Amoss, Delegate

William H. Cox, Jr., Delegate

CIR:B

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC WELFARE

HELEN B. O'BANNON
SECRETARY

TELEPHONE NUMBER
(717) 787-2600/3600

November 19, 1980

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

Dear Mr. Snyder:

You have requested comments on the Nuclear Regulatory Commission's environmental impact statement on the proposed clean-up of Three Mile Island. My comments will deal with the issue of psychological stress and are based on consultation with appropriate officials in the Office of Mental Health, which is under my jurisdiction in the Department of Public Welfare.

Psychological research, notably the study conducted by Dr. Evelyn Bromet of the Western Psychiatric Institute, University of Pittsburgh, indicates that for some in the immediate area, mental stress did result and continues to result from the TMI accident. While anxiety cannot be eliminated, the way in which the TMI clean-up is handled can minimize it. One point is of key importance: the need for the availability to the public of accurate and timely information which they can trust and use to help them cope with stress-producing situations.

The symptoms of stress are cumulative and can mount over time. While the clean-up itself, no matter what process is used, may prove to be stressful for some, it is certainly true that continued inaction and the containment of radioactive wastes in a facility that was not designed for longterm storage can add, on a daily basis, to anxiety levels in the general population. The best way to end stress is to eliminate the cause. Thus, the expeditious, safe and complete clean-up of existing contamination at TMI can be expected to reduce stress within the population.

I call your attention to the attached report by researchers from Hahnemann Medical College in Philadelphia. Of particular note is the finding that during the TMI accident, "people had a considerable lack of faith in the information they received, and in the quality of the reporting of that information. Approval ratings seldom reached 50%." (Page 7) The creation of effective networks to disseminate accurate information during the clean-up process is crucial if stress is to be minimized. As the NRC, Metropolitan Edison and the appropriate state agencies plan for the clean-up, effective public communication should be a major priority.

It appears essential, therefore, that the NRC must be prepared to respond quickly and completely, in an understandable fashion, to demands for information about the clean-up process, and must also be prepared to respond to any malfunctions or unexpected developments which could be stressful to area residents. For unless they have information, which they trust, that stress will increase. This can be accomplished through regular and well-planned briefings to the news media. Special care should also be given to making sure that appropriate community leaders and opinion makers are briefed and kept intimately aware of developments in the clean-up process as it progresses. These individuals, through their existing community networks, can serve as trusted sources of information and guidance for the population at large. May I say that the way in which the krypton venting was handled indicates that you already are aware of the need for effective communication with the public.

I hope these comments are of help to you in your deliberations.

Sincerely,

Helen B. O'Bannon

Helen B. O'Bannon

Submitted to:
Pennsylvania Department
of Public Welfare
Office of Mental Health

October 27, 1980

REVIEW OF STUDIES ON THE PSYCHOLOGICAL AND BEHAVIORAL IMPACT OF THE THREE MILE ISLAND NUCLEAR ACCIDENT

BY:

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INTRODUCTION

Immediately following the TMI nuclear accident, several social researchers undertook studies to determine the psychological effects of the accident, and to ascertain why people behaved as they did. Much, but not all of this work, was carried out by researchers in the vicinity of TMI. Some of the work found its way into the President's Commission Report on TMI, some of it did not. All of the research was hastily designed in order to capture the unique events as they unfolded. Most of the work was done on a very low budget. This report is a review of each of those studies in light of the others, done with an eye toward determining general trends and common findings. The purpose of undertaking the work was to be able to make recommendations for improved planning in TMI-like situations, and to identify important areas for future research.

While preparing this review, several distinct impressions emerged. First, the studies reported here form an important body of information. The accident unfolded quickly and the response of the utility, the Public and Government was in a rapid state of flux. There was a constant and everchanging stream of information exchange, action, emotion and decision-making. The picture was often confused. At the time of this confusion several studies were conducted which "caught" and recorded emotional and psychological reactions of the public. Individial memory for detail fades, and as time goes by the detailed record obtained by that research will become increasingly important.

Second, because of the uniqueness of the TMI event, there is little literature which is directly relevant to understanding the phenomenon. TMI was not a disaster in the classic sense of the term. There was no specific catastrophic event with a concrete manifestation and impact to which people had to respond immediately and in a self evident way. Further, the negative effects of the event were unknown to the TMI area population at the time of its occurrence. When floods come, or when planes crash, or when earthquakes strike, the problems are immediate, evident, and have clearly perceived and agreed upon negative consequences. Not so in the case of TMI, where the likelihood of a catastrophy was unknown, and where the negative effects of the accident were in constant debate. In addition, information conveyed to the public about the accident and decision-making on the part of officials, were embedded in a web of social, political and economic interests. That fact, combined with ambiguity concerning the magnitude of the problem makes for surprisingly little previous information which can be useful for understanding the TMI affair.

Third, there is a surprising uniformity of conclusions and clarity of trends which emerge from the various studies. This uniformity and clarity is all the more telling because each individual study is not particularly strong from a methodological

point of view. Measuring instruments were hastily constructed. Existing measures were at times used because of their availability rather than their suitability. Sampling plans were not as carefully drawn as might have been possible under other circumstances. Studies were not carefully grounded in theory or in a well developed rationale. None of this is surprising since speed was of the essence. A unique and important event was happening very quickly. Better that it be studied with less than optimal means than not studied at all.

Fourth, the findings of the various studies are reasonable and make sense when put in the context of other research which has been done on the reactions of people to disasters. TMI may have been a unique event, but the reactions of people were typical. This finding is of considerable help in aiding planners, and in determining the nature of future research which should be carried out.

Fifth, the research was surprisingly rich. There may not have been many studies to rely on but the work that was done yielded a large number of insights into the needs for planning and for the types of future study that would aid planners.

In making recommendations about future needs we were guided by a strong sense that the original accident at TMI can never happen again. There may be future nuclear accidents, but the social psychological and political climate will never be the same because TMI has affected all of us, and continues to affect us. The event is not over - announcements, reports about, and decisions at TMI are still news, and the pot continues to boil. Thus, we have attempted to make recommendations that would make sense in terms of the new social reality that would in our judgment surround a similar accident.

We are also aware of the possibilities of related types of accidents. At present many nuclear power plants are in operation, and more will likely be activated in the future. In addition to the plants themselves, one must consider accidents which may occur in the removal, transportation and storage of waste from these plants. TMI has most certainly changed the social-political context for any accident involving nuclear power.

This report will be divided into four sections. First, we will summarize the research which has been done and important findings in those studies.[1] The summary will deal with needs for information, psychological stress, and evacuation behavior. Second, we will present general conclusions which can be drawn from the data. Third, will be recommendations concerning the

[1] More research was done than is summarized in this report. We included only those studies that had an appropriate combination of methodological strength and relevance to the problems at hand, and for which sufficient data were available.

need to collect more information and conduct further research about TMI-like accidents, both in terms of social research activities and in terms of information collection through existing bureaucratic channels. In writing this section we attempted to focus on information which will allow planners to deal better with TMI-like accidents and the psychological aftermath of those accidents. Finally, we will make recommendations for planning action. This section will deal with actions that can be taken immediately, and for which further information gathering is not a prerequisite.

SUMMARY OF RESEARCH FINDINGS

Table: Summary of Research on the Psychological and Behavioral Impact of TMI

Study-Descriptive Title[2]	Shorthand Designation	Time of Study	Population
Reactions of Adolescents to the Three Mile Island Nuclear Power Plant Emergency (Part of President's Commission)	PC	May	Adolescents in the TMI area (junior and senior high school students)
Psycho-Social Effects of TMI on Nuclear Power Plant Workers (Part of President's Commission Report)	PC	August	Nuclear Workers at TMI and Peachbottom Plants
The Credibility of Government Officials in the Aftermath of TMI	G	June-July	General Population of TMI area; Mothers of Young Children, TMI and Wilkes-Barre area
Demographic and Attitudinal Characteristics of TMI Evacuees	Eliz.	April	Adults; Middletown, Marietta and Elizabethtown
Voluntary Withdrawal from TMI area of Middletown Residents	FM	April	Residents of Middletown

In the following summary, quotation marks will be used to indicate adjectives and phrases which are taken directly from the original research. We hope these quotes will give a sense of the reality of each research situation. This section is a summary of those findings which we consider to be most telling in light of our review of all the initial work that was done. Full details can be obtained by consulting the original sources. A catalogue of these sources can be found in Appendix A.

Needs for Information

Radio and television played an extremely important role in disseminating information about the TMI accident. Sixty percent of the people named radio as the prime medium for information. Forty-fifty percent named television (FM).

Opinion was divided as to the way in which the information media handled the reporting of the TMI accident. While 49% "approved" of how the media reported the event, 46% "disapproved" (Eliz.).

[2]This information is taken from a brief report we prepared earlier. That report is included in its entirety as Appendix A of the present document.

Similarly, opinion was divided on felt need for information. In one study, only 50% of the respondents claimed to have "enough information on emergency procedures" (Eliz.) In a second study, 53% requested more information on nuclear safety, while 35% wanted more information concerning evacuation, and 35% wanted information concerning happenings at the TMI site.

The following chart summarizes how various sectors of the population saw the credibility of public information during the TMI accident:

TABLE 2: % Claiming Information Source was Credible Source

	"government officials"	utility co.	Dr. Denton	unspecified source
general population	11% (FM) 21% (G)	6% (FM)	45% (FM)	57% (FM) 48% (ELIZ.)
mothers of young children	50% (G)			
TMI workers	30% (PC)	73% (PC)		

While the data from the above chart may be open to varied interpretations, it is our impression that perceived credibility of information sources during the initial days and weeks of the TMI accident was quite low. The only exception is the perceived credibility of the utility company in the eyes of utility employees, which very likely reflected the unique, common interest relationship existing between employees and employer.

Stress

A general summary of the important findings about stress reactions in the adult population surrounding TMI is presented in the following table:

TABLE 3: Summary of TMI Stress Reactions

Stress reaction	% claiming to have reaction	source of information
"felt threat to self or family"	50% (42% saw no consequence)	FM
"panic or concentration problems"	38%	FM
"severe demoralization"	26%	PC
"broke usual habits" (stayed in home, kept children from school, etc.)	18%	PC
saw accident as "very serious"	76%	ELIZ.

In addition to these general findings, several interesting facts emerged which related to the amount of stress people felt. Physical proximity to the TMI plant was important. Adults living within a five mile radius of the plant were more "upset" than those living farther away (PC). Also, adults within a five mile radius perceived the health threat as greater (PC). A similar finding emerged for teenagers. The closer they lived to the plant, the more "upset" they were (PC). These findings were replicated in another study which found that those living closer to the TMI plant tended to judge the accident as more "serious."

"Time after the accident" was also an important factor. "Severe demoralization" dropped from 26% to 15% within a two month period after the accident (PC). Similarly, the perceived health threat dropped in that time period, as did teenagers ratings of stress (PC).

Family status was also important. Mothers of pre-school children were more "upset" than the general population, as were teenagers who had pre-school siblings (PC). In addition, such teenagers experienced more somatic symptoms than peers without pre-school siblings (PC). People who were married experienced more "upset" than non marrieds (PC).

The age of respondents made a difference. Older adults perceived less of a "health threat" than younger adults (PC, Eliz.). In this regard, it is worthwhile to note that neither of these studies tapped large numbers of the very elderly.

Finally, sex played a role. Among adults, females were more "upset" than males, and also perceived more of a "health threat" in the TMI accident (PC). This finding also characterized teenagers. Females experienced more somatic symptoms than did males.

Evacuation Behavior

Three separate estimates of the extent of evacuation were obtained: 62% (PC), 53% (Eliz.), and 57% (FM).

Family related factors played a large part in determining who evacuated. Seventy-two percent of mothers with pre-school children left (PC). Another study found an evacuation rate of 48% among families with at least one child, 41% for married couples, and 28% for singles.

The age of respondents was also a factor in evacuation. In the 50+ year old group, the evacuation rate was 29%. For younger age groups it varied between 42 and 40% (Eliz.).

A final issue of considerable interest is where evacuees went. Eighty-one percent went to family, while another 9% went to homes of friends (FM).

General Conclusions

1. People had a considerable lack of faith in the information they received, and in the quality of the reporting of that information. Approval ratings seldom reached 50%.

2. There was a significant amount of stress and psychological discomfort among the people living near TMI. Although the figures do not appear terribly high, they must be considered in light of the sample of people who were questioned. A large number of people left the area, and it is reasonable to believe that those who left experienced the most stress. Thus the research reported here is likely to be biased in the direction of sampling those who experienced relatively small amounts of stress or psychological discomfort. Seen in that light, findings such as 26% feeling "severe demoralization" take on a new meaning.

3. Most people found places to go without having to resort to the efforts of the authorities or to special evacuation plans. Ninety percent simply visited friends or family.

4. People acted rationally. There was little if any panic. These results emerged from the striking parallels between the "stress" and the "evacuation" data. Mothers of young children and people with family ties left in large numbers than the general population. They also felt more stress than the general population. The same pattern held for physical proximity to TMI, and for other factors which logically would increase people's psychological discomfort or their wish to leave the area. None of the research turns up mention of wide spread panic or clearly irrational behavior. Interestingly, these findings replicate a more general finding in disaster research. Contrary to popular belief, disasters seldom result in panic reactions among the population experiencing the disaster.[3]

The parallels found between evacuation and stress patterns is even more remarkable given the rough measurements used for stress and psychological discomfort. The fact that such patterns showed up at all with such measures, and that they reflected the patterns

[3] Fritz, Charles E. International Encyclopedia of the Social Sciences National Research Council, 2101 Constitution Avenue, N.W. Washington D.C. 20418, 1968.

of evacuation, speaks strongly for the validity and the importance of the findings. Finally, the sex difference found in stress is also an indicator of the validity of the research results. There is considerable literature which indicates that women score higher than men on measures of stress psycho-somatic symptoms, anxiety, depression and the like.[4] Had that pattern not been found here, data would have been suspect.

NEEDS FOR FURTHER INFORMATION AND RESEARCH

Although filling in the information gaps higlighted in this section will necessitate the special skills of people trained in social research, some important information can be collected with existing bureaucratic resources. Where such possibilities exist, we will point them out in the subsequent section.

Credibility of Information Sources:

Who are the more or less credible information sources in TMI-like situations? More important, what are the properties of credible sources and how can their credibility be improved? The data show little overall confidence in any information source, as well as considerable diversity in credibility among various information sources. Unfortunately the data do not indicate why the overall ratings are so low, why some sources scored higher than others, or what might be done to improve the situation.

To what degree is credibility a function of informant role, informant personality, and of institutional response? There is good evidence to believe that each of these plays a part. The contribution of institutional response to the problem has been

[4] Guttentag, M. The Prevention of Sexism. In: G.W. Albee and J.M. Joffe, Eds. Primary Prevention of Psychopathology Vol. 1. Hanover N.H. The University Press of New England, 1977.

Maccoby, E. M. and Jacklin, C.N. The Psychology of Sex Differences, Chap. 5 Stanford CA, Stanford U. Press, 1974.

suggested by others. Reichlin[5] has argued that considerable confusion during the TMI accident resulted from poor coordination among the involved government agencies. The report further argues that such problems are a function of organizational structure rather than of the individual personalities involved. This conclusion is also found in the general literature on disasters.[6] The importance of organizational structure is given added credence if one notes the difficulties encountered by State agencies during a recent TMI accident practice drill.

In terms of factors related to role and personality, there is considerable evidence in the social psychological literature that these play a large part in how people perceive the credibility of information which they get from other people.[7]

Although we know that institutional and personal factors will undoubtedly affect the credibility of information in another TMI-like accident, we do not know how they might operate, or the most effective way of dealing with those factors in order to increase the credibility of information. If any future crisis is to be managed effectively, information on this topic must be discovered or generated.

Finally, one must consider the potential of existence indigenous community structures as information-giving channels during periods such as the one that immediately followed the TMI accident. Police and fire departments, school systems, churches, township offices, welfare agencies - these and many other structures might provide efficient means of conveying information viewed as credible by particular sectors of the population, depending upon the nature of the community. But how might these structures best be used or interrelated? At present, such questions remain unanswered.

Media Reporting

The research done on TMI indicates considerable dissatisfaction with how the media handled the situation, but it does not

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[5]Reichlin, Seth. Government Response to the TMI Accident - The Organizational Constraints. Paper presented to the American Sociological Association, 1979.

[6]Fritz, Charles E. Disaster and Community Therapy, National Research Council, 2101 Constitution Avenue, NW, Washington, DC 20418, 1961.

[7]Wrightsman, Larry, S. Social Psychology in the Seventies (Chap. 10), Monterey, CA, Brooks/Cole Inc., 1972.

indicate the source of that dissatisfaction. It may be that since sources of information were not perceived as credible, public dissatisfaction with the information was generalized to the media which reported that information. On the other hand, it may be that factors unique to the media themselves contributed to the low credibility of the information sources. There is little use in reporting credible information if people are dissatisfied with the method of reporting. Were there problems with the amount of information given? The timing of the reports? The reporters? The editing of the news broadcasts? These and many other factors might be involved, and research should be conducted determining what the issues might be, and how they could be managed.

Evacuation

We know that evacuees left, and that the decision to leave was related to sex, age, age of children, perceptions of seriousness of the situation, and proximity to the TMI plant. We also know that almost all evacuees went to family or friends. But we do not know how they traveled. As a first step, it seems reasonable to determine the modes of transportation that would be used if another TMI-like accident occurred. Such a study would give a sense of any strains on the transportation system that could be expected.

What would people's evacuation behavior be if another TMI-like accident occurred? The first time people went to friends and relatives, and they apparently moved reasonable efficiently. But would more people leave more or less quickly if the problem recurred? Would people evacuate more quickly, irrespective of what they may be told by those in "authority?" Given the publicity and the expanded knowledge people have about the facts surrounding TMI, such conjectures are not without substance. It is important to find answers, as changed patterns of evacuation might very well put more severe strain on transportation systems than occurred the first time, or greater strain on formal evacuation structures if they left late.

A related issue concerns the average distance that evacuees traveled or would travel. In the event of another nuclear accident, how far away would people have to be before they felt safe? A new nuclear accident may see many more people leaving their homes sooner. Also, people from a greater geographical area may go, including the family and friends of those who live close to the accident site. If such were the case, the range of evacuation resources would change significantly and be a potential source of increased stress for those close to the accident site. Government officials would be faced with a much more serious set of evacuation logistics than they had to deal with during the TMI accident.

It is also important to consider the question of who cannot evacuate on their own, what type of help they may need, where such people should be sent, and where they can be located if an evacuation should become necessary. These people would include shut-ins, the elderly living alone, and residents of a large variety of institutions (prisons, hospitals, nursing homes, residential treatment facilities, and the like). Some type of geo-coded directory should be developed and continually updated so that in the event of an evacuation, particular segments of the population are not left out.

Stress and Stress Reduction

Previous disaster research indicates that initial stress levels quickly return to normal, and that even under relatively prolonged disaster periods, there is little overt increased stress felt by the population.[8] This pattern certainly seems to be evident in the TMI situation. On the other hand, previous disaster research has not focused on the effects of prolonged low levels of stress, or of changes in people's stress thresholds as a function of a stress. Further, there is evidence that prolonged low levels of stress can have deleterious effects. Thus, it is important to ascertain whether such stress effects exist in the population, and to determine what their effects may be.

A related concern is that different sectors of the population probably experienced varying amounts of continued low levels of stress. As an example, the stress levels of teenagers with pre-school siblings did not return to normal as quickly as other groups. A recent follow-up study conducted nine months after the TMI accident suggest that this is also true of the mothers of young children.[9]

The general lesson is that the initial levels of stress in the population did not remain at extremely high levels, but that there may be continued low levels of stress which are manifest. Further, those remaining stress levels might well differ in different sectors of the population. The existence of these effects should be discovered and measured.

A related set of issues deals with reducing any low levels of long term stress which may exist. What might acheive that goal? Knowledge about nuclear power? Job flexibility? Knowing that one has people to go to in the event of another accident? In general, it is likely that stress is a function of uncertainty. Thus, it is important to determine what people are uncertain about as a starting point to dealing with the problem.

Finally, the role of social support systems in the reduction of stress should be studied. It is likely that such systems are important in helping people to deal with stress, and any plans made should attempt to capitalize on already existing social support systems.

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[8]Fritz, op. cit.

[9]Bromet, Evelyn. Preliminary Report on the Mental Health of Three Mile Island Residents. Pittsburgh, PA, University of Pittsburgh School of Medicine, Department of Psychiatry, 1980.

Social Change

Have people's interest in living near TMI changed? If they are unwilling to relocate, are they more willing to encourage their children to relocate? Will outside people be less likely to move into the area? Will any of this affect property values, a sense of "home," or any of a large number of other factors that could change people's quality of life and psychological well-being? Evidence collected soon after the TMI accident indicates that although many people considered leaving the area, few have done so and that although some suspicious changes have taken place in the real estate market, no serious economic problems have ensued.[10] It is unknown, however, how public sentiment will change concerning nuclear power or other man-made hazzards such as chemical waste disposal areas, liquid natural gas installations and the like. It is not unreasonable to assume that such proximity might affect people's perceptions of the quality of their lives, of where they might wish to live.

Another issue involves the effect of TMI on the general economic health of the TMI area. Little systematic research has been done on this topic other than an extremely preliminary investigation by Flynn and Chalmers.[11] At the time of the study no factors were detected which might have long term negative economic consequences. (In fact there is even the possibility that the money needed to clean up the TMI facility might have a salutory effect on the economy.) Still this data is extremely tenuous, and the likelihood of longer term problems should not be ignored.

It is also important to determine whether TMI altered people's priorities for social or political action. Given the furor over nuclear power, this question might have considerable impact on the social and psychological functioning of the community, on the stress that people feel, and on the general quality of life for people who live near TMI. It might also have profound effects on the decision making climate in which government must function, on the types of people who get involved in government, on the lobbying pressures which will exist, and on the will of the people. Some evidence suggests that such a change is already taking place. We know that there has been an increase in the TMI area in the number and level of activity of anti-nuclear

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[10]Flynn, C. B. and Chalmers, J.A. The Social and Economic Effects of The Accident at Three Mile Island Seattle, Mountain West Research Inc. 1979. (See especially sections 4.3 - 5.3. These authors mention a pending long range study of real estate values in the TMI area, but give no further information other than Pennsylvania State University as the site of the research.)

[11]Flynn and Chalmers, OP. CIT.

pressure groups.[12] We also know that the general level of political involvement in the population is relatively high, and that it is related to georaphical proximity to TMI.[13]

Finally, has TMI stimulated the emergence of new groups (both formal and informal)? Has it changed association patterns for friendship patterns in the community? Has it brought about a new set of community leaders? Previous studies of disasters indicate that such changes do take place, but the "staying power" of those changes has not been carefully researched. Since decisions relating to TMI have and continue to cause public controversy, and probably will for some time to come, TMI related social changes may be permanent. Also, they may result in new relationships between the Public, Government and Utilities. All of these changes may have considerable impact (positive and negative) on stress effects, on people's ability to cope, and the way in which people organize their lives.

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[12] Flynn and Chalmers, OP. CIT.

[13] Houts, Peter S., Miller, Robert W., Tokuhata, George K. and Kum, Shik H. Health Related Behavioral Impact of the Three Mile Island Nuclear Incident, Part 1 Pennsylvania Dept. of Public Health, 1980.

RECOMMENDATIONS FOR PLANNING ACTION

It is clear from the previous section that much important information is lacking, and that maximally effective planning cannot take place without more being known. But it is also true that specific steps can be taken by planners with the information that is now available, and that those steps would considerably enhance Government's ability to deal with TMI-like situations and to manage such crises when they occur.

The recommendations in this section emanate from specific facts which were uncovered by those who researched the TMI accident. In brief, those facts are:

1- The telephone can be an extremely important tool for the collection and dissemination of information during crisis situations. Many of the studies reported here relied on the telephone as their main data gathering tool. The experience of these researchers was that people will answer their telephones, and that they will volunteer considerable information concerning their needs, feelings, and beliefs. In addition, it is significant that during the entire TMI accident, the telephone system continued to operate.

2- During the TMI accident people acted reasonably on the basis of what they believed was true and how they felt about it. Most were suspicious of instructions and information they received, and many were willing to evacuate. Thus government leaders were faced with a situation that made it very difficult to "artifically" manipulate people's staying or leaving their homes.

3- Left to their own devices, the organizations in charge of managing TMI-like crises are ill-prepared to do so, both in terms of disaster planning and inter-organizational coordination.

4- Concerns about family members played a major role in determining people's attitudes and behavior concerning evacuation.

5- Considerable segments of the population are able to evacuate on their own, and have places to which they can evacuate themselves to. On the other hand it is clear that many people do not have the ability to evacuate at will, nor do they have an obvious place to go.

We believe that these facts dictate that the following actions can be taken:

1- A system should be developed which will quickly allow government officials to use a "random telephone survey system" in order to:

A - monitor citizen needs and activities during a crisis,
B - evaluate where plans concerning evacuation are being carried out effectively,

C - assess public beliefs about the adequacy and credibility of information they are receiving.

If appropriate random representative sampling is used, several surveys could be taken each day without fear of bothering any household more than once. The actual numbers of calls needed in any given survey would be relatively small, and the precise number could easily be determined with the advice of an expert in survey research. Finally, the length of each survey could be quite short. Each call should take no more than 10 - 15 minutes, if questions are carefully chosen.

2 - Plans should be made to coordinate the dissemination of public information about the crisis. Given turmoil in such situations, the pervasiveness of the media, and the number of people and agencies that can become involved, it is not reasonable to channel all information through a single source. Still, particular highly credible officials should be designated, and all efforts should be made to channel the dissemination through as few of those sources as possible. The public should be knowledgeable about information dissemination plans before the crisis.

3 - Information should be compiled as to which members of what community organizations would be willing to serve as information conduits, and how any system involving them might be activated in a crisis. As an example, how might information about a nuclear accident be transmitted to local police forces, and how might the police be used effectively to answer people's questions about the latest events?

4- A review mechanism should be established to make sure a.) that people are given the best information available, and that b.) they are told precisely how reliable that information is. The assumption must be made that in the short run people will act rationally if told the truth, and that such a policy will in the long run establish the credibility of information sources.

5 - Plans for evacuation should consider how to bring families together. This must involve coordination with schools and with work places. If this is not done, considerable telephone use and travel time may be wasted by people who want to unite themselves with their family members.

6 - A complete and updated list should be kept of all institutions that house people who cannot or should not evacuate on their own, including those in prisons, hospitals, residential treatment facilities, geriatric homes, and the like. The list should be maintained by whoever has overall authority for evacuation plans, along with specific plans as to where such individuals are to be moved and how.

7 - Specific plans for the evacuation of small children and their mothers should be established. This should involve education of such parents as to the necessity of their evacuating, this in turn suggesting the need to have a pre-established destination and means of getting there.

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Summary of Research Completed on the Psychological Affects of the Three Mile Island Nuclear Accident. *

Prepared by:

Jonathan A. Morell, Ph.D.
Hahnemann Medical College and Hospital
112 North Broad Street
Philadelphia, PA 19102

For:

Department of Public Welfare
The Office of Mental Health
Division of Planning and Evaluation

* Many of the studies listed in this summary contain much data which has not been analyzed, or has not been analyzed fully. All research reported here has, however, analyzed data to the point where some conclusions can be drawn.

Population, Time of Study and Principal Author	Discriptive Title	Methodology	Summary of Findings
4. Residents of TMI Area, Primarily Within 15 Miles Time: July 23-August 6 Author: Flynn	Telephone Survey of Resident in the TMI Area	Structured Interview, Carefully Drawn Random Sample n = 1500	Considerable amount of stress and upset immediately after the accident and continuing during time of study (Summer, 1979). Local Information sources (media and officials) were most trusted. Approximately half of respondants were not satisfied with information. Satisfaction increased with increasing distance from TMI.
5. General Population of TMI Area, Mothers of Young Children, TMI Area, Mothers of Young Children, Wilkes-Barre Time: June-July Author: Goldsteen	The Credibility of Government Officials in the Aftermath of TMI	Structured Questionnaire, n's for each sample: 494, 428, 368	Very considerable distrust of government officials and utility company statements concerning safety, the true magnitude of the problem, et
6. Adult Populations of Middletown, Marietta and Elizabethtown Time: First Week of April Author: Kraybill	Demographic and Attitudinal Characteristics of TMI Evacuees.	Phone Survey, Random Sample n = 290	Younger people more likely to evacuat Proximity to TMI also a factor, people living closer more likely to leave. Evacuees felt more negative than non-evacuees about TMI, nuclear power, etc. Little faith in information given about accident. In general, approval rates run about 50%.

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SUMMARY OF COMPLETED STUDIES

Population, Time of Study and Principal Author	Discriptive Title	Methodology	Summary of Findings
Adolescents in the TMI area (junior and senior high school students) Time: May Author: Bartlett	Reactions of Adolescents to the Three Mile Island Nuclear Power Plant Emergency (Report Prepared for President's Commission)	Structured Questionnaire n = 632	Affective domains measured. Ordering as follows (high to low): concerned, worried, disturbed, anxious. Psychosomatic symptoms also measured. Reported overall symptoms: headache 23%, loss of appetite 18%, increased eating 13%, others at less than 10%.
Residents of Carlisle, Children and Adults Time: April-September Author: Bechtel	Social and Psychological Effects of TMI	Open-ended, Anthropological Interviews n = 500	Only cursory data analysis is available. Evidence suggests a lot of stress among population.
Nuclear Workers * at TMI and Peachbottom Time: August Author: Dohrenwend	Psycho-social Affects of TMI on Nuclear Power Plant Workers	Structured Questionnaire	In general, workers had more trust in plant officials than did the general population. Their trust in other public officials matched that of the general population. TMI workers were more demoralized than Peachbottom workers, perhaps as a result of public attitudes. Unlike general population, demoralization did not return to norma

*This study is part of the technical staff report on behavioral effects to the President's Commission. The findings of some of the other studies on this list were also reported in the President's Commission Report.

Implications of Completed Research

1. Present research indicates that the TMI accident led to a considerable amount of stress among the population. It is important to monitor the longer term effects of that stress as they relate to mental health, the way people behave, and their attitudes towards political and social issues. The data also indicate that stress and its effects was not uniform across all sectors of the population. Thus, differential stress effects on various groups (young, old, mothers, power plant workers, etc.) must be taken into account.

2. The data indicate a good deal of mistrust of information that was given out during the TMI accident. In addition, local information sources seemed to be more trusted than other sources. It would be extremely useful if the dynamics of "trust in information" among the population could be studied. These studies should be done for the purpose of determining how information about TMI could be transmitted to people in an efficient, accurate and believable manner.

3. Evacuation behavior is not consistent across all social or geographical sectors of the population. It would be useful to know more about this phenomenon so that appropriate and timely evacuation can be carried out when necessary. Non-evacuation or premature evacuation can cause serious problems. Studies should be conducted which would lead to minimizing such behavior.

Population, Time of Study and Principal Author	Discriptive Title	Methodology	Summary of Findings
7. Adults (Taxpayer List) in Newberry Township Time: April Author: Newberry Township Board of Supervisors	Newberry Township Study: Need For Health Monitoring Study	Telephone Survey, Closed-end Questionnaire and Elicitation of Spontaneous Responses	Strong interest in health monitoring project, assurances of safety notwithstanding. Belief in President Commission Report: Yes / No Complete: 13% / 49% Truthful: 25% / 42% Factual: 30% / 30%
8. Adults in Middletown Time: First 3 Weeks of April Author: Smith	Voluntary Withdrawal From TMI Area Among Residents of Middletown	Structured Phone Interview, 123 Respondents Systematic Sample	Evacuation seems related to faith in information givers. Those who evacuated had least amount of faith in those who gave information about the accident.

Additional Studies

In addition to the studies listed above, other studies were done which for methodological reasons are highly suspected. Descriptive titles of these studies are listed here in order to give a sense of the types of issues that people saw fit to study.

1. Utilization of Mental Health Services during the Four Months After TMI.
2. The Impact of TMI on Demand for the Early Childhood Intervention Program at Holy Spirit Hospital.
3. Emergency Room Utilization during the TMI Aftermath.
4. The Effects of TMI on the Attitudes, Behavior and Adaptive - Coping in Young Children.

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Bibliographical Information on Completed Studies

Bartlett, G.S. Reaction of Adolescents to the Three Mile Island Nuclear Plant Emergency (Report prepared for the President's Commission on the Accident at Three Mile Island) Hershey Medical Center, Department of Pediatrics and Behavioral Science, 1979 (Commission Report available through the U.S. Government Printing Office).

Bechtel, D.R., Kassovic, J., Kassovic, M. and Malmsheimer, L. The Reaction to the Reactor Accident - A General Population Study, Unpublished Manuscript, Department of Religion, Dickenson College, Carlisle, PA, 1979.

Dohrenwend, B.P. et al. Report of the Task Group on Behavioral Effects to the President's Commission on the Accident at Three Mile Island, 1979 (Commission Report available through the U.S. Government Printing Office).

Flynn, C.B. Three Mile Island Telephone Survey: Preliminary Report on Procedures and Findings. Mountain West Research Inc., Seattle, 1979 (NRC Contract #04-78-192).

Goldsteen, R., Schorr, J.K., and Martin, J. The Credibility of Government and Utility Officials in the Aftermath of Three Mile Island. Paper read at the Annual Meeting of the Pennsylvania Sociological Society, University of PA, November 2 - 3, 1979.

Kraybill, D.B., Buckley, D., and Zmuda, R. Demographic and Attitudinal Characteristics of TMI Evacuees. Paper read at the Annual Meeting of the Pennsylvania Sociological Society, University of PA, November 2 - 3, 1979.

Newberry Township Board of Supervisors Newberry Township Study on Need for Health Monitoring. Address of Board: RD 2, Box 4, York Haven, PA 17370.

Smith, M.H. The Three Mile Island Evacuation: Voluntary Withdrawal from a Nuclear Power Plant Threat. Unpublished Manuscript, Department of Sociology and Anthropology, Long Island University, 1979.

Citizen Comments
NUREG 0683 .
November 19, 1980

The Draft Programmatic Environmental Impact Statement is a plan to clean up TMI. That sounds good, and at public meetings everyone has agreed. We are making a mistake. I don't believe that is what we want.

I am reminded of the statements made by the Governor's Commission on TMI. "Clean it up," they said. And then they went on to elaborate, "by venting the Krypton, the sooner the better."

The Krypton is cleaned up all right. It's not around to bother anybody in the containment building any more. That's because we've got it in our air and maybe in our bodies. And you make more every week.

Cleaning that place up and containing the radioactivity can be two entirely different things. We should not be mislead into proposing and supporting the superficial goal of Cleanup. What we are really talking about is HOW BEST TO CONTAIN THE LETHAL BYPRODUCTS OF A CLASS 9 ACCIDENT.

You admit - and we know - that you don't know what is in that plant. We know that everything you say in those 500 small-print pages is based on a guess - an educated guess, yes - but because this has never happened before, a guess really no better than mine.

That is why I resent your devoting page after page to outlining the environmental impacts down to the last millirem x 10^{14}. Couching your guesses and your gambles in scientific jargon does not make me any safer or protect me any better from genetic damage, degenerative disease or cancer.

I give you credit for trying, but let's be honest:
--You don't know what is in there
--You don't know how to get it out of where it is
--You haven't invented anything safe to put it in when you do
--You have no safe way of getting it to where you might put it
--And you haven't a place to put it when you get it there.

That waste isn't going anywhere, so let's start talking about the safest way to protect and maintain it where it is. Of course this is a lousy place to leave these wastes. Believe me, I am the first person to want it out of here and as far away as possible. But where? How? You declared the Susquehanna River Basin a Sacrifice Area the moment you allowed the first pencil to be put to the first plan.

We know the monster is cooling down now. It has structural protection we can't buy (the containment); it has mechanical protection (decay heat system); it has chemical protection (borated water). Why don't you discuss how to maintain that Containment building and that reactor vessel rather than considering putting it in barrels in makeshift bunkers on a flood prone lower island? Why suggest a No Action option without maintenance?

That waste is not going anywhere - not to Nevada or Washington or South Carolina. It is not going to disappear, not for hundreds and thousands of years. You can concentrate it, dilute it, vent it, disperse it, dump it, repackage it, compact it, store it, fill it with cement, or move it from building to island to state. But it is not going away. The PEIS talks only about the above manipulations. We want it contained and maintained.

Some of your suggestions are practically obscene. Take evaporation from ponds to create a radioactive fog in a stagnant air basin inhabited by 100,000 people. That is a solution?

When you were challenged in hearings about solutions of this type, you usually replied by stating that this was not your first choice among the alternatives you presented. Why then are they presented at all? What is the PEIS supposed to be doing - brainstorming all sorts of wild ideas, or presenting viable alternatives which could be implemented by the licensee? In addition, are you honestly suggesting he pick "none of the above." I'm confused.

If you are truly brainstorming, then let's include everything. Let's include polluting the Chesapeake Bay and its food chain for thousands of years, perhaps even destroying the eco-system of the whole East coast. If you are really going to present Worst Cases, let's include Recriticality and wiping the Commonwealth of Pennsylvania off the map. They did it with stored waste in Siberia - it could happen here.

The PEIS proposes to be a serious scientific document, but it has a few lapses (like putting TMI in Lebanon county on the map). More importantly, you cannot say on one page that you may release anywhere from 30,000 to 300,000 curies of radiation and on the next page say it will produce exactly 1.6 millirems. Does a variable that diverse produce an absolute figure?

Even if I accept your figure, you've left out a lot of exposures. Just how many waste truck drivers with how many loads, driving cross-country, will get how much exposure? Protesting that they do it at their own risk begs the question. How many members of the public may stand three feet from those trucks at how many stoplights and for how long? How close will those police escorts ride? How many accidents will happen in how many crucial places? Can you be sure those casks will drop less than 30 feet? That they won't be defective? Who will clean up those accidents and how long will it take them? How about those wooden boxes of noncrushables- don't they break open in accidents? And how much radioactivity is contained by a wooden box anyhow? Have you counted the people exposed as they load and unload and guard those shipments - and for how many hundreds of years? And lastly, how many generations of people living near Hanford and Beatty and Barnwell did you include in that offsite exposure?

How can you confidently state that offsite exposure won't add a significant amount of radioactivity to our bodies? What is significant? You have no base line to know how much we got before the accident. You never publicly discuss what exposure we got from those two operating plants (except to say that we got much less Krypton last summer than we'd normally get from an operating plant).

You confirm that every day Peach Bottom discharges radioactivity into the Susquehanna "which meets safe drinking water standards." Every weekly operating report cites liquid effluents released from Unit I "within limits specified by the technical specifications." How much safe radioactive water is too much for the people downstream to drink?

Where are the studies you have done since the accident on our physical health? Where can I read them? I don't want to hear statistics on what I should have gotten or how much I would have gotten if I divided my dose up with everyone who lives 50 miles from here. I didn't.

At the very least give us objective evidence that the people who live within sight of those "damn chimneys" did not get more than they should have had already. Confirm this not by statistics, but by close and continuing monitoring of their health. Then let's talk about the significance of additional exposures.

I shudder at every mention in the PEIS that says you will limit exposure to As Low As Reasonably Achievable. I know what that means-it means we'll try to keep it down but if we can't do what we want without overexposing you-tough.

I don't like reading that the dose I will get from a particular operation is o.k. because if it were divided up over a whole year it would be within safe limits. Because in the next sentence you say it won't be divided up over a year. It will come out in one blast which may be 500 times greater than that safe level. That's statistics, not my life and my health. That's an Alice in Wonderland environmental impact statement.

Don't misunderstand. I don't want that reactor to go critical. When you say you must fix a fan and put in a new monitor, I say do it. If you have to drain out some of the water in the sump to keep the electrical system from conking out, go ahead. We're willing to discuss taking those risks. But can we be positive you are not crying wolf? You told us you had to vent the Krypton to fix those things. That was June and it's now almost December and nothing has been fixed.

How about a real environmental impact statement that deals with the safest healthiest way to decommission this monster, not just clean it up? I am insulted by a PEIS which pretends to say how my government will best protect my health and safety - while offering MetEd a cafeteria of options detailing how it can best dump radioactivity into the air I breathe, the water I drink and the ground I grow my vegetables in.

Beverley Davis
200 Gettysburg Pike
Mechanicsburg, Pa. 17055

pssu
Local 668, SEIU
AFL-CIO, CLC

November 21, 1980

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

Dear Dr. Snyder:

We have just become aware that the Nuclear Regulatory Commission's draft programmatic environmental impact statement, NUREG-0683, contains no discussion of potential worker exposure for the entire clean up at Three Mile Island.

We view this as a very serious omission which reflects an inadequate consideration of radiation dangers to those workers who are now employed at Three Mile Island, as well as to the many more who will be employed at Unit Two during the long and potentially hazardous clean up process.

We regret that we have missed the announced period for public comment on the draft EIS, which passed on November 20. We need, however, to point out this very serious omission.

We look forward to seeing a revised draft that will address our concerns, upon which we can comment.

Sincerely yours,

Andrew L. Stern
President

ALS:red
UEU-Local #1

pennsylvania social services union • 1037 maclay street • harrisburg • pa 17103
andrew l. stern, president • jane perkins, secretary-treasurer
717•234•4113

Rec'd 11/24/80

I have read the Draft Programmatic Environment Impact Statement extensively and attended the meeting of the Nuclear Regulatory Commission on Oct. 6, 1980 at Hensel Hall, Lancaster. I became very upset at that meeting for several reasons.

First of all, I strongly believe the least amount of additional radiation the population near Three Mile Island receive during clean-up is the best and safest way to proceed. No one knows how much radiation was released during the first two days of the accident, because, as I understand, the records are missing. Therefore, it would apply, that all estimates of total radiation dosage the population will receive with the accident and clean-up are invalid. So, what kind of game are we playing? To even consider, let alone okay the possible release of 700,000 gallons of water with traces of cesium, strontium, and tritium into the river is a great injustice to the people of this area. To continue to store high level radiation wastes on the flood prone Susquanna River is ridiculous. Surely someone on the staff preparing this document can remember the floods from Agnes during June 1972. Or, perhaps it has been too long ago?

During the meeting on Oct. 6, my anger reached the boiling point when I read on a slide and was told by a staff member of the Nuclear Regulatory Commission that my stress has been alleviated now that the krypton gas venting is over. Let me tell you this is not so. I have been concerned about nuclear power plants for many years. I had my third child in my home that has no electricity on March 28, 1979. I left my home on March 30, 1979 because of the accident at Three Mile Island. At that time and now I am very angry at the Nuclear Regulatory Commission and Metropolitan Edison Company. It is your inability to regulate and operate this so called "safe" industry that has disrupted my life. The accident itself put me through the worse physical and emotional anguish I hope never to experience again. My husband and I have had marital counseling. The need to not subjugate my children to the consequences of your folly force me to want to leave my home and family in this area. We cannot because of finances do this. I have the radio on most of the day so I don't miss any news. I can't sleep at nite for fear something will happen and I won't know until morning. The idea that radiated water might be dumped into the river that is five hundred yards from my house is unthinkable. I swear sometimes, I think if it comes to that, I will not be responsible for my actions. People can take only so much abuse before they strike back.

Let's start a precedent of people and environmental concern, not utility concern. The utility companies are there to provide a service, not, to take advantage of the people to make money. Let's act responsibly and find a disposal site for these high level wastes that we have now. And, let's stop producing these wastes only to allow them to sit in the back yards of the population who are unfortunately living near nuclear power plants.

Please be sensitive to my

concerns. I don't enjoy going to all these meetings and writing letters all the time. However, I must try my best to protect my children and your children.

Sincerely,

Karen Adams
R.D. #1 Annville, Pa.
17302

NUREG-0683

18 November 80

US Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sirs:

This letter deals with the EIS, Environmental Impact Statement, A publication of the office of Nuclear Reactor Regulation - N.R.C. This comment is to be considered with other public comment concerning changes on the Draft. Please consider my comment as it comes before the November 20, 1980 cut-off point.

I attended the November 10th meeting of the NRC and interested public held at the Forum in Harrisburg. I was told the meeting was to deal with changes on the Draft. Very little was said about the EIS. I obtained a copy of the document and I can't help but feel the document is not made to help the public to understand the cleanup procedures and situations, rather to confuse the public, discourage them and bide for time. Also it appears that the NRC do not understand fully some of the points they discuss and this makes an already bad situation worse.

I beleive the best delivery of a statement is simple, due to a clear understanding of complexities.

I have several suggestions. First, Make a second draft of the EIS. It is obvious from a study of the present draft that putting it into a final printing would be highly ineffective and premature.

As that is highly improbable (a second draft), I have several suggestions concerning making the final copy;

1. The language and Technical figures should be brought to a high school level, as most people affected and concerned are in that status. There should be clear explainations of tables and maps, as to clarify clouded points and issues.

2. The table of contents is very hard to read. Provide headings and subheadings in different size print and separate chapters in an organized fashion, lending continuity to the document and yet breaking it into clearly distinguishable parts.

3. Print should be larger. People with poor vision can't possibly read it. Even people with good vision can't read it for an extended period of time.

4. A more complete index. The one in the draft is pitiful. An index of mathmatical terms, nuclear terms, and Business terms.

5. A more complete glossary.

6. Verify where your info comes from. Back up statements with verification of source. Footnotes would be handy for this.

7. Show an explaination on the figures used to reflect radioactivity; Rem, millirem manrem, hr. rem, etc.

-4-

Thank you for considering my comment. I hope the Final EIS is a far cry from the draft for two reasons. One, it's about time people are given clear factual statements. Two, because if it goes out like it is now I feel the NRC should be highly embarrased. Who knows, maybe you guys will surprise me!

Sincerely,
Alana Hunter
Alana Hunter
421 Spring Street
Middletown, PA.
17057

amh
copies made

6860 Parkway East
Linglestown, Pennsylvania 17112
November 19, 1980

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulation
Washington, D.C. 20555

Re: Draft Environment Impact Statement
Three Mile Island, Harrisburg

Dear People:

As a victim of the accident at Three Mile Island, my only comment for the *Draft Environmental Impact Statement* is not one of "expert opinion." I speak on behalf of the many in the 100 mile radius of Three Mile Island who attempt to garden or farm in an organic* fashion. Surely there is no area on this green earth exempt from man's (and in this case, it is truly "man's" doing) pollution - in the soil, air and waters. Yet in Pennsylvania, we have the only environmental constitutional amendment in the nation that states:

> "The people have a right to clear air, pure water, and to the preservation of the natural scenic, historic and aesthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustees of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people."

Need more be said? The impact on the local environment is and will continue to be atrocious. To deny that the levels of radiation will not affect the health of our children, livestock and pets is plain stupid. Certainly a person doesn't have to have a degree to realize that everything in this world is connected. Everything causes a reaction. Radiation, gases of questionable safety, chemicals - all has a huge negative influence on living organisms.

I beseech you to move gingerly with the clean-up of a messy situation. I beg you to consider the safest way to avoid any unnecessary exposure to the environment.

May God guide your way.

Sincerely,
Debbie Fetterman
Debbie Fetterman

cc: Mr. Gus Speth, Executive Director of Council on Environmental Quality
Congressman Allen E. Ertel
Congressman Bill Goodling
Three Mile Island Alert

*As defined by Webster's New Collegiate Dictionary (3a-2) - Organic: relating to, produced with, or based on the use of fertilizer of plant or animal origin without employment of chemically formulated fertilizers or pesticides.

City of Lancaster
Pennsylvania

Arthur E. Morris
Mayor

120 N. Duke St., P.O. Box 1559 17603
717-397-3501

November 19, 1980

U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTN: Director, Three Mile Island
Program Office

RE: Comments on the Draft 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

Dear Mr. Snyder:

We believe the EIS is deficient in the following four areas:

1. Cumulative radioactive discharges. We believe that the EIS should include a detailed discussion of the cumulative radioactive discharges to be expected in the Susquehanna River in the next decades. Particular attention should be given to the cumulative radioactive discharges to be expected from nuclear power plants operating and soon to be operating. Only against this background can the effect of any future discharge from TMI Unit 2 be evaluated fairly. Our concern involves both the total Curies present in the water, plant life and animal life and the radioactivity levels, past, present and future.

2. Disposal alternatives. In paragraph 5.2.2.2 of the EIS, eight process water disposal alternatives are mentioned, but several of these are discarded summarily. We believe the following alternatives should be elaborated upon:

   (a) Release to the air via natural evaporation from a pond.

   We disagree with the statements concerning the viability of evaporation as a disposal technique. Our own experience with evaporation of water reservoir sludge indicates

   that natural evaporation from a pond would be feasible (evaporation of approximately 1 million gallons per year from a 53,000 SF pond, 265' long by 20' wide by 7' deep). However, even if one accepts the statements and conclusions concerning equivalent evaporation and rainfall accumulation, it must be recognized that they apply to the volume of water rather than the amount of tritium. Depending upon the time of year evaporation begins, weather conditions and similar factors, the tritium levels should be reduced to 35-50% of the original amount in a 12 month period. If radioactive decay is also considered, a storage period of 2-3 years would reduce the tritium level to below 10% of the original amount.

   (b) Solidify with chemical agents and ship to licensed burial ground.

   No increased risks are specified for this alternative, and no details are given as to possible methods of handling and transportation. These details should be provided, and subject to comment.

   (c) Solidify with chemical agents and retain on site in solid form as a concrete slab.

   Again, no increased risks are specified, and no details are given about handling. Any problems known to the NRC staff should be specified in detail, and subject to comment.

3. Psychological stress. We believe the EIS seriously underestimates the psychological stress which will be experienced by water users downstream of TMI if processed radioactive water is released to the river. We believe that 20% to 40% of the people in Lancaster will experience significant long-term psychological stress if accident-generated water is released to the river. Because of City concern and customer reduction, pumpage from the Susquehanna facilities was reduced from 12 MGD to 8 MGD after the TMI accident. We feel that the release of accident-generated water would result in a long-term decrease in customer use of our water. A recent University of Pittsburgh study indicates that long-term psychological stress has been underestimated by previous studies of the accident and its aftermath. (See the attached article concerning the study). We strongly urge that local release to the river of processed water be rejected as an alternative.

The psychological stress which would be experienced by a large proportion of local residents would be unacceptable.

4. Costs of alternatives. We assume that at some point the costs of various alternatives will be considered. Estimates of the costs of the alternatives should be specified in detail, and should be subject to public comment.

We support the rejection of the "no action" alternative. The indefinite use of the TMI site as an uncontrolled waste storage or disposal facility is totally unacceptable.

The above matters should be addressed directly, clearly, and in detail and the Commission's draft comments on such matters should be subject to public comment.

Sincerely,

Arthur E. Morris

Arthur E. Morris
Mayor

AEM/dj
enclosures

NOTE: Referenced article is not attached since it is copyrighted.

Rec'd 11/24

William E. Long
4622 Tamer Drive
Hbg., Pa., 17111

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Wash. D. C., 20555

Dear Sirs,

I wish to express my concern in regards to the "Draft Environmental Impact Statement".

Experts have detailed the inadequacies of the operation of Three Mile Island, the lack of concern by the NRC for the public and the misinformation by both the nuclear industry and public utilities. Daily more people are learning about the myths of commercial nuclear power. They also are discovering the truth about alternative, renewable energy. This basic knowledge will lead us away from dependency upon giant electrical generating plants. Self-reliance and renewable energy will save us from the problems of nuclear power. This change will be more rapid when government and utility officials recognize and acknowledge the truth about renewables and the nuclear myths.

Very simply, TMI-2 should be cleaned up properly with no regard to cost, but with utmost regard for the people and environment in the affected area. TMI-1 and 2 should never be allowed to reopen, and all other nuclear power facilities should be phased out. It is very important that energy and utility officials acknowledge and learn about the alternatives to nuclear, oil, coal and the other non-renewables. Only then can meaningful energy policies and activities be fulfilled.

Thank you.
Sincerely,
William Long
William Long

P.S. The federal gov't. and utilities should finance the clean-up.

DR. ALLEN PETERSON (Tr 9): First, I'd like to just read for the record an article that appeared in "The Intelligentsia Journal," Lancaster paper, Friday, October 31st, 1980, entitled "Long-Term Depression Prevalent in Mothers Living Near TMI Plant." And I just want to read a couple of paragraphs from this article for the record: "Many mothers of young children living near the scene of the nuclear accident at Three Mile Island suffered long-term depression, according to a study which contradicts previous findings that mental stress resulting from the accident was short-lived." "I think" -- this is a quote now from the physician who did the study: "'I think our study shows that they were wrong,' Dr. Evylin Bromit of the University of Pittsburg said at a press conference Thursday." And I quote again: "'There were long-term effects.'" Once again, I quote: "'25 percent of the mothers at Three Mile Island showed clinical levels of depression or anxiety during the year following the accident,' Dr. Bromit said, adding that '12 percent of those with problems sought professional help.' Research will continue over the next three years to note the duration of the mental problems. "The study was commissioned by the National Institute of Mental Health, at a cost of about $375,000. "Pennsylvania's Welfare Department called the study 'the most authoritative and detailed' of any so far completed on the health effects of the nation's worst commercial nuclear power plant accident." At the Lancaster meeting, which I could not attend, there was a recommendation from someone there that there be a public meeting such as this held at a local place after Met Ed has suggested what to do with the water from TMI and after the Commissioners have decided what to do also. And I would like to also add my plea for such a meeting. Mr. Collins, I think that at that meeting in Lancaster a question was posed that you were not able to answer at the time, and hopefully you can now. And the question is: Does the present Clean Water Act prohibit discharge of radioactive waste into navigable rivers? I would like to make a plea that the treated water not be released into the river. Your reason for not wishing to solidify the waste water, as given in Section 513, and I quote: "This option would require the reactor site to be qualified as a low-level waste disposal site." I would like to point out that TMI is already a high activity waste disposal site by default. Certainly, solidification will take up some space on the Island. But I think the major problem to Met Ed, of course, would be the cost. I would rather that the water not be released, as the health consequences of radioactive wastes are not fully known. The fact that within a month of the release of the EIS you had already increased the risk of cancer deaths and genetic defects by a factor of one and a third adds to the uncertainty of the situation. Your assumption of calculating a linear dose-effect curve at low and lower doses -- at lower and lower doses -- is an issue that scientists have now completely agreed upon. Some feel that it's reasonable. Others feel that the bulk of radiobiological evidence indicates that for low linear energy transfer radiation, the

linear extrapolation is too conservative. This is according to Arthur Upton, who was recent Director of the National Cancer Institute. In the past we have heard false promises from the old AEC concerning any fallout in Nevada and Uath. We've also seen past, quote, "safe," end quote, levels of pollutants in every new industry, and these have become obsolete with time. Do you honestly understand our concern? And I'll open that up to anyone who would like to comment, and specifically on the solidification of the treated water, but anything else you would like to comment on also. Does anyone here have any data on release of tritium in the months we are talking about into human beings and follow-up data thereon? I am talking about, is there any known data in the literature concerning imbibiding water with concentrations of tritium such as we will see if this water is released into the water? Is there anything on the books, anything scientific? That's all I have concerning that, and I would like to get on to another subject, if I may. This is concerning solidifying or stabilizing and solidifying the radioactive cesium in the Epicore-2 resins, which is a completely different thing than solidifying tritium. And I would like to read to you for the record some of the conclusions from a Brookhaven National Laboratory report which I have received. I understand that this report is not being quoted with great openness by the NRC. It is entitled "Status Report on Leachability, Structural Integrity and Radiation Stability of Organic Ionic Exchange Resins Solidified in Cement and Cement with Additives," dated May 1980, by R. E. Barletta et al. And this is more or less a summary from their report: "The first stage Epicore-2 resins from TMI-2 will have cesium 137 activities, approximately 40 curies per cubic foot, that are about 1,000 times greater than the concentration guides for shallow land burial sites. The total inventory is equivalent to about 20 years production by a pressurized water reactor such as TMI-2." Some of their conclusions include -- and there were others, but I chose those that I thought might be more pertinent: One -- and this is from the Brookhaven National Laboratory, I might add -- they weren't able to find any study which answered the questions they felt pertinent to shallow land burial for this high specific activity and quantity of the first stage TMI-2 resins. Two, they were not able to find leaching data on samples larger than about one liter. The two types of TMI-2 containers are about 1400 liters and 4800 liters. The literature on vermiculite and ziolite additions to cement-resin waste mixtures is, quote, "promising but sparse." Four, the fundamental processes causing radiation damage in resins are not understood. TMI-2 resins would undergo significant decomposition specific to resin type. A moderate level of gas generation as a result of radiolysis will occur. Substantial liberation of radioactive cesium from resins will occur immediately after mixture with cement. Number five, they believe this type of resin waste should be treated by thoroughly understood more stringent waste management procedures. I would like to combine that, if I might, with one paragraph from a source entitled "Inside NRC," October 6th, 1980: "In March 1980 GPU President Herman DeCamp warned that it might prove difficult or impossible to solidify the Epicore-2 resins left from decontamination of difficult" -- I'm sorry -- of 500,000 gallons of, quote, "intermediately contaminated waste," unquote. Last month's "Inside NRC" says: "Researchers in the waste solidification field are urgently warning that radioactive decay of isotopes stored in 49 of the 69 canisters on the site may be causing the resins to degrade from a granular form into a jelly or molasses-like matter that could emit gases and, due to high acidity, may corrode the carbon steel containers rapidly. Uncertainties about the quality of the epoxy coating of the metal-lined containers adds to the concern that these resins will soon be a critical radioactive waste problem at TMI, one for which the research community lacks solutions other than the possibility of on-site incineration. "Each canister is believed to contain 1,000 to 1300 curies; in all, some 50,000 curies, mostly cesium 137." Would anyone like to comment on what I have just said conerning the solidification of cesium". My next question, do you have a centralized registry of the migrant nuclear workers' radiation exposures? In other words, as they traveled from state to state, as one plant closes down to be cleaned up, I'm just wondering how this is followed so that these people are not overly exposed, or at least it can be recognized in time so that they can be told at the new facility that they cannot work, because they have already reached maximum exposure. Since the citizens of the state of Washington have voted to allow non-medical nuclear wastes to be placed in their state, what is your alternative to transferring low-level wastes there, taking for granted that the courts will not overturn the democratic wish of the people of the state of Washington? I just have two short questions, if I may. Is it possible to run a nuclear power plant on the site of high activity waste storage outside of spent fuel pools, with the existing regulations within the NRC at the present time? And my last question. I am just wondering where the Epicore-2 resins are presently being stored today at TMI.

DAN PEFLY (Tr 24): My question would be relative to the conversation here with reference to the disposal sites. I would like to know the economic feasibility of the Metropolitan Edison Company to seek, at the costs probably necessary, sites in the western part of the country to dispose of this irradiated material. There's talk now that they're going bankrupt. I mean, they have to raise their rates, double their rates now, as far as service to their customers is concerned. What assurance do we have that they are going to be given a choice to get into this? If we the taxpayers have to foot the bill to dispose of the material, then you fellows who have the technical knowledge should be the ones to make the choice and not the deflunct and sorry, but incredible company at this particular point. I look at TMI as a hazardous waste disposal site. You know, your spent fuel cells are here. Your unspent fuel cells are stored in crypt that was constructed for that purpose; are a potential hazard to the community if something would happen to that crypt. So they're no different from the chemicals that were wasted in Love Canal. They're no different than the chemicals that were probably disposed of in Devil's Swamp in Louisiana or in Charles City, Iowa, or in Henderson County, Tennessee, perhaps as reported in New Jersey, Elizabeth, New Jersey, as current, you know, as April the 20th, 1980, and in various other sections of the country. And really, when we

get into this, you know, I think it is ridiculous to sit here and tell the people that Met Ed is going to be given a choice as far as the choice is concerned, as far as the costs are concerned. Hell, we are interested in getting rid of the stuff and disposing of it in the safest method. And however you're going to do it, you know, let's do it in such a manner that they are not going to be able to take a part of it and flush it into the river or send it into the atmopshere.

PAULA KENNEY (Tr 31): I have one short question to ask you, and that is: You have asked us to give you our comments, and I would just like to know, are our comments going to have as much weight as they did concerning the venting of the krypton?

JANE LEE (Tr 33): I want to address something to you, first Mr. Gilinsky. I sent a letter to all of the Nuclear Regulatory Commissioners regarding an incident on 83 where two nuclear chemical trucks were traveling and sprayed a gentleman and his 12-year-old son's car, when the gentleman tried to pursue the truck to call to the attention of the driver that his car had been sprayed with some debris, he had to get his car up to 80 miles an hour and was unable to catch that truck. He didn't even get the license number. I received a reply from the public relations, a man by the name of Ingram, informing me that my letter would be forwarded to the NRC office at TMI and that there were no provisions within the Nuclear Regulatory Commission to take care of shipments. I have real problems with that. I also have problems with the idea that we write to the Commissioners, some of whom I believe are genuinely concerned about what is going on down here, also the violations prior to the accident. I think there are a few. Unfortunately, they are outvoted on the NRC. My reservation is, we write to you, but you never see our letters. It's the same way with the President of the United States or anybody else. What becomes of our country when we get to the point where we know that our lives are in danger, that the children's lives are in danger, there is no one responding, there's no one watching the store? Then what? How long can we endure as a democracy, as a nation with a Constitution of the people, by the people and for the people that guarantees us life, liberty, and the pursuit of happiness, when it is all eradicated, when we continuously watch the bureaucrats with their blinders on, suffering from tunnel vision, who continuously respond in a cold-blooded manner and wipe everything away with a wave of the hand as if, who are we, we are expendable? All though these hearings, all we have heard, all that has permeated through the discussions -- and I have attended many, many of them -- is environmental impact. What is an environmental impact? Is it to establish how you are going to try to fix Unit 2, to clean it up? I always was under the impression that an environmental impact was to discover what is in the environmental, so that we can establish what is already there, to make a comparison to the damage. We don't even know what happened or what was in the environment prior to the accident. There is a very superficial report, just so everything is in order, let's go by the book, fellows; let's make sure we've got it in file. It doesn't make any difference whether we actually did it or not. Just make sure it's on file. Now, I've talked and I've talked and I've talked, before the accident even happened, about what is going on in the environment. And I have yet -- and I am still waiting for the first person to come down other than Mr. LaRoche from the NRC. I am waiting for the first government official on the state or the federal level to come down on the west side of the river and try to ascertain what is going on with the animals. Now, we have animals going down there, who have gone down, who suffer from muscle deficiency, who were born blind. We have a woman on the east side who had dogs who were born without eyeballs, multiple hairline fractures, waterlogged bones. We have animals with constricted uteruses, constricted birth channels, animals who are retaining their placentas and refuse to release them. We have animals who have been born dead, aborted, kittens in four different fetal stages. And I could go on and on. And I am telling you gentlemen here right now that I had people in my home who were born and raised on farms, who are appalled at the story that I'm telling them. Why is it that the report that was put out, that I only received today -- I haven't even had a chance to read it. People are calling me up and saying, open the book, look Jane, look what they're saying. Well, they can damn well say anything they want. The fact of the matter is you people do not know anything about low-level radiation. You haven't taken your blinders off to find out. You refuse to come into the environment and find out. And even when we tell you, you go back to Washington and you distort everything that we say.

ANN SESSA (Tr 42): How many nuclear plants around the country we have going right now, fired up and going. And how many more by the end of next year? And how long has the longest one been in existence, the one we just phased out down there because it did its job? Now, the other plants, now well over 100 going to be by the end of next year are nuclear plants. And still, we have no repository for nuclear wastes. Still, it took an accident. Still, it took 18 months. And we are sitting here tonight saying, what are we going to do with this hot baby, where are we going to get rid of it. And we come down with a great answer, that we're going to dump some water in the Susquehanna, into the drinking water of the people of this area, of Maryland, and the way downstream into that delicate area called the Chesapeake Bay, which is the spawning ground for all of our seafood, where temperature can make the difference in what lives and survives. I'm asking you: Why can we have faith in that, when I could have come up with that plan, with no education, with no nuclear background, back in 1957 coming out of high school? I could have said, if you have water in the way throw it in the river. Now, we were going to take this repository, this material, up in Washington, until they decided they didn't want it. Now our next feasible alternative plan is to take our hot water, clean it up so that we say we should believe you now that it's clean enough. We have never, as far as I know, done this before. Over in Russia, as I understand, they tried to bury some material in a hurry. And you want us to stand still for this. And that is what we are saying, gentlemen. It's not that we are saying you're lying. What we're saying is you don't know any more than we know. And this is a dangerous, dangerous thing you're proposing to get the thing over with. We all want it over with. But what we are doing is creating crazy, insane schemes to clean it up in a hurry. My God, we have to live with it. We have to live what that thing down there. We are scared. But I don't want to pollute the air and the water and everything else that goes to my progeny when I leave, because I wanted the fast way out. And that is what I am saying to you men. Can't you say why? Why was it going to be Washington until the referendum was passed? Where do we deposit it

now if we don't go to the water? I mean, that's the big problem. That's what I'm saying. We have not solved this problem. We keep loading these things, and when they get the okay even more will be started or built. But we haven't solved problem number one, which is when -- and gentlemen, this is the first, I keep telling you, nuclear -- it is not your last; it's your first accident. When do we solve the problem of what we do with this terribly hot material, this radioactive material, when you should have had that solved before you put the first plant in operation. That's why we're coming to you for the answer. Why isn't it done, why wasn't it done? I can see up to the accident. But why are we, 18 months after the accident, still scratching our heads saying there is no solution? There really is no safe depository. But we haven't even come up with a feasible plan that we can offer to these people for hope. And you want to pollute their water. I can't even imagine, after what we have taken in the air here and what has gone on here and what we have been through here, that your solution is, if we didn't get you the first time, guys, we're going to get your water.

AL MADDOCK (Tr 53): You have a plant in upstate New York that's been shut down for six months. It's in trouble. You have a plant under construction in Texas that you fined the utility for poor quality control, poor workmanship, in other words. You turned around now, because of the referendum in Washington, and make Three Mile Island a bigger dump. And I'm telling you, it's a mess. But you've been listening to us for quite some length of time here now. Now, I would like to listen to you. What are your plans for 1981? What are your safeguards, what are your risks, where are you going? We know where we're at. You're in trouble. But where are you going? What are you going to do for us? Don't go beyond the year 1981. Let's just take the year 1981 and tell me what you're going to be doing in 1981. You've been here long enough now, like the rest of the people have been telling you, to have some kind of a plan shaped up here. What are you going to do in 1981?

CARROLL S. EUELL (Tr 64): Are the rods in the reactor up or down? Are they in the reactor or are they pulled up out of the reactor? Do you have condensers to cool the surrounding liquid around the reactor? Do you have any condensers on that reactor to cool that surrounding liquid down?

JAN EMERY (Tr 69): We have been talking about evaporation. Unfortunately, everything that -- we can evaporate things, but it isn't going to only be water vapor that comes up from the evaporation, is that correct, no matter what method you use? And then there is the compatible, combustible trash on page 535. It says 99,000 cubic feet they expect in the auxiliary and fuel-handling building. Page 663, 45 to 150,000 cubic feet in the reactor building. And page 843, 35 to 100,000 feet in the refueling and the primary system decontamination. And the EIS says, we assume that 75 percent of the compactible trash can be burned. Actually, what it says is, we assume 25 percent of it cannot be burned. Page 674, Table 6.618, is offsite total body doses for trash compaction and trash incineration. Now, since this is in the chapter that deals with the reactor building, I assume this is in the reactor building. It gives a dose for inhalation and vegetable consumption. Do you want the page again? 674. Now, the doses do not seem large because, if you read it, it says millirems per drum. One of my questions is, is this per drum before or after burning, because there's 5700 drums before burning and 430 drums after burning? Is this dose per drum before or after burning? What are they talking about? Here's another very small point. On page 1027, which is just about the last page of the document itself, paragraph 10.7.3, because -- now, this is right out, quoted directly from your EIS: "Because of the rapidly renewable nature of the Susquehanna River and the regenerative powers and vast dispersive capacity of the atmopshere, the use of these resources to dilute and disperse the effluents of chemicals and radioactive materials from the cleanup of TMI-2 is not considered to be represent irreversible or irretrievable commitments of these resources." But what about the resources of the people?

MARY OSBORNE (Tr 73): Are all the environmental impact statements basically the same? Do they cover the same studies or whatever you people have to do? Is there anything different about one EIS than the other? What about the cumulative effects, though? You know, nobody has ever told me what was released the first two or three days. But I heard on TV, okay, so maybe I can get this finally answered -- there was a number mentioned, 13 million curies, and I think it was xenon. Okay. The first two days, that stuff was highly potent, okay. So what about that? Was that stuff taken into consideration? Was that a true number? Well, is it possible to get more radiation six miles out than three miles? Is there any possible way that it could have been in between your monitors? Because I saw -- and I picked over a dozen mutated flowers. And I've lived in this area, that particular area, over ten years and that has never happened. And every year we have picked those same flowers. So to me I just feel that, you know, that's what happened. And you're saying, you know, it was so well dispersed. But why would that happen?

KAY PICKERING (Tr 83): What process or processes do citizens or citizens' groups have for input into the cleanup process as decisions are made by Met Ed and then approved by NRC, step by step? How will we know all the things that are laid out, how Met Ed makes decisions, and then what goes into NRC approval or disapproval? The hearings are something that we've been asking and asking and asking for, and we have not had an answer. I am anticipating hopefully that there will be hearings and that there will be hearings soon, and that there will be hearings at each point. It is really crucial. I know at this point you don't have more people here, because most people believe decisions have been made and that facilities are being built down there to implement those decisions that Met Ed wants to see happen on down the road in the cleanup. People actually fully

believe that. If EPA, NRC, DER want to believe or help people believe that any other process is going to happen, you will actually have to show us step by step how decisions are made, get input from citizens in a hearing process, and show that those things that Met Ed has gone ahead and done sometimes are irreversible and not wholly based on financial decisions. Well, it is important that we have the information and that it be dispersed to citizens' groups. I think that you have built up a list. You are increasing your list. I think it is important not to let down. As much information as possible should get out. It is important to have advisory meetings that are open to the public. You have to do it in a multitude of ways. I mean general meetings. There haven't been any hearings or hearings planned on the PEIS, as I understand it. I mean general meetings and hearings.

MRS. RANDALL (Tr 87): On the waste issue, I've been around with Mr. Collins on this before, and I beg his time one more time. I've been around with Mr. Snyder. High-level resins, stage-one resins in canisters of questionable integrity, which the Brookhaven report says may be leaking, which the other report says the epoxy may not be working, that 30 to 90 days after it is in there the cesium comes unbound and is floating around, I guess in some kind of a gelatinous mass. It sits in an area where there might be a big flood. If the flood -- which the data they're using is eight years old. If the flood is bigger, which it's got to be because there are more bodies and more driveways in this area, it will give it a continuous water path and the crud will go down the river. If the crud goes down the river you'll lose the bay. It's obviously not any good. When I asked Mr. Collins and I asked Mr. Snyder in Lancaster and Havre de Grace and at other meetings, where are these high-level wastes going, they said, why don't you write to Mr. Charles Duncan, Secretary of the Department of Energy. The Nuclear Regulatory Commission, in this house with no outhouse at the time of this accident owes to this neighborhood, owes to the United States of America, a solution of the wastes issue now. I don't want to be told that, as a housewife living in Lancaster, it is my responsibility to write to Charles Duncan at DOE and to ask him if he would please open a military dump, or if he would please designate a deep geological repostory. How many years later? 1957. Would you please, Mr. Gilinsky, sketch for us, where are the wastes going, who are we supposed to be writing to while we would rather be reading children's stories at home, what is the time frame? Will you assure the people in this room that the radioactive wastes on a flood-prone island in the middle of the river will be gone, and will you put a time on it? And if you can't do it, will you tell us where we are supposed to be going with our anger and our worry and our concern?

DON HOSTLER (Tr 99): One thing that you should realize is that it's very difficult for the people to take that large volume and really digest it. I think you can see some of the frustration tonight. And I've shown the document to many people and said, I'd like you to take a look at this, take a chunk of it and see what you can do with it. And I even had trouble going through parts of it. And it's very, very difficult, single-spaced. People with visual problems won't even try to tackle it. And I think it's rather disjointed. I have a couple questions and then I'd like to say a few things. First of all, Mr. Collins, I guess you can decide to decommission or restart TMI-2. So let's say you decide to decommission it. I guess the preferred immediate way would be to mothball it? If you would decide to mothball it, which would probably be the easiest, I suppose, of all of the other decommissioning possibilities, would you reduce worker exposure to a degree than if you would try to recommission it? And then the second thing is, like on the cost estimates -- you know, remember during the venting, this thing about selective absorption. Met Ed said in their thing it was like 20 million, and then finally the figures were coming out, courtesy of Congressman Ertl, and I guess it was 8 to 10 million. I don't know if my figures are right, but anyway it was reduced. And what I am getting is, when you come out with these cost estimates in the final, you know, you've got a lot of cynicism here, a lot of frustration, and I can't say that I would believe any of those cost estimates unless somebody independently could verify that they were accurate, because probably those estimates are coming from the utility, is that right? But I'd just like to say a few things here on the PEIS, on page 10 -- chapter 10, page 24. For example, here it says: "The start of the purging" -- they're talking about the krypton gas -- "was well-publicized, so that persons concerned about long-term health effects could leave the area." Well, that's not true. Some people did not have enough money to leave the area. Some people didn't know where to go. A lot of people were prisoners in their homes for several days. Also, you say here that: "Radiation mapping and damage assessment inside the reactor building, the next phase of the decontamination, should have no psychological effect on the people." I disagree, because every time Met Ed goes in there they keep saying things like: Hey, we could get No. 2 on line. There's a good chance that it isn't damaged that bad. And I'll tell you, that is really damaging psychologically to the people of this area. That brings me to another thing. I'm just saying, like you state in here, going in here doing radiation mapping and assessment won't have any psychological effect. Well, I'm sorry, it does when Met Ed comes out with these glowing statements about there isn't as much problem in there as was originally though. Well, now the other thing: "Including Epicore-2 processing of contaminated water has been in progress for many months, with little apparent concern to the population." The program is that the last public meeting was held in March at the Liberty Firehall -- I'm sorry, it occurred one day after the Liberty Firehall meeting in Elizabethtown. It was a DER meeting. From March until September there were no public meetings. Yes, you went to Kiwanis Clubs and all that kind of thing. But the point is that a meeting where Jane Lee can come to and Judy Johnswood and people like that, and can ask questions, that the press can jump on and dig for more information, and get the kind of things we need to know, those kind of meetings were not held. And that's why there wasn't much concern about Epicore. We had no forum to go to. And I think, Mr. Gilinsky, what

you were asking one of the other ladies was important. I think a meeting about every six weeks, like DER was holding, would be great, where you have Met Ed and you have NRC. You might only get 50 or 60 people, but people are -- it's something that Robert J. Lipton calls the denial syndrome. The people are denying that this kind of thing is happening, and they say, oh, well, they're going to reopen it anyway. And that's a big problem that we all have here. Another thing -- well, let's see. I'll skip that. Okay. Then on chapter 3, page 24, this Mr. Dupont, who evidently is a psychologist -- there's a quote in here on page 324: "Dupont, however, says that worry of what-if reflects a general nuclear phobia, amplified by national TV news coverage." Well, I think a "what-if" is what's going to happen with this highly radioactive waste. It looks like it's a what-if situation to me, and I think we ought to know about it. And the final thing is the last sentence on chapter 3, page 24: "The degree to which the community believes it has some control over TMI decisions will have a significant impact on the public's perception of future events at TMI." And first of all, I don't see how anybody can have control, when they try to read this big green thing. And the second thing is there just aren't any public meetings like this, where questions can be asked of the utility and of the NRC by the people are really care. That's what's important, the people who really care. And there are a lot of people who care, but they say: Look, I'd rather stay home and read my daughter stories at home, I'd rather rake the leaves, because I know the government's just going to run right over you anyway. But I don't think that one -- I don't want that thing reopened and I want it cleaned up. And that's a very prevalent attitude in this area. But I don't think Dr. Struford has done very many clinical studies, which a group in Middletown is prepared to do, to prove that we've got a problem here.

Comments made by ANNE VALSING of the LEAGUE OF WOMEN VOTERS appear as comment number 56 in this appendix.

AL MANICK (Tr 9): There are basic flaws in the environmental and impact study that would invalidate the entire document. We urge the NRC to prepare a new draft that will be acceptable to this committee and the citizens not only of Maryland but all the citizens who are involved or will be involved in nuclear energy. On your slides you somewhat boast of the only 2.2 increase in cancers. Whether they be an increase in this disease of cancer deaths I do not know. But this I know for certain: that we must and will decrease that 2.2 figure to zero for future generations. We want the plant shut down for nuclear energy. May I say this issue is further compounded by the waste water problem. The best that the NRC can hope for is that while experimenting with the waste water it may be possible to come up with some solution that may work. So I hope you can meet this problem. However at the present time you, the NRC, are doing a lot of groping. At the present time you do not know what you are doing. However you knew very little of the problems in dealing with this accident.

BEN SLOAN (Tr 12): I would like to address Section 7.2 of the PEIS. In there you consider various alternatives to processing of the primary water system. I believe you consider various alternatives including EPICOR II filter/zeolite/resin. However it seems you did not include various modifications which could be made to the EPICOR II system which would include some type of prefilter/zeolite/resin system in EPICOR II for processing of primary water. It would seem at this time that if the NRC did permit EPICOR II processing of the primary water that it could be done in a short period of time, essentially probably somewhere in the period of nine months to a year before any decision is probably made on the SDS. Could somebody comment on that?

JOHN SMITH (Tr 14): Dr. Snyder last time talked about the waste problem. He said there was a possible court challenge to challenge the referendum in the State of Washington and that Hanford would not become available. I think at this point in time one gets the distinct impression between a rock and a hard place regarding disposition of waste. We have the military who doesn't want the waste mixed in with its military waste. So I am wondering at this point in time, Dr. Snyder, (inaudible). What I would like to know at this point in time is where are the wastes going to go on disposition. They can't go to the military. They can't go to Hanford. They can't go to Barnwell. Where are they going to go?

FRANK THOMPSON (Tr 18): Just a bit of a followup question to his. Cleanup is projected now to take until when, 1985 or '87? When you go to work on the core you will have a large quantity of high level radioactive material. It is becoming clear to me and I believe to most of us that nuclear dumps are going to be a problem in the future and citizens such as ourselves are going to raise our voices and say "not here." You answered part of his question about low level radioactive material dumping. I don't believe you have any answer for high level radioactive material. We in Middletown are afraid that TMI will be very convenient and it will be stored on the island in the middle of the Susquehanna and we don't want this. I would

like to know what is the answer. What are you going to do with that high level radioactive waste? You say we don't know, maybe by '85 we will figure that out.

BARBARA HIVELY (Tr 21): On October 20, 1980, Middletown area residents gathered here to address the subject of the draft Environmental Impact Statement with representatives of the NRC and the Environmental Protection Agency. That meeting was arranged by P.A.N.E. and provided area residents with the opportunity to express their concerns about the cleanup of TMI. Many also attended a similar meeting held by the NRC on November 10 in the Forum Building in Harrisburg. Some others traveled to Lancaster on October 1st, 1980 to attend the NRC meeting hosted by the Susquehanna Valley Alliance. Still others attended the NRC meeting in mid-September at the Swatara township building hosted by Three Mile Island alert. P.A.N.E. sincerely hopes that the NRC heard the people's comments, criticisms and suggestions at those meetings and that the NRC staff will use them in preparing the final PEIS. In September 1979 P.A.N.E. petitioned the NRC to be admitted as an intervenor in the TMI Unit No. 1 restart hearings which are currently under way. P.A.N.E.'s only contention was to provide testimony on the psychological stress which has been caused by the March 1979 accident and will continue until Unit No. 2 is safely cleaned up and TMI is permanently closed as a nuclear facility. During the 13 months since September 1979 the NRC Commissioners have neither accepted nor denied the psychological stress contention. We find this inaction to be for abhorrent. Concerns about the psychological stress were considered in both the environmental assessment on the decontamination of the containment atmopshere of TMI Unit No. 2 and in the draft EIS on TMI Unit No. 2 cleanup. In fact it has become the most talked about "non-issue" in all the discussions about Three Mile Island. The presence of psychological stress in this area cannot be denied. Area residents must have a strong voice heard by the NRC and heeded in shaping the future actions of TMI. These actions will embrace our lives for the next seven years and beyond. The NRC shows a callous disregard for the people of this area by holding tonight's meeting which was first publicized this past Sunday as only three days ago in a newspaper in Lebanon, Pennsylvania, 25 miles from here. It was not in our local newspaper. During the past week there have been two NRC-related meetings held in Harrisburg. Why was there no announcement made then at that time about tonight's meeting?

ANN SESSA (Tr 26): I want to know under what the NRC operates? Is it a law? Was it established by Congress? And if so, why wasn't there, why isn't there a provision put in there that any utility that generates an accident, say of a 3 dimension automatically loses control of that facility until after the cleanup and the NRC and the Government people step in. What we have now and what is throughout the area here is the utility proposing things well in advance of what you gentlemen say you will do. For instance in Lower Swatara Township meeting Mr. Arnold stood there and said we will vent and the bottom line he gave us was: it doesn't matter whether you like it or not. When we get the NRC's approval, then we will vent and we horsed around for months but they vented because it was the cheapest, easiest way to do it. Now you are asking the utility to govern themselves, to escalate their costs for the common good and when it hits the pocketbook they are not going to do it. So I am asking you if you truly are a government agency, when they generate a 3 accident, which isn't supposed to happen we all know, why don't they lose control? Because God knows they didn't have control in that whole accident down there. And why doesn't someone step in and say here is where the buck stops? Because what we have in meeting after meeting is Dr. Snyder saying we don't want to see that water dumped in the Susquehanna but if Met Ed proposes it we are going to have to take it into consideration. And geneltmen, that sets my head on end, because I came to you and said, "Do you have a rubber stamp?" Do you remember that, Mr. Collins? And you very blithely said, "I don't have a rubber stamp." What I meant and what I mean tonight is when the money speaks is that who you listen to or are our kids and our safety and our family important? And if they are, why in heaven's name would we allow these utilities to govern their own cleanup in this tragic accident? I am really concerned about this. It struck me last week when we were talking about it, when they had the newly elected Citizen's Counsel talking about it and it always came down to that: well, we have to take into consideration. The other thing I wanted to ask you Commissioners is does that not go back to Met Ed until the fifth commissioner is appointed? In this regard wouldn't the case go back to Met Ed with what they can and cannot do without your fifth commissioner? Do you see what I am saying? We are going to wait until January. We are going to waste months. We are going to appoint a commissioner who is going to acquaint himself with all the facts. We are going to waste some more months. I have the feeling we are going to do what you wanted in the beginning. It wish it was changed. I have seen it happen one time before.

MICHAEL CORRIGAN (Tr 42): I heard Mr. Ahearne say that his role, the NRC's role for the Environmental Impact Statement was to look at all the options and people's comments were very important. In the Environmental Impact Statement if you were looking for all the options, why don't you address the issue of decontaminating by decommissioning the plant. That is a viable option and that would be very cheap. Why not? Secondly you said the people's comments are very important. If the people's comments are very important why then, there was overwhelming response for no venting of krypton, something like 800 to 500. Yet they did vent. We asked for a citizen's advisory panel. You gave us some kind of shit that wasn't even near it. You don't listen to us and we don't believe you. Very recently we heard about Russia having an accident. I found out that over ten years ago the atomic agency, now the NRC, did a study on this. You kept it from the public. I am just wondering how much you are keeping from us. What is going on at TMI? What is really going on? What was vented and what will be released?

We don't want any water leaked into our river, not one iota, because a lot of these things, the tritium wouldn't be released into the water. It doesn't die for a long time and it will go into some living organism. When that organism reproduces it will reproduce with a malfunction. We are just breeding death. And you gentlement are breeding apathy by not listening to us and apathy is going to kill the country. Please listen to us and please take what we say. You give us this great big Environmental Impact Statement to go through and listen to. I went to give meetings. Every meeting I went to and somebody asked a good question. You took no responsibility, somebody was just supposed to look at all the different options. You say we don't have the answer, we can just check it out.

VOICE (Tr 47): You said that this EIS will not address the disposition of Unit 2. I didn't even read the environmental statement so I don't know anything about the cleanup. So it would seem to me that you would have to take both those questions into account when you do an Environmental Impact Statement. And I don't know if Met Ed sits in on the meetings when we are discussing the environmental impact, but couldn't they say well, if you do it that way and clean it up that way that means we cannot refurbish the plant? Does that have a bearing on the Environmental Impact Statement? Are you saying that this Environmental Impact Statement only goes so far? Is that what you are saying, that it only covers, that it doesn't matter what you are doing right now in the cleanup of that plant to either decommission it or refurbish it? In the Environmental Impact Statement on the releasing in the atmopshere there was a table and I think it was 131 million to decontaminate and decommission plus another couple of hundred million to remove the whole containment building and it was about half a million to refurbish. Why is it $1 billion now? It was a billion in 0662, Volume 2. Now has that jumped up to a billion from a half a billion which was the high estimate to refurbish the plant after it was cleaned up? Why is it a billion now? A billion in this table was to build a new plant on the old site. Now I would like to know how you came up with $1 billion?

PATRICIA LAWBETTER (Tr 54): October 20 we met and I brought up some incidents in Canada in Section 1. I asked if some followup could be done from those incidents. One was the Chalk River. They were 1952 and 1958. In these cases we had rems such as 5 rems exposure to workers. We had radioactive water spillage and we gave those incidences as examples of mechanical, technical cleanup. If they are included in an EIS then it would be my hope that there has been followup after these to indicate there was no impact on the environment in these cases. The one I refer to especially was the water was allowed to seep into the soil. It said it removed it. It removed it to where is my question. How, has there been followup? I would like some information on this. The point is here we have excellent examples to look back. Here we are into the '80s. The time period has elapsed. Who but the people in Canada today in these areas could give us some advice as to what is going to happen here to our ground water and our environment, right? I have one other question. It keeps coming up again and again throughout here. We have exposures of rems to be expected. We have seen it down on the island again week in, week out with workers. Supposedly they are inconsequential doses. Now where in the history of your agency have studies been done with human beings to show that these are safe allowable doses? How were these doses arrived at for us to be following today in 1980?

SUSAN BARLEY (Tr 58): What I am really concerned about: there was one mention here of something like an estimated 300,000 worker hours for total cleanup. This was the projection when the cleanup would have been completed in '84. Now they are saying '87. I want to know how does this change the projected number of working hours? How will this affect the maximum-minimum which will the maximum and minimum doses be? Where will the workers come from? This original figure is 14,000 workers years which worked out to about a thousand workers for four years. It is not going to take us four years. Now it is going to take us seven. How many more people? Where are these workers going to come from? And who is going to go on high radiation first? I don't think it is going there because they are not as expendable as low paid spongers. What about records? Will there be records kept on all workers? And send them down the road with the cash and don't even pay them by check? Medical records for how long? These TMI-2 technical specification hearings going on right now how modify the technical are going to effect the cleanup and implementation of this blueprint? And one thing that Snyder said very early on is that very little high level risk has been generated thus far except in the core. I want to know about the spent resin filters from the high level wastes that were formerly a solid form and are now turning into jelly because No. 1, the acid base and No. 2, the intense radiation. I don't think 5,000 curies is a small amount, especially when it contains only 49 or so containers. This wasn't considered in the PEIS. Because it already exists does not mean it is something going to come up. We have to deal with that. What is going to happen there? Clean water to be used for cleanup. So basically my concern that we still have to live here is what about the workers? Met Ed wants to throw out all the records on the workers after five years and that is one of the things that came up. How is that going to affect the cleanup and recordkeeping? What about temporary workers, does it keep records on sponges? There is one more thing that was mentioned about decommissioning versus restart. I am an electrician in industry so when you go into a place I know how to put in a system. You do it carefully. And it matters whether or not the pipes are cut straight or how the wire is clipped. On the other hand when you are tearing something out you don't have to take as much care with it. The same goes with cleanup. If you are trying to preserve the integrity of the plant or system you have to be really careful how you clean up, which is going to take longer. On the other hand if you are going in to decommission it is very simplistic to turn it off and tear it down. That is going to affect worker doses too. You got out of addressing it by saying that decommissioning it not granted. It is not according to the rule that you are playing with. But that doesn't mean you ignore the alternative of it. You didn't even talk about it. Just because you don't have to doesn't mean you shouldn't.

CARLA MEYER (Tr 67): I think this whole business about like you have as well as I understand it I think the people are saying look, we don't want like a TMI to waste and store. But then you come up and say well, what about South Carolina, our fondest last hope. I think that is like putting people of this country against each other. There is no safe storage for that material. So what are the people from Nevada supposed to do, suffer the same pains as people in this area? It's like pitting region against region. I think there is a lot of lessons to be brought out here. I think actually what NRC is sitting on top of is a meltdown much more severe and long term than the meltdown of the reactor. I think it is a meltdown of people's whole trust in this government and people's whole trust.

DON HOSTER (Tr 71): My first question is the accident occurred on March 28, 1979 and it took the NRC eight months to decide to do this document a lot of organizations, they blame organizations which are nuclear critics for holding up the cleanup. And I think I should say it took eight months for the NRC Commissioners to decide on this document formally. I would like for you to explain to me why it took the NRC Commissioner to vote on a document like this. Then I have some comments, since you clarified that. For example on Chapter 10, page 24 you talk about the psychological effects of the PEIS. In here I find many interesting problems and I would like to get it on the record rather than writing a letter. For example in here it says that -- I will quote from the document -- stress would be less severe for a person with gas. I find that a difficult statement because a person that has some krypton is still going to be around for ten years or whatever it is, even though it is going to disperse somewhere. Nevertheless it will be in the atmopshere and a lot of gases that are released. Also the statement that says, "The start of purging was well publicized so that persons concerned about long-term health effects could leave the area." Unfortunately some people didn't have enough money to leave the area. Some people didn't have anywhere else to go. So that is not a very true statement either. Then it says, "Radiation mapping and damage assessment inside the reactor building -- the next phase of the decontamination process -- should have no psychological effects." I disagree with that because quite frankly every time you go in there the suspended licensee comes out and says it looks good, there is a good chance we are going to get this thing cleaned up and started. I think that is a psychological problem also. Also it says in here, "including EPICOR II processing of contaminated water, has been in progress for many months with little apparent concern for the population." I would like to point out to you that from the middle of March in 1980 until about the midele of September there were no regular public meetings. There were meetings with (inaudible). There were no meeting with DER held successfully I thought for people to come and ask the utility and NRC questions. The press had an opportunity and this helped people understand a little more what was happening. I say the reason why there was no apparent concern with the general public (inaudible) didn't have much access. We could have walked down to the NRC office. I know that. But there are people who are afraid to talk to the NRC and are afraid to get up and talk tonight a lot of people. You have to keep that in mind. I will move right along. The last section here under comments, Chapter 3, page 24, there is a (inaudible) psychiatrist. He is cited in the references. He is talking here about Chapter 3, page 24: DuPont, however, suggests, that worry of what-if reflects a general nuclear phobia amplified by national T.V. news coverage. The problem I have is that I think the problem nuclear waste disposal permanently and safely isn't a what-if. I think it is a very real problem here. I really have trouble with that statement. Then in the last sentence it says, "The degree to which the community believes it has some control over TMI decisions will have a significant image on the public's perception of future events at TMI." Like I said it was a large document like the PEIS with no regular monthly public meetings anybody can come to. I don't think the people have a good control over the entire situation. I would also like to remind you that in January of 1980 Peter Houts of Hershey Medical Center released a study showing that 20,000 to 40,000 people living within ten miles of TMI showed stress on the physical system, plus the program study recently came out which you are probably aware of. So those are my basic comments on the psychological part of PEIS. My final question to you is I am wondering if you can tell me who the Decision Science Consortium of Falls Church, Virginia, the consultants for DOE, who are they and what are they doing here in TMI area and what impact will they have on the cleanup or whatever?

JACK SUSKIND (Tr 78): I think that to follow up on the comment, the lack of communication between the citizens and the government employees I think stems more from other sources than lack of a microphone. I think that is a sense of where we are coming from. We are concerned with our lives and the lives of our families. You are concerned with the bureaucratic problem, the scientific technological problem, with an economic problem. We are vitally concerned with our lives and our family's lives and our family's futures and hour homes. I think that is for me anyway a big gulf that I have. I am a lay person. I think I am fairly intelligent like any ordinary individual. And for me to read through that EIS statement and to make some intelligent comments about it is not really a layman's job, not really my job. I should be able to entrust you with my life. I should be able to hope that you will clean up that plant quickly and safely. And I think that is what I have been hearing you say tonight. I can only hope that you will take our feelings into account and proceed in the most safe and expeditious manner.

ROBIN SITES (Tr 79): As an observer tonight and seeing everything more or less objectively between you and the people of Middletown, I can see that a lot happened that you didn't anticipate of course when you built Three Mile Island. Of course you didn't anticipate that there would be an accident in the first place. But I would like to know if there was ever a precedent set that if there was an accident, of course you take that into consideration, was there ever a precedent that said we would be allowed to dump our nuclear waste, the radiated water waste into the Susquehanna

which filters out to the Bay and the drinking water of Baltimore and into people's lives? You can't promise that it wouldn't affect the fish and the wildlife. Was there ever any precedent set when you built Three Mile Island? All I can say is we are against the dumping of that radioactive water into the Susquehanna, no matter what. I would say that if the people as individuals get their vote across then it would be voted out.

MR. GREEN (Tr 83): Do you not recognize the people who live here should have the right to make the decision? Do you or do you not recognize that right?

LANA HUNTER (Tr 83): This book here, I would like to show people who haven't had one or seen one. The print is so tiny that you can't read this for more than an hour without really having a lot of difficulty, even with good vision. Another thing, the language used in it is not the kind of language that a person with a limited education, say a high school graduate can understand easily. Surely with something to back it up they can understand it and these are the people that this book is for. These are the people that this book is about. Most of them even if they felt brave enough to dive into it, they have they would have a lot of difficulty. It seems highly ineffective to me to put this thing out and then this is what your comments are based on and this is what everything you say is based on. And if people bring it up, even when they do bring it up at these meetings you say oh, we can't talk about that now because we don't know, we will get back to you. It is nonsense. I appreciate the fact that you are doing it for us. But I think that it should be more directed for the people to understand. That is just my opinion and my comment. There is one thing also that I was curious about. After this is out will this be the last publication of your people? I mean how much of a lapse of time will pass between when this goes out and something else that you would print as far as for the American public?

VOICE (Tr 87): I want to know if there is a deadline for the emergency plan and the radiation protection plan. I also want to know can too much boron or borax solution cause any problems? Will potassium iodide also be included in that? Will we have to have a supply locally of that? Would the boron ever indicate a problem if you had too much of that? My last comment is I don't like the idea of putting the water into the river but I also don't like the idea of evaporation. A couple of economic questions. Largely due to regulatory constraints there has been a rapid escalation in the cleanup budget for TMI-2. What is your regulatory right or position on a grant or a loan for general public utilities? And if general public utilities go bankrupt before the completion of the cleanup does the NRC have an action formulated to take over the site or to manage the site and what is that plan of action? If I could address one other question, if it is proper, about the accident itself: during the accident the NRC came out very strongly with the hypothesis that the hydrogen bubble in the core created an extremely large concern. At the same time I believe various other nuclear experts as such declared that there was not a strong possibility of catastrophe due to that hydrogen bubble. Now I believe it has been resolved by the Kemeny Commission concluding that there was not an extremely large probability of additional accident scenarios because of a hydrogen bubble. I would like to know if the NRC has resolved the hydrogen bubble incident and if the NRC has done anything to correct such things as the hydrogen bubble scares from leaking out to the press or to the general population without confirming them.

PAULA COLKEY (Tr 93): I know I said this before but please understand we are not anti-cleanup. We definetly want this plant cleaned up. But understand we want it done safely, not to skip through the red tape and everything. We want it step by step safely, but we want it cleaned up. Concerning the psychological effect that this accident had and is having, continuing on the majority of the people. First of all I just briefly want to tell you in the '60s when I was a senior in high school I used to look at the people against the Viet Nam War and I thought what are these idiots doing marching in the street and carrying on like a bunch of fools. Don't they know their Government is going to take care of them? What good is this? Little did I know that in the March of 1979 and ongoing that I would be the same nut walking down in Washington with a sign saying for God's sake, please help us.

1960 Quarry Road
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November 18, 1980

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:

I am writing to express my comments on the "Draft 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)". At this time, I wish to thank you for mailing me this draft for my review and comment.

First, I would like to express my comments concerning the structure and general presentation of the report as follows:

1. One of the basic purposes of the PEIS is to inform and involve the public as well as government officials in the decision making process of the Commission. The PEIS staff has utterly failed to effectively draft a statement which would allow the public to rationally and comprehensively participate on the subject of decontamination and disposal of radioactive wastes concerned at Three Mile Island or any nuclear facility. The staff has categorically demonstrated through this report a lack of ability to properly convey and inform the public as to a clear understanding of the subject. It is not that the public lacks the intelligence or desire to comprehend, but that the staff has failed to organize and present that material in an educatable manner.

2. The material presented must be placed into its correct prospective of its significance to other releases to the environment with respect to industrial, other energy producers releases, non- industrial, and background.

3. Since the accident, the role the NRC has assumed in involving and informing the public in the decision making process has not served the residents in gainning greater confidence, credibility in the nuclear industry. But, rather, has consistently served those of the negative minority at the expense of time, of the majority the utility, and the nuclear industry,

3. The facade of neutrality has long since been lost through your lack of leadership and has become in essence a politically tax funded organization, which I feel should be totally abolished by Congress. If you are to establish a positive rationale, then you soundly educate the public and allow those members of the majority to be represented on the same basis as those of the negative attitude.

4. The organization of the report is often confused and constantly interrupted with "refer back to" or "see appendix" for further reference. The arrangement and discussion of subject material in the present order is not constructively set up for logical understanding. At least four or five chapters should be arranged as to order in the total presentation.

Next, I would like to express my views concerning material in the report as follows:

1. In the first chapter, the staff stated that commercial nuclear power plants are not designed with special consideration for large scale decontamination operations. This statement represents the total inability of the NRC to provide leadership in plant safety and design. Quite frankly, I believe the commercial industry would have been far better to regulate itself as to design, safety, and training of its staff than to be engulfed in bureaucratic strangulation and total inability to lead and set standards and educate those concerned with this industry. These efforts, or lack of, have only served to undermine public confidence, severely attack the credibility of the nuclear industry and the utility in question.

2. The major environmental impact of the cleanup at TMI is the occupational doses received by the workers involved. This is not presented in a clear and concise manner to the public in relation to the workers and the best alternatives for them. To demostrate your fairness and neutrality, you should have a representation from this work force to allow their views to be presented and advise considered. Yet you have consistently ignored the workers, and the public, and taken under advisment those views from areas that are the most vocal, and threatening , and technically lacking in expertise on the matter.

3. I would like to comment on the repetitive mentioning of the failure of the HEPA filters and its possible release of radioactive effluents to the environment. As of the writing of the PEIS, much of the Auxiliary and Fuel Handling Builings have been decontaminated, yet, the report does not illustrate the actuality of the failure of these filters and their releases during this operation.

3. To promote public confidence, the staff should illustrate what these filters are, their purpose, placement in the buildings involved, failure under normal operations, failure and resultant releases involved during the operation of decontamination involved in the Auxiliary and Fuel Handling Buildings. Then the reader can realistically place this possibility in its true prosepctive and relationship to the cleanup effort.

4. To give credence, by disclosure, of such ideas as pouring cement into the containment building to solidify the water in containment, only serves to enhance your lack of expertise and seriously impairs your ability to lead and regulate. I feel the public should be grateful that the staff could not find a way to insert a slurry into the building and give us a permanent problem. With the additional time the staff required to prepare this draft, it seems to me that the staff desparately grabbed at all ideas, the more the better, to enhance the facade that YOUR NRC IS ON THE JOB AND CAN OUTDO THE INDUSTRY. The licensee has demonstrated its expertise through its presentations, carefully studied and researched. This presentation of a quantity of alternatives against the licensee's presentation only serves to confuse the public and demonstrate your success in using paper not intelligence.

5. We simply do not have an eternity to clean up the plant and to delay this effort for the presentation of your studies, and reports places the citizen in a situation of severe financial burden and a attitude of endless frstration. In over eighteen months you have only succeeded in raising the costs, increasing the damage, and increasing the risks of safety and health to the general public.

6. If the alternatives presented will result in little or insignificant impact environmentally to the public; then you should demonstrate this in the context of other releases or pollutants in the environment. To say that this is not within your area of demonstration; then this report should have been compiled in concjunction with the proper agencies concerned with the total environment and perhaps taken the total responsibility from your agency.

7. I have far greater confidence in proposals presented by the licensee, such as the SDS system, especially since their proven performance in designing the venting of Krypton-85 gas and its successful completion.

Page 4- Comments to PEIS-continued

8. The attitude of neutrality which you have tried to relate to the public concerning decontamination at TMI is totally discredited through the selection of individuals to sit on the TMI ADVISORY PANEL. If you wish to be fair and have representation for the minority, then you must have the majority represented. By ignoring, refusing to appoint members or individuals of groups representing the majority, you cannot consider this a fair and equal representation. The official credence of the negative attitude further corrodes public confidence in your efforts.

I hope my comments will constructively aide you and your staff in preparation of the final report. My purpose is simply to help you effect a better and fairer relationship with the public, and creating a positive atmosphere concerning the decontamination effort at TMI and the nuclear industry. As a resident of Pennsylvania, I strongly feel that this situation must be placed into a realistic prospective, so that an expediously safe and clean effort can proceed and the unit returned to operation. If I can be of any further assistance, please do not hesitate to contact me.

Thanking you in advance for your consideration in this matter.

Yours truly,

Mrs. Patricia A. Books

Mrs. Patricia A. Books

PAB/pab
cc: Mr. Ed Helminski
Mr. Matthew Bills
Mr. Allen Ertel
Mr. John F. Ahearne

Lise K. Haager
2 Madison Place
Annapolis, Maryland
21401

Office of Nuclear Reactor Regulation
U.S Nuclear Regulatory Commission
Washington, D.C. 20555

November 19, 1980

Sirs:

I am writing to express my interest and concern about how the Three Mile Island clean-up proceeds. How it proceeds is within my interest as a taxpayer and a resident of the Chesapeake Bay area. I (along with other taxpayers) am paying for it and I will have to live with the consequences of the choices made by the Nuclear Regulatory Commission. As a taxpayer, I should have access to cost estimates of the clean up methods proposed in order to submit a judgement about the best clean-up proposals in the P.E.I S. yet the P.E.I.S. does not include cost figures. Why not?Certainly cost is a factor.Nor does the P.E.I.S. make any proposal about what the N.R.C. will do if Metropolitan Edison defaults.The most upsetting aspect of the P.E.I.S. to me though, is the proposal to dump radioactive water into the Susquehanna River. The N.R.C. has not adequately demonstrated to me that tridium will have little or no effect on the marine life in the Bay. And it can not since whatever long term effects tridium may have on living organisms can not be foreseen but must be observed over a long period of time. Trace amounts of strontium 90 and cessium 137 would also be released with that water but no amount of those substances is safe.Those radioactive substances would mutate marine life species and ultimately be absorbed into our bodies to irradiate us and mutate our genes for the rest of our lives.
I find and proposal to release radioactive water into the Susquehanna River preposterous and completely unacceptable. Once the water is released , it would be irretrievable forever and the negative effects would last for an equally long time. Many people depend upon the Bay for their livelihood.The Bay and the creatures who live in it are unique and beautiful. The quality of these lives should not be jeopardized.

Yours Truly,

Lise K. Haager

Patricia A. Smith

RD 1, Fore Fairway Dr.- Valley Green Golf Course Etters, PA 17319

Nov. 19, 1980

N.R.C. Commissioners:

The "draft programmatic E/S" is the pits. You all can't do anything right. There are so many wrong + unanswered problems.

I request another "draft" before a final E/S.

Why don't you all try to be as "nearly perfect" as possible this time since our lives depend on it.

Mrs. Patricia A. Smith

ENVIRONMENTAL COALITION ON NUCLEAR POWER

Co-Directors: Mr. George Boomsma—R.D. #1, Peach Bottom, Pa. 17563 717-548-2836
Dr. Judith Johnsrud—433 Orlando Avenue, State College, Pa. 16801 814-237-3900

November 14, 1980

Secretary of the Commission
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Madame or Sir:

I enclose a summary of comments on NUREG-0683, the Draft Programmatic Environmental Impact Statement on the Decontamination and Disposal of Radioactive Wastes Resulting from the March 28, 1979, Accident at the the Three Mile Island Nuclear Station, Unit 2.

These comments are of a general nature, covering the major over-all deficiencies which members of our public-interest organization throughout Pennsylvania and adjoining states have expressed to us. Detailed critiques and comments are being submitted separately by members and by member groups of the Environmental Coalition on Nuclear Power. Additional criticisms have been voiced by ECNP's members and member groups at the numerous public comment meetings held by NRC Staff personnel at locations throughout the lower Susquehanna Valley during the past two months.

It is our position that the Nuclear Regulatory Commission has failed to comply with the Council on Environmental Quality's regulations concerning public hearings under the National Environmental Policy Act of 1969. Although many "public meetings" have taken place, the agency has failed to provide for full and proper hearings to fulfill the spirit and purpose of NEPA.

We find the Draft PEIS on TMI-2 decontamination and radioactive waste disposal incomplete, erroneous, and inadequate to permit the Commission to make a finding that the cleanup of TMI-2 may proceed under the program options considered in NUREG-0683.* We recommend that the Draft PEIS be withdrawn, rewritten, and reissued for further draft review by Federal agencies and the public, with adequate time for receiving and commenting on the document. We recommend that NEPA hearings be provided prior to issuance of the Final PEIS.

The precedents set by the NRC in the aftermath of the TMI-2 accident will affect the operations of the entire nuclear power industry for the remainder of its duration. The "business-as-usual" mind-set of the NRC Staff in this seriously flawed document must not be tolerated by the Commissioners of the NRC who are ultimately responsible for carrying out the mandate of the Atomic Energy Act of 1954, as amended, to protect the public health and safety.

Sincerely,

Judith H. Johnsrud

Judith H. Johnsrud, PhD
Co-Director

*See CEQ's NEPA Regulations Part 1502.9(b) and 1503.4(b)

NOTE: Comments mentioned in the above letter as being attached are included in this appendix with comment number 64.

104 Davey Laboratory
The Penn. State University
University Park
Pa., 16802
19 November 1980

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

Gentlemen:

Enclosed are my comments on NUREG-0683, the Draft Programmatic Environmental Impact Statement on the cleanup of TMI - 2. Please note that the opinions and calculations presented are not necessarily those of The Pennsylvania State University, which is well known as a collection of free thinkers. The University affiliation is used here for identification purposes only.

I hope that the final statement will reflect the suggestions enclosed herein.

Sincerely,

William A. Lochstet

Wm. A. Lochstet

Environmental Impact of the Three Mile Island, Unit 2 Decontamination Program

by

William A.Lochstet,Ph.D.

The Pennsylvania State University*

November 1980

The Nuclear Regulatory Commission (NRC) has attempted to evaluate the expected environmental impacts of the program to decontaminate and dispose of the radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island, Unit 2 in its Draft statement, NUREG-0683 (PEIS) (Ref. 1). There are several aspects of the program which have been omitted or overlooked.

Leakage of the reactor building sump water is considered as an accident in section 6.3.4.2 (Ref. 1), in which the entire contents leak out in one or two days. No consideration is given to probable normal leaks. It is stated in section 6.1.2 (Ref. 1) that "the building could begin to leak unexpectedly". The reactor building is fitted with a steel inner membrane which is designed to limit leakage to 0.2% by weight in 24 hours, at 55 psig air pressure. The building has an internal free volume of 2,000,000 cubic feet. Thus, the building is not obviously, water tight.

Water is standing in the building to a height of 8 feet (Sec. 1.2, Ref. 1). This produces a pressure at the bottom of about ¼ atmosphere, or 3.75 psig. The reactor building is being maintained at a slight negative pressure, so that a net driving differential of 3.45 psig will be used here (Ref. 2 notes a pressure of -0.3 psig). This is 6.3% of the design

* The opinions and calculations contained herein are not necessarily those of The Pennsylvania State University, which is well known for its encouragement of independent thought. Affiliation for identification purposes only.

pressure. If it is assumed that leaks are distributed randomly, then they will occur in proportion to area. The water is in contact with 16,540 square feet of membrane area. There is a total of 104,546 square feet of membrane area. Thus, water is in contact with about 16% of the area. As a first assumption, the flow rate for water will be taken the same as for air in the pre-accident condition. If the leak openings are unchanged in size, this should overestimate the leakage. The spilling of hot water on the floar suddenly by the accident may have altered the status of the membrane. With this assumption, the leak rate is 6.3% of 16%, or about 1%. The origional leak rate is taken as 0.2% of 2,000,000 cubic feet, or 4,000 cubic feet. Thus, the expected leak rate is 1% of 4,000 cubic feet, or 40 cubic feet per day.

A leak rate of 40 cubic feet of water per day is 1.1 x 10^6 ml per day. It is suggested in the PEIS (Fig. S-1, Ref. 1) that sump water may begin to be processed in Jan 1981. This is 1 3/4 year after the accident. In this time, a total of 7.2 x 10^8 mL would escape. At a concentration of about 190 μCi/mL (Sect. 6.3.1, Ref. 1) this amounts to a total activity release of 137,000 curies, contained in about 190,000 gallons. It is unlikely that such a large release has gone undetected, but lacking an exterior sump surrounding the reactor building, some leakage cannot be totally dismissed. Thus, there is here a discharge to the environment which was not considered in the PEIS (Ref. 1).

The NRC has considered a number of expected industrial accidents in its analysis of the cleanup program. It would be useful if some imagination were used to anticipate things that very well could happen. The site is very near to an active airport, but no consideration was given to the effects of the crash of an airplane of any size. I presume this oversite will be remedied. There is some inconsistancy about a possible flood. Section 10.5.3 suggests that the 1972 Hurricane Agnes flood (300.5 ft MSL) was below the top of the station dike at 304 ft MSL. In fact, the dike was under water.

It is suggested in section 1.6.1.2 that organic resins are stable at exposures less than 10^9 rads(Ref. 1). It would be useful if the NRC could reference some studies to prove this point. This is particularly interesting in contrast to the comments made in Appendix H , at section H.3.3 about the effects of 10^9 rads on bitumen.

It is stated in section 5.3.4.1 that experience in the processing of nuclear fuels in chemical processes that 0.01% of the total material processed may become airborn(Ref. 1). The reference for this is ANL-75-78 (Ref. 3), which is a study of plutonium, not fission product releases. Further, the statement in Ref. 3 is " The fraction of plant material estimated to become airborne is 10^{-4}.". This is given with no further justification. There seems to be more certainty in the statement in the PEIS than in ANL-75-78. Furthermore, this figure of 10^{-4}, or 0.01% appears in many other places such as: sections 5.2.4.1, 5.3.4.1, 5.4.4.1, 6.3.4.1(twice), 6.5.4.1, 6.6.4.1, 7.2.4.1, 7.3.4.1, 8.4.4.1, (Ref. 1). These discussions frequently (in the PEIS) go on to discuss the protection given by HEPA filters. No mention is given to the size of the particles. The efficiency of HEPA filters depends to a very large degree on the size of the particle in the air. ANL-75-78 suggests a minimum efficiency for particles of plutonium near 0.4 micron diameter. It is an oversimplification to not discuss particle size. Therefore, it is suggested that these sections on HEPA filters be re-written with explicit discussion of particle sizes.

There is also little discussion of the failures of HEPA filters except for burning. In particular, no problems are suggested due to personell error. This is in contrast to the finding of Moeller (Ref. 4) that the major share of filter failures " appear to be due to errors by those responsible for the operation and maintenance of air-cleaning equipment." It is hoped that this will be discussed in the final PEIS.

The discussion in section 5.1.4.1 of the HEPA filters (Ref. 1) presents two stages with a given penetration of 3×10^{-4} each for a total rating of 9×10^{-8}. It is then pointed out that NRC Regulatory Guide 1.140 allows only a factor of 10^{-2}. In this case xxx the NRC should honor its own Regulatory Guide and tabulate the numbers based on 10^{-2}. Similar discussions appear in sections: 5.3.4.1, 6.3.4.1, 6.4.4.1, 6.5.4.1, 10.4.1, (Ref. 1). In addition there are several places where a factor of 10^{-6} is noted as in sectionsx : 5.4.5.2, 5.4.5.3, 6.6.5.2, 6.6.5.3, 7.3.5.2, 7.3.5.3, 8.4.5.2, and 8.4.5.3. The discussion in section 7.2.4.1 does not give a factor. These discussions should be also modified to x discuss the size effects mentioned above.

It is implicitly assumed in these discussions that the amount of material released is proportional to the amounts processed. It is certainly true that if no material is x processed, none is released, but there are other factors that relate releases to inventories. It is unclear how similar the practices and care of a DOE military facility compare with a commercial operation of a unique kind. It x is also true that for many years one of the smallest nuclear power reactors had the largest releases (Humboldt Bay). There are many other variables x that have been ignored by the NRC here.

It is not indicated that workers will be using breathing apparatus at all times. Thus , they will be breathing in radioactive dust. This should be taken into account as a dose commitment in evaluating occupational doses for both normal operations and accidents.

It is also true that people in the general public will absorb materials (Cs-137, Sr-90) by breathing , Etc. These should be evaluated as a lifetime dose comittment.

The monitoring of employees should be extended to include urine samples as a measure of body burden of Cs-137 and Sr-90. These should be taken weekly and Red/White blood counts should be performed monthly.

In general it is unclear how the doses reported in the PEIS were totaled. Total dose commitments should be given for the next 50 years or so. Also, total population doses (in person-rem) should be calculated for all cases, rather than just presenting the dose to the maximum exposed individual. These population doses must be carried out beyond 50 miles (to infinity) and for at least 100 years. The case of Kr-85 is useful as will be shown next.

The Kr-85 inventory of the reactor building was estimated at 57,000 curies. If this were uniformly diluted inthe atmosphere, the concentration would be 1.4×10^{-20} Ci/cm^3. Given the conversion factor of 1.5×10^4(rem/yr)/(μCi/cm^3) from the EPA (P. C-12, Ref. 5), the dose rate is 2.1×10^{-10} rem per year per person. I here assume a linear, non-threshold dose response relationship, as per the 1972 BEIR report (Ref. 6). For a world population of 4 billion, the starting dose rate is 0.84 Person-rem per year. Summed over all time this produces a total dose commitment of 13 person-rem. This should be included with the other effects in the final PEIS.

There is a discussion of background in section 5.1.5.2. It occurs as the top paragraph on page 5-8 (Ref. 1). This paragraph appears many times thruout the PEIS, verbatum. It compares the radiation dose to background. This may be interesting, but most readers know the level of background, and at most need to be reminded only once. The PEIS is required xx by NEPA to evaluate the impact of the project at hand. The existance of background cannot justify any exposure , regardless of how smalll. Deaths of people due to other causes does not justify adding to the death rate by releasing dangerous materials, or direct murder. In particular in the middle of this paragraph is states that " the health effects are non-existant", but later it evokes the linear, non-threshold thxxxx model." This is a contradiction. The linear theory clearly states that no effects are "non-existant". A regulatory agency should be more cautious.

A similar situation occurs in the forth paragraph of section 10.1 (Ref. 1) which discusses the threshold level for deleterious effects on aquatic species or humans. The linear, non-threshold model must be the basis for regulatory policy.

The PEIS discusses the psychological stress impacts to some extent. This should be considered in light of some thinking that the NRC, or other agencies may have to resort to torture in interrogations for plutonium control (Page 163, Ref. 7)). It is a small step from being concerned with terrorist acts against plutonium to such acts against a shipment of spent fuel or other high- level waste.

The third paragraph on page S-2 implies that all the water in the sump came thru the PORV. Much of it leaked out of the primary loop well after the accident, After the block valve was closed.

The discussion in section 1.2 (Ref. 1) suggests that the Reactor pressure was reduced to 400 PSi on 7 April, and was not increased. In fact the pressure during the latter part of April was 1050-800 PSIG. Please check with Met - Ed. (Ref 8).

Page 1-26 (Ref. 1) Does not follow from the previous page. Something is missing.

The discussion on section 9.5.2.1 (Ref. 1) states that solidified TMI wastes would be similar to simulated waste in glass. This statement is not at all obvious, and might appear to be rediculus. It is suggested that some explanation might be useful to justify this position.

In the same discussion consideration should be given to an accident involving a fire and subsequent immersion in water. Most fire departments use water on fires. This is a more likely source of water, but the submersion makes the analysis easier. It should be noted that high temperatures destroy the cement as is used for cement immobilization of waste.

References

1 "Draft 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, Draft, US. Nuclear Regulatory Commission (July 1980)

2 "NRC TMI Program Office Weekly Status Report, Week of October 26 - November 1, 1980."

3 W.D. Seefeldt, W.J. Mecham, M.J. Steindler, " Characterization of Particulate Plutonium Released in Fuel Cycle Oparations"., Argonne National Laboratory, ANL-75-78, P 71., May 1976

4 D.W. Moeller, "Problems in Nuclear Air-Cleaning Systems" Nuclear Safety, 16 (4): P. 469 (July- August 1975)

5 "Environmental Analysis of the Uranium Fuel Cycle" Part III - Nuclear Fuel Reprocessing" EPA-520/9-73-003-D, U.S. Environmental Protection Agency, (October 1973)

6 " The Effects on Populations of Exposure to Low Levels of Ionizing Radiation" (BEIR), Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, NAS/NRC (Nov. 1972).

7 C. Gordon, T.F. Gessell, M. Prichard, C. Anderson, " Review and Integration of Existing Literature Concerning Potential Social Impacts of Transportation of Radioactive Materials in Urban Areas", NUREG/CR-0742, SAND78-7017, (July 1980)

8 Letter from NRC, Attached as Appendix, following.

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

August 13, 1980

Mr. William A. Lochstet
119 E. Aaron Drive
State College, Pennsylvania 16801

In the Matter of
Metropolitan Edison Company, et al.
(Three Mile Island Nuclear Station, Unit 2)
Docket No. 50-320 OLA

Dear Mr. Lochstet:

I have just obtained a graph of the post-accident pressure history for the TMI-2 reactor coolant system mentioned at our July 11, 1980 meeting. A copy of that graph is enclosed for your information.

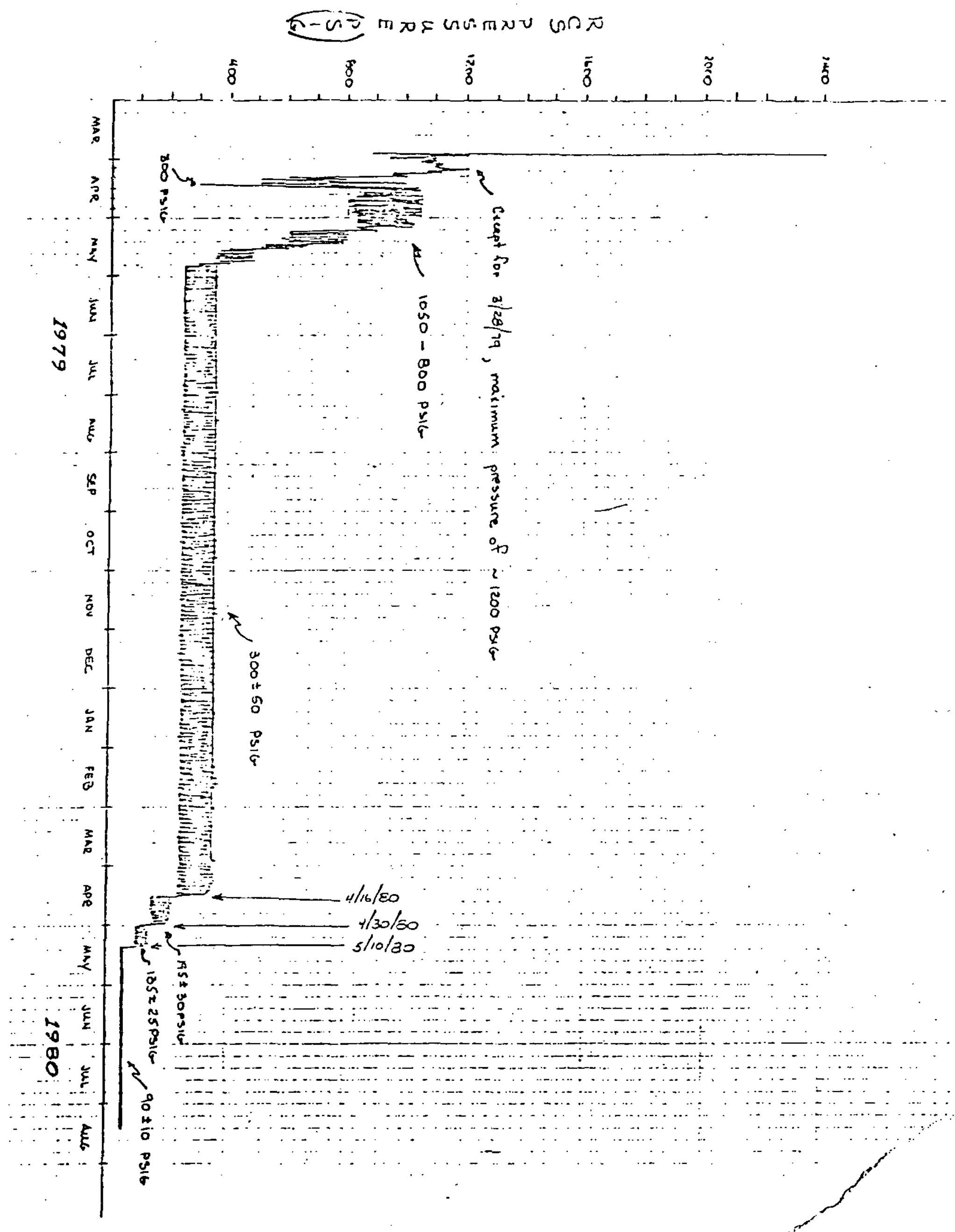
Sincerely,

Steven C. Goldberg
Counsel for NRC Staff

Enclosure:
As stated

cc w/enclosure:

George F. Trowbridge, Esq.
Mr. Steven C. Sholly
Dr. Judith H. Johnsrud



MILLERSVILLE STATE COLLEGE
MILLERSVILLE, PENNSYLVANIA 17551
(717) 872-5411

November 18, 1980

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

Dear Dr. Snyder,

Attached are our comments on the Draft Programmatic Environmnetal Impact Statement related to the decontamination and disposal of radioactive wastes resulting from the accident at Three Mile Island, March 28, 1979.

Some of the comments are general and some are specific. We are all from different disciplines, however most of our concerns are the same. We have found the PEIS deficient in some respects, misleading in other respects, and inconsistent. You are to be complimented on requesting imput from the outside (public) regarding a complex and involved topic.

General Comments:

1. Although amply detailed, this document is not a "statement." It lists only alternatives in some cases and gives the 'best' and the 'worst' alternatives in other cases. If this is to be a statement, it should develop a suggested program of compatable processes to bring about the safe and expedient clean up of TMI 2. As a regulating body, NRC should give priorities for Metropolison Edison to operate by in carrying out the clean up operations.

2. It is our understanding that all the alternatives were considered for this impact statement. We suggest that not all alternatives were in fact considered.

   a. All the alternatives given are alternatives that preclude reopening of TMI 2. No alternatives were considered (or at least reported) that would in any way jeprodize the reopening of the reactor. Entombment is one example. We understand that decontamination procedures will have to proceed regardless whether TMI 2 resumes operation or not. Procedures already in existence for the decommissioning of a nuclear reactor may very well apply here. Why were these procedures not listed as alternatives?

   b. As stated in the opening comments, cost analysis was not a factor in consideration of any one alternative. This is difficult to comprehend since one method of disposal of radioactive wastes was not mentioned, namely ceramics and waste. It is a costly process and we believe it was eliminated for this reason. From our knowledge of research at Penn State University and other institutions, ceramics as a means of waste disposal is one of the best ways.

3. The susquahanna River is used in several ways and is critically important. There are several towns below TMI that draw their drinking water from it. Its purity has to be maintained as high as possible for that reason. Also, several small industries that are involved with food processing also draw water from the Susquahanna River. The marketability of their products depend on the status of the cleanliness of the river. The Susquahanna River empties into the Chesapeake Bay where one of the most productive areas for seafood and fish is located.
   It is clear that <u>we do not want the dumping of any radioactive water into the Susquahanna river regardless of whether it has been filtered or not</u>. There is no filtering process that can remove tritium from the water. The PEIS gives no information on the effects of tritium on animals and plants that live in the river nor on the population who would be drinking the water from it. Even small dose releases into the river would be recycled in the food chain in the river and possibly accumulate to significant levels.

4. The study is deficient in that there is very little information on the ecological impact of radiation releases that might occur during clean up operations. Some values were given for human consumption of water and fish from the river, but there is a paucity of information on the ecological effects of radiation releases. What amounts could be recycled within the food chain? What substances are likely to be released that would have, or not have, significant effects on the wildlife? We might point to a study published in the December 1979 issue of <u>Ecology</u> where plutonium that was released twenty years ago at the Savanna River S.C. station is still being recycled in the plants and animals and within the first 5 cm. of topsoil both near and at some distance from the plant. Dispositions of radionuclides during clean up operations should be discussed in this statement.

Specific Comments:

1. Throughout the statement references to different measurements of radiation are made (e.g. REMS, RADS, person-rems, etc.). It is our opinion that every effort should be made to use one measurement of radiation. Comparing for example the number of curies released or obtained with the population exposure in person-rems is practically impossible for the reader. Standardize the units.

2. Once a plan of clean up procedures has been chosen, it is our opinion that there should be public hearings on the choices made. Hearings on the EIS are called for in the guidlines of the Council on Environmental Quality. There is no indication that these hearings were held or plans indicating they will be held in the PEIS. We urge you to have public hearings on alternatives given and chosen in the statement.

3. Some of the radioactive water has already been processed by Epicor II. The resins from this system are being stored on the island in continers in a special pool. There are several questions which the PEIS failed to consider regarding these resins.

   a. How "hot" are they? At meetings with the NRC and with Met. Edison it was stated that the resins were being considered for deposition in a military depository because they were either too radioactive for the Washington State depository and/or because they were in a slurry and not solidified. We would hope that NRC would work with DOE in finding a depository for these resins.

   b. How long will these resins be stored on the island? The commonly used word is "temporary storage". This is not precise enough. Perhaps more importantly, what is the maximum period they can be stored safely on the island?

   c. The resins are fairly acidic. In what type of containers are they being stored in? Some estimates from Penn State University researchers indicate that the resins are losing as much as 4% weight per 2 weeks. This loss is due to the interaction of the resins and the canisters. If this is true, then it will be a very short time before the resins will eat through the canisters. This potential problem is not discussed in the EIS and it should be.

   d. What alternatives for resin waste disposal are there if no suitable depository can be found?

   e. In the sections discussing the Health Effects of the clean up operations constant comparisons are made using the number of <u>cancer deaths</u> per amount of people. Figures on the occurrence of non-fatal cancers are not given. This is a great oversight. It appears that the study is trying to present the smallest effect of radiation by reporting the number of cancer deaths rather than the number of cancers that may result. If Health Effects are to be considered in the PEIS they should include more than cancer deaths (and genetic effects).

   f. In a few sections of the PEIS a 'threshold dose' of radiation is mentioned. If the concept of the linear model of dose response is used, as was stated, then there would not be a threshold dose. This is very contradictory in the PEIS.

   g. Radiation doses reported in the PEIS are often given as whole body counts. There is clear evidence from a number of sources that radioactive nuclides are accumulated in certain parts of the body (e.g. kidney, thyroid, etc.). It is logical to assume that these organs would have higher doses than would be apparent by giving doses as whole body counts. Efforts should be made in the PEIS to itemize the radiation levels per organ.

4. In the summary it is stated that an average exposure to radioactive releases during clean up operations would be 1.2 mrem. This would amount to 1.7 cancer deaths per 10 million population. It is also pointed out that the normal cancer death rate in the U.S. is 1 in 5, from all causes. This is an unfair comparison because the 1 in 5 figure includes synergistic effects. Calculations of cancer deaths

to exposures of radiation do not take into account the synergistic effects. For example, will smokers have a greater chance of cancer deaths than non-smokers if both are exposed to additional radiation (above background)? Some analyses of radiation coupled with other conditions that bring about stress that may result in cancer deaths should be addressed in the PEIS.

Submitted by:

David R. Dobbins

David R. Dobbins, PhD
Biologist

Conrad Miziumski

Conrad Miziumski, PhD
Physicist

Thomas Greco

Thomas Greco, PhD
Chemist

William Yurkiewicz

William Yurkiewicz, PhD
Biologist

Stephen T. Patto.
3664 N. 3rd St.
Harrisburg, Pa. 171..

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

11/20/80.

Dear Sir,

This is my Reply to your request for comments on the Draft PEIS Related to the cleanup of TMI Unit II.

I have three major areas of concern about this report. 1st - The psychological stress on the residents of the TMI vicinity are not emphasized properly in the draft + should be considered in the final EIS with careful attention. The draft's conclusion on how to handle stress is "... completing the clean up expeditiously is desirable" this is completely off track. We, that are under this stress, want the safest clean-up possible. This is the only way to humanly deal with us, to plan the safest method of clean-up + to monitor all activities as if your life depended on it. 2nd - The worst case scenarios discussed are severely understated. To assume that the core will not be exposed during the cleanup is optimistic. The licensee seems to have the misfortune of having every project they attempt go wrong. This can't be all misfortune - there is an inability to handle complex problems. The potential dose of radiation to the community is understated because of this overly optimistic projections should be recalculated in the final EIS. It seems that the draft intends to calm us about radiation, it even uses the familiar comparison to smoking a cigarette as an equal dose. This leads to the 3rd point, the draft does not recommend a course of action. To try to review all the possibilities and recommend a perfect clean-up plan is impossible for a layman, it may be impossible for the experts but I hope they can accomplish this task. If I could have taken a look at what was the suggested course, It would have been possible to provide useful input. In fact, the possibility of decomissioning was not considered. Why? I am sure they are some portions of the cleanup that could be done more safely if scrapping some items is done. I believe that the damage caused by the accident is enough to say - Shut it down. I understand that an addendum is to be issued to cover this possibility but I won't be able to comment on it.

In conclusion, I am not a scientist but I should not be treated as a child. I have a psychological need & a constitutional right to decide on anything that affects my life, & my pursuit of happiness, my liberty allows my to attempt to tell my government how to deal with TMI. This limited input into the decision making process is not enough for the citizens of this area (Harrisburg). We must be able to participate equally with the scientists on the cleanup. All decisions must be ~~to~~ made with the people of this area as the 1st concern, not stockholders, not utility companies, not an United States Nuclear policy, the people are not part of an expiriment voluntarily as should not be treated like it.

Sincerely
Stephen [signature]

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C.

November 20, 1980

Dear Sirs:

We, the members of Priority, the environmental action group at Millersville State College, appreciate the opportunity to comment on the draft programmatic environmental impact statement related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2.

Despite numerous pages of charts, graphs, tables and text, the draft says little about possible effects on the environment. The words "No significant effect on the environment is expected" are repeated over and over with little or no supporting evidence.

There are several issues we wish to address specifically. The first is a matter of obvious error. Health effects are estimated using figures from Table 10.2.1. These figures are well below the figures given in the text: "It should be noted that based on a task-by-task examination of the reactor building decontamination effort, an occupational dose of 30,000 person-rem has been estimated." A range of estimated dosage from 2,700-12,000 person-rem is used in the table to calculate additional cancer deaths and additional genetic effects among offspring of the work force; this is at most a third of the dose reported in the text.

The second is a matter of ecological effects. The conclusions in the draft state (12-1), "After suitable dilution, the processed water could be released to the Susquehanna River without adverse environmental impact." This statement summarizes the points made in sections 10.7.3 and 3.1.5 and seems to be based on the philosophy that has haunted America since the problems of pollution began, "The solution to pollution is dilution." Whether or not one believes in that philosophy is not the point, however. In Section 10.7.3, it is stated that "the use of these resources (water and air) to dilute and disperse the effluents of chemicals and radioactive materials from the cleanup of TMI-2 is not considered to represent irreversible or irretrievable commitments of these resources." That this statement is false is apparent to all of us as students of biology; any change of an eco-system must have an effect and is indeed irreversible. The dilution of the wastes is "assumed" in the draft, but no supporting data is provided. More importantly, however, the biota of the river are not mentioned here at all.

In Section 3.1.5, where the ecology of the area is considered, there is no support for the statement that no environmental effects will result from the cleanup of TMI-2. The section reads like a local tourist guide, and a poor one at that; it is hardly an in-depth and specific account of the ecosystems to be affected by the cleanup. Apparently no experimental research has been done specifically for the impact statement; it is further apparent that little research of the literature has been done. There are no references cited on the effects of tritium and other wastes on aquatic organisms. Unless some research investigating the effects on the plants and animals in the TMI area and downriver is done, any attempt to do a "cost-benefit" analysis is meaningless.

The discussion of the storage of fuel and high activity wastes on the island also concludes with the statement, "No significant environmental effects are expected." Yet the impact statement also says (12-2), "Long-term. . . storage of high-level waste is not appropriate at the TMI site." The statement that it is "safe" to store wastes on the island is based on calculations using Hurricane Agnes as the worst possible flood and four days as the longest possible time that storage cannisters might be subjected to flood conditions. It is obvious that the occurrence of a worse flood is very possible; increased building and paving over of ground continues to make flooding worse every year.

What is it that makes "temporary" (how long is temporary?) storage safe and "long-term" (how long is long-term?) storage inappropriate? This is an important question, especially since the recent decision closing the Hanford plant to more nuclear waste makes the date for finding an offsite storage area further in the future and indefinite. In addition, the draft does not explain that the liquid resins from Epicor-II cannot be transported until they are solidified. In Section 10.1, it is noted that after decontamination of the water by Epicor-II the suspended and dissolved radionuclides removed would be transported to an "offsite repository." For a complete picture of the TMI-2 cleanup, it is necessary to inform the public about the problems with finding such a repository and transporting wastes to it.

Psychological stress is addressed a number of times throughout the draft. In the conclusion (12-2), it is stated that some low-level stress will probably continue in some people for as long as the cleanup is in progress and that "Consequently, completing the cleanup expeditiously is desirable." It seems to us that the desirable factor in preventing or alleviating stress is not to complete the cleanup quickly but to complete it most safely.

Despite claims that the draft was written in "layman's terms," we found the rhetoric to be nearly incomprehensible in some sections. Generally, the problem was not one of too highly technical language; rather, it was simply a matter of poor writing. The organization of the draft is such that related subjects are separated from one another. There is much repetition. In some cases, the confusion seems almost deliberate, such as tables of figures in microcuries accompanied by text discussion framed in millirems. When there is some obvious attempt to relate information for the non-scientist, as in Table 10.3.2, it is so oversimplified as to be ridiculous.

Because economic costs were not available at the time of the preparation of the draft, they were not included. The cost-benefit analysis printed in the draft simply states that the cost of not cleaning up TMI-2 outweighs the cost to the environment. The validity of this analysis is undermined by the lack of supporting evidence throughout the draft statement.

The effects to the environment of the accident at TMI-2 and the cleanup procedures will not truly be known for years. However, we feel that the draft leaves some essential questions unanswered and some important conclusions unsupported by scientific data.

Sincerely,

Carolyn J. Kroehler

Carolyn J. Kroehler, President
Priority, environmental action club
Millersville State College
Millersville, PA 17551

NUREG 0683 Nov. 20, 1980.

ANGRY

ANTI-NUCLEAR GROUP REPRESENTING YORK

245 WEST PHILADELPHIA STREET, YORK, PA, 17404. 717/843-7705

TO: 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

COMMENTS ON THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMAPCT STATEMENT RELATED TO DECONTAMINATION AND DISPOSAL OF RADIOACTIVE WASTES RESULTING FROM MARCH 28, 1979, ACCIDENT AT THREE MILE ISLAND NUCLEAR STATION, UNIT TWO. (NUREG 0683)

OUTLINE

The Draft Programmatic Environmental Imapact Statement (PEIS) issued in July 1980 as Nureg 0683 is an insufficient document in both scope and content and therefore the NRC should issue a Revised Draft PEIS for public comment before issuing a Final PEIS. While the clean-up requires timely consideration, safety and adequate opportunity for public comment on the full scope of the clean-up are more important than simple timeliness.

The Draft PEIS is incomplete and in violation of NEPA in that it does not set forth or discuss the financial costs of the clean-up and in that it does not discuss alternatives that would involve other agencies of the Federal Government which might play a part in the clean-up.

The Draft PEIS is insufficient in scope in that it does not but should also include discussion of the impact that the restart of Unit One has upon clean-up, particularly in the disposal of additional spent fuel created by the operation of Unit One, the impact of possible accidents, incidents, "abnormal occurances," "unscheduled outages," or run-of-the-mill unusual events might have upon the clean-up or the licensee's ability to effect a safe clean-up.

It should also adress the psychological impact of the restart of Unit One during the clean-up and the possible stress related to the decision on the disposition of Unit Two, and stress caused by the combination of the restart of Unit One, Unit Two and the clean-up processes. Surely this assessment should be in this Programmatic EIS and not be allowed to slip between the cracks separating the issues involved.

The Draft PEIS is also incomplete in that it does not set forth or select criteria for the selection of the mode of clean-up and does not identify the NRC staff"s choice amoung the modes of clean-up discussed. Further, it is incomplete in that it not only does not address financial costs it does not address what the consequences are of the lack of adequate funding or of having to cease in the middle of the process for lack of funding.

The timeline set forth for the Final PEIS is unnecessarily advanced and does not allow enough time for the Three Mile Island Advisary Panel to research and assess the situation, and it does not, perhaps intentionally, allow time for public input on the many gaps in the statement as issued. By adhering to this timeline and not issuing a Revised Draft PEIS the NRC will further erode public confidence in the NRC and cause further stress and frustration to the area population, including the state and local representatives on the Advisary Panel whose time and efforts will be wasted if they are not given the time and resources to do the job that they have been asked by the NRC to do.

The Draft PEIS is more notable for the missing information than for the actual comment; discussion of what is in the Draft PEIS follows discussion of specific lacks.

DISCUSSION

The Draft PEIS barely discusses the respective costs of the variuos alternatives. Human safety is held forth as the most important consideration in the evaluation of the alternatives, yet, in reality, the costs will be the primary factors that will determine the the alternatives elected. Costs, with human safety, are the most controversial aspects of the statement. But costs are only peripheralyy referred to because the NRC knows that the public will demand to have a full hearing as to how much each alternative will cost and from where the money will come. Thus, the NRC fails to comply with its historical and regulatory requirement that a detailed cost analysis be performed in its PEIS.

The NRC cannot elude its requirement to adequately discuss costs by saying that the final statement will more fully set forth costs. This defeats the spirit and substance of NEPA and the NRC regulations that mandates public input at the draft statement stage. Therefore, the NRC should issue a Revised Draft PEIS that fully sets forth all the cost details.

At one of the NRC presentations on the PEIS, an NRC representative (in response to a question) stated that the PEIS does not discuss alternatives involving other agencies because such a discussion is not permissible. More particularly, the question involved the possible use of missle silos as storage for contaminated wastes. The representative indicated that the idea was considered feasible, but because an agency other than the NRC (the Army) would be involved, the NRC could not consider such an alternative. Besides being bureaucratic, such a theory is inconsistent with court cases interpreting NEPA so as to require a Statement to consider and discuss alternatives involving agencies other than the one issuing the Statement. Therefore, the NRC should issue a Revised Draft PEIS that discusses and alternatives that would involve any other agency. Such a discussion is particularly mandatory where, as in this instance, a solution might be feasible and possible.

There is not only adequate time for a Revised Draft PEIS but also safety and public confidence require it.

On page S-3.Section S.2, the Staff states, "...timely removal of the damaged fuel to safe storage is the paramount objective of the clean-up."

"Timely removal" should not be the first priority. Safe removal and safe storage must be the priority. Any rush to decontaminate and defuel the reactor poses a great danger to the public health and safety. Moreover, in the PEIS, the information that the staff presents does not justify its conclusion that speed deserves priorty over long-term safety.

Dispite repeated public requests that safer disposal of KR-85 be used the NRC allowed venting because, it claimed, speed was essential in order for the licensee to do vital maintainance. The NRC decided to allow venting ostensibly because of timeliness but in reality we think this was because the licensee did not want the expense of safer disposal. In the four months since venting the licensee has done little or no maintainance and has even delayed or temporarily suspended clean-up operations because of financial conflicts with the Pa PUC. So much for the importance of a speedy removal of KR-85; we find that the licensee's finances determine the safety of the clean-up, and once again public confidence in the NRC is further eroded.

The Staff states, rightly, that Three Mile Island is not a suitable site for long-term storage of radwaste. The PEIS focuses on the dangers of leakage and recriticality if the waste remains within the containment building for a long time.

But the PEIS does not demonstrate that removal from containment will reduce the chances of leakages into the environment. In reality, the Staff wants to keep the restart option open and thus dismisses all alternatives which would preclude restart.

The PEIS confesses (at 2-1) that "there is currently no waste repository open for the disposal of high-specific-activity and transuranic wastes, it will be necessary to place these wastes in temporary storage until a permanent waste repository can be found. Onsite storage is considered for this temporary measure." Further down on page 2-2, "long-term storage" is defined as "beyond the normal operating lifetime of a powerplant, which is approximately 30 years." Thus, the PEIS considers storage of high-level wastes onsite for up to 30 years. Given the current lack of a coherent federal policy on high-level waste disposal, such a length of time for onsite storage of high-level wastes seems probable.

The PEIS must therefore address the additional waste which TMI-1 would generate if it is allowed to restart. Not only must the high-level spent fuel wastes be considered, by also the intermediate and low-level wastes which the November elections in the State of Washington may not now allow at Hanford. This consideration is not adequately addressed in the TMI-1 restart Hearings and must not be allowed to be ignored in the PEIS. The question of radwaste disposal from "normal" operation of TMI-2 should also be addressed in the PEIS, given that the licensee "plans" to reopen TMI-2 in 1986, according to recent financial statements of GPU.

How much of Three Mile Island, in the middle of the Susquehanna River which feeds the largest inland commercial fishery in the world will the NRC allow to become a 30-year "temporary" repository for spent and damaged fuel and other radwaste? The PEIS does not address this, and it should.

Such "interim onsite storage" is consistent with the practice of storing high-level waste within the containment buildings. This forces the question: what sort of onsite storage is safest? The supposition that the bunkers proposed will be safer than controlled storage within the containment building is not founded in the PEIS. Why then should there be any rush to move the fuel from the containment building when there is no safer place to store it, and no forseeable place to move it off the island? The PEIS provides no reasonable justification for the rapid decontamination and the removal of the fuel from containment. Safe, long-term "interim" storage within the containment must be considered.

The only conceivable justification of "timely removal" is the restoration and restart of the TMI-2 reactor. The Staff is perpetrating a fraud on the public when it states that the "ultimate disposition of TMI-2 ... is not within the scope of this PEIS" (p. S-1).

On page 2-6, the Staff explicitly refuses to consider the alternatives of "destructive decontamination" because it "implies a decision not to rebuild." It assumes on page 1-1, "A decision to either restore or decommisssion the facility probably would not occur until a detailed inspection and engineering assessment is made of the nuclear steam supply system... To make this inspection requires that the core be removed." This is a blatant assumption that only technical and design or financial considerations will determine the possibility of the restart of a reactor that almost destroyed "an area the size of the state of Pennsylvania."

This fraud concerning the scope of the PEIS and the lack of consideration of the effects of the possibility of restarting either

Unit One or Unit Two is even more reprehensible in the Staff's consideration of "psychological stress." At page 3-24, the Staff states that "The continuing tension seems related to two issues: future decontamination plans for TMI-2, and a distrust of those responsible for those activities." It completely ignores the stress created by the potential restart of either reactor. The Staff's inclination to put off any decision on the disposition of Unit Two multiplies the stress of the many who want TMI out of their lives forever, and most local polls show that 50-60% of the people in the area do not want even TMI-1 to ever go on line again, but the Staff refuses to acknowledge that it is the NRC's allowing the possibility of either reactor to restart that is the central cause of stress in this area, not just the clean-up or the distrust of the NRC and the licensee.

In the case of the KR-85 venting, the NRC's haste in allowing venting instead of a safer mode of clean-up served to increase stress and frustration, and increase distrust of the NRC by the general public, and yet on page S-11 it states " The long-term nature of the clean-up program presents the potential for chronic psychological stress for some people; consequently, completing the clean-up expediciously is desirable." Their conclusion is simply wrong.

The Staff even goes so far as to claim (page S-11) that stress has been relieved, "now that the venting of the reactor building has been completed in a controlled manner." What possible justification does the Staff have for such a bald, erroneous statement?

The licensee has elected for financial reasons to slow the clean-up activities to a crawl-- the only major decontamination operation scheduled for 1981 is the operation of SDS-- if that is approved, which we go on record opposing for reasons better covered by the Susquehanna Valley Alliance and other commentators. Under the circumstances, and the licensee's slow-down occured after the issuance of the Draft PEIS, there is no need to issue the Final PEIS that is as pressing a need as to insure completeness and full opportunity for public comment and for full, informed and considered directions from the TMI Advisary Panel. In fact, given the gaps

in the PEIS as issued, the violations of NEPA by omissions, and the insufficient analyses of alternatives listed here and in other commentaries, it is unreasonable to expect that a complete and satisfactory PEIS could be issued by the beginning of the year.

Likewise, it is impossible for the newly-formed TMI Advisary Panel to do its job by the Staff's January deadline. We also recommend that the NRC Commissioners empower and enable the TMI Advisary Panel by providing funds for outside technical support and advice of their choosing, in addition to sufficient time to address the issues set forth, and those omitted, in this Draft PEIS.

Respectfully submitted,

Gail Bradford

Gail Bradford, on behalf of
the Anti-Nuclear Group
Representing York.

This Comment was prepared by
Stephen Brooks,
Penny Sanstead, Esq.
and Gail Bradford.

3184 Main Street Buffalo, New York 14214 (716) 832-9100

November 24, 1980

Dr. Bernard 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 Sierra Club Radioactive Waste Campaign wishes to submit the enclosed comments on the draft PEIS for TMI-2 cleanup. These comments are submitted four days late and we apologize for the delay. As a citizen group whose primary focus is not TMI but other nuclear waste matters, we have not been able to put full-time effort into our review. We trust that these comments can be factored into the final EIS without too much difficulty.

We would appreciate it greatly if you could send us the final EIS on TMI-2 cleanup.

cc: B. Hess
PIRC
NIRS

Sincerely yours,

Dr. Marvin Resnikoff, co-director

sierra club
radioactive waste
campaign

3184 Main Street Buffalo, New York 14214 (716) 832-9100

COMMENTS OF THE SIERRA CLUB RADIOACTIVE WASTE CAMPAIGN
on the
DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT
RELATED TO DECONTAMINATION AND DISPOSAL
OF THREE MILE ISLAND-2 WASTES
NUREG-0683

The Three Mile Island-2 situation, if not so desperate for citizens in the vicinity of and downstream of the TMI-2 reactor and for Met Ed and its ratepayers, would be comical. Reactors are built on an island, in a river - an absolutely unthinkable location for a permanent radioactive waste repository, yet there is no acceptable location for the TMI-2 wastes. No permanent waste repository exists and space is severely limited in low level waste burial grounds. Where will the radioactive rubbish be taken? The Harrisburg community understandably wants each gram of radioactive contamination removed, yet no community wishes to accept the material and many do not even want this toxic material to pass through its borders. Met Ed is busily in the process of decontaminating the TMI-2 reactor, that is, it is in the process of moving radioactive material from one place to another, attempting to collect and reconcentrate the radiation in one location. According to the PEIS, this decontamination to almost "surgically clean" standards, is taking place in order to stabilize the TMI-2 reactor. This decontamination is taking place at great cost to the occupational personnel at TMI-2 and to the ratepayers of Met Ed, who must bail out the utility and the banks for their, and not the ratepayers', mistake. It is clear to any disinterested observer that Met Ed is on the path to rebuilding and restarting TMI-2. There is no other reason for making TMI-2 "surgically clean" at this time. The Harrisburg community is opposed to the restart of either TMI reactor, yet the utility and the NRC are intent on imposing their decision on an unwilling populace, the absolute antithesis of democracy in action. The TMI-2 situation is replete with irresolvable contradictions.

The Sierra Club Radioactive Waste Campaign, an educational and organizing effort by the Sierra Club on the issue of radioactive wastes, has examined in detail the PEIS, NUREG-0683. Our viewpoint is that of an environmental organization located outside the immediate Harrisburg area who is concerned about the health and safety of Harrisburg area residents, occupational personnel, and those residents living along transportation routes and near low level waste dumps. Because of our experience at the West Valley low level waste dump and at other radioactive waste sites, we have been able to compare the NRC claims on decontamination factors for HEPA filters, submerged demineralizer systems, etc. We do discuss these matters under Specific Comments below. However, what is needed here is a discussion of overall policy and direction and not a fixation on minutia or a debate on whether the PEIS is "off" by a factor of two on cesium releases to the environment. A great weakness of the PEIS is that it is lost in detail and lacking in creativity. The major question must be addressed: how is the cleanup to proceed and towards what end?

sierra club
radioactive waste
campaign

PROPOSED NRC DIRECTION TOWARDS DECONTAMINATION AND DISPOSAL OF TMI-2 WASTES

In gross outline, the NRC plan is to decontaminate all sections of the TMI-2 reactor and concentrate, by zeolites and resins, all radioactive contamination, except tritium. After most of this work has taken place, the reactor pressure vessel (RPV) will be opened and the uranium fuel will be removed. All All radioactive materials, in up to 1700 shipments, will be taken to an unknown waste dump 2300 miles away. Radioactive materials which have not been adsorbed by the ion exchange resins will probably be released to the Susquehanna River. We assume that an EIS will be produced to show that the harm is trivial compared to background radiation. Then, after up to 12,000 person-rems of radiation dose have been absorbed by occupational personnel, a decision will be made by Met Ed and the NRC Staff, with criteria presently unknown, whether to reconstruct the reactor internals and restart TMI-2. That decision will be an economic one and have little to do with the public health and safety. The above approach by the NRC is based on years of past decontamination practice, and, from our perspective, is intended to lead inexorably to the startup of TMI-2. We suggest instead an alternative approach which will lead to lesser occupational exposures and lesser environmental releases, but will not lead to the startup of TMI-2.

SUGGESTED DIRECTION

The NRC plan should be directed instead towards the goal of zero release of radioactivity, and a minimization of occupational exposures, consistent with the goal of stabilizing the reactor so that re-criticality cannot occur. We suspect that this requires opening the RPV to remove the fuel which is now distributed within the RPV in an unknown array, though we are not convinced by the NRC Staff arguments that this is necessary. We think that the only decontamination work that should take place should be directed towards this end. We differ with the Staff that the containment building should be "surgically clean" before the RPV is opened. Continual decontamination work and recontamination of previously cleaned areas will only lead to higher occupational exposures and is not consistent with ALARA. Our recommendation is the following: a lead-lined control room inside the containment building, within which operators could manipulate remote equipment, should be designed and constructed. Such a shielded work room is required in any case to remove TMI-2 reactor internals at a later stage, and is needed for decommissioning reactors that operate 30 years without accident. If it is necessary to remove the sump water, it should be placed in shielded tanks. After securing the reactor, the U fuel could be placed in casks. The end result would be a contaminated containment building, with all radioactive liquids remaining on-site. This situation would remain so until a permanent waste repository is available to accept the contaminated materials. At that later time, the radioactive cesium and strontium could be separated from the tritium, which would have decayed to low levels compared to the Cs and Sr, or the entire quantity could possibly be shipped as a liquid and be made into a cement at the Federal waste repository. It makes no sense to us to make the containment building "surgically clean" and to prepare the radioactive materials for transport at this time when there is no burial location that would accept the radioactive garbage.

It is absolutely necessary that the company be forced to set aside a liquid decommissioning fund for the later decontamination, transportation and final disposal costs. These liquid funds must be an independent public agency. This proposed direction, discussed under Specific Comments (E) below, would lead, we believe, to almost zero environmental releases, lesser occupational doses, and be less expensive in present day dollars. We therefore propose that the NRC give it serious consideration.

WEST VALLEY IS UNFIT AS A BURIAL SITE

Because many persons, including the NRC Staff, are unfamiliar with the operating history of the West Valley dump site, we want to briefly sketch the salient points. As will be clear, West Valley is not an option to be considered for the TMI wastes. The poor operating history of the West Valley site is primarily due to the poor location, but was compounded by the operator, Nuclear Fuel Services.

The West Valley burial ground was opened for commercial radioactive wastes in 1965. As an Agreement State, it was licensed by the State of New York. Clearly inadequate studies were performed at that time. The burial ground consists of long trenches 500' to 700', dug 20 to 30 feet deep in predominantly clay soil. The area has a heavy rainfall and the soil is water-saturated and relatively impermeable except for sand lenses within which water moves more rapidly. One set of trenches, the northern trenches, were filled by 1970; another set, the southern trenches, were filled between 1970 and 1975, when the burial ground was finally closed down. The trenches are covered with a clay cap -4' in the northern trenches and 8' in the newer southern trenches. In 1975, radioactive water broke through the top clay covering of the trenches and began to enter the waterways. The reason for burial ground failure could have been diagnosed by a third grader who has played at the beach. If one digs a hole in water-saturated earth and fills it with floss (filters, resins, papers and animal carcasses), the hole fills with water. This water entered the trenches through the clay top, but also through sand lenses. The capped northern trenches filled with water, broke through the cap and radioactive water began to flow out, like water overflowing a bathtub. It was thought that the newer southern trenches, capped with 8' of clay and contouring to aid water run-off, would not fill with water. The optimism concerning the southern trenches was expressed by DOE,

> "Experience with the southern trenches indicated that it is possible to operate and maintain the burial area so that there is no significant release of radioactivity."
> "...experience with the southern trenches would indicate that filtration through the caps should now cease and erosion should be prevented." (TID-28905-2, "Western New York Nuclear Service Center Study", November, 1978, p.3-53, DOE)

At the same time DOE was writing those sentences, Nuclear Fuel Services was pumping out the southern trenches to prevent a recurrence of the cap breakthrough of the northern trenches, i.e., DOE was telling a direct lie. This radioactive trench water was pumped to a water treatment plant, similar in some respects to EPICOR-II. Cesium and strontium were removed and placed back in the burial ground; tritium was released quantitatively to the Cattaraugus Creek watershed. Between the years 1975-1977, two million gallons of radioactive water were released to the environment, including 6,700 Ci of tritium. The figures are not yet available for the period 1978-1980, though we do know that 700,000 to 900,000 gallons of radioactive trench water were pumped from the southern trenches in 1980. Unless the radioactive material in the burial ground at West Valley is exhumed and placed in above ground bunkers, a position the Sierra Club Radioactive Waste Campaign advocates, this problem, leading to the continual radioactive release of radioactive materials, will recur for hundreds of years.

The problem of the West Valley burial ground is of concern to a large population since Cattaraugus Creek enters Lake Erie near the water intake for southern Erie County towns. Further down Lake Erie this radioactivity enters the Buffalo water intakes. These water intakes service 1½ million people. Because of the annual rainfall and inadequate geology of the West Valley site, it is a poor location for a low level waste burial ground. Further, the consciousness of persons in Western New York concerning toxic and radioactive wastes is very high. It would be an understatement to say that additional radioactive materials would not be acceptable.

ARE THERE OTHER LOW LEVEL BURIAL SITES?

To recount the low level waste situation in the United States, the low level waste dump at Maxey Flats, Kentucky has had similar waste migration problems. The dump at Sheffield, Illinois, is filled and the State of Illinois has opposed its expansion. Of the three remaining sites, Barnwell, SC, is still accepting radioactive wastes, but is reducing acceptance to ½ of previous levels. Because of a recent referendum, the Hanford , Washington site will be off-limits to all but medical wastes after July, 1981. The remaining site at Beatty, Nevada is open, but the Governor of the state is attempting to close it after operating irregularities, and waste transportation mishaps. Pu-contaminated wastes are barred at all, but the Hanford site, and that will be off-limits after July, 1981. While it is generally recognized that TMI, in the middle of a river, is not the proper place to dispose of radioactive materials, there is not a safe or publicly acceptable site to take this radioactive garbage.

Since the Federal government cannot resolve this issue, it has asked the states to do so. Federal legislation is being readied to allow states to enter into compacts. One state may have a facility for toxic chemical disposal and another state may have an ideal location for radioactive waste disposal (we doubt it). A swapping of poisons would occur. It is our intuition that state governors will have less success locating a low level waste dump than the Federal government. It is not a function of the level of government, but the technical fact that there is no secure radioactive waste burial ground in areas of high rainfall, and there is a continuous infinite stream of radioactive materials to be disposed of.

Since there is no acceptable location for Pu-contaminated radioactive materials, it is our position that TMI should be secured so that no off-site releases occur, and re-criticality is not a possibility. This should occur with minimal occupational exposures. We disagree with the NRC head-in-the-sand, business-as-usual approach of securing Cs-Sr for low level waste disposal, releasing tritium, and scrubbing the reactor till it is "surgically clean". The NRC plan is a thinly disguised attempt to start up TMI-2 again.

SPECIFIC COMMENTS

A. The PEIS is not complete because no economic costs have been included. According to the agreement between the City of Lancaster, the utilities and the NRC (p.1-23), no discharges can take place until the PEIS is complete. Apparently, these economic costs will be put in the final EIS (p.1-1). If this is so, the public must still be given an opportunity to comment upon this section before the EIS can be considered "final". The economic costs must include costs of transportation and disposal. There is a real possibility that Met Ed may go bankrupt before cleanup is complete, the remaining assets (less TMI-1 and -2)being purchased by another utility. The EIS must address this possibility and the consequences. Citizens in public hearings have asked the NRC to address this point concerning Met Ed bankruptcy and the NRC has stated that this comment has "been considered in planning this statement where appropriate to its scope". However, questions of Met Ed insolvency have, in fact, not yet been considered.

B. The total radioactivity released from the U fuel to the sump water and other locations within the TMI facility seems rather high, higher than we had previously thought. Over 50% of the Cs-137 produced in the fission process is now dispersed within TMI-2. The nuclear industry and the NRC Staff have often stated that no more than 1% of the Cs contained in spent fuel assemblies could be released in a spent fuel transportation accident. For high burnup, short-cooled fuel assemblies, in an accident involving a loss of coolant, it appears to us, based on the TMI experience, that much more than 1% could be released.

To document this assertion, we have the following amounts of Cs-137 in various sections of the TMI facility:

	Cs-137 (Ci)
Auxiliary Building Tanks (Table 5.2-1)	2.87×10^4
Auxiliary Building Sumps (Table 5.3-2)	9,000
Containment Bldg. Sump Water (p.6-13)	4.32×10^5
Primary Coolant System (Table 7.2-2)	1.39×10^4
	4.84×10^5

Assuming a burnup of 3165 MWd/MT, 90 MT of U fuel, and using the computer code ORIGEN, a total production of 9.06×10^5 Ci of Cs-137 is expected. Thus, 53% of the produced Cs-137 has been released to various sections of the TMI-2 facility. This may indicate that more than 50% of the U fuel was exposed to air for extended periods of time.

There also seems to be an anomaly in the data in the PEIS in the ratios of Sr-90 to Cs-137. The ratio Sr-90/Cs-137 is 0.68 and 0.016 in the primary coolant system and sump water, respectively. One would expect this ratio to be the same in both systems. The NRC Staff should explain the reason for the difference.

C. The population and occupational radiation exposures in the PEIS due to the transportation of radioactive materials appear low. Our estimate, using WASH-1238, is 435 person-rems. The NRC estimates 26 to 66 person-rems (p.S-10). Assuming a dose of 10 mrem/h at 6 feet, a population density of 130 people per $(km)^2$ (which is representative of populated areas), with no person closer than 30 meters, a travel distance of 320 km per day and 1700 shipments of 2300 miles, we find a radiation exposure to the population and occupational personnel of 155 and 280 person-rems, respectively, or a total of 435 person-rems.

We differ with the NRC as to the significance of these radiation exposures and others within the PEIS. The data from Hanford workers, as re-analyzed by Gofman (Health Physics 37, p.617 (1979)) suggests 3,774 additional cancers per million person-rems. (Other analyses which the NRC employs suggest many less cancers.) Thus, the Hanford data indicates 1.6 additional cancers from the transportation of TMI radioactive materials. Genetic effects may be three times this number.

D. The major number of additional cancers and health effects will arise from occupational exposures and these will be greatly increased with early decontamination. The NRC estimates a range between 2,700 and 12,000 person-rems. If the occupational exposures reach 12,000, the number of additional cancers among workers may reach 45 (with genetic effects three times as much). Assuming 200 workers (an arbitrary number) involved in radiation work at TMI, one would expect 50 cancers since the cancer rate is 20% of deaths. Thus, occupational personnel may have a doubling of the cancer rate due to cleanup operations. This occupation is, by far, the most hazardous industrial adventure in the United States. These exposures could be greatly reduced if the goals of the cleanup operation were changed and the methods were improved.

E. We are in agreement with the NRC Staff that the "paramount objective of the cleanup of TMI-2" should be the "timely removal of damaged fuel to safe storage", in order to prevent criticality. However, we believe the scope of the actual effort indicates that Met Ed desires to restart TMI-2. It is not required to make TMI-2 "surgically clean" in order to secure the damaged U fuel. If restart were not the "paramount objective", the containment building could remain in its present contaminated state, except for the possible securing of the sump water. Cleaning the TMI-2 facility to "surgically clean" standards will only increase the occupational exposures and environmental releases as compared to other options which could be employed.

We suggest instead a shielded control room. designed to be quickly assembled within the containment building, be set up above the RPV. All operations, such as removal of the RPV head, used fuel and other operations, should be accomplished remotely by manipulators from this inner control room. Such a shielded room, albeit less substantial than the one proposed here, would have to be constructed in any case under the NRC plan to remove the U fuel pellets and reactor internals (we do not propose removing the reactor internals, if this can be avoided). Further, such a shielded room could also be used at numerous reactor decommissionings or accident situations. From the containment control room, the U fuel pellets could be prepared for removal by the overhead crane through the fuel channel and loaded into casks. If the reactor internals need to be removed in order to remove the remaining fuel pellets (if there is sufficient remaining to cause criticality), they could be dissected and placed in shielded containers, assuming cutting torches are developed to cut through the thickness of commercial reactor steel.

We see no point in separating Cs, Sr and other radionuclides from tritium at this time since the radioactive material cannot be moved anywhere at present. Radioactivity, on the order of 10^5 Ci of Cs-137 must be buried in a permanent waste repository and none will be located until the year 2,000 at the earliest. On the other hand, TMI-2 should not be considered anything more than a near term holding tank for this radioactive contamination.

We believe that the NRC should examine the option of a 60 year holding period in much greater detail. After a long waiting period, the radioactivity would decay to less than a fifth of present levels (assuming 60 years) and the resultant occupational exposures would be a fraction of the preferred option.

F. Even if the NRC decides to make the containment building "surgically clean" and to remove U fuel and damaged components of the reactor at this time, the liquid radioactive contamination could still be held in specially designed tanks within the containment building. There does not appear to be a need to immediately remove the liquid contamination from tanks within the containment building and to separate Cs and Sr from other radionuclides at this time, unless the NRC and Met Ed wish to restart the TMI-2 reactor. In a 30 to 40 year period of time, tritium levels will be reduced to less than 10 Ci while Cs levels would still be on the order of 10^5 Ci. It appears to us that the radio-

active liquids could be reduced by evaporation later, and the evaporator bottoms could then be solidified. If it is desired, the tritium, contained in the evaporate, could be solidified. The NRC Staff objection to the evaporation process, that iodine would also be vaporized with the water, is correct. However, the zeolites and resins are also not effective in trapping iodine either. The evaporation method achieves decontamination factors for non-volatiles, on the order of 10^5 to 10^6.

G. The planning schedule and methods for removal of the fuel and lower reactor internals is not sufficiently detailed in the PEIS. The NRC Staff refers to fuel removal by "special equipment". What does this mean? The Staff must specify what it is referring to. If the equipment is not available, the STaff must specify the R & D requirements and the probability of success. To cut up reactor internals, a plasma arc has been used to cut through 1½ inches of stainless steel underwater at the Elk River Reactor, but it will probably be necessary to cut through 2 3/4 inches of stainless steel at TMI-2, more if the metal has agglomerated. The carbon steel pressure vessel at the Elk River Reactor was 3½ inches thick; a large power reactor would have a pressure vessel 9 inches thick.

H. The postulated accidents considered in the PEIS inexplicably do not include the possibility of reactor startup. Since the purpose of all the decontamination and disposal is to avoid re-criticality, we regard this as a fatal flaw in the PEIS. The Staff does note, on p.S-3, that it is possible for re-criticality to occur, "even though improbable". Yet the Staff does not address the possibility of this occurring during cleanup operations at TMI-2, especially the possibility of this occurring while the RPV is opened. It seems to us that this is the worst credible accident and therefore it must be addressed under CEQ guidelines. The Staff argues both ways on this point. On the one hand it states that neutron absorbing material, especially boron in the coolant, has been effective in preventing criticality. On the other hand, it states (p.2-7) that neutron-absorbing material may not reach all parts of the fuel because of blockage within the reactor. This argument is advanced by the Staff in opposing a suggestion to fix the reactor with neutron absorbing material that dries to a solid. It seems to us that if boronated water can reach the fuel, so can other liquid neutron absorbing material. If no liquid reaches the fuel, no criticality can occur in any case. The sections on recriticality and the probable success of different types of neutron absorbing material have not been done carefully and should be considered in greater depth by the Staff.

I. From our experience with nuclear companies who disappear when the clean up bill must be paid, we believe that the Staff must, with each option considered in the PEIS, indicate how that option will be financed. The option proposed here, removal of damaged fuel, minimal decontamination and holding tanks for radioactive liquid materials, is the least expensive option, in present day dollars. Most deferred action options are less expensive in present day dollars. However, we only support this option if a decommissioning fund is set aside by Met Ed and the liquid funds are administered by the NRC or the State of Pennsylvania. If this is not done, Met Ed will likely disappear when the bill must be paid. The NRC Staff will probably argue that the NRC only regulates the public health and safety aspects of nuclear power and the State Public Utility Commission sets the rates. We regard the two as inextricably linked in this case.

friends & family of tmi
P. O. BOX 82, HIGHSPIRE, PENNSYLVANIA 17034

November 20, 1980

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

Dear Dr. Snyder:

The Programmatic Environmental Impact Statement presents comprehensive choices of cleanup for Unit 2. We of Friends & Family of TMI would like to address one of the activities of cleanup (the treatment of radioactive liquids), recognizing that this is the essential first step in the entire cleanup process. We are confident that efficient technology exists to decontaminate the radioactive water, and we urge that this be approved and implemented as soon as possible.

Specifically, we feel the Submerged Demineralizer System now under construction by Metropolitan Edison Company is a safe, efficient means of processing contaminated water. Friends & Family believes this system is crucial to the cleanup process, and we urge the NRC to approve its use.

Processed water should be either returned to the Susquehanna River or used for further decontamination efforts. Of the alternatives for disposition of the processed water, these seem to be best. Solidifying the water or evaporating it seem to serve no one's best interest.

The large amount of contaminated water generated by the accident in Unit 2 can be efficiently and safely handled by the systems Metropolitan Edison Company now has, instead of searching for other ways to get the job done, and thus prolonging the risks and stress. Friends & Family supports the methods stated above as described in the Programmatic Environmental Impact Statement.

Sincerely,

Lori Dubiel

Lori Dubiel
President

---

147 South Front Street
Steelton, Penna, 17113
November 20, 1980

Nuclear Regulatory Commission
Middletown, Penna.

Gentlemen,

I urge you to give more consideration and study of all the proposed clean up activities of Unit II (NUREG-0683). The most important objective for this Review must be a search for improved methods to drastically reduce the expected exposure to cumulative doses of radiation of the TMI workers and surrounding area population.

The health and lives of the innocent victims of the March 28, 1979 'accident' are at stake. It is imperative that People must be your utmost consideration. They must be regarded important primarily above anything else on this planet in every necessary decision in cleaning up (and shutting down permanently) that 'Chamber of Horrers' on TMI!

Sincerely,
Joan Petrosky
7 miles from TMI

Commonwealth of Pennsylvania

DEPARTMENT OF HEALTH

HARRISBURG

THE SECRETARY

November 20, 1980

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

Dear Mr. Snyder:

You have requested a review and comment regarding the Nuclear Regulatory Commission's Environmental Impact statement.

Attached are the comments of George Tokuhata, Dr.P.H., Ph.D., director of the Pennsylvania Health Department's Division of Epidemiological Research.

I trust Dr. Tokuhata's comments will be of assistance to you and your staff in your important discussions.

Sincerely,

H. Arnold Muller

H. Arnold Muller, M.D.

Attachment

POST OFFICE BOX 90. HARRISBURG, PA. 17120 . 717-787-6436

11/19/80

Comments on
ENVIRONMENTAL IMPACT STATEMENT BY NRC
by

George K. Tokuhata, Dr.P.H., Ph.D.*
Director, Division of Epidemiological Research
Pennsylvania Department of Health

*Also, Professor of Epidemiology (Adjunct), University of Pittsburgh Graduate School of Public Health; Associate Professor of Community and Family Medicine (Adjunct), Temple University College of Medicine.

Comments made on the draft Environmental Impact Statement prepared by the U. S. Nuclear Regulatory Commission, dated July 1980 are primarily confined to those areas related to offsite radiation doses and health effects, including psychological stress and behavior in the local population.

The NRC staff's conclusions regarding potential health effects are based on the existing literature on the biological (health) effects of radiation and some of the studies conducted since the TMI accident, particularly those related to the psycho-behavior of local residents.

Our comments are divided into two major components: Somatic effects and psychological effects. These comments are made under three premises: First, It is difficult to separate the effects of the TMI accident itself from those of the residual cleanup activities; this is particularly true in terms of the psychological effects. Second, We consider radiation doses computed and cited in the draft document "as given" since this is not our area of responsibility nor of professional expertise. Third, only human exposure is considered.

A. Somatic Effects:

The NRC standard indicates that the cumulative whole body dose to any individual offsite exposed to gaseous and liquid release from the cleanup operations should not exceed 1.2 mrem. The probability that this dose would cause a cancer death over the lifetime of the individual who received the dose is about 1.7 in 10 million. This potential excess cancer death is too small for the available epidemiologic method to detect with any certainty. The probability of genetic effects from that dose to offspring of the exposed individual is about 3.1 in 10 million. These risks are extremely small compared to the normal incidence of hereditary disease in offspring in the U.S. at the rate of one in 17.

The maximum total body dose that is estimated to occur to an individual offsite during the cleanup operation is about 1 mrem, and the probability that this dose causes a cancer death over the lifetime of the individual receiving the dose is about one in 10 million. The 50-mile cummulative population (approximately 2 million people) dose that could be expected would be about 6 person-rem (6,000 person-mrem), and the average dose received by an individual in this population would be 2.7×10^{-3} mrem. The background radiation in this area is reported (by NRC) to be about 116 mrem per year (including 36% cosmic radiation, 39% terrestrial radiation; and 24% internal radiation-mostly K-40 deposited in the body). Comparison of this extremely small offsite doses calculated here to those of natural background radiation suggests that the somatic health effects are essentially non-existent. This we agree without reservation.

Although we do not anticipate any significant somatic effects of low level radiation within the TMI population, we do continue epidemiological surveillance as a matter of routine practice of the State Health Department. Such surveillance program includes cancer and congenital anomalies, as well as other radiation-related conditions.

One important comment that deserves mention here is that there is still disagreement among certain radiation biologists and epidemiologists with regard

to the biological (health) effects of low level ionizing radiation. The most recent report BEIR III from the National Academy of Science clearly reflects this reality. Although the maximum estimated total body radiation offsite during the 10-day period of the TMI accident is said to be no more than 100 mrem per person, combination of this dose with already existing (accumulated) radiation in certain individuals from various other sources (e.g., medical, occupational, and industrial) could possibly subject these individuals to a different risk category.

B. Psychological Effects:

The NRC staff's conclusions regarding psychological effects are based on several studies of human behavior and psychological stress attributed to the accident at TMI-2 and on the general literature concerned with response to various disasters.

Undoubtedly, anxiety was high among some members of the local population at the prospect of any emissions from the plant, especially of krypton gas released to the atmosphere from the reactor building. The NRC staff considers that the stress on persons who feared accidental releases of the gas should be relieved considerably after the purging has been essentially concluded. We agree with this view.

On the other hand, disposal of "accident water," even though it would be essentially decontaminated of all radionuclides except tritium, remains a concern of downstream communities who oppose its release to the Susquehanna River. We agree that this concern could result in stress for some individuals because of their perception that drinking the water would be harmful. Needless to say, the "accident water" will continue to be a source of anxiety until its proper disposal is accomplished.

The presence of damaged nuclear fuel on site will probably prolong the anxieties of some individuals in the local population. Also, transport of radioactive wastes, as it occurs, will probably result in anxiety for a small number of people along the route.

The NRC staff's analyses of plausible accidents associated with the decontamination activities indicate that the offsite doses for most of them would be small and would have negligible health effects. However, it is understandable that any accident that occurs, however small, probably will increase anxiety and stress, as well as amplify public distrust of those who are responsible for the TMI-2 cleanup.

The NRC staff concludes that "low levels of stress will continue during the cleanup process and that releases to the environment, planned or unplanned, will be perceived by some people as a threat, which will thereby increase stress. For the great majority of people in the TMI community and downstream, no long-term psychological effects are anticipated. Nevertheless, the long-term nature of the cleanup process does present the potential for chronic psychological stress for some of the population.

We are generally in agreement with this view. However, some additional comments are in order in this respect.

1. In considering possible health effects of decontamination and cleanup activities of the TMI plant, such effects cannot, in reality, be separated from those of the initial unit 2 accident where releases of larger radiation doses and greater psychological stress were monitored. Furthermore, from an epidemiological standpoint, the combined or cummulative effects of these two phases over time would be of greater

importance. Possible increase in the incidence of certain selected diseases or conditions in the affected local population should be evaluated in such context.

2. In the absence of documented comparable experience prior to the TMI accident, it is important that proper documentation of the impact, positive or negative, of the psychological stress is indicated. Probably the most important area of epidemiological investigation is that of pregnancy outcome (immediate impact) and child growth and development (long-term impact). A special Study of Pregnancy Outcome (prematurity, immaturity, congenital anomalies, fetal and neonatal death, etc.) within the 10-mile radius is currently underway and another special Study of Child Growth and Development (physical growth such as height, weight, head circumference, and intellectual-social-emotional development) is scheduled to commence in January 1981 for a period of five years.

3. Two recent studies of psycho-behavioral impacts in the local population suggest that (a) the psychological effects are much longer than previously assumed, (b) the extent of stress and its manifest behavior is a function of the distance from the damaged nuclear plant (beyond 15 miles the level of stress significantly decreases), and (c) women with small children are most vulnerable in terms of anxiety and stress caused by the nuclear accident.

4. Two new studies are also scheduled to commence shortly within the State Health Department; (a) psychological stress due to TMI accident and its potential impact on cardiac mortality; and (b) psychosocial

impact of TMI accident upon family structure (particularly divorce and separation).

5. The Pennsylvania Department of Health has established a TMI Population Registry based on the 1979 special census within the 5-mile radius. Approximately 36,000 individuals included in this cohort, now on computer tape, will be followed for an indefinite period of years to study possible health impact of the nuclear accident. The same census has also provided necessary basis for a special study of population mobility in and out of the 5-mile radius.

6. Related to the TMI Population Registry is another study currently underway, i.e., Individual Radiation Dose Assessment for those registered within the 5-mile radius and for all pregnant women (at the time of the accident) within the 10-mile radius. These individualized dose estimates are being derived from several well documented source materials compiled by other agencies, Federal and State, and will be used for various epidemiologic surveillance activities of the affected population.

7. The Pennsylvania Department of Health is also planning an automated health-environmental monitoring system around all nuclear power plants in the State in order to provide baseline epidemiologic data for future studies.

8. An in-depth analysis of the 1979 TMI census data now underway will provide valuable information relative to the incidence of spontaneous abortions following the nuclear accident, as well as the prevalence

of cancer (various forms) and thyroid diseases in the area at the time of the accident. This will provide important baseline data.

9. One of the most often used indicators of potential health effects of the TMI accident is infant mortality. We are continuously monitoring and evaluating the level and specific causes of infant mortality along with the incidence of congenital hypothyroidism in the same area. To date, no convincing evidence has been found that the infant mortality rate in the 10-mile radius of TMI has been affected by the accident. The incidence of congenital hypothyroidism also appears to be within the normal range of expectation.

BILL GOODLING
19TH DISTRICT, PENNSYLVANIA

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SUBCOMMITTEES:
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October 3, 1980

United States
Nuclear Regulatory Commission
Washington, D. C. 20555

Attn: Director, TMI Program Office

I would like to take this opportunity to give my position on the Draft Programmatic Environmental Impact Statement.

I think it is of the utmost importance to hold public hearings which should be very well publicized in the Three Mile Island area on the environmental impact. There has been a growing distrust of public servants as well as of the operators of the nuclear power plant, mainly because of poor and inadequate channels of communication. In order to restore confidence in the people, it is imperative to have their input on any decisions which may be made in regard to their health and safety.

I appreciate your consideration of my comments.

Sincerely,

Bill

BILL GOODLING
Member of Congress

BG:re/rp

Comments Received at November 17, 1980, Meeting with Maryland Citizens
Baltimore, Maryland

BRUCE GILMORE (Tr 37): I am a Special Assistant to Senator Sarbanes. The Senator had a previous engagement in Southern Maryland tonight and he asked me to read this statement which he also requests be submitted as part of the record. I appreciate the opportunity to submit this statement at this public meeting on the draft environmental impact statement concerning the post-incident clean-up of the Three Mile Island nuclear reactor. Earlier this fall I wrote to the Chairman of the Nuclear Regulatory Commission underscoring the importance of public comment on this issue and urging that this public meeting be held. It is important that this meeting provide Maryland citizens with a further opportunity for a public hearing of the critical issues raised by the TMI clean-up. This hearing is, of course, part of the public comment process associated with the draft EIS, a public comment period which was extended to November 20th, 1980. It is my understanding that the NRC plans to complete the final EIS by early 1981. While the public comment period on the draft EIS will end shortly, it is my strong view that the NRC should actively continue to seek public participation in the clean-up decision-making process. The serious nature of the TMI accident and of the consequences of any clean-up activity will require the opportunity for further public comment before a final decision is made on any of the various proposed clean-up options. Maryland citizens, given their proximity to TMI and the possible consequences for our environment, are entitled to no less. Turning to the draft EIS itself, I remain concerned about the adequacy of the environmental assessment of the various disposal options for the contaminated water now being held at TMI. Release of this water into the Susquehanna River and thus into the Chesapeake Bay is clearly an alternative fraught with serious negative environmental consequences. Chesapeake Bay is one of our nation's preeminent estuaries upon which Marylanders depend in a number of important ways. The Susquehanna River provides the greatest amount of fresh water for this huge estuary systems as well as drinking water for a substantial number of Marylanders. Under no circumstances can the integrity of the river as a source of drinking water or the bay and its seafood products be compromised. Consequently, I take strong issue with the draft EIS statement at pages 10-23 downplaying the effect of the release of the processed water on the bay. Ongoing research on the Chesapeake Bay's ecosystem has revealed that both fin fish and shell fish and even aquatic grasses are under a great deal of stress. Populations of many species have decreased and evidence is accumulating that adverse changes in water quality may be responsible. Under these circumstances increased levels of radiation, even small, may have a severe impact. Furthermore, I believe the views set out in the impact statement that the marketability of the fisheries products will not be adversely affected if, and I underscore if, the effects are properly understood by consumers amounts to a tacit admission that such adverse effects will in fact occur. The NRC must undertake a more complete analysis of the other options for dealing with the contaminated water, including more detailed information on each option and the full cost thereof. The purpose of the environmental impact statement process is to set out the details of the range of choices available. The draft EIS will not achieve that purpose unless all the options listed are subject to greater analysis. Detailed comments on the draft EIS have been made by many citizens in groups as well as public officials and representatives from Maryland agencies with responsibility in the environmental area. The expertise and critical analysis offered by these commentators were critical to the decisions to be made about the clean-up action. In his respect, given the unprecedented and highly complex nature of the clean-up, it is imperative for the Nuclear Regulatory Commission to continue to consult with the public concerning the clean-up. I again urge the Commission to assure Maryland citizens and public officials that they will be consulted prior to and be given a chance to comment upon any action the Commission proposes to authorize during the lengthy clean-up process.

JOHN CABLER (Tr 43): As you know from former testimony in Annapolis and Harve De Grace, the Ad Hoc Committee and the Clean Water Action Project believe that basic flaws in the document invalidate the document completely. We would therefore urge you to put together a revised environmental impact statement that will correct the flaws by including cost estimates, because, as you know, there are no cost estimates in the programmatic environmental impact statement which makes it impossible for citizens to perform a cost-benefit analysis to find out if maybe you are doing maybe the cheapest and not the safest clean-up. Also, we are worried that there are no assurances that the high-level waste on the island will be disposed of or any of the waste on the island. Governor Hughes agrees with me. This is a letter from Governor Hughes to President. "The draft environmental impact statement reveals that federal agencies are following a course of action that will make Three Mile Island a long-term storage dump for radioactive waste. Nothing could be more dangerous to Chesapeake Bay and the people of Maryland. No responsible agency would locate a dump for radioactive waste on an island in a flood plane above the water supply of a major metropolitan area poised at the head of the Chesapeake Bay. Yet, because of refusal to consider any other realistic alternative that will be the result of actions described in the draft environmental impact statement." I agree with Governor Hughes that that is not the right answer. Also, as far as the statement in the draft about the marketability of the seafood, it seems from what your fisheries expert said there will be an effect on the marketability of the seafood if a release occurs. Our feeling is that if you are consider releasing water into the Susquehanna River and expect that statement to fly that it won't affect the marketability of the seafood, you will at least have to do a market research analysis independently, hire an independent team that can do those surveys and come up with a more credible answer. We would also hope that you would respond to the new

EPA funded Independent Scientific Research Team, something that EPA has just put together that we are looking forward to working with, and also, that you complete the revised environmental impact statement quickly. I know you have indicated to me that you thing we are trying to slow the process down. That is not true now. It was at the beginning. It was like trying to catch a speeding bullet, this clean-up, going somewhere. We wanted to catch it before it got away. Now I thing we have caught and we want to see where it goes. We want to change its direction. That is what we are trying to do. We are not trying to slow things down. What we would like would be full public hearings on the revised draft. We would like the revised draft not to be a best case/worst case analysis as the present environmental impact statement is, but instead to be a blueprint, as we suggested on March 20th, a blueprint to follow that would suggest compatible processes that would work together to ensure a safe cleanup. We feel that the credibility of the Nuclear Regulatory Commission is shot with the public anyway, with the people of Maryland, and that you can't put it back together without us, without working with us. The accident focused a powerful spotlight on the clean-up arena, a beam of light on the arena. We can now see what needs to be done. My question to you is, will you do it? Will you write a revised EIS as quickly as possible and have public hearings, cost estimates, adequate consideration of waste disposal methods, develop alternatives to dumping in the Susquehanna River, an option that is clearly not acceptable to the people here, to the people in Harve De Grace and to the people of Maryland, to Senator Sarbanes. It is not acceptable to anyone, to the Maryland Waterman's Association, the Chesapeake Bay Foundation, and the list goes on and on and on, as you know. Will you write a new environmental impact statement?

BILL HOLSTON (Tr 50): I am an engineer in the Nuclear Engineering Section at Baltimore Gas and Electric working on the Calvert Cliffs Nuclear Power Plant. I would like to point out at this point my viewd do not necessarily represent those of Baltimore Gas and Electric's. I am here as a citizen. I would like to read a statement I have read in the Nucleonics Week, and then ask a question from that. Metropolitan Edison, the Nuclear Regulatory Commission and the Department of Energy are acutely aware of the political relations ramifications of dealing with TMI waste and therefore are hesitant to strike a clear waste management plan even though the waste that must be handled is no greater, and I repeat no greater in radioactivity or volume than that generated by some government and commercial nuclear operations a variety of sources say. Most of the waste in question at TMI consists of cesium and strontium isotopes and is divided into two categories, low-level material consisting of resins from the Epicore 2 systems, treated water which spilled into the TMI auxiliary building and high-level material in the water resting in the containment sump. Speaking of low-level waste, a DOE source said ordinary low-level waste can be disposed of by shallow burial. This, however, has been deemed not ordinary. The comment was a reference to NRC's order that low-level waste as TMI be solidified. I realize that you said that cost is not a question, but I question the fact that why are taxpayers' and ratepayers' valuable resources being wasted on spending on systems that really aren't needed? Why is a concrete solidification system needed at TMI when this waste is no different than at other plants and it is not done there?

LEWIS FOSTER (Tr 54): For five years up until last November I worked as a nuclear environmental research technician for a nuclear environmental contractor. In April 1979 I was transferred to the Three Mile Island plant to work on a unit team doing studies on the environmental air and water quality. We were doing monitoring. In my previous statement at the Harve De Grace meeting on October 29th I mentioned the tendency of the nuclear industry to emphasize data which fits the needs of the industry and to overlook relevant information which is less than desirable to the industry. We believe that several aspects of the biological and psychological impact of the TMI situation have been overlooked in the present PEIS draft. The current position of the industry and the NRC is based on conclusions arrived at after considering what they believe to be meaningful and accurate data. All too often it was my experience that similar conclusions are based on data that is frequently in a scientific sense erroneous and irrelevant as far as the human and biological aspects are concerned. One such situation was the improper use of air monitoring equipment in auxiliary building of the damaged reactor at Three Mile Island. Radioactive iodine was the most prevalent contaminant in the air of the auxiliary building after the accident. The company that I work for designed and marketed the charcoal cartridges used to determine the iodine levels at Three Mile Island. I personally did the quality analysis testing in the lab myself almost a year before the accident occurred. Known quantities of air would be pumped through the charcoal cartridge at a constant flow rate. The cartridges would then be measured by equipment sensitive to radioiodine and to determine the amount and particular type of the isotopes. Samples were taken from five different installations by health physics personnel on a daily basis from early April until June 22nd and every three days thereafter. These samples were analyzed in my lab as well as by the NRC and were used to determine the levels of air-borne radioiodine in the Unit 2 auxiliary and fuel handling buildings. The results were subsequently posted at the health physics control point and were used to determine the necessity of breathing apparatus by the Three Mile Island personnel. My research program necessitated frequent entry into the restricted areas of Unit 2. During my activities in the auxiliary building and the fuel handling building I would frequently find cigarette buts that hadn't been there on the previous visit. Presumably the workers involved in the clean-up would assume that the levels of iodine were safe and would remove their respirators to have a smoke. Also, when the levels of iodine were low enough workers would be issued respirators which would not filter iodine but only particulate material. I am simply saying that my request to the NRC is that they seriously consider the possibility of another draft statement. I think it is very important that we look into these matters. Some of the biological factors haven't been completely addressed. Several of the factors that my colleague John Cable mentioned have not been correctly addressed.

KAREN GUSTIN (Tr 63): We have a few friends here that would like to say something to you from the Union of Concerned Crabs. They would like to tell you something. Our friends, crabs, rock fish, sea nettles, clams, oysters, turtles and others have asked us to come here to tell you we don't want radioactive water dumped in our hope, the Cheapeake Bay. We live there, we eat there and we sleep there. We have for a very long time and we hope for a long future. It is the human beings' responsibility to protect the planet and the creatures dependent upon it who have no voice in your conference rooms and no stock in your corporations. We ask you the representatives of the Nuclear Regulatory Commission to take our message to your leaders in Bethesda. Don't dump the water.

TANYA PALMITY (Tr 64): I have a rather simple question. I was just wondering what the activity was in the low-level tanks?

BONNIE FRADKEN (Tr 66): I work with the Communist Workers Party. I am not an expert, but I know when the wool is being pulled over my eyes. I am getting really tired of hearing about how the NRC is really concerned about the public health and well-being, and I think a lot of people in here have been thinking this, and I am going to say it. Cleaning up the Three Mile Island Nuclear plant doesn't mean they are cleaning it up for the interest of us. It means cleaning it up to start it up. That is what it is all about and I think a lot of people here know that. Also, the NRC isn't a neutral body concerned about the interests of the American people. I am just saying that I am tired of having this run down on me every time you speak. I think all of us know that Three Mile Island showed where you stand. The NRC is just covering for the fact, you know, that the monopoly corporations that are profiting from the nuclear industry are going to be allowed to continue to profit. The questions that people have asked haven't been answered sufficiently because you don't intend to answer those questions. Not only do the monopoly corporations want the profit, but the government is preparing for World War III. For World War III you need a large nuclear stockpile. The Communist Workers Party under the leadership of Jerry Tongue says that in the 1980's we can be certain of two things. There are going to be two things that could happen. One is world war, and that means World War III, or the other solution is socialist revolution. I believe that the American people are not going to profit by world war any more than they are going to profit by the nuclear industry and the system that backs it up to the hilt. When workers control this country they are going to be putting an end to this nuclear nightmare. That is what we are fighting for and that is why I am taking a stand against the nuclear disasters that are being forced down our backs. All of these nuclear accidents, the burdens are put on the working people in this country while the monopolies who are behind them and the government who is behind them are profiting at our expense. I am really tired of it and I am really tired of you guys, so-called experts, being paid with our tax money to try to pull the wool over our eyes.

PAUL YOUNG (Tr 69): I have here a synopsis of the NRC report we are discussing here this evening. One item in the report has not received any discussion during the course of these hearings. I will read this paragraph to you because my questions will be on this material. This summary was written by Lee Tory for a British publication called "New Scientist" and appears on page 766 of the September 11th, 1980, issue. "Removal of the sump water, expected to be the most difficult task of the clean-up operation, must be accomplished before full-scale decontamination and defueling of the reactor can begin. According to the NRC report, leakage from the reactor's primary cooling system adds 550 liters per day to this spill, that is in the sump, and the continuing rising water level now poses a hazard. Some instruments and electric cables have already been shorted out by the water. Late last month the water level was a mere 2.5 centimeters below electric motors on two valves that must remain in operation in order to maintain the safe cooling of the reactor. Unless the water leakage is ended or it is transferred to a different location, warns the NRC impact statement, the present safe status of the plant may deteriorate." What is the current volume in the sump right now? Are there any present contingency plans for an emergency should this water have to be discharged?

THOMAS GLOSS (Tr 73): I use the bay a lot, the upper bay. I fish the upper bay almost exclusively. The bay is hanging on by threads now, especially the rock fish industry which benefits everybody up and down the East Coast. The grass beds, the small microscopic life that the fry feed upon have enough problems with pollutants in the upper bay, let alone dumping this from up in the Susquehanna River up in Pennsylvania and bringing it down here. We have had enough problems with not getting an adequate flow coming over the Susquehanna Dam in previous years. There have been thousands of fish killed and yet you want to dump water like that in there. I find it unbelievable.

GREG DUNN (Tr 73): Early on in you presentation this evening you mentioned several times that you have not as yet specifically recommended releasing the water into the river. You also in that presentation mentioned that the tritium ladened water that you are planning to recycle it and use it in part of the scrubbing process within the plant itself. What I am asking is if you choose not to release the water what other specific recommendations are you considering at this point and will that recycling pocess impact on those decisions and, if so, how?

BILL MALLISH (Tr 77): I am still a little concerned that we haven't addressed one issue in the dumping as much as I would like even though the biologist has talked to us about this. The Susquehanna flats itself where the river literally ends or becomes part of the Chesapeake Bay, we seem to have a flow rate problem here. I guess that is why we formed a giant delta there. We have hundreds of acres of very, very shallow water which means to me that the river is dumping the sediments that it carries right there and has been doing it for hundreds of years. Are we

going to, no matter how slowly we would let the stuff go at Three Mile Island, build up the material on the Susquehanna flats, which of course is the upper bay breeding ground. This is where the rock fish spawn. This is where the young fry survive the dangers of the larger fish eating them or something because it is very shallow and there is grassland there and they are protected from this. If we dump radioactive material in an area where the first cells of the first eggs are hatching is this not a threat to us? Are we in turn dumping most of the radiation in the womb of the Chesapeake Bay? The water that is there at low tide many times, it will expose the shoreland. Twenty-five thousand acres is covered by this area in the upper bay. It is very shallow. You can be miles and miles from shore and be standing in ankle-deep water. It is a very special area, one that is very rare as far as a giant estuary like this. I know of no other shallow lands other than some perhaps marshlands over on the Eastern Shore that would be similar to this.

STEWARD STAYMEN (Tr 80): I am trying to get a perspective of the dose rates from a potential release of the water from the plant into the river. I was very glad to see one of your charts contained a table showing comparing the EPA drinking water standards to the levels of contamination from TMI. I would suggest that you include that in the final EIS. I would also suggest that you include a comparison of what the potential controlled release of water from the clean-up to the river compared to what the release from TMI, if it was operating normally, what the license from the NRC permitted. I think that that would help give readers some of the perspective that you have been trying to provide tonight. I would also like to make two other comments. I would suggest that further down the road when you are getting to removal of the high level radioactive material, if we still do not have at that time civilian high-level waste storage facilities that because of the special circumstances of TMI that you not wait until some ar found but that you use military facilities. Thirdly, a very minor point, I just have a question, in the trucking of the low-level wastes out to Washington State, will that be done by commercial private contractors or will that be done by the government?

JOE CLYDE (Tr 82): I am very inspired by the amount of technical research that people have put into this question. I mean I see a lot of people using their hard earned years of training for what I hope we all here tonight regard as social purposes. However, I take exception with the conclusions and the role that the Nuclear Regulatory Commission is playing here. I think it is essentially a cover-up of a massive catastrophe in terms of the way our technology is being misued. In terms of public comment and public input I think there are basically millions of people who should be here tonight or somehow involved in direct input into this. Now, we all know that when we tried to call people to get them to come out we are dealing with the weather, we are dealing with the short notice that John Cabler talked about and we are dealing with people's so-called apathy which I don't think is apathy. People no more feel apathetic about who runs this country than they did about what happens with nuclear power. I think it is a question of getting information and it is a question of feeling that you can actually do something about it. So I would like to encourage people here tonight, anyone who belongs to a trade union, to be sure and go back to your unions and try to get them very much much involved in this struggle and all of my brothers and sisters in the environmental movement. Please realize there is a powerful movement of over 20 million people just on the brink of becoming anti-nuclear en masse and we can't lose a minute in getting the resources of the labor movement. So let's pull together as fast as we can because we don't have a day to waste. We don't know when the next catastrope will be the last one.

CAYLE SCHNEIDER (Tr 84): The one question I would like to direct to you is that the Susquehanna River supplies domestic water to Columbia Borough, the City of Lancaster, Safe Harbor Village, Holtwood Village, City of Chester, City of Baltimore, Conowingo Village, Brainbridge Naval Training Station, include Port Deposit, Perry Point Veterans Hospital and Harve De Grace. Section 3.19 of Draft PEIS states that the Susquehann's use as a community water supply is very limited. Please explain.

BRUCE PRIOR (Tr 85): I was just curious if this is only one out of several alternatives and if you were holding similar meetings in other parts of the country where they where considering dumping this material? Well, I submit that you should be having similar meetings in other areas where you would be considering dumping.

ROBERT JACOBSON (Tr 88): I just want to make two comments on points made in the blue covered booklet, Answers to Frequently Asked Questions About Clean-Up Activities and so forth. On page 25 of the booklet you discuss transport by truck of the nuclear wastes from Three Mile Island and you state that all the states along the way from Pennsylvania to Washington are notified prior to these shipments and that some states provide police escorts. Since this was published in September you neglected to mention that last spring the Federal Department of Transportation came out with proposed regulations that would change all of that. Basically it would deregulate truck transportation of any radioactive materials so that they could virtually go over any highway, any toll facility and through any state without notifying any emergency response agencies and go through any locality at any time of day. I see this as nothing but dishonest that this wasn't included. While taken at face value what you stated here is true now, but I believe this month the Deparment of Transportation is going to decide on those changes. They were proposed last spring and they were published in the spring. Final comments were in by June 30th and they are to be decided on this month. If these regulations are changed then obviously you have to significantly change your predictions on the number of accidents which you assume would be between two and seven accidents which is significant enough. I am certain that with those restrictions being lifted they will be significantly higher. My second comment. It seems to me that the blue booklet has two purposes. One is to inform the public on what the various options are. The second is to reassure the public. Personally, and I

am commenting on pages 30 and 31, I am not reassured by the fact that there will be only 3 to 10 cancers in workers from this clean-up process and between 7 and 20 genetic defects in children of the clean-up workers which are the estimates that you make. And I am certainly not reassured by your putting this in the context of one in five Americans getting cancer and one in seventeen people in the country passing on a genetic defect. To me that is the height of cynicism, particularly when it is largely recognized that the majority of those cancers are caused by industrial factors. I would like to make one last comment. Again, I would agree with everyone who said that there should be public hearings on this clean-up process every step of the way. And in the future 12 days, which was the notice given for this hearing and the one in Harve De Grace is just not adequate.

MORTON REFF (Tr 91): I have two areas of concern and two basic questions. No. 1, I was impressed with the data, the statistical data on the effect of a processed discharge, discharge of processed water in the Chesapeake. I was really very impressed with all of the specific effects on the various fish, the various chemicals. I didn't hear at all any doubt on the part of the speaker in terms of question, is there that much surety that a fish, any fish in the Chesapeake, doesn't act as a filter and won't maintain various levels of any of the chemicals that you have described? Is there any doubt at all is my question. Do you have any data on residual effects of the chemicals; in other words, long-term effects of the chemicals on the fish? Why can't you combine a couple of alternatives. I noticed that in computing the solidification alternative you indicated that it would end up as 10,000 cubic yards. If you evaporate it first you would reduce your volume by 1/30th, according to your own figures. That would end up with less than 400 yards, 400 cubic yards and then solidify it and then dump it in the middle of the ocean. I don't see why you are hung up only on one alternative. It is either discharged process, vapor, forced injection or holding it at TMI. And holding it at TMI for 60 years is ridiculous. In other words, why can't you combine the alternatives? Why are you hung up on only one?

MICHAEL TAYLOR (Tr 94): My comment tonight is I believe it is time for the people of Maryland to take a stand on the issue of nuclear waste. How you can say that dumping of nuclear wastes into the Susquehanna River causes no threat to the people of Maryland is beyond me. I do not want my family and children to die or to become ill from the NRC's incompetence. The river feeds into the bay. If it is so unsafe why not leave it at Three Mile Island, or better yet shut down the reactor permanently. I would rather move from the state than witness the results of the stupid actions the NRC is considering. I thank you men for letting me speak tonight, and you have got to find another way to get rid of this stuff. Don't put it in Maryland.

VIRGINIA COBLER (Tr 95): I would like to know why does Metropolitan Edison continue to spend significant amounts of money and time in constructing a submerged demineralizer system when the EIS is still in draft form? There is no reassurance that this system will be approved as best to protect the environment and health and safety of the public. Will this expenditure prejudice the NRC's decision as to which alternative for clean-up of the highly radioactive water will be best?

TONY WALLACE (Tr 97): Given that tritium cannot be removed by any feasible methods, and given that the radiological effluent released by the TMI site will have an insigificant, even undetectable effect on the environment, therefore in order to minimize the clear and present danger of psychological stress to the general population, I propose that a control group of fewer than 15,000 nuclear power advocates can serve as the environmental processors. These would be strictly volunteers. They could divide the 750,000 gallons of contaminated water into an equal share of, say, 55 gallon drums. Surely you could find 15,000 dedicated advocates of nuclear energy, maybe the shareholds, who would drink this. My question is if the water is going to be safe, if the effluents are supposed to be minuscule, why don't people simply take gallon jugs home? Why are we worried about trucks breaking down on the highway? That would just spill off the highway into the ecosystem just like dumping it into the river. You would think the trucks could be open-bodied pick-ups driving along and spill it out. They could drive in all directions. They could rive to New York City, California, they could just spill the water out over 3,000 miles in any direction. The fact that the water is just going to be processed and received directly into the river suggests to me that it is the cheapest way. And when you say feasible, removing tritium, is that economic or is that an engineering task?

DIANE POLINSKY (Tr 99): I want to know on a ratio how many comments have you gotten in support of dumping the tritium water? One final comment. I have never heard of anybody at any of these meetings, and I have been coming for over a year, stand up and say that they thing that the tritium water belongs in the Susquehanna. So if you care about the democratic process at all, we shouldn't even be here still talking about this because it should be settled.

BOB ADAMS (Tr 101): Basically my comments have to do with the nature of radioactivity. The way that the radioactivity has been presented it has been in terms of concentrations and that is really misleading to the people of the nature of radioactivity. It is not so much the concentrations of the radioisotopes, there are many other considerations, such as the half life which I don't know if everybody knows. What a half life is, but it is considered to be a time for half the amount of the substance to no longer be there which we call decay. So if like you have a hundred atoms of a substance, the half life is when you have 50 atoms

of that. There are other things to consider like the dose, which is a concentration at a distance. Like the tritium, it gets incorporated into your DNA. So you can have a very small amount of tritium and it can cause great damage. In fact, many scientists believe that tritium is the most dangerous isotope there is. Also, there is a great controvery among scientists over the safe level of radioactivity. In the National Academy of Science report on low-level radiation there is a wide range of what they consider to be safe doses. As far as cancer is concerned, it just takes one single vent for one alteration for cancer to occur. So there is really no safe level of radiation for anyone. But, as I said, there is a great controversy among scientists over what a safe level is, and this is not presented in the report. I haven't read the whole report so I don't know if it is or it isn't. But there is this big controversy and it should be pointed out in the report that no all scientists feel that there is one safe level of radiation.

MICHAEL BRYAN (Tr 105): I am a resident of California and I would like to address one point that Mr. Snyder made before about a forced evaporation not being very relative to the people in this area or not being of concern to the people in this area but just to the people in the immediate area of Three Mile Island. It is a concern of mine and I think any decision that you make is a concern of every person in this country that cares about this environment and about themselves and about future generations. I want to make that clear.

STAN CHARODS (Tr 105): I wasn't satisfied with your answer to the question raised earlier about radiation into the flats. That is a problem because of the spawning grounds, and if that is a problem isn't that significant enough not to consider that as an alternative?

JOHN MONAHAN (Tr 107): Now, after listening for two or three hours of statistics from the NRC and after having listened to them at other meetings, I am left with the fact that as many statistics as you give us, we have to take you at your word. We have to trust you. My question is, why should we trust you? Why should we trust the clean-up of Three Mile Island? You are the same people that licensed Three Mile Island in the first place. In a clean-up that will take five to eight years, how can we trust people that only give the public 90 days to comment and who ultimately have the ability to accept or dismiss these comments arbitrarily?

PETE SPASKEY (Tr 110): I would like to suggest that instead of dumping in the Susquehanna which is sort of like sweeping it under the rug or it has the connotation of, you know, getting rid of it and hiding it, that maybe the water should be left in the containment building as a monument to a nuclear disaster, the same way that after World War II there was a building in Berlin that was left as a monument to World War II. The second proposal would be that if the water couldn't be kept at Three Mile Island for some reason because they might have some reason they don't want it there, there is a body of water in Washington, D.C., there is a Reflecting Pool where there are no fish, no life in it, and I would imagine it could hold a hundred thousand gallons, and then put up a little monument. It would probably be safe to all kinds of life except certain political kinds of political life.

VOICE (Tr 112): One way, it seems to me, to put things in proper perspective in Maryland would be to have a referendum vote on this question of dumping the water in the Susquehanna.

MS MATTHEWS (Tr 113): I am concerned about the difference between exposure to radiation and the exposure one's tissues have to something that is taken into the body. I would like to know what you know about the effect of tritium on tissues, when it is taken into the tissues and becomes part of the body.

JIM TITEN (Tr 116): It says here on page S-7 for local release to the river that the water would satisfy the EPA's internal drinking water standards at the nearest potable water supply. I would like to know how far away is that from the water supply, from the source, and what would be the amount of curies per cc in the water released at the source? Do you have any numbers for the EPA internal standards for the potable water supply as compared to the values at the discharge point?

BRENT VANZUST (Tr 118): You talked about a person standing three feet away from the truck for three minutes gathering about three millirems, and I was just curious about this poor sucker that is driving the truck for eight hours that is three feet away.

Pennsylvania State Clearinghouse

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Commonwealth of Pennsylvania

GOVERNOR'S OFFICE
OFFICE OF THE BUDGET

December 2, 1980

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

Dear Dr. Snyder:

Enclosed are comments on NUREG 0683, "Draft Programmatic Environmental Impact Statement relating to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Nuclear Station Unit II", from Dr. Walter Plosila, Director of the Governor's Office of Policy and Planning. Please incorporate these comments in the final PEIS to be issued in March 1981.

Sincerely,

Anne Ketchum

Anne Ketchum
Supervisor

November 19, 1980

SUBJECT: Environmental Impact Statement
Three Mile Island Nuclear Station, Unit 2
PSC 58008024

TO: Pennsylvania State Clearinghouse

FROM: Walter Plosila, Director WP
Governor's Office of Policy and Planning

In Section 10.6.1.1. of the above referenced document under the section entitled Housing, reference is made to a decline in the number of homes sold and new construction starts, and decreased property values within five miles of the Three Mile Island station in the time frame which followed the TMI emergency period. A report issued by this office is footnoted as the source for the finding.

This finding was based on preliminary data which was available at the time the report was issued. Subsequent analysis of more current data indicates over the longer term, through March, 1980, that the TMI-2 accident had no significant impact on property values, new construction starts and number of homes sold.

The final environmental impact statement should incorporate this more current finding.

Federal Register / Vol. 44, No. 229 / Tuesday, November 27, 1979 / Notices

Statement of Policy and Notice of Intent To Prepare a Programmatic Environmental Impact Statement

AGENCY: U.S. Nuclear Regulatory Commission.

ACTION: Statement of Policy.

SUMMARY: The Nuclear Regulatory Commission has decided to prepare a programmatic environmental impact statement on the decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Unit 2. For some time the Commission's staff has been moving in this direction. In the Commission's judgment an overall study of the decontamination and disposal process will assist the Commission in carrying out its regulatory responsibilities under the Atomic Energy Act to protect the public health and safety as decontamination progresses. It will also be in keeping with the purposes of the National Environmental Policy Act to engage the public in the Commission's decision-making process, and to focus on environmental issues and alternatives before commitments to specific clean-up choices are made. Additionally, in light of the extraordinary nature of this action and the expressed interest of the President's Council on Environmental Quality in the TMI-2 clean-up, the Commission intends to co-ordinate its action with CEQ. In particular, before determining the scope of the programmatic environmental impact statement the Commission will consult with CEQ.

The Commission recognizes that there are still areas of uncertainty regarding the clean-up operation. For example, the precise condition of the reactor core is not known at this time and cannot be known until the containment has been entered and the reactor vessel has been opened. For this reason, it is unrealistic to expect that the programmatic impact statement will serve as a blueprint, detailing each and every step to be taken over the coming months and years with their likely impacts. That the planned programmatic statement inevitably will have gaps and will not be a complete guide for all future actions does not invalidate its usefulness as a planning tool. As more information becomes available it will be incorporated into the decision-making process, and where appropriate supplements to the programmatic environmental impact statement will be issued. As the decontamination of TMI-2 progresses the Commission will make any new information available to the public and to the extent necessary will also prepare separate environmental statements or assessments for individual portions of the overall clean-up effort.

The development of a programmatic impact statement will not preclude prompt Commission action when needed. The Commission does recognize, however, that as with its Epicor-II approval action, any action taken in the absence of an overall impact statement will lead to arguments that there has been an inadequate environmental analysis, even where the Commission's action itself is supported by an environmental assessment. As in settling upon the scope of the programmatic impact statement, CEQ can lend assistance here. For example should the Commission before completing its programmatic statement decide that it is in the best interest of the public health and safety to decontaminate the high level waste water now in the containment building, or to purge that building of its radioactive gases, the Commission will consider CEQ's advice as to the Commission's NEPA responsibilities. Moreover, as stated in the Commission's May 25 statement, any action of this kind will not be taken until it has undergone an environmental review, and furthermore with opportunity for public comment provided.

However, consistent with our May 25 Statement, we recognize that there may be emergency situations, not now foreseen, which should they occur would require rapid action. To the extent practicable the Commission will consult with CEQ in these situations as well.

With the help of the public's comments on our proposals we intend to assure, pursuant to NEPA and the Atomic Energy Act, that the clean-up of TMI-2 is done consistently with the public health and safety, and with awareness of the choices ahead. We are directing our staff to include in the programmatic environmental impact statement on the decontamination and disposal of TMI-2 wastes an overall description of the planned activities and a schedule for their completion along with a discussion of alternatives considered and the rationale for choices made. We are also directing our staff to keep us advised of their progress in these matters.

Dated at Washington, D.C. this 21st day of November 1979.

For the Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 79-36478 Filed 11-26-79; 8:45 am]

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APPENDIX C. "FINAL ENVIRONMENTAL ASSESSMENT FOR DECONTAMINATION OF THE THREE MILE ISLAND UNIT 2 REACTOR BUILDING ATMOSPHERE, FINAL NRC STAFF REPORT," VOLUME 1, U.S. NUCLEAR REGULATORY COMMISSION, NUREG-0662, MAY 1980

NUREG-0662
Vol. I

Final Environmental Assessment for Decontamination of the Three Mile Island Unit 2 Reactor Building Atmosphere

Final NRC Staff Report

TMI Support Staff
Office of Nuclear Reactor Regulation

Prepared for
U.S. Nuclear Regulatory
Commission

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NUREG-0662
Vol. I

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Manuscript Completed: May 1980
Date Published: May 1980

TMI Support Staff
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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PREFACE

This Final Environmental Assessment revises the draft Environmental Assessment issued for public comment in March 1980. Revisions to the draft Assessment have been made in response to comments received and to additional reviews and analyses conducted by the NRC staff.

The Nuclear Regulatory Commission has not yet made a decision on the disposition of the krypton-85 gas in the reactor building atmosphere at TMI Unit 2. The views and recommendations expressed here are those of the Commission staff.

This report was prepared by the staff of the Three Mile Island Program Office, Office of Nuclear Reactor Regulation, with the assistance of additional staff members from within NRC.

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

1.0 Summary and Recommendation

The NRC staff has prepared this summary of the Final Environmental Assessment for those who prefer to follow the main themes of the assessment without referring to the technical descriptions, calculations, and other data that provide the foundation upon which the staff's recommendation is based.

The krypton-85 (Kr-85) released into the reactor building during the accident on March 28, 1979, must be removed from the building so that workers can begin the tasks necessary to clean the building, maintain instruments and equipment, and eventually remove the damaged fuel from the reactor core. Those tasks must be performed whether or not the plant ever again produces electricity. Radiation from the krypton gas, although thinly dispersed through the reactor building atmosphere, nevertheless poses a threat to workers who would have to work in the building for prolonged periods.

This Final Environmental Assessment (NUREG-0662) presents a discussion of the information considered by the NRC staff in arriving at its recommendation that the preferred method for removing the krypton-85 from the reactor building is by a kind of flushing process by which the gases would be pushed out of the building and fresh air pulled in.

The Metropolitan Edison Company (the licensee) on November 13, 1979, asked the NRC staff for permission to purge or remove the reactor building atmosphere containing the krypton-85 to the outside (Ref. 1). In March 1980, the NRC staff published the draft version of this Environmental Assessment (NUREG-0662) and two subsequent Addenda for public comment (Ref. 2). The staff has received approximately 800 comments on the draft Environmental Assessment. Of these, approximately 195 responses generally supported the purging of the reactor building, approximately 500 opposed it, and the remaining responses were either recommended alternatives for removing the krypton or comments that took no position on the staff's recommendation. Substantive comments received by the NRC staff will be printed in Volume 2 of this Assessment.

From this process have emerged some NRC staff conclusions on four basic aspects of dealing with the reactor building atmosphere:

---The potential physical health impact on the public of using any of the proposed strategies for getting rid of the krypton-85 is negligible.

---The potential psychological impact is likely to grow the longer it takes to reach a decision, get started, and complete the process.

---The purging method is the quickest and the safest for the workers on Three Mile Island to accomplish.

---Overall, no significant environmental impact would result from use of any of the alternatives discussed in this Assessment.

The Problem

As will be developed in the following discussion, decontamination of the reactor building atmosphere at this time is a necessary activity irrespective of whether subsequent cleanup operations are authorized or of the nature of such operations. There presently exists a need for relatively prolonged access to the reactor building for purposes of maintenance of equipment essential for continuation of the safe shutdown mode and for data gathering activities so that the nature and extent of future cleanup measures can be determined. In addition, it is believed that the prompt initiation of decontamination will be beneficial from the standpoint of alleviating some of the psychological stress now being experienced by the nearby public.

Furthermore, authorization of any of the alternative methods for decontaminating the reactor building atmosphere, being an action independent of any subsequent cleanup activities, does not foreclose, nor predetermine, the consideration or selection of any alternative to such subsequent measure.

Taking the foregoing into consideration, the staff believes that it is in the best interest of the public health and safety to authorize this activity at this time, prior to issuance of the Programmatic Environmental Impact Statement, now in preparation.

The March 28, 1979 accident in Three Mile Island Unit 2 heavily damaged the uranium fuel in the core of the reactor. Many radioactive substances that normally remain trapped in the fuel rods were released when the fuel rods were themselves broken. Some of the radioactivity, in the form of gases, leaked out of the reactor system, along with a large amount of water. Some of the gases escaped to the environment and some of the water reached other parts of the plant before being captured. A great deal of water and a substantial amount of radioactive gases remained confined in the reactor building.

As long as the damaged fuel in the reactor core is cooled and remains relatively undisturbed and surrounded by boron, there is essentially no chance that the fuel chain reaction, which was abruptly stopped by the accident, could start again. But as time passes, the NRC staff believes that there will be an increasing chance of essential equipment wearing out or malfunctioning. If the core were accidentally to begin to undergo a chain reaction once more, it could cause releases of more radioactivity within the reactor building. Therefore, removal of the damaged fuel for safe storage is the paramount objective of the cleanup of TMI-2.

Shortly after the accident, the radioactive gases xenon and iodine accounted for most of the radioactivity in the reactor building atmosphere. But because these gases decayed to nonradioactive forms rapidly, they now account for only about one millionth of the radioactivity in the building air. Nearly all of the radoactivity now in that air comes from the relatively longer-lived krypton. Traces of a radioactive form of hydrogen, called tritium, are in the building atmosphere at levels 10,000 times lower than the krypton. Most of the radiation given off by krypton-85 in the reactor building is a kind that can be blocked by heavy layers of clothing (which could also severely hamper workers). However, it is not this "beta" radiation that is of primary concern for worker health. The primary concern is with the more penetrating gamma radiation. Since krypton-85 contributes significantly to the gamma dose within the reactor building (it accounts for as much as 75% of the total in some areas of the building), removal of the krypton is necessary. Even with the krypton-85 removed, there would still be radiation from the damaged reactor core, from radioactive material deposited on surface, and from the more than seven feet of contaminated water in the basement of the building. But, the radiation dose rate for workers would be cut from about 2.3 rem per hour to 1.6 rem per hour at the 305-foot level in the building, and from about 1.3 to 0.3 at the 347-foot level if the krypton-85 were removed from the building.

At the present time, the reactor building is sufficiently air-tight so that steady cooling of the air in the building has kept its pressure at slightly below outside air pressure. Whatever small air leakage there has been has come in from the outside, rather than to the outside. However, the cooling system fans, designed to run continuously for only a few hours, have been running for more than a year, and they may fail over a period of time. If they do, a rise in pressure inside the reactor building would lead to small puffs of uncontrolled leakage of the building atmosphere to the outside. This would not pose a health hazard to the public but would be of major concern and could contribute to anxiety among residents in the area. Controlled and monitored removal of the building atmosphere before the cooling fans fail would avert that possibility.

The Proposed Solution

In performing its Environmental Assessment of Metropolitan Edison's proposal to purge the reactor building atmosphere, the NRC staff has not only evaluated that plan but also has evaluated several alternatives, including the following:

1. No action.
2. Purging (Slow or Fast, Lower or Higher Release Points).
3. Selective Absorption Process.
4. Charcoal Adsorption, Including a Refrigerated Adsorber System.
5. Gas Compression and storage.
6. Cryogenic Processing (Liquifying the Gas and Storing for Later Disposal).
7. A Combination of Purging and the Other Alternatives.

1. No Action

Leaving the contaminated air in the reactor building indefinitely would leave one important phase of the cleanup process undone. It would also carry other risks. First, it would be physically more difficult, if not impractical, for workers to do any significant cleanup work in the building because of the heavy protective clothing and air-supply equipment they would be required to wear. Under these conditions, workers may be limited to only 15-30 minutes in the building before air supplies must be replaced. Dose considerations would also limit the "stay time" of workers in the building. Second, to the extent that it would interfere with maintainance of already over-used equipment in the building, indefinite delay might cause failure of equipment essential to keeping the damaged reactor core in a safe condition. Third, the building could begin to leak unexpectedly. Although the leakage is not considered a significant threat to the health and safety of the public, it could generate the same anxiety and stress that similar minor leakage incidents at the plant have generated in the past.

2. Purging

The TMI-2 reactor building has two separate systems that can be used to move air from the inside of the building to the outside by way of filtering and monitoring equipment leading to a ventilation stack that reaches 160 feet in the air. The smaller of the two systems was designed as a backup system to the hydrogen recombiner system to reduce hydrogen concentrations in the building following a loss-of-coolant accident so as to prevent possible gas explosions. This hydrogen control subsystem, when modified, would employ a fan with the capacity to move up to 1,000 cubic feet of air per minute. This fan would be started slowly and run at low rates until the krypton-85 concentrations in the building had been lowered by dilution with fresh air so that larger volumes could be sent outside without raising the concentrations of radioactivity around the site. If this system of fans and ducts was used by itself, it would take about 30 days of actual purging, spread over about a 60-day period, to complete the purging operation. The larger of the reactor building purge systems is the building's ventilation system. If this larger system were used along wth the hydrogen control subsystem, both systems could remove the required amount of air in about five days of actual purging, during good weather, over a 14-day period. Both the hydrogen control subsystem and the reactor building purge systems are equipped with control valves and their own trains of filters so that fine particulate radioactive material would be removed from the air before it is discharged to the outside through the ventilation stack. Just before reaching the stack, the air from the reactor building would be mixed with air from other plant buildings to provide some dilution before it is discharged from the stack. As the air bearing the krypton-85 is pulled out of the reactor building, fresh air from the outside would enter the building through an open valve.

The staff also examined the possibility of extending the 160-foot high stack to 400 feet with piping supported by scaffolding or guy wires. The staff believes that under the best of weather conditions elevating the stack could reduce the maximum possible exposures closest to the site to as little as 1/8th the dose predicted to occur for the 160-foot stack. The staff has estimated that designing, construction, and leak testing the added stack section would delay cleanup of TMI-2 by about four to five months.

The staff next considered construction of a new 1000-foot stack to provide additional altitude for releasing the reactor building air. The staff estimated that it would take at least 11 months to design, build, and test such a stack to adequate safety criteria. They also felt that while the higher stack would reduce the public's radiation exposure, the projected exposure was already so low as to pose no radiological health hazards and that the minimum of an 11-month delay to build a stack of 1000 feet could not be justified. Finally, the staff evaluated two proposals submitted by the Union of Concerned Scientists to Governor Thornburgh (Ref. 3). The first proposal was that the reactor building air be heated to give it more buoyancy upon its release from the stack for more effective rise and dispersal.

The NRC staff believes that although heating of the discharge would reduce the public's radiation exposure somewhat, the UCS has underestimated the time it would take to put such an incinerator-heating system into operation, and that instead of the seven to nine months predicted by the UCS, it would take a minimum of 9 months. (The UCS estimated construction time only, excluding design, engineering, procurement, and testing of the incinerator scheme.) The staff said the expected dose reduction of a factor of about 30 to an individual and the delay do not justify the impact of delaying the cleanup operation.

The second proposal was that a 2000-foot tube of reinforced fabric, held aloft by a tethered balloon, be used as a stack for discharge of the reactor building air. Because the method is unique and untried, the staff said there was some uncertainty as to how long it would take to implement, but the staff thought it could work. The staff thought it would take 7 to 10 months to design, build, and test such a system. However, the staff felt that the psychological impact of a balloon clearly visible over the site may offset any advantage which might be gained by a reduction of the dose to any individual.

3. Selective Absorption

The selective absorption process would withdraw all the air in the reactor building, separate from it essentially all the krypton, and return the decontaminated air to the reactor building. The contaminated air would pass through a column in which liquid Freon would absorb the krypton while allowing the other gases to pass through unchanged. Once separated, the krypton could be stored for approximately 100 years under either high pressure in a few gas cylinders, or under low pressure in a larger number of cylinders.

The Union Carbide Company of Oak Ridge, Tennessee, has been developing a selective absorption process since 1967. Their latest small-scale pilot plant, in operation since 1978, can remove 99.9% of the krypton passed through it. Union Carbide officials are optimistic that a larger version of this pilot plant (scaled up at least 10 times) can work at Three Mile Island. Estimated times for completing this larger version vary. Oak Ridge personnel estimate that a system could be put in service at TMI in 10 months. To construct the system in this period would require a crash program that would use standard industrial design criteria, off-the-shelf

components, and no competitive bidding. This estimate does not consider the need for a suitable building at the TMI site and is based on other questionable assumptions.

In the best judgment of NRC construction experts, the shortest possible time to design, procure, construct and test a suitable selective absorbtion system is 16 months. This time period is considered by the staff to be an undesirable delay in getting the cleanup of the reactor building initiated. It is relevant to note that the Oak Ridge National Laboratory, the organizaton most knowledgable about the selective absorption system, has recommended against using that system and favors controlled purging to dispose of the krypton gas.

4. Charcoal Adsorption

Charcoal adsorption is a process by which the contaminated air from the reactor building would be piped into large tanks containing charcoal. The krypton would adhere to the surface of the charcoal after coming in contact with it. The charcoal from this process would then be isolated and stored.

The NRC staff evaluated both normal temperature and refrigerated charcoal adsorber systems. Both systems require large quantities of charcoal; the first 34,000 tons and the second 12,000 tons. During normal operation, no releases of radioactivity would be expected. Since noble gases do not react chemically with charcoal, but just stick to its surface, long-term surveillance would be required during storage. The krypton-bearing charcoal would have to be stored (and watched over) for up to 100 years to allow the radioactivity to decay to insignificant levels.

The staff's major concern was the environmental impact of long-term onsite storage, and the long delay caused by construction of the charcoal system. Construction and testing of a charcoal system would delay by from two to four years the containment atmosphere cleanup. The staff considers this to be an intolerable delay in the overall cleanup effort.

5. Gas Compression

Gas compression is a process by which the air containing the krypton gas in the reactor building would be drawn off into pressurized storage containers. These pressurized containers would then be stored in sealed sections of piping. For example, at a pressure of 300 pounds per square inch, about one million cubic feet of pipe, 36 inches in diameter would be required. This corresponds to about 28 miles of piping. The advantages of this process are that it would expose the general population to less radioactivity than purging the krypton and gas compression and is a known technology. The disadvantages are that two to four years would be required to put the system into operation, the krypton gas would have to be maintained under pressure in storage in many pressurized containers for approximately 100 years, and the krypton could leak at some time during storage. The staff has concluded that this alternative is impractical.

6. Cryogenic Processing

Cryogenic processing is the condensation of krypton-85 from the incoming air by bringing it into direct contact with liquid nitrogen (-320°F). The liquified krypton-85 is collected, restored to a gas form, and stored to allow decay. An alternative to storing would be to transport the containers of the separated krypton (whether from the cryogenic or selective absorption systems) to a burial ground or to a remote area and release the krypton gas to the environment.

The NRC has looked at several cryogenic systems available from commercial nuclear power plants. None of these systems has been operated successfully. Although these new systems could be purchased, a new building would be required to house the system and contain any possible leakage. The cryogenic system would be connnected to the piping of the existing hydrogen control system. The air from the reactor building would be passed through the filters and charcoal adsorber of the hydrogen control system and then piped to the cryogenic processing system in the adjacent building. At least 20 months are estimated to be required to obtain a fully operational cryogenic system at the TMI site. This estimate is based on NRC staff assessments and consultations with construction engineers at Oak Ridge National Laboratory.

During the approximately 2-½-month period required to process the reactor builidng atmosphere, about 60 curies of krypton-85 would be released to the environment with the purified effluent from the system. Also, some leakage from the system is anticipated, but the staff believes this can be minimized by judicious monitoring and a rapid system shutdown if trouble develops. However, based on limited experience with these systems, operation and maintenance are likely to result in a relatively high occupational dose. Designs have been proposed to store the radioactive krypton on the site while it decays. This will require surveillance for 100 years and represents a continuing risk to workers at the site, as well as a potential source of anxiety to the public. Alternatively, burial or release of the contaminated krypton at a remote site could be accomplished. However, the NRC staff believes that release in a remote area probably would not be acceptable to local officials and residents.

7. Combined Processes

The staff evaluated combinations of various alternatives, using one of the krypton extraction and recovery systems, such as charcoal adsorption, gas compression, cryogenic, or selective absorption for most of the krypton, and purging the rest to the environment. One of the krypton recovery systems would trap about 95% of the krypton (54,000 curies) and the other 5% (3,000 curies) could be released to the environment. The size of the processing system or the size of the storage facility for the final material holding the krypton would be only about 25% to 33% of what would be needed if there were no purging used at all. Of all the combinations considered by the staff, those using smaller size cryogenic processing or selective absorption could be built the fastest but even so would take at least one year to be operational. Additional time would then be required to complete the processing and final purging. The staff still considers this an unacceptable delay in the overall decontamination of the reactor building atmosphere.

Onsite Long-Term Storage of Krypton-85

With the exception of direct controlled purging of the reactor building to the outside, all the proposed processes leave the radioactive krypton to be stored onsite, in some form, for about a century. If a leak were detected in an above-ground storage facility at the site, actions could be taken to terminate the leak by transferring the contents of the leaking container to a new one. The staff believes that more study is needed in the selection of materials for such storage containers, and in their fabrication, because of the possibility that containers may corrode over the projected 100 years it will take the krypton radioactivity to decay away.

Transportation and Offsite Disposal

Alternatively, the krypton gas would be appropriately packaged and transported to a waste burial facility for burial or taken to a remote location, such as a desert, and released to the environment. The NRC staff estimates that the impact of handling, packaging, transportation and burial or remote release of the Kr-85 would be 8-24 person-rem (total body).

Public Health and Environmental Effects

Physical Effects

The NRC staff has determined that there are negligible physical public health risks associated with the use of any of the alternatives (excepting the "no action" alternative). For the venting alternative in particular, in independent analyses, the National Council on Radiation Protection and Measurements, the U.S. Environmental Protection Agency, the U.S Department of Health, Education, and Welfare, and the Union of Concerned Scientists have reached the same conclusion. Additionally it should be noted that, based on the relatively greater radiosensitivity of humans, purging would have no adverse impact on plants or animals.

An estimate of the total number of fatal cancers, resulting from purging and the other alternatives, has been made by the NRC staff. The total potential cancer deaths for both the 50-mile population surrounding TMI-2 and plant workers is estimated to range from a minimum of 0.0003 (purge option) to a maximum of 0.034 (cryogenic option). Almost all of this small risk would be borne by workers exposed at the plant (purge = 0.0002, cryogenic = 0.034). The total fatal cancer risk among all people within 50 miles of TMI from purging would be about 0.0001. This corresponds to an average risk of 0.000000000045 to each of 2,200,000 individuals living within 50 miles of the plant, i.e., about 5 chances in 100 billion.

The total risk of some type of genetic abnormality, resulting from the decontamination alternatives, to the public within 50 miles and plant workers has also been estimated. This genetic risk has been estimated to range from a minimum of 0.0005 effects (purge option) to a maximum of 0.066 effects (cryogenic option). Again, almost all the risk would be borne by workers (and their descendants) at the plant (purge, 0.0003 effects; cryogenic, 0.066 effects. The maximum genetic risk to any offsite member of the public from the various options would be 5 chances in 100 million (0.000000005), compared to the current expectation of all kinds of normally occuring genetic effects of one million to five million in 100 million (0.01 to 0.05).

Finally, the NRC staff has estimated risks associated with development of skin cancer. As a result of purging, a skin dose of 11 mrem (see Table 1.1) to the maximum exposed individual, is estimated to result in a risk of death of about one chance in a billion (0.000000001). A population skin dose of 63 person-rem (purge option) would be estimated to cause considerably less than one (about 0.000006) additional skin cancer deaths among the 50-mile population of 2.2 million people. This compared with about 4,000 deaths from skin cancer (from other causes, primarily sunlight), which would normally be expected in the 50-mile population (assuming 75 years life expectancy) around TMI. Other risk comparisons are provided in Tables 7.2 and 7.3.

Psychological Stress

The various alternatives for decontamination of the TMI-2 reactor building atmosphere are expected by the NRC staff to have different psychological impacts.

The NRC staff, with the assistance of consulting psychologists from the Human Design Group, has compared these to what already has been found by some studies of the psychological stress effects of the TMI accident. Previous research suggests that an event like the accident at TMI-2 produces two types of stress: short and continuing. Short-term effects or those directly related to the occurrence of the incident are reported to be intense but short-lived. Some researchers have reported that while stress-related indicators were high shortly after the accident, they had dissipated by mid-summer of 1979. Their findings suggest that stress changes with time, and that long-term mental health implications may be less than previously thought.

Based on consultations with psychologists, the staff has concluded that the purging alternative, which can be implemented promptly, has less potential for creating long-term psychological stress than those alternatives which take longer to complete. Furthermore, since a prompt decision on, and completion of, purging will be the first major step toward eventual cleanup of the reactor building and decontamination of the site, it is anticipated that a majority of the public will perceive this action as leading to elimination of future risks from TMI-2. The NRC staff, based on advice received from its consulting psychologists, believes that this public perception will reduce the stress and anxiety of the public.

Radiological Environmental Monitoring Program

The radiological environmental monitoring around the TMI site and nearby communities during decontamination of the reactor building atmosphere would be performed by (1) the U.S. Environmental Protection Agency, (2) the Commonwealth of Pennsylvania, (3) the U.S. Department of Energy, (4) the Nuclear Regulatory Commission, and (5) Metropolitan Edison Company (the licensee),

The EPA is the lead agency for the Federal government in monitoring the area surrounding Three Mile Island. EPA operates a network of eighteen air monitoring stations ranging from one-half to seven miles from TMI. EPA will also use a number of mobile radiation monitoring vehicles positioned in the predicted downwind trajectory during purging. EPA will issue daily reports of their measurements to the public during the purging of krypton.

In addition to their own direct monitoring, the Department of Energy and Commonwealth of Pennsylvania are sponsoring a Community Radiation Monitoring Program that involve people from 12 communities in an approximate 5-mile circle around TMI.

About 50 individuals have completed training classes conducted by the Nuclear Engineering Department of Pennsylvania State University. The classes involved classroom instructions, laboratory training, and actual radiation monitoring in the field. The teams will use EPA gamma-rate recording devices, which are currently in place around TMI, and which will be supplemented by gamma/beta sensitive devices being furnished by DOE through EG&G Idaho, Inc.

The training sessions were designed to provide a working knowledge of radiation, its effects, and detection techniques, and included hands-on experience with monitoring equipment in the field. Citizens will be expected to demonstrate minimal competence in radiation monitoring efforts begin. Following the completion of training, team representatives in each of 12 selected areas have been gathering and reporting data from the gamma and gamma/beta-sensitive instruments on a routine basis.

Response to Comments

The draft "Environmental Assessment for Decontamination of the Three Mile Island Unit 2 Reactor Building Atmosphere" (NUREG-0662) and two subsequent addenda were issued for public comments late in March 1980. The public comment period ended May 16. Approximately 800 responses have been received, each of which fell into one of three categories: (1) those supporting the purging alternative recommended by the NRC staff (approximately 195 responses), (2) those opposed to the purging alternative (approximately 500 responses), and (3) those who recommend decontamination alternatives other than those discussed in the Environmental Assessment or who otherwise commented on the assessment (approximately 105 responses). Section 9 of this report provides the NRC staff's response to these comments.

Copies of correspondence received are available for inspection and copying for a fee at the NRC Public Document Room at 1717 H Street, NW, Washington, D.C. 10555, and at the NRC Local Public Document Rooms, State Library

of Pennsylvania, Government Publications Section, Education Building, Commonwealth and Walnut Street, Harrisburg, PA 17126, and York College of Pennsylvania, Country Club Road, York Pennsylvania 17405. All substantive comments received will be published in Volume 2 of this final assessment.

Public Information Activities

In an effort to better inform the public in the area around Three Mile Island about the contents of the draft Environmental Assessment (NUREG-0662, and Addenda 1 and 2), NRC has conducted a series of 38 informational meetings and activities. The staff also issued an easy-to-understand report that answers frequently asked questions about removing the krypton from the reactor building. Copies of the report, "Answers to Questions about Removing Krypton from the Three Mile Island Unit 2 Reactor Building" (NUREG-0673), are available free of charge by writing to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Most of the meetings held were planned by the NRC, although some were organized by other interested groups, at which NRC officials were invited participants. Members of the U.S. Environmental Protection Agency and the Pennsylvania Department of Environmental Resources (DER) were usually invited participants at these meetings. EPA officials outlined their agency's program and responsibilities for environmental monitoring in the vicinity of the TMI site, while State DER personnel explained the community monitoring program and other state functions related to the clean-up of TMI Unit 2. At these meetings, NRC officials expressed their willingness to meet with other groups of people who had an interest in receiving additional information on the Environmental Assessment or clean-up operations at Unit 2.

Table 1.1

Environmental Impacts of Alternatives for Removing the Krypton-85 from the Reactor-Building Atmosphere

Total Offsite Dose to Maximum Exposed Individual*

Method	Normal Processing	Accidents	Occupational Exposures
Reactor Building Slow Purge	Beta skin dose - 11 mrem Total body gamma dose - 0.2 mrem	Beta skin dose - 25 mrem Total body gamma dose - 0.3 mrem	1.2 person-rem
Reactor Building Fast Purge	Same as above	Same as above	Same as above
Elevated (400 ft.) Purge	Approximately 1/8 (0.13) of Slow Purge above	Same as above	Same as above
Elevated (1000 ft.) Purge	Approximately 1/230 (0.004) of Slow Purge above	Same as above	Same as above
Hot Plume (250 ft.) Purge	Approximately 1/30 (0.003) of Slow Purge above	Same as above	Same as above
Balloon/Tube (2000 ft.) Purge	Approximately 1/300 (0.003) of Slow Purge above	Same as above	Same as above
Selective Absorption Process System	Less than Cryogenic Processing System	Absorption Process Beta skin dose - 6 mrem Total body gamma dose - 0.1 mrem Gas Storage Beta skin dose - 1700 mrem Total body gamma dose - 20 mrem	115-220 person-rem
Charcoal Adsorption Systems	Less than Cryogenic Processing System	Ambient Charcoal System Beta skin dose - 41 mrem Total body gamma dose - 0.5 mrem Refrigerated Charcoal System Beta skin dose - 124 mrem Total body gamma dose - 1.5 mrem	47 person-rem

Table 1.1 (Continued)

Total Offsite Dose to Maximum Exposed Individual*

Method	Normal Processing	Accidents	Occupational Exposures
Gas Compression System	Less than Cryogenic Processing System	Beta skin dose - 410 mrem Total body gamma dose - 5 mrem	41 person-rem
Cryogenic Processing System	Beta skin dose - 0.01 mrem Total Body Gamma dose - less than 0.0002 mrem	Beta skin dose - 1700 mrem Total body gamma dose - 20 mrem	157-255 person-rem
Combination Process/ Purge	Approximately 1/95 (0.01) of Slow Purge above	Beta skin dose - 1700 mrem Total body gamma dose - 20 mrem	115-255 person-rem
No Action	Beta skin dose - 0.01 mrem Total body gamma dose - less than 0.0002 mrem	(The potential offsite and occupational dose from the extremely large inventory of radioactive material within the reactor building cannot be reliably estimated for long periods of containment, but is potentially high and could exceed other alternatives considered.)	

*The collective 50-mile offsite population doses resulting from the purging alternatives are estimated to be 0.76 and 63 person-rem for total-body and skin doses respectively. Although elevating the release point would reduce these population dose estimates, the reduction would probably be no greater than 10%.

2.0 Proposed Action

The action proposed is to purge from the reactor building at Three Mile Island, Unit 2, the krypton-85 released from the damaged fuel as a result of the accident on March 28, 1979. This NRC staff Final Environmental Assessment responds to a proposal submitted by Metropolitan Edison Company (the licensee) for purging the reactor building atmosphere through the building's existing hydrogen control subsystem (Ref. 1). This Assessment does not address decontamination of reactor building equipment, interior walls and surfaces, and treatment and disposition of water in the reactor building sump or in the reactor coolant system. These issues will be addressed in a Programmatic Environmental Impact Statement to be issued by the NRC staff later in 1980.

3.0 Introduction

As a result of the March 28, 1979 accident at the TMI Unit 2 facility, significant quantities of radioactive fission products and particulates were released into the enclosed reactor building atmosphere because of substantial fuel failure in the reactor core. At the present time, the dominant radionuclide remaining in the reactor building atmosphere is krypton-85 (Kr-85), which has a 10.7-year half-life. Based on periodic sampling of the reactor building atmosphere since the accident, the concentration of the Kr-85 in the building is about 1.0 μCi/cc, yielding a total inventory of approximately 57,000 curies. Reactor building atmosphere sampling and analysis are discussed in detail in Section 4.0.

At the present time the reactor is safely shut down, and is being maintained that way with the damaged fuel in the reactor vessel. Reactor building air-cooling equipment is maintaining the building at a slightly negative pressure (approximately -0.7 psig) with respect to the outside atmosphere. This pressure differential ensures essentially no leakage of the reactor building atmosphere to the environment. However, before the facility can be considered to pose no threat to public health and safety, the damaged fuel must be removed from the reactor vessel and building, placed in containers if necessary, and safely stored. The radiation levels in the reactor building are currently such that occupancy is severely restricted. Less restricted access to the reactor building is required to facilitate the gathering of data needed for planning the building decontamination program, and for the subsequent work required to accomplish decontamination and other cleanup operations. Less restricted occupancy will require that the building atmosphere be decontaminated to protect workers from exposure to the beta and gamma radiation associated with the Kr-85 in the reactor building atmosphere.

On November 13, 1979, the licensee submitted a request to the NRC staff for authorization to decontaminate the reactor building atmosphere by controlled purging (feed and bleed) through the reactor building hydrogen control subsystem (Ref. 1). In a letter to the licensee on December 18, 1979, the staff withheld approval of the request to purge the building and stated that the NRC would prepare an Environmental Assessment on the subject in early 1980 (Ref. 4). The staff reviewed the licensee's submittal, including the discussion of various alternatives to reactor building purging. As a result of that review, the staff requested additional information in the form of 33 questions on December 18, 1979 (Ref. 5). The licensee responded to the staff's request on January 4, 1980 (Ref. 6). Pursuant to the requirements set forth in the Commission policy statement of November 21, 1979 (Ref. 7) and the February 11, 1980 Order by the Director of the Office of Nuclear Reactor Regulation (Ref. 8), the NRC staff prepared a draft Environmental Assessment (NUREG-0662) in March 1980 (Ref. 2). That assessment included the staff's evaluation of licensee modifications to the reactor building hydrogen control subsystem, as well as a discussion of the need to decontaminate the reactor building atmosphere and alternatives to controlled purging to the environment. The original comment period for NUREG-0662 was scheduled to end April 17, 1980, but was extended by the Commission, at the request of the Governor of Pennsylvania, to May 16, 1980. This Final Environmental Assessment (NUREG-0662) is based on information and public comments received since publication of the draft Assessment and includes an update of the NRC staff's evaluation of reactor building decontamination alternatives, and an evaluation of potential physical and psychological health effects associated with reactor building purging.

4.0 Reactor Building Airborne Activity

4.1 Gas Sampling and Analysis

Three types of reactor building air samples are periodically collected to determine the nature of airborne contaminants in the building. Samples are taken for noble gases (including Kr-85), particulate matter, and radioiodine activity. Air samples are taken from two points in the reactor building. The samples are transmitted through two lines running from the dome to the reactor-building air-sample gaseous monitor.

Redundant inlet and discharge valves are provided for the system to prevent a single-active failure of any valve from impairing the function of the system. Samples are analyzed with a gas chromatograph to determine hydrogen content and isotopic composition is determined with a gamma spectrum analyzer. The Kr-85 gas activity in the reactor building atmosphere is determined by gamma spectroscopy techniques. Isotopic identification is made on the basis of the discrete energy levels at which gamma rays are absorbed in a germanium-lithium (GeLi) detector. Particulate activity is determined in the reactor building atmosphere by pumping building air through a filter. Particulate activity is removed from the air by filters, which are then analyzed using gamma spectroscopy. To determine the concentrations of the different types of iodine in the atmosphere, a sample of the reactor building air is pumped through a series of filters. Separation of the different forms of iodine is accomplished based on the relative affinity of each iodine species for a specific filter medium. Each filter is then analyzed using gamma spectroscopy.

In addition to the routine sampling for noble gases, particulates, and iodine, samples are obtained for tritium, and gross beta analyses. The results of the sampling program are presented in the following section, "Source Term Derivation."

4.2 Source Term Derivation

Sample results to date indicate that the dominant isotope within the reactor building atmosphere is Kr-85. Radioactive decay has reduced other radioactive isotopes of xenon and krypton to negligible quantities. Reactor building gas sample data from May to December 1979 indicate the source term for Kr-85 is 0.78 μCi/cc, with a standard deviation of ±0.23 μCi/cc. Since late 1979, reactor building gas-sampling techniques were improved to eliminate small sample line leaks and to allow for direct counting of the samples. With these improved sampling techniques, the source term for Kr-85 is measured to be 1.04 μCi/cc, with a smaller standard deviation of ± 0.03 μCi/cc. This smaller standard deviation indicates improved sampling accuracy. Other noble gases (e.g., Xe-131m, Xe-133m, Xe-133, Xe-135) have decayed to below minimum detectable activity (MDA) levels of 1×10^{-6} μCi/cc.

Radioactive decay has reduced iodine levels in the reactor building to below MDA levels of 1×10^{-9} μCi/cc. Particulate levels, primarily those of cesium-137, are less than 1×10^{-9} μCi/cc. Reactor building air samples have been specifically analyzed for strontium-89/90. Those analyses, plus the results of gross beta analyses, show that airborne strontium-89/90 levels are small, that is, in the order of 1×10^{-10} μCi/cc. The airborne concentration levels of all the above isotopes are measured to be below the maximum permissible concentration (MPC) levels listed in Table 1 of Appendix B to 10 CFR 20 (Ref. 9). Additionally, it should be noted that all of the decontamination alternatives (listed in Section 6) include systems (e.g., HEPA, and charcoal filters)

which, if utilized, would further reduce the already small airborne concentration of these isotopes. The removal efficiency (99.97% or better) of these filters would reduce any release of particulate radiation to negligible quantities.

Airborne tritium concentrations in the reactor building are measured to be approximately 8.4×10^{-5} μCi/cc. This value is consistent with the calculated estimates of airborne tritium concentration which is based on reactor building relative humidity and on tritium measured in the reactor building sump water. This concentration is 10 times lower than the maximum permissible airborne concentration limit for tritium listed in Table 1 of Appendix B to 10 CFR 20 (Ref. 9).

5.0 Need for Decontamination of the Reactor Building Atmosphere

5.1 Summary

The reactor building atmosphere needs to be decontaminated in a timely manner primarily to permit the less restricted access to the reactor building necessary to gather information, to maintain equipment, and to proceed toward total decontamination of the Unit 2 facility. At present, the Kr-85 dispersed inside the reactor building atmosphere limits operations which could be conducted inside the building to preliminary contamination data gathering. Following decontamination of the reactor building atmosphere, larger scale activities, such as detailed radiation mapping, preliminary decontamination, and shielding placement, will be possible since lowered radiation exposure levels will reduce the need for personnel protective gear.

The eventual removal of fuel from the reactor vessel (or defueling) is an important milestone in the overall cleanup effort which cannot proceed until atmospheric decontamination is completed. Defueling will eliminate the small, but finite, potential for inadvertent core recriticality, which could occur, for example, from accidental *boron dilution of the reactor coolant. In addition, defueling will eliminate the major source of radioactive* material in the reactor building. Decontamination of Kr-85 in the atmosphere would also provide the less restricted access to the reactor building needed to repair or replace core nuclear instrumentation, to maintain the reactor building air cooling system, and to support processing of the reactor building sump water.

Although difficult to quantify, present conditions inside the reactor building pose risks to the physical and psychological health of residents in the Harrisburg-Middletown area. Public health risks, including psychological stress, will continue to be a concern throughout the cleanup process. In the NRC staff's opinion, elimination of *these risks require a safe and expeditious completion of* *__all__* *cleanup activities at the site.* Decontamination of the reactor building atmosphere is the next required step in achieving this goal.

5.2 Discussion

The TMI-2 reactor is presently being maintained safely shut down, with damaged fuel in the reactor vessel. The extent of fuel damage and the present core configuration are unknown. It is important that the reactor continue to be maintained subcritical and that the damaged fuel inside the reactor be removed from the reactor vessel and placed in a safe configuration to eliminate any potential for core recriticality.

As the minimum negative impact, core recriticality would result in the production of additional radioactive material which would require decontamination. Core recriticality could also lead to further degradation of the reactor coolant system and the possibility of uncontrolled release of radioactivity to the environment.

The licensee is presently relying on boron injected into the reactor coolant system to maintain the core subcritical. Normally, this function is accomplished by inserting control rods into the core. During the accident, however, it is believed that some of the control rod material melted and may have drained out of the core. At present, most instrumentation provided for monitoring reactor neutron flux, and therefore providing feedback on boron effectiveness, is inoperable. Only one nuclear instrument channel is operating. If this instrument fails, direct measurement of neutron flux in the reactor core would not be possible. It would then be necessary to infer the status of the core by periodic sampling and analysis of boron concentration in the reactor coolant. Although the staff considers the potential for core recriticality to be of low probability, it will be a number of years before defueling is anticipated. In the interests of public and worker health and safety, the staff believes that removing the fuel in a timely fashion will eliminate the potential risk, no matter how small, associated with the core in its present condition. Since decontamination of the reactor building atmosphere is the necessary next step in the path leading to core defueling, it should be undertaken in a safe and expeditious manner. Purging the reactor building can achieve both of those goals.

While activities leading to core defueling are being undertaken, it will be necessary to continue direct core monitoring. To allow the remaining core monitoring instrumentation to deterioriate would pose additional risks to the public and to workers because of the potential for core recriticality to result in the generation of more radioactive fission products at Three Mile Island. Should this existing instrumentation fail it will be necessary to decontaminate the reactor building atmosphere to achieve the access necessary to repair or replace them.

At present, radiation levels in the reactor building at the 305- and 347-foot elevations would result in total body dose rates of approximately 2.3 rem/hour and 1.3 rem/hour, respectively. If a reactor building entry is made prior to decontamination of the atmosphere, heavy protective clothing and equipment will be required. The necessary gear, including self-contained respiratory equipment, radiation detectors, communications equipment, personnel dosimeters, and protective clothing would weigh approximately 85 pounds and would hamper the movement necessary for workers to perform decontamination or maintenance-related tasks inside the building. Heavy protective clothing would be expected to shield workers from essentially all of the direct beta radiation from the krypton cloud (150 rem/hour to unshielded skin), although some diffusion of the krypton through the suit would probably occur. This clothing, however, would not protect workers from gamma radiation or from high-energy beta-emitting radionuclides which are believed to contaminate surfaces inside the building.

Decontamination of the reactor building atmosphere would reduce the total body dose rate by 30% on the 305-foot elevation and by 75% on the 347-foot elevation (the operating floor) to 1.6 rem/hour and 0.3 rem/hour, respectively. The dose-rate values shown below provide an example of expected dose rates accruing to an individual in self-contained breathing apparatus and protective clothing.

Radiation	Dose Rate (Rem/Hour)	
Elevation 305 Feet	Before Decontamination	After Decontamination
Gamma (total body)	2.3	1.6
Beta (skin)	0.8	0.8

Radiation		
Elevation 347 Feet	Before Decontamination	After Decontamination
Gamma (total body)	1.3	0.3
Beta (skin)	1.2	1.2

It should be noted that Kr-85 beta skin dose (approximately 150 rem/hour) is not a factor in this example due to the presence of protective clothing before decontamination and elimination of Kr-85 beta radiation after decontamination. Decontamination of the reactor building atmosphere, then, is necessary to reduce worker risk from gamma total-body exposures from Kr-85 and to eliminate and the risk and inefficiency of working in burdensome protective clothing (including risks involving tearing the protective suit and worker injuries due to falling).

The reactor building atmosphere, which is at 100% relative humidity, is currently being maintained at approximately 75°F by the reactor building air-cooling system. This cooling action is maintaining the reactor building at a slight negative pressure (approximately -0.7 psig) with respect to the outside atmosphere. This pressure differential prevents leakage of the reactor building atmosphere to the environment. Other factors that affect the pressure differential between the reactor building atmosphere and the outside atmosphere include: (1) pressure differentials caused by wind currents over and around the building, (2) changes in barometric pressure, (3) changes in external air temperatures, and (4) the solar heat load on the building. The building air- cooling fans (four operating, one standby) were qualified for three to four hours of continuous operation in a 100% relative humidity environment. Four fans have been operating nearly continuously since the March 28, 1979 accident in a high-humidity environment. It is not known if the standby fan is operable. The operating fans can reasonably be expected to fail sequentially over a period of time. Their sequential failure would result in a decrease of heat removal capability from the reactor building atmosphere and could ultimately cause the atmospheric pressure in the reactor building to increase and become positive relative to the outside atmosphere. The NRC staff has calculated that for worst-case conditions (i.e., all fans fail), this pressure could rise to as high as four psig. The reactor building has a design leakage rate of 0.2% by weight per day at 60 psig. The measured leakage rate of the reactor building during its most recent leak-rate test (conducted in early January 1978) was 0.095% by weight per day at 56 psig. Based on the relationship between observed leak rate and differential pressure, the staff calculates that uncontrolled leakage of Kr-85 from the reactor building would not exceed five curies per day. The corresponding beta skin dose to the person receiving maximum exposure from this leakage would be dependent on local meteorology (i.e., the dispersion factor or X/Q) which typically varies from 1×10^{-4} to 1×10^{-7} sec/m^3 Thus, the one-day dose could vary from approximately 0.02 millirems to 0.00002 millirems. In view of the fact that the annual average X/Q is approximately 6.7×10^{-6} sec/m^3 and uncontrolled leakage from the reactor building would involve small amounts of Kr-85, the staff does not consider such leakage likely to threaten the health and safety of the public. However, based on past public response to relatively small leaks of gaseous effluents to the environment, (e.g., leakage from the makeup and purification system resulting in a gaseous discharge of 0.3 Ci of Kr-85 on February 11, 1980), the staff believes that future uncontrolled leaks could generate significant psychological stress in the community. In the staff's view, a controlled purge, which is publicly announced, fully monitored, and conducted during favorable meteorological conditions, is preferable to uncontrolled leakage.

The reactor building cooling system will also perform a vital function following decontamination of the reactor building atmosphere. This system will be needed to maintain a reasonable working environment inside the building and allow expeditious building decontamination and defueling activities. Decontamination of the reactor building atmosphere would allow for cooling system maintenance and avoid recovery effort delays that might accompany cooling system failures.

Although a discussion of systems and alternatives for processing the reactor building sump water is not appropriate for this document (the forthcoming Programmatic Environmental Impact Statement is the appropriate document), access to the reactor building will be necessary to effectively support processing this water. Should NRC approve a system for processing the sump water, the licensee will require less restricted access to the reactor building to support processing with area washdowns. Area washdowns will assist in the removal of the crud and filterable material that would otherwise adhere to the walls and surfaces in the basement of the building as water levels decline. The primary reason for these washdowns is to protect workers from direct or airborne (from drying out) sources of radiation from the walls. Area washdowns will not be possible unless the reactor building atmosphere is decontaminated.

Lastly, the NRC staff believes expeditious decontaminaton of the reactor building atmosphere is necessary to reduce long-term psychological stress in the TMI area by shortening the time necessary to complete the entire cleanup project.

6.0 Decontamination Alternatives

6.1 No Action

The NRC staff has considered the possibility that no action be taken to decontaminate the TMI-2 reactor building atmosphere. This alternative would necessitate retaining the radioactive gas within the reactor building. This option has been rejected, however, as totally inappropriate for several reasons.

First, taking no action would subject the public to potential health and safety risks which exceed those of any other alternative, considered within this Environmental Assessment, for decontaminating the reactor building atmosphere. The potential risks associated with taking no action are discussed in detail in Section 5.0. These risks include possible core recriticality and corresponding production of additional radioactive materials. The NRC staff believes that minimizing these risks depends on access of workers to the reactor building to permit continuation of activities leading to eventual defueling. This access, in turn, depends on the decontamination of the reactor building atmosphere.

An indepth discussion of both public health and occupational risks resulting from the employment of other decontamination alternatives is presented in the following subsections. Public health risks for all alternatives have been determined to be negligible.

6.2 Reactor Building Purge Systems

6.2.1 Introduction

A number of purge methods could be used to decontaminate the reactor building atmosphere. The staff has evaluated four purge methods which could be implemented utilizing existing plant systems and structures and two other purge methods which would require either new or modified plant systems and structures. Those methods include: (1) a slow purge using the existing hydrogen control subsystem with releases from the unmodified 160-foot plant vent stack; (2) a fast purge using the existing hydrogen control subsystem and reactor building purge system with releases from the 160-foot plant vent stack; (3) an elevated purge using the existing hydrogen control subsystem and reactor building purge system with releases from the plant vent stack elevated to 400 feet; and (4) an elevated purge using the existing reactor building purge system with releases from a new 1000-foot stack.

In addition, the staff has evaluated two methods of purging proposed by the Union of Concerned Scientists in a report submitted to the Governor of Pennsylvania (Ref. 3). The two methods proposed are release of a heated plume from a 250-foot refractory lined stack and an elevated release at 1000 to 2000 feet through a relatively light-weight tube held aloft by a tethered balloon.

6.2.2 Slow Purge

The hydrogen control subsystem was originally installed for use as a backup system to the hydrogen recombiners. The system is being modified to allow variable flow rates up to a maximum of 1000 cfm. Actual purge rates during a purge would be dependent on meteorological conditions and reactor building concentrations of Kr-85. The hydrogen control subsystem would withdraw the reactor building atmosphere through a filter system, monitor the effluent radioactivity levels, and discharge the effluent through the 160-foot plant vent stack to the environment.

These releases would be made based on existing meteorological conditions such that release rates of radioactive materials would be controlled to ensure that the requirements of 10 CFR Part 20, the design objectives of 10 CFR Part 50, Appendix I (Ref. 11) and the applicable requirements of 40 CFR Part 190.10 (Ref. 12) are not exceeded.

6.2.2.1 System Description and Operation

The proposed purge of the Unit 2 reactor building atmosphere to the environment would use the hydrogen control subsystem of the reactor building ventilation system. Radioactive gases purged from the reactor building would be diluted with the exhaust air from the auxiliary and fuel building ventilation systems and released through the Unit 2 vent stack, which is 160 feet above grade level. The major components of this system include: an exhaust fan, isolation valves, filtration system, and a radiation monitoring system. The filtration system consists of a prefilter, a HEPA filter, an activated charcoal filter, and a downstream HEPA filter. Replacement air to the reactor building would be supplied through the reactor building pressurization valve.

The slow rate purge alternative recommended by the NRC staff would be carried out within several limiting conditions. Most importantly, purging would be controlled to limit the cumulative maximum individual offsite dose resulting from the purge to less than the annual dose design objectives (5 mrem total body, 15 mrem skin) of Appendix I to 10 CFR Part 50 (Ref. 11). Doses would be tracked during actual purging by using real-time meteorological data to calculate hourly dose rates in affected sectors surrounding the plant. (The region around TMI is divided into 16 directional sectors; wind directional changes during purging will result in differing dose rates for individual sectors.)

Cumulative dose, based on these calculated dose rates in each affected sector, would be updated hourly throughout the purge process. No hypothetical person in any sector would be permitted to receive a dose in excess of the Appendix I dose design objective. For example, if the calculated cumulative dose to a hypothetical person, based on actual Kr-85 release rates and real-time meteorology, reached the annual Appendix I total body (5 mrem) or beta skin (15 mrem) dose objective in the North sector, purging would be discontinued when existing wind conditions could result in any incremental increase in dose to the North sector.

In addition to Appendix I constraints, the slow purge procedure would be limited by the existing Three Mile Island effluent release technical specifications for noble gases (Ref. 13). These specifications consist of an instantaneous release rate limit and a quarterly average release rate limit. Although these specifications have dose limitations as their bases, they have been implemented as noble gas release rate limits. Release rate alone determines conformance or non-conformance with the technical specifications. As applied to the slow purge rate alternative, the technical specifications effectively apply only to Kr-85 since it is the remaining noble gas in the reactor building.

One Kr-85 release rate technical specification requires that the instantaneous rate not exceed 45,000 μCi/sec. This instantaneous limit is derived from the annual average X/Q* (6.7×10^{-6} sec/m^3) for the TMI site and the maximum permissible concentration (MPC) for Kr-85 in unrestricted areas (3×10^{-7} μCi/cc) as listed in 10 CFR 20, Appendix B, Table 2, Column 1 (Ref. 9). This specification provides for short-term operational flexibility. Any extended release at this relatively high rate would quickly become limiting to operation because the cumulative Appendix I dose restriction also limits the conduct of the purge alternative (Ref. 11).

A quarterly averaged release rate technical specification limit of 7200 μCi/sec, based on a more restrictive X/Q value (4.2×10^{-5} sec/m^3), would also be applicable to a slow purge. This quarterly averaged release rate limit is based on not exceeding, in one quarter, four times the annual Appendix I dose design objective. Again this

*See the Glossary for a definition of X/Q.

specification provides for relatively short periods of operational flexibility because relatively high release rates (and hence dose rates) can be averaged in a quarter with relatively low release rates. Cumulative Appendix I dose, however, cannot be exceeded.

The dose rate during a purge period is dependent on the product of three variables; the Kr-85 release rate, meteorological dispersion factor (X/Q) and the Kr-85 dose conversion factor. Only the Kr-85 dose conversion factor is a fixed value, $\frac{\text{mrem-m}^3}{\text{Ci-sec}}$. While meteorology (X/Q, sec/m^3) cannot be controlled during a purge, release rate (Ci/sec) can be adjusted to limit the resulting dose rate. During periods of less favorable meteorology, therefore, release rates can be selectively reduced to maintain desired dose rate levels. Detailed licensee procedures for maintaining acceptable purge dose rates during varying meteological conditions by adjusting release rates, have been reviewed and approved by the NRC staff. In addition, members of the NRC onsite staff will monitor the licensee's actions during the entire purge.

At the onset of the slow purge scenario, purge rates would be expected to be in the range of 50 to 75 cfm. As the Kr-85 concentration in the reactor building decreases, the purge rate would be increased to a maximum of approximately 1000 cfm. The purge rate during any period would be dependent on the aforementioned limiting conditions.

The incremental dose (mrem) for each purge period is obtained from the product of the dose rate (mrem/sec) and time duration (sec) of the period. The total dose due to the entire purge of 57,000 Ci of Kr-85 is obtained by summing the individual incremental doses from each purge period. The staff estimates that over a 60-day period it would require approximately 30 days of actual purging to reach the MPC level of 1×10^{-5} μCi/cc in the reactor building.

During purge operations with the hydrogen control subsystem, makeup air would be supplied to the reactor building through the reactor building pressurization valve. This ensures that air would flow into the reactor building and a small negative pressure relative to the auxiliary building would be maintained with the hydrogen control subsystem exhaust fan. The reactor building pressurization valve is interlocked with the exhaust fan to shut when the fan stops. Nevertheless, there is the potential for backflow of contaminated reactor building air through the reactor building pressurization valve to the 328-foot level of the auxiliary building if the reactor building pressure is not maintained slightly negative with respect to the auxiliary building. General area radiation monitors in the auxiliary building would detect the radioactivity to signal for isolation of the reactor building by stopping the purge.

Flow rate, temperature, and radiation level of hydrogen control subsystem flow would be monitored during purging operations. System flow rate, temperature, and radiation level are measured at the hydrogen control subsystem fan discharge point. General area radiation levels around the filter housing on the 328-foot level of the auxiliary building would be monitored by a local radiation monitor. General area radiation monitors have local and remote readouts in the Unit 2 control room.

Table 6.2-1 provides a list of the major components used in the hydrogen control subsystem. The subsystem exhaust fan is interlocked to stop automatically and valves close automatically to isolate the system if high activity is detected in the effluent.

Figure 6.2-1 provides a flow diagram of the hydrogen control subsystem. Modifications to the hydrogen control subsystem would include (1) replacing the hydrogen control subsystem exhaust fan with a fan capable of producing a maximum flow of 1000 cfm, (2) recommissioning the auxiliary building and fuel-handling building filter trains, (3) calibrating and reactivating the stack monitor, (4) securing the supplementary filter train by turning off the supplementary fans and closing the isolation door from the stack inlet plenum to the filters, and (5) uncapping the plant vent stack.

Table 6.2-1 Hydrogen Control Subsystem

System	Operator	Effects of Loss of Operator	Auto-Action	Interlocks
Fan AH-E-34	Electrical	Reduced flow thru system	Stop fan	High activity on HPR-229*
Pressure Sensing Line Isolation Valves A-V5 & AH-V6	Electrical	Fail as is	None	None
RB Pressurization Valve AH-V7	Air operated	Valve fail closed	Closes on loss of power	When fan AH-E-34 stops, valve shuts
RB Hydrogen Control Valve AH-V25	Electrical motor-operated local control	Fail as is	None	None
RB Hydrogen Control Discharge Valve AH-V36	Air operated	Fail closed	Opens when fan starts	None
Reactor Bldg. Hydrogen Control Isolation Valve AH-V52	Air operated	Fail closed	None	None
AH-V-3A, B RB Isolation Valves	Air operated	Fail closed on high radiation,	Fail closed loss of power	None

*Monitor mounted in the exhaust duct downstream of the exhaust fan.

6.2.2.2 Occupational Exposure

The design criteria for the existing hydrogen control subsystem is consistent with the "as low as reasonably achievable" guidance of 10 CFR Part 20 and Regulatory Guide 8.8 (Ref. 14). Control during a purging interval would be exercised remotely from the Unit 2 control room. However, an auxiliary operator would be required to be in the auxiliary building during system operation. This operator would have communication ties with the control room and be stationed in a low-radiation area.

The dose to operators during processing will be approximately 0.8 person-rem. Changing the two HEPA filters will also contribute to occupational exposure. These filters have a surface dose rate of approximately 0.17 R/hr and filter changeout will require approximately one-half hour per filter. It is expected that the filters will be changed only once at the end of the purge operation, resulting in approximately 0.4 person-rem. Therefore, the total exposure for processing and filter changeout would be approximately 1.2 person-rem.

6.2.2.3 Environmental Impact

Slow Purge - Using the Hydrogen Control Subsystem With Release from the Unmodified 160-foot Plant Vent Stack.

Based on the release of 57,000 ci, and the annual average dispersion factor of 6.7×10^{-6} sec/m^3, the beta skin dose is estimated to be 11 mrem and the gamma total body dose is estimated to be 0.2 mrem. These numbers represent the maximum dose that could occur to an individual present at the site boundary for 70% of the release period.

In the staff's evaluation, an annual average X/Q is used to calculate offsite concentration and dose. The annual average X/Q is used because predictions of actual meteorological conditions for a particular time are impossible. However, the probabilities are high for having hourly atmospheric diffusion conditions during any season that would provide a considerably less conservative X/Q than the annual average X/Q used by the staff in their evaluation.

The dose received by the population residing in the 50-mile radius around the reactor due to the release of the 57,000 Ci of Kr-85 was evaluated. The methods used for this calculation are described in Regulatory Guide 1.109 (Ref. 15). A standard grid was employed which segmented the population into 160 elements. This grid contains 16 sectors (N clockwise through NNW) each centered on the appropriate direction. Each sector is divided into segments at standard distances of 2000 ft (.37 mi), 1, 2, 3, 4, 5, 10, 20, 30, 40, and 50 miles. The meteorological dispersion parameters which were used were the same as those that were used for the Final Supplement to the Final Environmental Statement for Three Mile Island Nuclear Station, Unit 2, (NUREG-0112), issued December 1976 (Ref. 16).

The meteorological dispersion parameters represent annual average conditions and were developed on the basis of historical data collected at the site. The 1980 population was taken from NUREG-0558 (Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station) (Ref. 17).

The 50-mile population dose calculated by this method is 0.76 person-rem total body due to the gamma component of krypton decay and 63 person-rem skin due to the beta component of the krypton decay.

6.2.2.4 Accident Analysis

The components for the purge system are located in the Unit 2 auxiliary building. A major rupture in the purge system would allow Kr-85 to be released to the auxiliary building. Any Kr-85 released to this building would be exhausted through the auxiliary building ventilation system to the plant stack. This path would be the same release pathway as that for the normal purge system.

The worst-case accident would be an inadvertent initiation of the purge system at maximum flow of 1000 cfm with a Kr-85 concentration in the reactor building atmosphere of 1 uCi/cc. In our analysis we assumed that 30 minutes were required for the operator to detect the leak and isolate the system. The 30 minutes used in this analysis is extremely conservative and was used only for calculational purposes. During actual operation a high radiation alarm monitor would automatically stop the hydrogen control subsystem purge fan and valve closure would automatically isolate the reactor building.

In a 30-minute period, a total of 850 curies would be released. For conservatism, the meteorological dispersion parameter (X/Q) used for this accident scenario was 6.8 x 10^{-4} sec/m^3 which is 100 times higher than the annual average value. Using Regulatory Guide 1.109 (Ref. 15), the staff calculates that the total body gamma dose to an individual at the site boundary would be 0.3 mrem and that the beta skin dose would be 25 mrem. The total body dose represents only a small fraction of the 10 CFR Part 100 limit (Ref. 18) of 25 rem. (Skin dose limits are not included in 10 CFR Part 100.)

6.2.3 Fast Purge

The reactor building purge system is an existing system originally installed for purging the reactor building atmosphere. Use of the reactor building purge system in conjunction with the hydrogen control subsystem represents a variation in the purging alternatives for decontaminating the Unit 2 reactor building atmosphere. A scenario for this purge is described in Subsection 6.2.3.1 This variation in the purging alternative would function only under meteorological conditions favorable for atmospheric dispersion. In addition, the purge could not be conducted in accordance with the existing instantaneous and quarterly average release rate limits of the existing radiological effluent technical specifications. The fast purge would be conducted in accordance with the weighted annual average requirements of 10 CFR Part 20 (Ref. 19), the design objectives of 10 CFR Part 50, Appendix I (Ref. 11), and the applicable requirements of 40 CFR Part 190.10 (Ref. 12). Additionally, the fast purge would be conducted to conservatively limit the maximum beta skin dose rate to 3 mrem/hr, since technical specification limits which normally accomplish this would have to be waived, as discussed above.

The reactor building purge system is capable of purging the building at flow rates of 5,000-50,000 cfm. Actual purge rates authorized during any time interval would be dependent on meteorological conditions and reactor building concentrations. Like the hydrogen control subsystem, this system would remove the reactor building atmosphere through a filter system and discharge it through the 160-foot plant vent stack to the environment. The advantage of using the reactor building purge system in conjunction with the hydrogen control subsystem is that, given the required favorable meteorology, it could decontaminate the reactor building atmosphere in five days of actual purging over a total elapsed time as short as approximately 14 days. Accordingly, the calendar time frame associated with heightened psychological stress during the conduct of the purge would be minimized.

6.2.3.1 System Description and Operation

The fast purge alternative would use the hydrogen control subsystem described in Section 6.2.1 in conjunction with the reactor building purge system. The reactor building purge system consists of two air-moving units, each of which has a flow rate that can be varied from 5,000 to 25,000 cfm. These units can be operated separately or simultaneously. During operation of the system, radioactive gases purged from the reactor building would be diluted with exhaust air from the auxiliary and fuel handling building ventilation systems and released via the Unit 2 plant vent stack, which is 160 feet above grade level. This purge system is operated from the Unit 2 control room. However, because of modifications to the system to allow for flow control, an auxiliary operator would be stationed in the auxiliary building to control the purge flow rate. The auxiliary operator would have communication ties with the control room and would be stationed in a low-radiation area.

Figure 6.2-2 provides a flow diagram of the reactor building purge system. The major components of this system include two air supply fans and filter units, two isolation valves in each purge air supply duct, two air exhaust fans and filter units, and two isolation valves in each purge air exhaust duct. The exhaust filter units consist of a prefilter, a HEPA filter bank and a second HEPA filter bank.

The slow purge method evaluated in Section 6.2.2 was based upon not exceeding the existing Appendix B Technical Specification limit (45,000 μCi/sec) for Krypton-85 (Kr-85) releases through the 160 foot plant vent stack (Ref. 9). These Technical Specification limits are based on conservative annual average meteorological conditions, where X/Q ≈ 6.7 x 10^{-6} sec/m^3. However, by controlling the purge rates to take advantage of more favorable meteorological conditions, higher purge rates can be achieved while still not exceeding the requirements of 10 CFR Part 20 (Ref. 19), the design objectives of 10 CFR Part 50, Appendix I (Ref. 11) and the applicable requirements of 40 CFR Part 190.10 (Ref. 12).

When favorable meteorological conditions exist, the hydrogen control subsystem would be operated at its maximum flow rate of 1000 cfm until the Kr-85 concentration in the reactor building is reduced to 0.22 uCi/cc. It would require approximately 50 hours to reduce the current reactor building Kr-85 concentration of 1.0 uCi/cc to 0.22 uCi/cc. When the reactor building Kr-85 concentration is reduced to 0.22 uCi/cc, the hydrogen control subsystem would be secured and the the reactor building purge system started with an approximate flow rate of 5000 cfm. The reactor building purge system would operate at 5000 cfm for approximately 70 hours to reduce the building concentration of Kr-85 to MPC (1 x 10^{-5} uCi/cc). Thus, the total actual purge time using both systems would be approximately 120 hours. The calendar time frame necessary to complete the fast purge scenario is dependent upon achieving favorable meteorology and is especially sensitive to the seasonal variations that can occur (see discussion in Section 6.2.3.3).

6.2.3.2 Occupational Exposure

The occupational exposure anticipated from the fast purge scenario is approximately the same as for the slow purge scenario as discussed in Section 6.2.2.2.

6.2.3.3 Environmental Impact

The fast purge environmental impact would be approximately the same as for the slow purge as discussed in Section 6.2.2.3.

For the fast purge during the spring season (March-May) there is a fair likelihood of being able to expeditiously release and maintain sufficiently low doses to the public in accordance with the criteria discussed in Section 6.2.3.1. We estimate that favorable meteorology during these months may permit the fast purge option to be accomplished within a 2-calendar week period. However, for the fast purge during the summer and fall months (June-October), we estimate, based on historical data which show a small probability of favorable meteorological conditions, that this alternative would require approximately two calendar months to complete. Thus, given the June thru October meteorological conditions, the calendar time frame necessary for both the fast purge and slow purge are essentially equivalent. As the period of favorable meteorology (i.e., March-May) is nearly over, the staff considers the fast purge to be a less desirable alternative for the following reasons:

(1) The advantage of the fast purge, namely a lessening of potential psychological stress for area residents, would be lost during the summer months when total elapsed time required for both fast and slow purge alternatives are essentially the same.

(2) Reactor building purging should not be delayed past the summer and fall months to allow for better winter meteorological conditions for those reasons elaborated in Section 5.0.

6.2.3.4 Accident Analysis

The accident analysis described in Section 6.2.2.4 would apply to this alternative.

6.2.4 Elevated Release Points

6.2.4.1 Introduction

Stacks are normally designed to assure that effluent exit velocities will give maximum rise to releases and eliminate the wake-cavity effects of adjacent structures. Factors affecting meteorological dispersion of stack effluents include the height and position of nearby structures and the layout of local terrain. The existing plant vent stack is 160 feet above grade, with an exit diameter of 9 feet. In order to evaluate the dose reduction offered by increasing stack height, the staff has evaluated the alternatives of raising the existing stack to 400 feet or construction of a new 1000-foot stack.

6.2.4.2 Extending Stack Height to 400 Feet

6.2.4.2.1 Description

A temporary sheet metal extension with the same diameter as the existing stack, could be used to elevate the existing plant stack to 400 feet above grade. The extension would be surrounded with scaffolding, which would be used to support the extension with the aid of guy wires. The existing stack could also be elevated to 400 feet by the addition of 10-foot sections of the carbon-steel pipes. These sections would have the same diameter as the existing stack.

Assuming that procurement of the necessary materials for extending the stack can be readily accomplished, the staff estimates that the engineering design, procurement, construction, and leak testing of either variation would require a minimum of four to five months. This estimate does not consider the potential interferences of existing and new structures (e.g., processed water storage tanks) which may result in further schedule delays.

6.2.4.2.2 Occupational Exposure

Occupational exposures described in Section 6.2.2.2 would apply to this alternative.

6.2.4.2.3 Environmental Impact

An increase in stack height to 400 ft would eliminate the effect of the reactor building wake cavity however, the stack would remain within the wake cavity of the site cooling towers. In addition, the plant location in a river valley surrounded by higher elevation terrain diminish the effects of an elevated release point of 400 feet. An increase in the plant stack height (up to 400 ft) would reduce the already negligible (see Section 7.1) dose to the maximum exposed individual by a factor of approximately eight below the doses estimated for the fast or slow purge.

6.2.4.2.4 Accident Analysis

The accident analysis described in Section 6.2.2.4 would apply to this alternative.

6.2.4.3 Constructing a 1000-Foot Stack

The staff has evaluated the dose reduction benefit resulting from the construction of a 1000-foot stack.

A 1000-foot stack would assure that releases are unhindered from the effects of all onsite structures. The technology for constructing a stack this height is well established.

A stack 1000 feet high would require, at a minimum, a 60-foot diameter base. Construction of a foundation this size would require not less than three months and construction of the remainder of the stack would require approximately six months. Additional design, engineering, construction, and testing time required to connect the stack with the existing purge system and ensure proper operation would add two to three months to the installation schedule. Therefore, the staff estimates that a minimum of 11 months would be required to construct and make functional a new 1000-foot stack.

6.2.4.3.1 Occupational Exposure

Occupational exposures described in Section 6.2.2.2 would apply to this alternative.

6.2.4.3.2 Environmental Impact

A stack release at 1000 feet would physically place radioactive effluents above the effects of the cooling tower wake cavity and nearby terrain and would result in reducing offsite doses to the maximally exposed individual by a factor of approximately 230 below the doses estimated for the fast or slow purge.

6.2.4.3.3 Accident Analysis

The accident analysis described in Section 6.2.2.4 would apply to this alternative.

6.2.5 Staff Evaluation of Union of Concerned Scientist Elevated Release Proposals

6.2.5.1 Introduction

In response to a request by the Governor of Pennsylvania, the Union of Concerned Scientists (UCS) evaluated the health and safety consequences of the disposition of the reactor building atmosphere including the purging alternative recommended by the NRC staff in its draft Environmental Assessment (NUREG-0662). In their report to the Governor (Ref. 3), the UCS reported that based on "current evidence of effects of whole body radiation on human populations, ...no health effects would be anticipated as a result of the 'ground release' venting." However, the UCS did not recommend purging, as proposed by the staff, because of the potential psychological stress UCS believes purging might induce. As a result, the UCS proposed two alternative means of purging the reactor building which they believe will minimize potential psychological stress. The first method proposes purging by heating the effluent with an incinerator prior to releasing it through a 250-foot refractory lined stack. The second method proposes an elevated release at 1000-2000 feet through a relatively light-weight tube held aloft by a tethered ballon.

5.2.5.2 Hot Plume Release Through a 250-Foot Stack

6.2.5.2.1 Description

The staff has evaluated the Union of Concerned Scientists (USC) proposal to construct an incinerator (and stack) to heat the effluent purged from the reactor building. Under ideal conditions, an incinerator of this type should be located as close as possible to the auxiliary building to minimize the engineering and construction effort necessary to interface with the reactor building purge system. UCS "rough estimates" place the construction time for an incinerator facility at from seven to nine months. This time estimate does not include time requirements for design, engineering, procurement of material, and pre-operational testing. The staff estimates for these required efforts would add at least two months to the overall construction effort, resulting in a minimum schedule of nine months for system availability.

6.2.5.2.2 Occupational Exposure

Occupational exposures described in Section 6.2.2.2 would apply to this alternative.

6.2.5.2.3 Environmental Impact

Staff evaluations show that dose reductions can be achieved if heat is added in sufficient quantities to allow the effluents to raise above the wake cavity of the cooling towers. The release of a heated plume from a 250-foot stack would result in reducing offsite doses to the maximally exposed individual by a factor of approximately 30 below the doses estimated for the fast or low purge.

6.2.5.2.4 Accident Analysis

The impact of an accident involving this alternative would result in a total-body dose which is approximately five times greater than the slow purge accident dose discussed in Section 6.2.2.4. These doses would still represent a small fraction of 10 CFR Part 100 accident-dose limits (Ref. 18).

6.2.5.3 The Tethered Balloon/Tube Release at 2000 Feet

6.2.5.3.1 Description

The staff has evaluated the UCS proposal to purge the reactor building atmosphere through a reinforced fabric tube held aloft at 2000 feet above Three Mile Island by a tethered balloon (Also see Section 9.2.5). As stated by the UCS, this technique is unique and untried and would require further study to determine its feasibility. In addition, the UCS stated that they did not know if suitable space was available on Three Mile Island to implement this alternative.

In general, the staff finds the UCS proposal, while not without problems, technically workable and probably capable of being implemented within a year from the time the decision is made to use it.

The major problem with the UCS proposal is that, at present, there is no existing area on Three Mile Island which is suitable for launching the tethered balloon and its attached 2000-foot fabric tube. The UCS has stated that their proposal would require unobstructed ground and air space approximately 2000 feet long by 200 feet wide. The staff has examined Three Mile Island for potential sites of sufficient size to implement the UCS proposal.

The island is approximately 11,000 feet in length by 1,700 feet in width. The northern one-third of the island is occupied by Three Mile Island Nuclear Station Units 1 and 2. The southern part of the island contains some open area, a fairly large wooded area, and a shallow basin area that is prone to flooding. The area with the most open space is south of the Unit 2 cooling towers and includes an existing parking lot. The staff estimates the open space to be approximately 200 feet or more wide and 1500 feet long. Some trees in the wooded area of the island would have to be removed to enlarge the area.

This potential site is a considerable distance from the auxiliary building and the reactor building purge system with which it would have to interface. The large distance would magnify the engineering and construction effort involved, and would ultimately impact the schedule for system availability. A detailed design and layout of the interconnecting piping between the auxiliary building and the launch site would have to be performed.

The piping would have to be buried (at least in some locations) in order not to restrict normal traffic (e.g., solid radwaste shipments, concrete truck deliveries, etc.) about the site. The piping would require leak testing following welding to ensure that no gas bypass pathways exist. The need for booster pumps would have to be determined in a detailed engineering evaluation. The staff has also consulted with the Department of Energy's (DOE) Ames Laboratory concerning the feasibility of the UCS balloon proposal. In their judgment, the first 500 to 1000 feet of elevation crucial in determining what effect wind shear and air turbulence will have on fabric tube behavior. Testing is recommended. The staff concurs with this observation. Thus, a test of the integrity of the reinforced fabric tube (1-foot diameter) under different wind shear and air turbulence conditions would be required. The staff envisions these tasks as a major design effort. The staff has determined that the schedule required to accomplish these actions and demonstrate system operability is longer than the timetable estimated to the UCS for system availability.

The UCS stated that a timetable for a tethered balloon system was "somewhat difficult to estimate" but projected a schedule of four to seven months. This schedule is based on the availability of a suitable location on Three Mile Island for system implementation and successful completion of feasibility tests. Based on the remote location of suitable land area from the auxiliary building, the staff believes that the UCS has underestimated the engineering and construction effort required to maje this technique workable. The staff estimates that this effort would require from 7 to 10 months to make the tethered balloon system operable. The staff does not believe that postponing decontamination of the reactor building atmosphere for this period of time is acceptable for the reasons discussed in Section 5.0.

6.2.5.3.2 Occupational Exposure

Provided adequate controls are established to isolate or bury the required interconnecting piping, the occupational exposures described in Section 6.2.2.2 would apply to this alternative.

6.2.5.3.3 Environmental Impact

An elevated release at 2000 feet would physically place radioactive effluents above the effects of the cooling tower wake cavity and nearby terrain and would result in reducing offsite doses to the maximum exposed individual by a factor of approximately 300 below the doses estimated for the fast or slow purge. However, the staff would have to assess the psychological impact of this highly visible alternative on nearby residents.

6.2.5.3.4 Accident Analysis

The accident analysis described in Section 6.2.5.2.4 would apply to this alternative.

6.2.6 Summary

The staff has evaluated six alternative methods for purging the contaminated reactor building atmosphere to the environment. Those methods include (1) a slow purge using the existing hydrogen control subsystem with releases from the unmodified 160-foot plant vent stack, (2) a fast purge using the existing hydrogen control subsystem and reactor building purge system with releases from the 160-foot plant vent stack, (3) an elevated purge using the existing hydrogen control subsystem and reactor building purge system with releases from the plant vent stack elevated to 400 feet, (4) an elevated purge using the reactor building purge system with releases from a new 1000-foot. stack, (5) a hot plume release using the reactor building purge system and a new incinerator and 250-foot stack (a UCS proposal), and (6) an elevated purge using the reactor building purge system and a reinforced fabric tube held aloft at 2000 feet by a tethered balloon (a UCS proposal).

All six purge alternatives are similar in some respects. All the proposed alternatives would result in approximately the same occupational exposure and the consequences of a postulated accidental release are also roughly equivalent. All the alternatives are capable of being implemented in accordance with the requirements of 10 CFR Part 20 (Ref. 19), the dose design objectives of 10 CFR Part 50, Appendix I, (Ref 15), and the applicable requirements of 40 CFR 190.10 (Ref. 12). No health effects would be anticipated from implementing any of the six purge alternatives (see Section 7.1).

However, there are significant differences among these alternatives. The slow purge and fast purge could essentially be implemented immediately (except for meteorological constraints for the fast purge). The remaining four alternatives would require modifications to plant systems and structures resulting in estimated schedules for system availability ranging from a minimum of four to five months (stack modified to 400 feet) to as long as 11 months (a new 1000-foot stack). Another potential difference associated with the various purge alternatives is the potential psychological impact that each might have. In fact, the UCS proposed their variations of the purge alternative not because of concern over health effects (none are anticipated), but as a means of reducing potential psychological stress. Because of inherent and uncertain delays, the NRC staff does not believe that the UCS proposals would succeed in alleviating psychological stress. On the contrary, the tethered balloon could even augment stress, depending on public perception. A tethered balloon would be easily visible to the nearby residents and would be an attraction of sorts that may create as much stress as it is intended to alleviate.

The NRC staff supports the slow purge alternative as the best means of decontaminating the reactor building atmosphere, thereby expediting the continued cleanup of the plant in a safe manner. In the staff's opinion, the best means of alleviating psychological stress in the vicinity around the plant is to complete the overall recovery effort safely and quickly.

6.3 Selective Absorption System

6.3.1 Introduction

The selective absorption system evaluated by the NRC staff would operate by withdrawing gases from the reactor building, separating essentially all the krypton from the gases, and returning the gases to the reactor building. Krypton is separated from other gases in a combination absorption stripping column which operates at greater than atmospheric pressure and uses a liquid fluorocarbon as a solvent. The separated and concentrated krypton may then be stored onsite or transported offsite for disposal. Alternatively, krypton gas in containers could be transported to and released at some remote site.

6.3.2 System Description and Operation

A fluorocarbon absorption process for removing noble gas fission products (krypton and xenon), carbon-14, and other radioactive contaminants from gaseous waste, has been under development since 1967 by Union Carbide at Oak Ridge National Laboratory (ORNL). Following their initial work to obtain solvent chemistry information and to develop the process system, ORNL personnel constructed a small pilot plant. This pilot plant utilizes a single absorption column process with a maximum gas flow rate of 15.0 scfm and has been in operation since 1978. Actual removal efficiencies greater than 99.9% for krypton have been obtained. However, these efficiencies were obtained for influent concentrations of noble gases substantially higher than those existing in the reactor building. Based on the results of the developmental and pilot plant test programs, ORNL personnel are optimistic that their absorption process could be used at Three Mile Island (TMI).

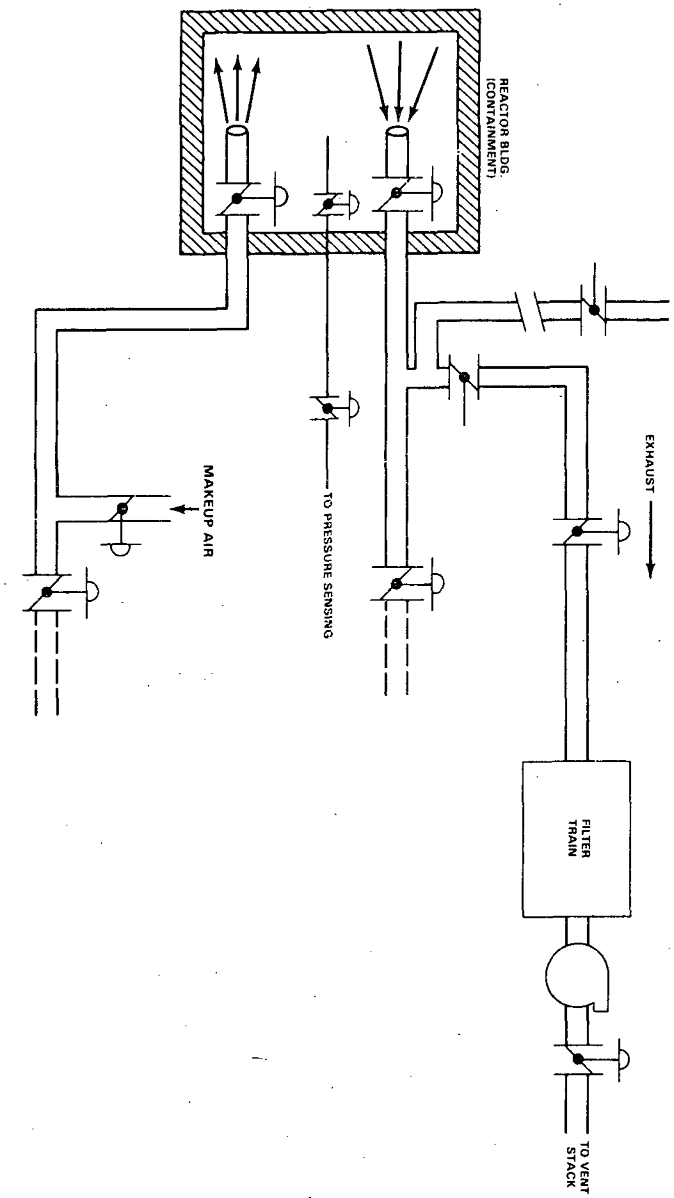

Figure 6.2-1 Flow Diagram for Purge Using Hydrogen Control Subsystem

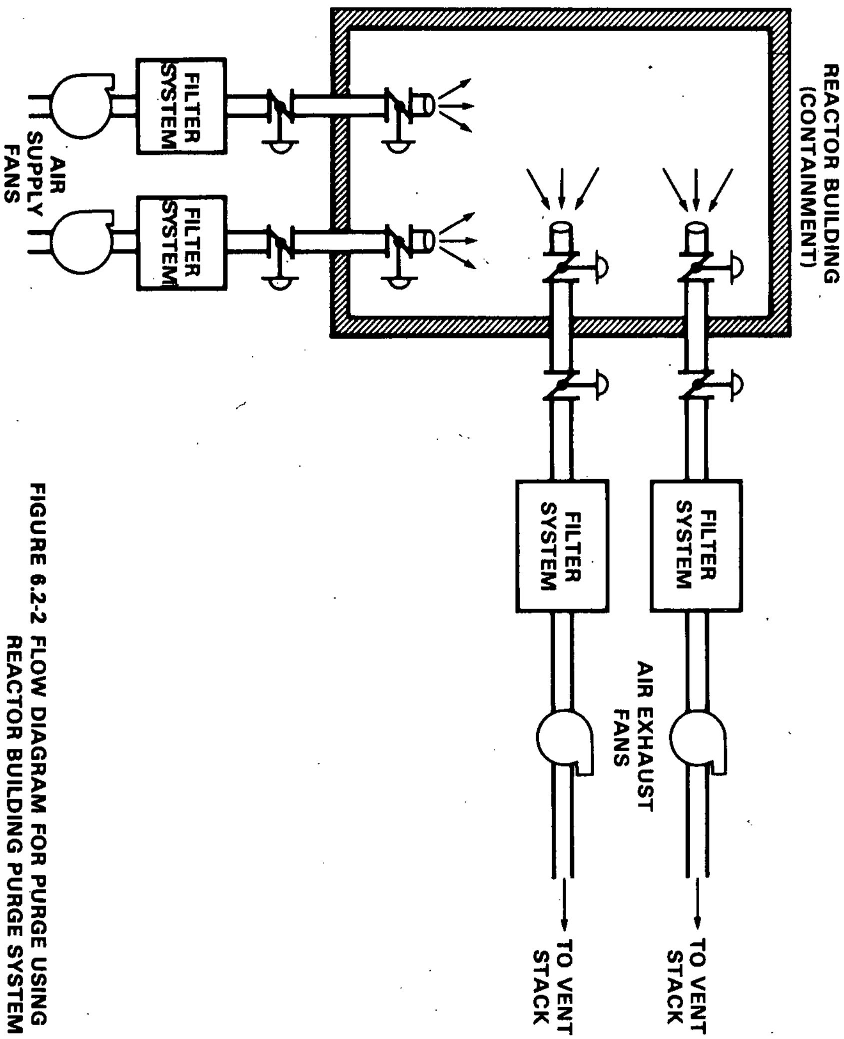

FIGURE 6.2-2 FLOW DIAGRAM FOR PURGE USING REACTOR BUILDING PURGE SYSTEM

The existing pilot plant, however, is not believed, by either the NRC staff or ORNL personnel, to be a practical system for decontaminating the TMI reactor building atmosphere. This small-scale laboratory system was not designed to be portable and is not readily adaptable for use at TMI. Approximately 50% of the hardware, including refrigeration and reversing heat exchanger systems, which would be needed at TMI, are not presently incorporated in the ORNL model. Most importantly, however, the existing pilot plant is unacceptable for use in decontaminating the atmosphere in the reactor building because of this system's very small flow capacity. At 15 scfm it would require nearly three years of continuous processing (i.e., no downtime for repairs and maintenance) to decontaminate the atmosphere to the maxmimum permissible Kr-85 concentration (1×10^{-5} µCi/cm^3) for workers as required by 10 CFR 20 (Ref. 19).

A larger selective absorption system, with the capability to process approximately 150-200 scfm, has also been evaluated by the NRC staff. Although a selective absorption system of this size has never been constructed, it would be expected to effectively remove more than 99% of krypton from the process stream. After passing through the column, the gas stream would flow back to the reactor building. Krypton would be removed from the column in a separate flow stream and transferred to pressurized containers for long-term (100 years) storage. The krypton removal may be accomplished by either a bleed-and-feed process or by continuous operation. A system designed to process 150-200 scfm, if operated continuously for about two months, would reduce the amount of Kr-85 in the reactor building atmosphere to less than 0.1% of its current inventory. We estimate that processing about 23,000,000 ft^3 of gas (11.5 reactor-building volumes) would be required to reduce the krypton level in the reactor-building gases to the maximum permissible concentration of Kr-85. This would require approximately three months of continuous processing.

The absorption system is based on the property of a fluorocarbon, namely dichlorodifluoromethane, or Freon 12, to selectively absorb noble gases. The process has been integrated into a single combination column with supporting equipment, as shown in Figure 6.3-1. Contaminated gases are withdrawn from the reactor building, dehumidified, filtered, compressed to approximately 125 psig, and cooled to near -30°F. The gas would then be fed into the absorption section of the combination column and contacted countercurrently with the downflowing liquid freon solvent. The solvent containing the dissolved Kr-85 would subsequently flow into the intermediate and final stripper sections of the column. The reboiler at the bottom of the column would operate at 104°F and 125 psig. The solvent from which the Kr-85 has been removed would be cooled to -30°F before it would be pumped back to the top of the column. Trace quantities of water and iodine may be removed from this solvent stream by a molecular sieve and/or silver-impregnated zeolite prior to recycling. The decontaminated gas would then leave the top of the column. Decontaminated gases may contain 5 to 10% Freon 12, and would, therefore, be passed through a turboexpander and a molecular sieve bed (a filter) to recover solvent. The decontaminated gas would then be recycled into the reactor building until the Kr-85 concentration reached allowable limits.

The concentrated krypton waste gas would be compressed and placed in high pressure cylinders for storage. The cumulative waste gas collected from processing the contents of the reactor building could be stored at 2000 psig in a few standard gas cylinders. The internal volume of one standard gas cylinder is 1.54 feet^3. The krypton activity in a cylinder will necessitate radiation shielding (approximately one inch of lead) and some cooling. Alternatively, the krypton gas could be stored at lower pressure (and with lower risk of leakage) in a larger number of these cylinders. Onsite storage is discussed in Section 6.8 and transportation and, burial or release of krypton in a remote location are discussed in Section 6.9.

Members of the NRC staff with extensive nuclear construction experience estimate that it would require at least 16 months* to make a scaled up selective absorption system, capable of processing 150-200 scfm, into operation

*ORNL personnel have estimated that a minimum of 13 months would be required on a "best effort" schedule for making a 150-scfm system operational at TMI. This estimate includes no contingencies and several simplifying assumptions (Ref. 23). A more optimistic schedule of 6 months has also been estimated by a Congressional staff aide (See Section 9.0).

at TMI. This estimate is based on such considerations as personnel mobilization and organization (including engineers and construction workers), system design, component procurement, system fabrication, site coordination (including construction of a building to house the system), and system testing prior to operation. As a "best effort" estimate, this schedule assumes that competitive bidding for equipment would not be used and that the design criteria (Ref. 22) for the system would be the minimum required for radwaste systems built at nuclear power facilities. These criteria establish the minimum acceptable requirements for quality assurance, seismic design, component quality classification, and preoperational testing. This estimate, although recognizing that some necessary equipment may be available "off the shelf" assumes, based on experience, that procurement of other equipment will take approximately 3-4 months. It should be noted that even where equipment is available it will be necessary to determine where it is located, whether it is functional, what maintenance will be necessary prior to operation, and whether it is compatible with the system design (i.e., can components be connected based on capacity and available connections).

6.3.3 Occupational Exposure

The occupational radiation exposure at the Oak Ridge pilot plant has been negligible. It is anticipated that the exposure would increase slightly with a larger system. The feature that sets personnel exposure during system operation and maintenance is the volume of krypton contained within the process at any one time. Shielding would be provided for components having a high-radiation field. For major maintenance activities, krypton can be completely removed from the absorber system to further reduce exposure. We estimate that an occupational exposure of about 25-50 person-rem would result from operation of this system including filter removal. If a decision were made to store the krypton onsite, the storage system would be designed for remote operation; however, it would be unrealistic to assume that the storage system would not require some maintenance and surveillance during the approximately 100 years while the Kr-85 decays. This would result in an additional estimated occupational exposure of 90-170 person-rems. As discussed in Section 6.9, the occupational exposure resulting from a decision to transfer the gas for offsite disposal (i.e., handling and packaging of the gas for transport) would result in an occupational exposure of 8-24 person-rems.

6.3.4 Environmental Impact

Selective absorption has zero release as a goal. Krypton is removed from the reactor building and stored in pressurized containers with only minimal release to the environment, although some leakage is expected. In addition, a few cubic centimeters would be released each time gas cylinders are changed. Subsequent long-term storage of the pressurized containers on site will not affect the environment directly; however due to possible corrosion of the storage containers with time the potential for accidental release would remain while the Kr-85 is stored on site (see Section 6.8).

6.3.5 Accident Analysis

For the purpose of analyzing potential accidents, the absorption process system and pressurized storage containers will be reviewed separately.

(1) Absorption Process

The maximum curie content in the absorber system (12-inch column) at any one time would not exceed 200 Curies. Process components will be housed in a confinement structure. Automatically activated isolation valves would be used to separate the absorber from the reactor building and the gas storage system whenever a malfunction is detected. Assuming an accident which results in a release of the entire process inventory of krypton (200 Curies) to the confinement structure and subsequently to the environment over a 2-hour period, the resulting total-body gamma dose at the site boundary would be 0.1 mrem and a beta skin dose of 6 mrem assuming a X/Q of 6.8×10^{-4} sec/m^3.

(2) Gas Storage

The process product, concentrated krypton gas, could be stored onsite in pressurized containers. Numerous container configurations can be designed. For a bounding calculation, the staff has assumed that all 57,000 Curies of krypton are stored in one container. If that container ruptured, a release of the krypton to the confinement structure and subsequent releases to the environment over a two-hour period would result in a total-body gamma dose at the site boundary of 20 mrem and a beta skin dose of 1700 mrem, assuming a X/Q of 6.8×10^{-4} sec/m^3. This calculated total body dose is a small fraction of the limits set forth in 10 CFR Part 100 (Ref. 15). There are no skin dose limits in 10 CFR Part 100.

Summary

The selective absorption process has been studied and has had extensive development on a small scale. Large-scale operation has not been proven, but all signs indicate that the absorption system would perform satisfactorily to remove krypton from the TMI reactor building atmosphere. The existing pilot plant at ORNL is not portable and does not incorporate all of the components which would be needed at TMI. The pilot plant, because of its small flow capacity, would require more than three years to process the building atmosphere to the maximum permissible concentration of Kr-85. The NRC staff's "best effort" estimated time required to construct a scaled-up (150-200 scfm) absorption system at TMI is at least 16 months, but a longer time may be needed, depending on the number and complexity of problems that could arise during the design, procurement, construction, testing, or operation phases of such a project. Based on prior operating experience, the occupational exposure due to processing should be very low. Doses to the public would be neglibible since only minimal leakage of Kr-85 from the system itself is expected. The estimated occupational exposure resulting from extended onsite storage is 90-170 person-rem. (See Section 6.8.) See Section 6.9 for a discussion of transportation and offsite disposal. Worst case accident scenarios do not result in threats to public health and safety.

6.4 Charcoal Adsorption Systems

6.4.1 Introduction

The following discussion presents the NRC staff evaluation of a nonregenerative charcoal adsorber system. This system is similar to those used in boiling water reactor (BWR) off-gas treatment systems which are routinely used to retain noble gases for decay prior to their release to the environment. The staff evaluated both the ambient temperature and refrigerated charcoal adsorber systems. Both systems would require extremely large volumes of charcoal; the ambient system would require 34,000 tons and the refrigerated system 12,000 tons. Both charcoal systems when operating normally would have no releases associated with them; however, during anticipated operational occurrences minor releases can be expected. Since noble gases do not react chemically with charcoal, long-term surveillance would be required.

A regenerative charcoal adsorber system was proposed in a public comment. The NRC staff has determined that this proposal is not feasible and it is not recommended. A discussion of this proposal is contained in Section 9.5.16.

6.4.2 System Description and Operation

Ambient Charcoal System. The transfer of radioactive airborne activity from the reactor building to the ambient charcoal system would follow the same flow-path described for the purge system. The radioactive airborne activity from the reactor building atmosphere will contain moisture. If the charcoal in the adsorber system is exposed to humidity in excess of 3%, the charcoal would lose its capacity to adsorb krypton. The major fraction of the moisture would be removed as the airborne activity passed through the cooler condenser. Additional moisture

(2) Gas Storage

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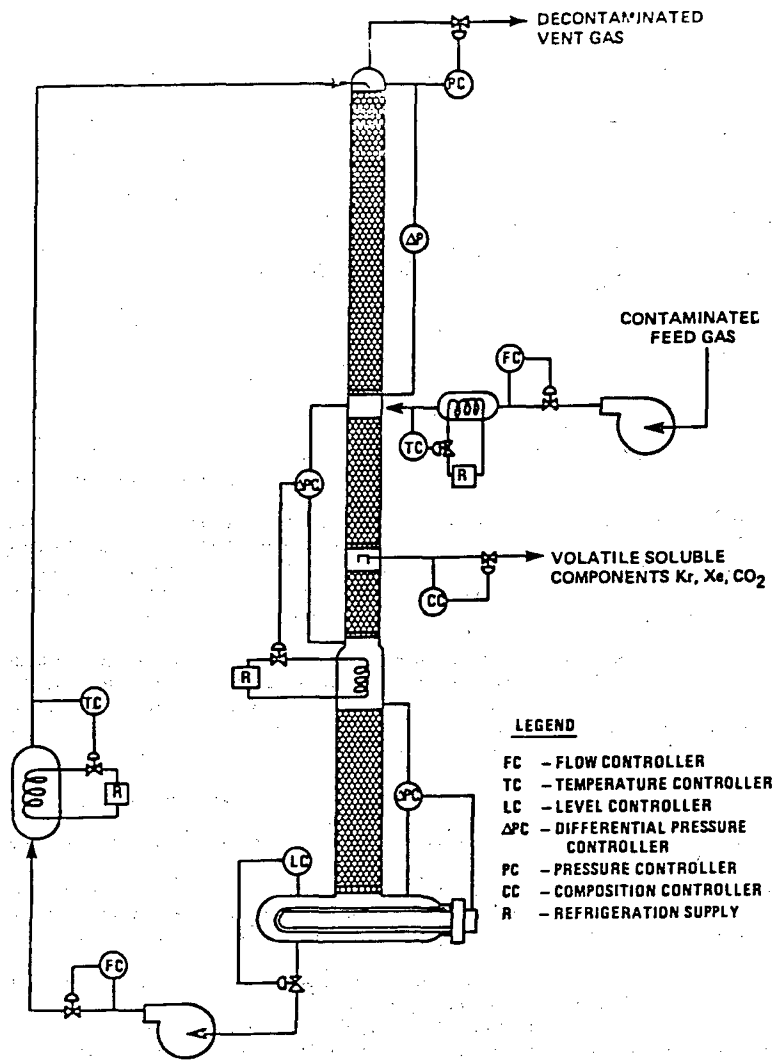

Figure 6.3-1 Schematic of the Combination Column

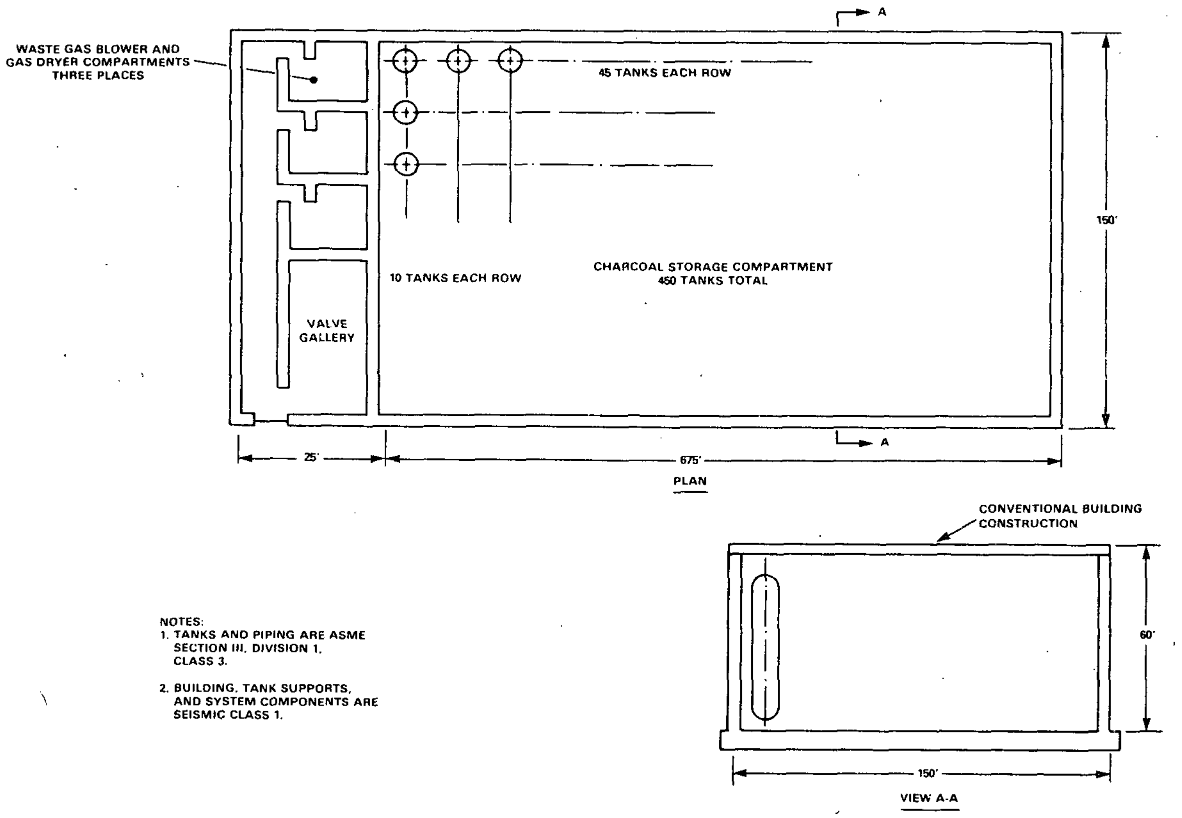

Figure 6.4-2 Conceptual Layout - Charcoal Storage Arrangement

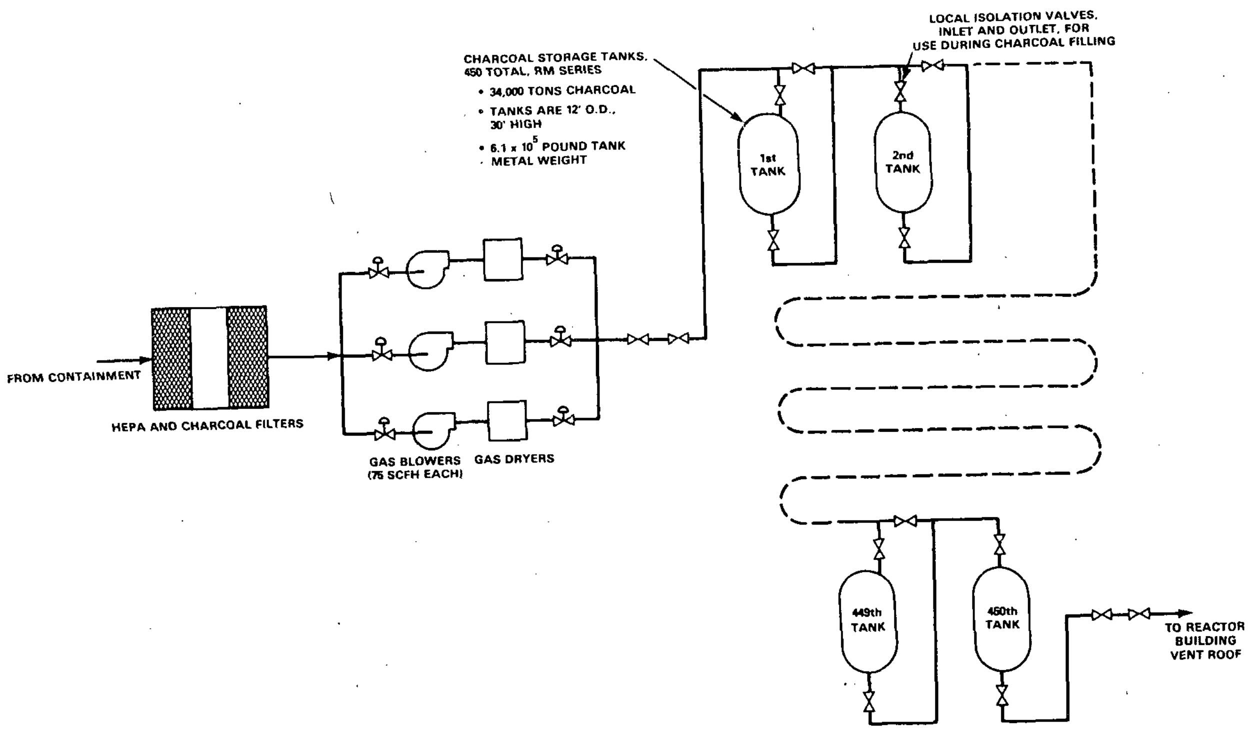

Figure 6.4-1 Flow Diagram for Purge Using Charcoal Adsorption System

Refrigerated Adsorber System. This system would require 150 tanks of charcoal. The radioactivity in each succeeding tank would decrease as the activity in the reactor building decreased. The tank with the highest activity would contain approximately 4300 Curies. If the same accident assumptions are used for this evaluation as were used above, the resulting doses would be increased by a factor of 3. Therefore, a beta skin dose of 124 mrem and a total body dose gamma of 1.5 mrem could be expected.

Summary

It is possible to remove the Kr-85 from the reactor building with either room-temperature or refrigerated charcoal adsorber systems. The primary advantages of the room-temperature charcoal adsorber system are simplicity of operation and the capacity to accommodate extremely radioactive gas mixtures. However, the major disadvantage for a room-temperature charcoal adsorber system is the large volume of charcoal it requires. A refrigerated charcoal adsorber system would reduce the volume of charcoal required. However, to gain a reduction in charcoal volume, an increase in equipment complexity would result. Since the primary form of radioactivity in the reactor-building atmosphere is Kr-85, a noble gas fission product that does not ordinarily react chemically, the charcoal adsorber would function as a physical adsorber to retain the Kr-85. Loaded charcoal beds would then have to remain in storage approximately 100 years to permit radioactive decay of Kr-85 to insignificant levels. The NRC staff has estimated that a charcoal system could be made operational in 2-4 years. This lead time is unacceptable for those reasons discussed in Section 5.0.

6.5 Gas Compression System

6.5.1 Introduction

The gas compression system involves drawing off the reactor building atmosphere into suitable pressurized storage containers so that the entire inventory of Kr-85, remains in pressurized storage for approximately 100 years to permit radioactive decay to insignificant levels. This system would reduce the Kr-85 concentration in the reactor building by feed-and-bleed operation to the maximum permissible concentration of 1×10^{-5} μCi/cc. To accomplish this, approximately 23 million cubic feet (11.5 reactor-building volumes) would have to be processed by the system.

The staff has received a number of letters from the public suggesting alternatives to the onsite purging of the Kr-85 gas. Included were suggestions for compression and storage of Kr-85 and offsite shipment with subsequent release at a remote site. Transportation and offsite disposal of Kr-85 are discussed in Section 6.9. Additionally, comments on gas compression alternatives are addressed in Section 9.0.

6.3.2 System Description and Operation

The gaseous contents of the reactor building would be transferred to pressurized gas containers for long-term storage. The containers can be designed in various pressure/volume combinations to accommodate the reactor-building gases.

To reduce activity in the reactor building to maximum permissible concentrations, a total of 11.5 reactor building volumes (23 million cubic feet) would be transferred to storage. The compressed gas train would include gas dryers, a charcoal adsorber, a HEPA filter, three gas compressors, storage containers, and associated piping and valves. Figure 6.5-1 provides a flow diagram of the system. The compressed gas would remain stored on the site for approximately 100 years to allow the Kr-85 to decay to insignificant levels. The minimum volume for the storage system would result if the gas were stored at the highest possible pressure. The practical upper pressure limit for gas storage is 2500 psig. At this pressure, 80,000 standard gas bottles (1.54 cubic feet) would be needed to store the gas. An alternative to extended onsite storage would be to package the gas for

offsite disposal. This alternative is discussed in Section 6.9. At the other end of the spectrum is a large-volume, low-pressure storage system. For example, if a container the size of the existing reactor building were constructed, the gas could be stored at 170 psig.

The General Public Utilities Corporation (GPU) contracted with MPR Associates to investigate the most practical means for storing the compressed gas (Ref. 21). MPR recommended a low-pressure storage system in which the gas would be stored at 340 psig in 36-inch outside-diameter standard-wall pipes. One million cubic feet of storage volume would be required, which would be equivalent to 150,000 linear feet, or 28 miles of pipe. The proposed pipe storage complex is divided into two major sections (high activity and low activity) to minimize shielding requirements. The high-activity piping section would include 20% of the piping and would contain 90% of the Kr-85. The high-activity section would be segregated into five units to limit Kr-85 releases in the event of leakage and to optimize inherent shielding. Low-activity pipe units would be placed to the outside of the storage area to act as a shield for the highest activity units in the center. The building to house the high-activity piping, the filters, dryers, and gas compressors, would be 260 feet long, 90 feet wide, and 30 feet high. Six inches of concrete shielding around the high-activity piping would be required. The low-activity pipe section would contain 80% of the total piping and 10% of the Kr-85. The building for housing the low-activity piping would be 220 feet long, 160 feet wide, and 60 feet high. It would require no shielding.

6.5.3 Occupational Exposure

No significant amount of radiation exposure should be incurred by plant personnel during operation of the gas compression system. All system components are relatively simple and should require minimal maintenance during gas processing. Should maintenance be required, most components could be isolated and purged to decrease radiation exposure during repairs. The staff estimates an occupational exposure of approximately six person-rems during operation and maintenance.

Periodic maintenance of the long-term storage system is a potential source of occupational exposure. Although a system can be designed for maintenance-free operation, it would be unrealistic to assume that some maintenance would not be necessary during the approximately 100 years of storage required. The staff estimates that surveillance and maintenance during long-term storage would result in an occupational exposure of approximately 42 person-rems.

6.5.4 Environmental Impact

Krypton-85 can be removed from the reactor building and stored in pressurized containers with minimal release to the environment. The resulting doses to the public due to the anticipated minor releases would be insignificant.

Although subsequent long-term storage in pressurized containers onsite will not affect the environment directly, the potential for accidental releases will remain for over 100 years as the stored Kr-85 decays.

6.5.5 Accident Analysis

The gas compression process was analyzed for its radiological consequences following an accidental release of compressed gas from the storage system. The radiological consequences of a failure in the feed train were not analyzed since it was assumed that the feed process would be isolated well before the accidental release approached a magnitude which would equal a release following a storage-system failure. The accidents analyzed therefore, represent the most severe occurrences with respect to their potential exposure potential at the site boundary. Analyses were performed on accidental releases from several storage configurations.

Assuming the compressed gas storage system is segregated into four units, postulated unit failure with a subsequent release of 14,250 Curies to the environment in a two-hour period would result in a site boundary total-body gamma dose of 5.0 mrem and a beta skin dose of 410 mrem assuming a conservative X/Q of 6.8 x 10^{-4} sec/m³. The total body gamma dose is a small fraction of the limit set forth in 10CFR Part 100 (Ref. 15); 10CFR Part 100 does not include a limit for beta skin exposure.

Summary

The gas compression system offers several advantages. The gas compression system is essentially a "zero release" system which could be operated to decontaminate the reactor-building atmosphere with insignificant environmental impact. The occupational exposure resulting from operation and long-term surveillance of the system is estimated to be 41 person-rems. The major disadvantages of the gas compression system is the extensive time required to build and install the system (25 to 35 months). The NRC staff considers this time period unacceptable for the reasons discussed in Section 5.0.

6.6 Cryogenic Processing System

6.6.1 Introduction

A potential means of decontaminating the contaminated reactor-building atmosphere is through the use of a cryogenic processing system. The operating principle of the cryogenic processing system is the condensation of Kr-85 from the incoming air by direct contact with liquid nitrogen (boiling point, -195.8°C). The liquefied Kr-85 would be allowed to concentrate and would then be vaporized and transferred to an onsite storage facility for subsequent disposition. Use of the liquefaction or cryogenic processes has been recommended by various members of the public.

The NRC staff has evaluated the availability of an existing cryogenic processing system (CPS) at a commercial boiling water nuclear power plant to decontaminate the reactor-building atmosphere. The cryogenic system has never been placed into operation and is being offered for sale by its current owner because of anticipated high operating costs and the degree of continued maintenance that the unit would require. Although the system is available for purchase and use by the licensee, the erection of a new building would be required to house the system because of the need to confine anticipated leakage from the CPS. The building would be approximately 110 feet long by 72 feet wide and would vary in height from 20 feet to 35 feet.

6.6.2 System Description and Operation

If installed, the cryogenic system would connect with the reactor building through the existing hydrogen-control system. The contaminated air from the reactor building would be transported to the cryogenic processing system in the adjacent building after passing through the HEPA filters and charcoal adsorber of the hydrogen control system.

The cryogenic processing system consists of three processing trains. The major components of each train are the prefilter, catalytic recombiner, aftercooler, and cryogenic treatment subsystem. The three processing trains are supported by a hydrogen storage system, a liquid-nitrogen storage system, and a noble-gas storage system. A flow diagram of the cryogenic processing system is shown in Figure 6.6-1. The cryogenic processing system can process air from the reactor building at a flow rate of approximately 225 scfm. After passing through the HEPA filters and charcoal adsorbers of the hydrogen control system for removal of trace quantities of airborne radioactive particulates, the air from the reactor building would be heated in the CPS preheater prior to injection into the CPS catalytic recombiner for oxygen removal and corresponding volume reduction of the recombiner effluent. The effluent gas from the recombiner would then be cooled in a downstream aftercooler and directed to the cryogenic

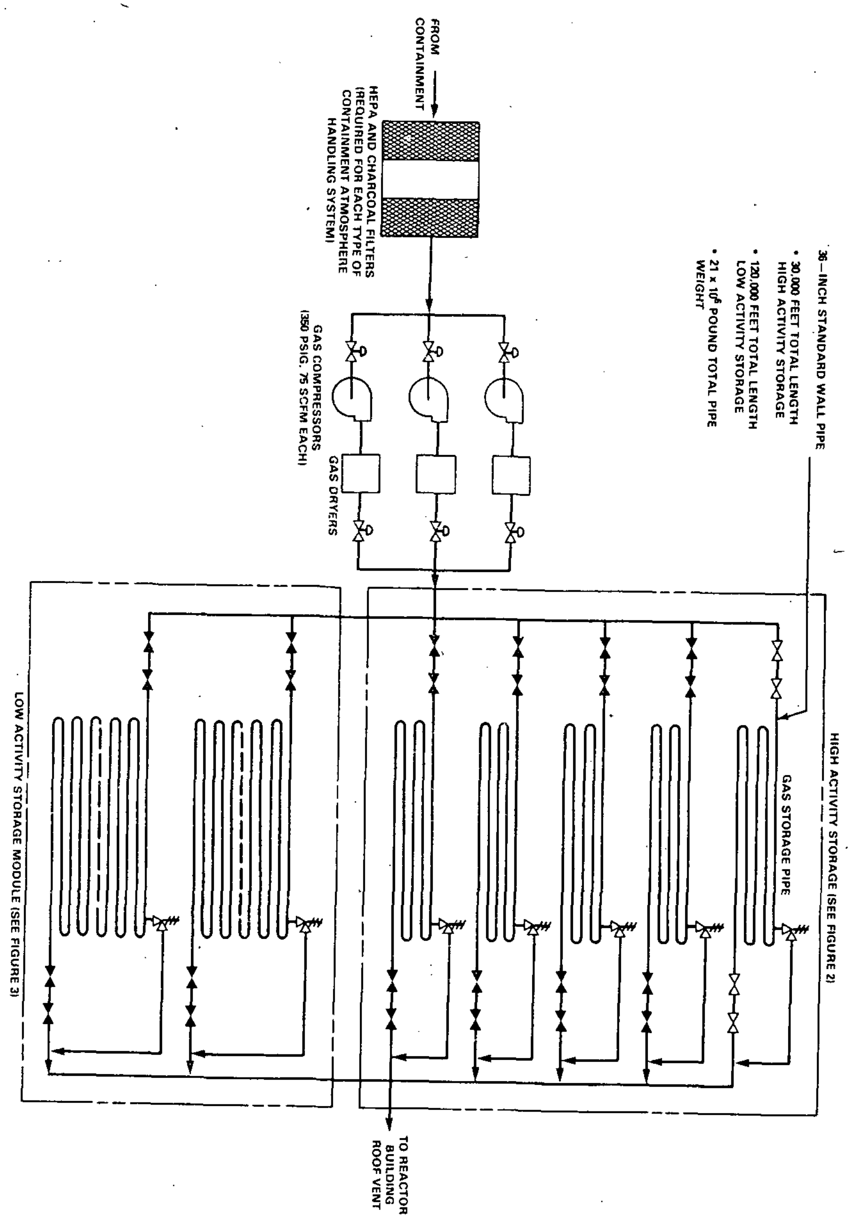

Figure 6.5-1 Flow Diagram of Gas Compression System

treatment subsystem (CTS). The major components of the CTS consist of two feed compressors, a gas preheater, a trace recombiner, an aftercooler, a separator, three prepurifiers, a cooldown heat exchanger, a removal column, a condenser heat exchanger, a phase separator, a decay column, a hydrocarbon conversion unit, and an ambient heater. (A flow diagram of the cryogenic treatment subsystems is shown in Figure 6.6-2.)

The effluent gas from the CPS aftercooler would enter the suction side of the CTS feed compressors. The feed compressors would transport the gas through the preheater, trace recombiner and aftercooler for gas heating, removal of trace quantities of oxygen, and gas cooling, respectively. Moisture would be removed from the cooled gas in a downstream separator. The gas would then enter the prepurifier for removal of carbon dioxide and any remaining moisture. The purified gas would then enter the cooldown heat exchanger to reduce the gas temperature to approximately -29°F. The chilled gas would enter the removal column where the methane and noble gases (essentially Kr-85 and stable krypton, xenon, and argon) would be removed by condensation from counterflowing liquid nitrogen to collect in a pool at the bottom of the removal column. At periodic intervals, the condensed methane and noble gas pool would be vaporized and removed from the column via the CPS product compressor and compressed into storage vessels for onsite storage at ambient temperatures. See Section 6.8 for a discussion of onsite storage. The licensee estimates that it would take from 20 to 30 months to put the system into operation. From consultations with construction engineers at Oak Ridge National Laboratories and in the nuclear industry, the staff estimates that it would take a minimum of 20 months to get any CPS operational.

6.6.3 Occupational Exposure

Of all the alternative systems considered for the decontamination of the reactor building atmosphere, the CPS is the most complex in that it consists of more and varied components than the other systems and is expected to require a greater degree of maintenance during operation. In addition, the system operates at positive pressure (85 psig) so leaks must be considered as an anticipated operational occurrence. If leakage from the system occurred downstream of the CTS removal column, that leakage would contain highly concentrated Kr-85 (that is, at least three orders of magnitude higher than in preceding portions of the system). Therefore, the exposure to workers operating and maintaining the CPS is anticipated to be greater than that of any of the other treatment alternatives. The licensee estimates the exposure to workers due to processing, maintenance, and required surveillance activities during long-term onsite storage of the Kr-85, would be approximately 570 person-rems. Most (approximately 90%) of this estimated exposure would occur because of surveillance activities (inservice inspection of components, maintenance, and sampling) associated with the long-term storage of Kr-85. The staff, however, does not agree with the licensee's estimates of the frequency and dose rates that could be encountered during surveillance activities nor with licensee estimates that exposure to workers would be in the range of 137 to 255 person-rems. The staff's lower estimate is based on the emphasis that would be placed on maintaining inplant exposure ALARA and on the assumption that workers would spend less time in high-dose-rate areas than the licensee has estimated. The licensee agrees that extra steps could be taken during design, engineering, and construction stages to reduce worker exposure; however, they state that such changes would significantly extend the 20- to 30-month period estimated for implementation of the CPS. The NRC staff believes that if ALARA concepts are implemented in the initial engineering and design efforts for the facility, the schedule would not be significantly extended.

6.6.4 Environmental Impact

The CPS, designed for a removal efficiency of 99.9% is not, therefore, a "zero-release" system. During the estimated 2-1/2 months that would be required to process the reactor-building atmospshere, approximately 60 curies of Kr-85 would be discharged in the purified gas effluent from the system. In addition to this, an unspecified amount of Kr-85 would be discharged to the environment due to anticipated leakage from the system. The staff believes that the CPS can be designed to minimize the environmental impact of uncontrolled leakage by

judicious monitoring and rapid system isolation upon indication of an upset condition. In any event, the staff estimates that the environmental impact during normal operation of the CPS would be insignificant (i.e., less than 0.01 millrems beta skin dose and 0.0002 millirems total-body gamma dose, assuming a X/Q of 5×10^{-5} sec/m^3).

6.6.5 Accident Analysis

The CPS was analyzed for the hypothetical worst-case failure of the Kr-85 storage system. This failure assumes the rupture of all gas storage vessels and a corresponding breach of the secondary storage containment structure. Under these circumstances, the entire Kr-85 inventory of approximately 57,000 curies is assumed to be released to the environment over a two-hour period. Based on annual average meteorological conditions, the calculated total-body gamma radiation exposure to a person at the site boundary would be 20 millirems, with a corresponding beta skin dose of 1700 millirems, assuming a X/Q of 6.8×10^{-4} sec/m^3. This calculated total-body dose is a small fraction of the limits set forth in 10CFR Part 100 (Ref. 15). There are no skin dose limits in 10 CFR Part 100.

6.6.6 Air Products and Chemicals, Inc., and MITRE Corp. Systems

The CPS discussed in the preceding section was chosen as a typical cryogenic system that is currently available. This system is designed by Linde Division of the Union Carbide Corporation. Another currently available CPS, which operates by essentially the same principle, is designed by Air Products and Chemicals, Inc. This system also uses the basic two-step process, which consists of hydrogen and oxygen recombination, and then removal and concentration of the radioactive gas by cryogenic distillation.

Yet another CPS was described by the MITRE Corporation. This system proposal, while using the same cryogenic techniques, would include a closed recycle to the reactor building. The proposal states that the system would also employ several other unique features including a normal krypton makeup feed, and a process combination of air separation plant, krypton distillation column, and molecular sieve filter bed to remove the Kr-85. The proposed project schedule totals 11 months, which would allow nine months for procurement, fabrication modifications, and installation, and two months for the startup, debugging, system optimization, and removal of the Kr-85. However, the schedule does not consider the need for a new building to house the system. The NRC staff, based on the discussion in Section 6.6.2, believes this schedule to be an unrealistically short estimate.

Summary

The cryogenic system evaluated here is essentially the same as the other currently available CPS. A difference noted is the addition of a hydrogen supply to the recombiner in the Linde system to further avoid oxygen accumulation. The MITRE system, which includes an air-separation technique and a recycle to the reactor building, would require additional fabrication, and more importantly, may require proof-testing before finalization of a system design.

The primary advantage of each CPS proposed is that the offsite environmental impacts either from operation of the system or from worst case accident scenarios are insignificant. Selection of any CPS as the best alternative is not without its disadvantages, however. First, design, construction, housing, and testing the CPS would result in significant delays in the TMI cleanup effort. From NRC staff consultations with construction engineers at Oak Ridge National Laboratory and in the nuclear industry, we estimate that it would take a minimum of 20 months to get any CPS operational. Second, based on prior experience, operation and maintenance of each CPS would be likely to produce a relatively high occupational exposure. Finally, the onsite storage of concentrated quantities of Kr-85 generated by each alternative would require long-term periodic surveillance and would accordingly represent a continuing risk to workers on the site, as well as to the public.

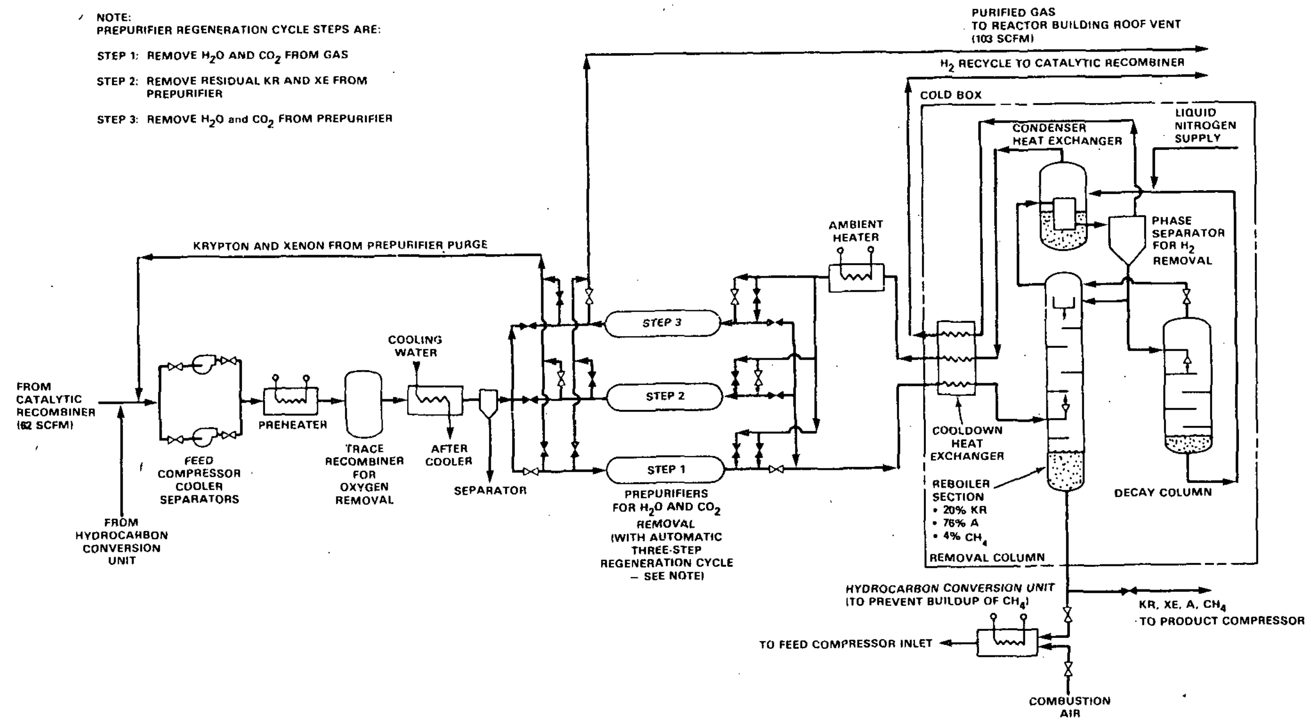

Figure 6.6-2 Flow Diagram of Cryogenic Treatment Subsystem (One of Three)

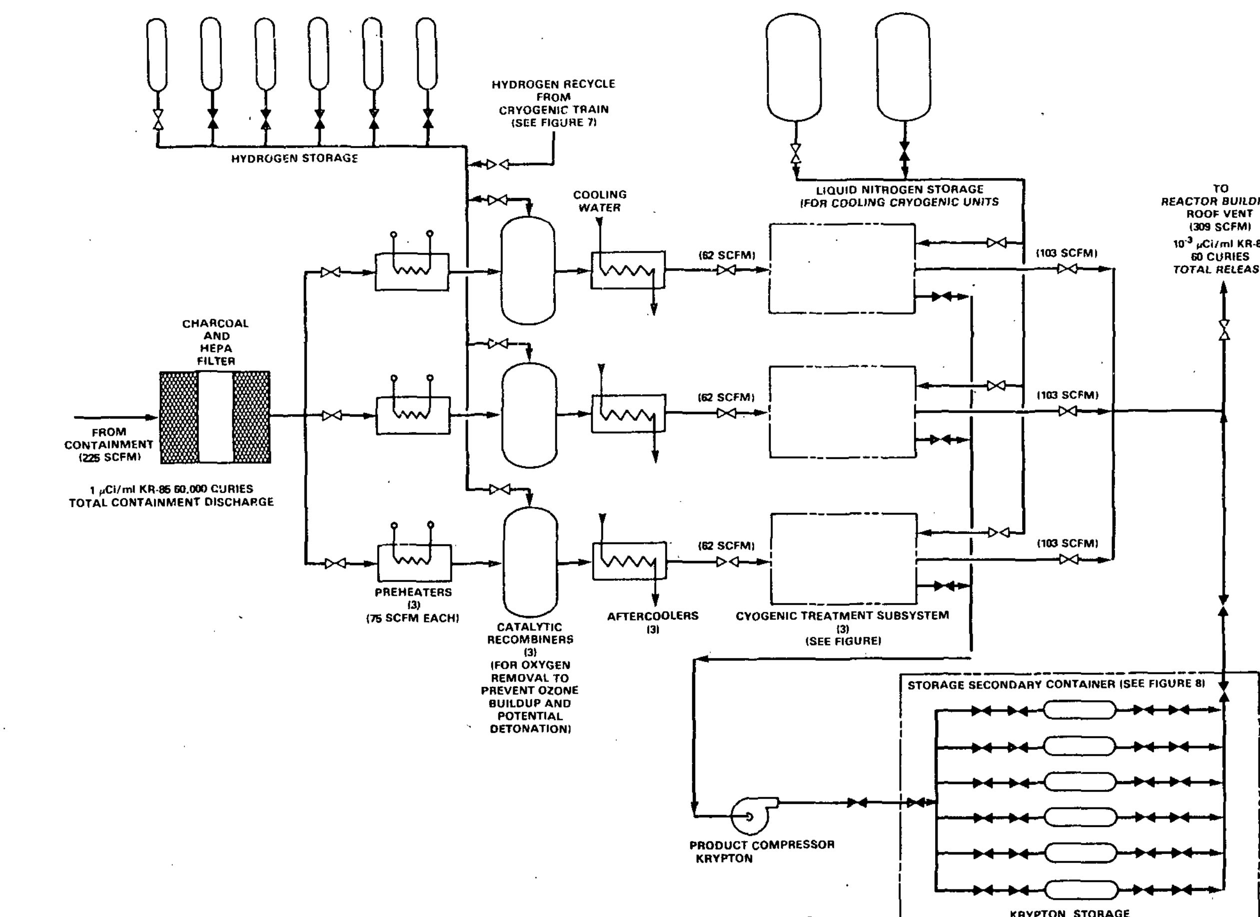

Figure 6.6-1 Flow Diagram of Cryogenic Processing System

6.7 Combination Process and Purge Systems

6.7.1 Introduction

The staff has evaluated the feasibility of combining a krypton-recovery system (charcoal adsorption, gas compression, cryogenic processing, or selective absorption) with one of the building-purge alternatives (hydrogen control or reactor-building purge system). This combination method would be performed in two steps. First, a krypton-recovery system (the primary system) would process and contain approximately 95% of the krypton from the reactor building. Then the remaining krypton (approximately 3,000 curies) would be purged to the environment through either the hydrogen control or reactor-building purge system (the secondary system).

The chief advantage of this alternative is the shortened time period, relative to the alternatives discussed in Sections 6.3-6.6, which would be required to implement it. This advantage results from smaller scale processing system requirements. If a 95% Kr-85 removal efficiency is desired with the primary system, approximately six million cubic feet of contaminated air will have to be processed before purging could proceed. In order to process this volume within approximately two months (comparable to slow purge time) the primary system would require a flow capacity of 75-100 scfm. This, primary system used in combination with purging would require flow or storage capacity (if gas compression is chosen as the primary system) approximately 25-33% of the capacity requirement for full-scale krypton-recovery systems described within this assessment.

The staff has estimated a schedule for making a combination alternative operational. The two primary systems that could be operational in the least time are the cryogenic processing system (CPS) and the selective absorption system (SAS). The staff estimates that the minimum times for a full-scale CPS or SAS to be operational are 20 months and 16 months, respectively. The charcoal-adsorption system and gas-compression systems would require a minimum lead time of 24 months for full-scale system availability and would represent a major construction effort. Even scaled-down, charcoal adsorption (e.g., 3000 tons of refrigerated charcoal) or gas compression (e.g., 7 miles of 35-inch OD pipe storage) systems represent relatively impractical alternatives compared to the CPS and SAS.

6.7.2 System Description

In the NRC staff's estimation, a scaled-down CPS would consist of one 75-scfm processing train (as opposed to three trains in the full-scale system). The remainder of the CPS, including the noble gas storage system, would remain essentially as designed for the full-scale system (see Section 6.4.2). The staff estimates, based on the construction of a small building for a CPS with one processing train, that the lead time for the CPS might be reduced, as compared to full scale, by as much as 4 months. Thus it would still take approximately 16 months to make a small-scale CPS operational and an additional two months to process the first six million cubic feet of contaminated air. At least another month would be required for purging, assuming summer/fall meteorological conditions (see Section 6.2), to reduce the reactor building concentration of Kr-85 to below maximum permissible concentrations of Kr-85 (that is, less than 1×10^{-5} μCi/cc).

The full-scale SAS described in Section 6.3 would require the capability of processing several hundred standard cubic feet per minute of reactor-building air, whereas, the scaled-down SAS would be required to process from 75 to 100 scfm. Thus, the scaled-down system could consist of a single train and feed components (dryer, compressor, cold trap, and molecular sieve) and a lower flow capacity absorption column. The requirements for the noble gas storage system would remain unchanged but the overall building requirements would be smaller than needed for the full-scale system. The staff estimates that the lead time for the small-scale SAS might be reduced by as much as four months. Thus it would still take a minimum of 12 months to get a small-scale SAS operational, followed by several months of system operation and at least one month for subsequent reactor-building purging.

These estimates for anticipated lead times for scaled-down cyrogenic processing and solvent absorption systems are based on the simplest designs and assume little or no redundancy (for increased reliability) in system components. These estimates also assume minimum standards in regulatory requirements (Ref. 22) for building and system quality and seismic classification. Thus the schedules for a combination method do not reflect allowances for regulatory requirements which may be recommended as the result of a detailed staff review of a licensee proposal for such a method.

6.7.3 Occupational Exposure

The occupational exposures that could result from implementation of this alternative range from 115-255 person-rem (depending on the selection of either the SAS or CPS as the primary system) and are discussed in Sections 6.3.3 and 6.6.3.

6.7.4 Environmental Impact

The environmental dose impact associated with this alternative (assuming 5% of the reactor-building atmospheric inventory of Kr-85 is purged) would be approximately 1/95 (0.01) of the impact associated with the slow purge alternative discussed in Section 6.2. This would present negligible public health risk (See Section 7.1.)

6.7.5 Accident Analysis

The accident analyses described in Sections 6.3.5 and 6.6.5 would apply to this alternative. The resulting total-body and beta skin dose to the maximum exposed individual are estimated to be 20 and 1700 mrem, respectively.

Summary

The staff's evaluation shows that the "combined" alternative method can reduce the lead time for system availability by as much as 25%. Nevertheless, the minimum time frame to make this method operational is one year and, for the reasons outlined in Section 5.0, represents an unacceptable delay in the decontamination of the reactor-building atmosphere.

6.8 Onsite Long-Term Storage of Krypton-85

All alternatives proposed for removing the Kr-85 gas, other than by reactor-building purge or disposal offsite (see Section 6.9), require provisions for a long-term storage facility on site (for approximately 100 years to allow for radioactive decay). See Section 6.9 for a detailed discussion of the transportation and offsite disposal of radioactive gases.

The existing technology for storing Kr-85 is limited. Table 6.8-1 provides an assessment of different storage techniques.

Although shallow land burial is a common disposal method at the commercial low-level waste facilities, the NRC staff is opposed to burial of any radioactive waste at Three Mile Island because of the potential for subsequent release to the environment. Thus onsite gas storage in an engineered facility remains as the only practical alternative, even though this type of storage has not been perfected. For example, container corrosion is a major problem that can be caused by collected gas impurities such as oxygen or nitrogen oxide, and water. Also, rubidium, the decay product of Kr-85, may combine with oxygen to form Rb_2O. The long-term corrosion effects of Rb_2O in pressurized storage containers of Kr-85 are not known. Thus further study and staff evaluation would be necessary if a Kr-85 disposal method were chosen that required long-term storage.

6.9 Transportation and Offsite Disposal

6.9.1 Discussion

The implementation of the Cryogenic Processing System alternative, Selective Absorption Process System alternative, or Gas Compression System alternative (using high pressure standard gas cylinders) would result in contained inventories (57,000 Ci) of Kr-85 which would be stored onsite to permit radioactive decay. Based on the half-life of 10.7 years for Kr-85, it would take approximately 100 years for the krypton to decay to insignificant levels. An alternative approach to extended storage of the gas at TMI would be to transfer the gas to DOT and NRC approved containers for transportation and offsite disposal.

The staff has considered several alternatives of disposing of the Kr-85 at an offsite location. The alternatives include transport to a commercial low level waste burial ground (for burial) and transport to a remote location (e.g., a desert) for release to the environment.

6.7.2 Environmental Impact

There are three commercial low-level waste burial grounds currently in operation, located in Barnwell, South Carolina; Beatty, Nevada; and Richland, Washington. However, the State of South Carolina has imposed a ban on shipments of waste from TMI Unit 2, leaving only the two Western sites as potential receipients of gas-filled containers of Kr-85 from TMI. Each site has different criteria for acceptance and burial of radioactive gases in Federally approved containers. The Richland, Washington site is licensed to accept pressurized containers (up to 1.5 atmospheres absolute) of gases containing not more than 100 curies per container. The containers must also be buried individually and located at least 10 feet from neigboring containers. Given the site restrictions for burial of radoactive gases at Richland, the inventory of Kr-85 from TMI would require approximately an acre and a half of burial space.

The site in Beatty, Nevada is licensed to accept gas containers that are pressurized up to one atmosphere (absolute) and limited to 1000 curies or less. Gas containers containing from 100 to 1000 curies must be surrounded by at least 6 inches of concrete on all sides.

It should be noted that transportation of radioactive gases for disposal in commercial shallow land burial sites has not been a common practice in the U.S.

Given the burial site limitations for container pressure and curie content, and the required use of DOT and NRC approved shipping containers, the number of required containers for transporting 57,000 Ci of Kr-85 is potentially high. Under ideal conditions, a minimum of 57 and 570 containers would be required for acceptance at Beatty and Richland, respectively.

The environmental impact resulting from the burial of 57,000 Ci of Kr-85 would essentially be the population exposure incurred by the workers who would be required to package the gas at TMI, handle the gas shipping containers, transport the gas to a low level waste burial site and handle the gas containers at the burial site. The packaging and transportation of the Kr-85 gas would be conducted in accordance with appropriate DOT and NRC regulations. The estimated exposure resulting from these operations would range from 8 to 24 person-rems. The corresponding population exposure to members of the general public is negligible by comparison because of limited contact of the waste containers to the general public during transportation. In addition, the staff assumed that the population dose due to subsequent release (from corrosion of the containers in the ground) of the total inventory of Kr-85 gas is also negligible. The assumption is based on the minimal environmental dose impact of a release of 57,000 curies of Kr-85 (see Section 6.2) and low population density in the vicinity of the burial site.

Table 6.8-1. Comparison of Krypton-85 Containment Techniques*

Technique	Development status	Advantages	Disadvantages
Low-pressure tanks	Feasibility studies performed; no field tests	Low pressures with low peak probability	Very large storage volume; ozone removal required; radiolytic product corrosion unknown
High-pressure cylinders	Used for shipment at ICPP; no long-term tests	Low-storage volumes; long technical background	Long-term corrosion unknown; high pressures increase probability of massive release; secondary containment required
Adsorption on charcoal	Development data completed; short-term operation	Reduces vapor pressures of containers	Large storage volume; fire and explosion hazard
Encapsulation (include solid matrix entrapment e.g., clathrates)	Laboratory studies only partly completed primary containment	Reduces vapor pressures of containers; provides process technically difficult	Effects of radiation, temperature, and corrosion need extensive study;
Engineered storage facility	Cost and feasibility studies continuing; no field experience	Protection from environment, earthquakes, and gas leaks; secondary containment and recovery of leaked gases	Delay in TMI cleanup

*Adapted from T. R. Pinchbacks, "Materials Screening Test for the Krypton-85 Storage Development Program, "EG and G, CR EY-76-c-07-1570, January 19, 1979.

The alternative to offsite burial is transportation to a remote location for controlled release to the environment. This alternative presupposes that a suitable facility would be constructed to effect a controlled release at the remote site. This alternative also assumes that there will be a negligible population dose to the public following release for the reasons elaborated above. Because the same basic operations (i.e., packaging, handling at TMI, transportation to a remote location, and handling at the remote site) and limitations (i.e., DOT and NRC packaging and transportation regulations) on this alternative apply to the operations for the burial alternative, the expected population dose is the same, namely, 8 to 24 person-rem. Although burial or release of the radioactive krypton of a remote site could be accomplished, the NRC staff believes this probably would not be acceptable to local officials and residents.

6.9.2 Summary

The environmental dose impacts resulting from the operations associated with transportation and offsite disposal would be in addition to the exposures incurred during the decontamination (i.e., during process operation) of the reactor building atmosphere but would not include the exposure incurred for the surveillance required during extended storage.

Although the environmental dose impact resulting from transportation and offsite disposal of the packaged Kr-85 is negligible, the NRC staff does not recommend this course of action for the following reasons. This course would presuppose the selection of a reactor building atmosphere decontamination alternative which would result in a delay of the entire TMI cleanup effort. Purging, as a method of decontamination, could be accomplished quickly with negligible public health consequences (see Section 7.0).

7. Health Effects

7.1 Physical

7.1.1 Summary and Conclusions

The NRC staff has determined that there would be negligible physical public health risks associated with the use of any alternative evaluated in this assessment, except the "no action" alternative. For the staff's proposed purging alternative in particular, this determination has been supported by others, including the U.S. Environmental Protection Agency, the U.S. Department of Health, Education, and Welfare and two groups of independent scientists reporting to the Governor of Pennsylvania. The Union of Concerned Scientists reported that, based on "current evidence of effects of whole body radiation on human populations, ...no health effects would be anticipated as a result of the 'ground release' venting" (Ref. 3). The National Council on Radiation Protection and Measurements (NCRP) in their report to the Governor, noted that "exposures likely to be received as a result of venting are no valid bases for concern with respect to health effects" (Ref. 23). In the NRC staff's judgment, there is, then, no physical public health basis for eliminating the purge alternative. Additionally it should be noted that, based on the relatively greater radiosensitivity of humans, there would be no adverse impact on plants or animals following purging.

7.1.2 Discussion

The NRC dose model for Kr-85 and other noble gases released at the time of the accident is based on present day state-of-the-art dosimetric models. Noble gases have no significant food pathway involvement or modes of exposure other than from immersion in a cloud of the gas. The NRC Kr-85 dose model is in good agreement with estimates provided by other groups. The National Council on Radiation Protection and Measurements provides a consensus of the risks of Kr-85 exposure in Krypton-85 in the Atmosphere--Accumulation, Biological Significance, and Control Technology (hereafter NCRP Report 44) (Ref. 24). Much of the basic information about Kr-85 in this section is derived from NCRP Report 44.

Krypton-85 is a radioactive isotope produced by the fission of several heavy isotopes, such as uranium-235, uranium-238, and plutonium-239. Most of the Kr-85 in the TMI-2 reactor building resulted from the fission of uranium-235 prior to the accident. Krypton is one element in the series of noble gases that include, in order of increasing atomic mass, helium, neon, argon, krypton, xenon, and radon. These gases are colorless, tasteless, and do not undergo chemical reactions with other molecules in living tissue. Krypton-85 has a 10.7-year radiological half-life and emits beta particles by two different decays. Beta emission is not followed by emission of a gamma ray for 99.6% of this decay process.

People are continuously exposed to Kr-85 which is normally contained in the world's atmosphere. In the past krypton has been released into the atmosphere during nuclear weapons tests. In addition, krypton has and continues to be released to the atmosphere from nuclear fuel reprocessing plants throughout the world. As a result of these releases, background levels of krypton throughout the earth's atmosphere are readily detectable with suitable instruments. In the TMI area, for example, the U.S. Environmental Protection Agency has measured normal background concentrations to be about 30 pCi/m^3. This concentration results in annual Kr-85 background skin and total-body doses of about 0.00004 and 0.0000005 mrem respectively to all members of the public. This compares to an average annual total-body background dose (from sources other than medical) of about 100 mrem in the U.S. Medical and dental exposures normally account for another 100 mrem per year to individuals in this country.

Krypton-85 has low blood solubility and high lipid (fat) solubility, but diffuses rapidly in tissue to reach concentrations proportional to those in the surrounding air, a condition referred to as an equilibrium concentration. NCRP estimates that the equilibrium concentration of Kr-85 in body tissues (pCi/g) relative to the surrounding air (pCi/cm³) is as follows: (1) separable fatty tissue, such as breasts, thighs, waistlines and around some body organs-41% of the concentration in air, (2) skeleton-13% of the concentration in air, (3) soft tissues (such as organs, muscles, brain, etc.), -8.3% of the concentration in air. Considering the dose from beta particles and gamma rays (plus their resulting radiations, such as bremstrahlung*) both from around and inside a person, the skin is the organ that receives the highest numerical dose, followed by lung and bone tissue. However, as noted in NCRP Report 44, the skin is one of the least susceptible tissues to radiogenic cancer. Furthermore, while any cancer is potentially fatal, most skin cancers lend themselves to successful treatment.

The 1979 draft report of the Committee on the Biological Effects of Ionizing Radiation (National Academy of Science) provides a tentative estimate of risk of radiogenic skin cancer (Ref. 25). That model would indicate that the risk of inducing a fatal radiogenic skin cancer is less than 1% of the risk of death from other cancers resulting from total-body irradiation (per unit of dose). As a result, the NRC staff concludes that the total-body dose is critical for determination of cancer mortality risk for estimating genetic risk for both sexes. This will be discussed in more detail later in this section.

The NRC health effects model was developed in 1975 for the Reactor Safety Study by a 13-member advisory group, (three of whose members were also members of the 1972 National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR) (Ref. 26). The advisory group included six physicians, one veterinarian, and six life scientists. Two members were from the University of Pittsburgh School of Public Health.

The NRC health effects model is shown in Figure 7.1 in graphic form. This model, which uses observed estimates from the 1972 NAS/BEIR Report (Ref. 27), assumes that, following a radiation dose, there is a latent period during which no cancers occur. The latent period is variable, and is assumed to be dependent only on the specific type of cancer.** Following the latent period there will a period in which cancers will be observed (plateau).

Using the total-body dose estimates for the alternatives shown in Table 1.1 and the NRC cancer mortality risk estimate of 135 deaths per million person-rem, the potential cancer deaths were calculated. The total potential cancer mortality to both the 50-mile population surrounding TMI-2 and to plant workers is estimated to range from a minimum of 0.0003 (purge option) to a maximum of 0.034 (cryogenic option).*** Almost all of that risk would be borne by workers exposed at the plant (purge = 0.0002, cryogenic = 0.034). The cancer mortality risk among the general population within 50 miles resulting from the purge option would be about 0.0001.

The maximum potential lifetime-individual risk of cancer mortality would accrue to a fetus that received the maximum estimated dose of 0.2 mrem. Using 300 deaths per million person-rems from Table 7.1, the excess cancer-mortality risk for this scenario would be six chances in 100,000,000 (0.00000006) compared to a current normal lifetime expectancy of one chance in five (0.2) from all types of cancers. Risks for all other age groups would be even lower than this extremely small value.

Using the total body dose estimates for the options shown in Table 1.1, and the NRC genetic effect risk estimate of 260 cases per million person-rem the potential genetic effects per generation were calculated. The total

*A type of X-ray.

**Animal studies indicate that the latent period generally increases with decreasing dose.

***EPA, in an April 11, 1980 letter to NRC, (Ref. 28) independently estimated 0.00022 and 0.057, respectively. These values represent close agreement with NRC estimates.

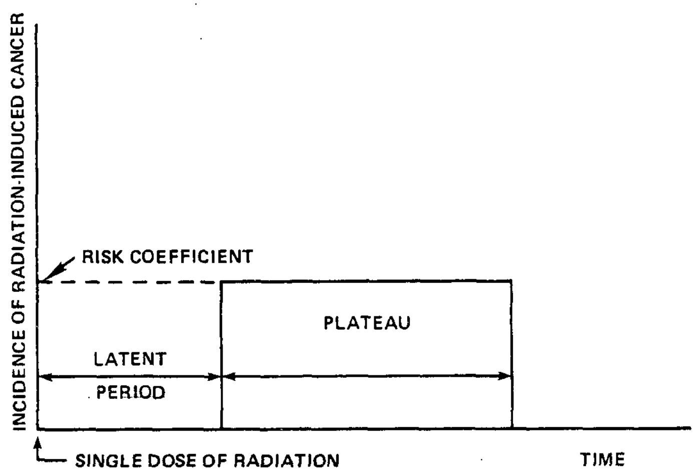

Figure 7.1 Basic Model for Latent Cancer Fatalities

potential for genetic effects in plant workers and the 50-mile population surrounding TMI-2 is estimated to range from a minimum of 0.0005 (purge option) to a maximum of 0.066 (cryogenic option). Almost all the risk would be borne by future descendants of workers at the plant (purge = 0.0003, cryogenic = 0.066). The maximum genetic risk to future descendants of any offsite member of the public would be five chances in 100,000,000 (0.00000005) compared to the current expectation of a normally occurring genetic effect at a rate between one and five chances in 100 (.01 to .05).

Recent cancer statistics indicate that more than 14 persons per 10,000 persons will contract skin cancer each year (calculated from Ref. 29). Thus, the typical risk of occurrence per lifetime is about 11%. Most of these cancers occur on the face, neck, arms, and hands due to exposure to the ultraviolet (UV) rays from the sun.

Since most skin cancers are not fatal, most are unreported in cancer registries. Estimates indicate more than 300,000 new cases of skin cancer occurred in the U.S. (population of 220 million) in 1979 (Ref. 29). However, of those cases reported, there were 5,900 deaths. Of those that died, 4,300 (out of 13,600 cases) were from melanomas,* and 1,600 (out of more than 300,000) were from other types of skin cancer. Therefore, the mortality rates were about 30% for melanomas and less than 0.5% for non-melanomas. The overall lifetime mortality risk of all types of skin cancer is currently less than 2 chances per 1,000 persons (that is, about 1.5% of the total risk of cancer mortality).

The 1979 draft BEIR report indicates on the order of one case of skin cancer will develop per year per million person-rem of low LET radiation (such as emitted by Kr-85) (Ref. 25). Although no studies have indicated a definite increase in melanomas as a result of radiation exposure, it was assumed for this assessment that the lifetime risk of mortality (not incidence) from radiogenic skin cancers is the same as for naturally occurring spontaneous skin cancers. That assumption implies that the lifetime mortality risk is on the order of one death per million person-rem (skin).

Based on this assumption, the lifetime cancer mortality risk from a total body dose is at least 135 times greater than a comparable skin dose.** The beta dose to the exposed skin from Kr-85 is about 80 times greater than the total body gamma dose for unprotected members of the public. This implies that the cancer mortality risk from Kr-85 skin doses to the public would be on the order of 60% of the cancer mortality risk from the Kr-85 total body dose.

Therefore a skin dose of 11 mrem to an individual (purge option) would be predicted to cause less than one (about 0.000006) additional skin cancer mortality among the 50-mile population of 2.2 million people. This compares with 4,000 expected deaths from skin cancer from other causes (primarily sunlight), and over 400,000 total expected cancer deaths in the area regardless of whether the Kr-85 is released or not.

Using the estimates of average life-shortening in Table 7.1, and the dose estimates in Table 1.1, it is possible to estimate the average loss-of-life expectancy associated with latent cancer mortality. The maximum life-shortening would result from irradiation of a fetus in the mother's womb. Using 7.2 days per rem, the maximum dose of 0.2 mrem would result in a statistically average risk of 2.1 minutes. Risks to all other age groups would be even less.

*Melanomas are a rare but dangerous skin cancer.

$$**\frac{135 \text{ cancer deaths}/10^6 \text{ person-rem (total body)}}{\leq 1 \text{ cancer deaths}/10^6 \text{ person-rem (skin)}} \leq 135$$

Table 7.1 Summary of Age Specific Cancer Mortality Risk Estimators and Associated Life-Shortening

Age Group	Potential Cancer Mortality per 10^6 Person-Rem*		Average Life-Shortening per Person-Rem*	
		Totals	Hours	Total Days
In-Utero	150 Leukemias 150 All others	300	87 87	7.2
0-0.99 years	50 Leukemias 43 All others	93	25 11	1.5
1-10 years	50 Leukemias 55 All others	105	24 12	1.5
11-20 years	25 Leukemias 171 All others	196	10 40	2.0
20-70 years	23 Leukemias 108 All others	131	5 10	0.63
All ages	28 Leukemias 107 All others	135	10 18	1.2

*For a population composed only of that age group.

A summary of other common competing risks of mortality comparable to the maximum total-body dose (purge option) is shown in Table 7.2.

Table 7.2. Summary of Lifetime Risks of Mortality Numerically Equivalent to 0.2 mrem

Type of Activity	Equivalent Mortality Risk*	Causes of Deaths
Cigarette Smoking	Inhaling of few puffs	lung cancer and cardiovascular diseases
Drinking	A few sips of wine	cirrhosis of the liver
Automobile driving	three miles	accidental death
Commercial flying	14 miles	accidental death
Canoeing	20 seconds	drowning
Being a man aged 60	one minute	all causes of death at age 60

*Sir Edward Pochin, "The Acceptance of Risk," (Ref. 30).

The staff has compared the dose conversion factors for the noble gases released during the TMI-2 accident with that for Kr-85. It can be shown that it would require the release of approximately 500 million Curies of Kr-85 under the same exposure conditions that existed during the accident to result in population doses comparable to those received from the 10 million curies of xenon and krypton radioisotopes actually released during the accident. Stated another way, the release of 57,000 Curies of Kr-85 under accident exposure conditions would have resulted in only about 0.01% of the population dose which was estimated to have resulted from the accident.

It should be noted that even the relatively large amounts of noble gases (including Kr-85) released during the accident were determined to present little risk to the public by the *Kemeney Commission* (Ref. 31), *Rogovin* Report (Ref. 32), and NRC staff (Ref. 17).

Comparison with Other Radiological Risks

A summary of other common competing risks of mortality comparable to the maximum total-body dose (purge option) is shown in Table 7.3.

Table 7.3. Summary of Latent Radiogenic Cancer Risks Comparable to 0.2 mrem

Type of Exposure	Equivalent Radiological Risk	Source of Dose
Commercial Subsonic jet travel	29 minute flight at 30,000 ft.	cosmic rays (Ref. 33)
Commercial supersonic jet travel	18 minute flight at 60,000 ft.	cosmic rays (Ref. 33)
Living in Denver, Colorado (as opposed to Middletown)	one day	cosmic ray and terrestrial radiation (Ref. 34)
Moving to a location about 20' higher in elevation than Middletown (same type of home)	one year	cosmic rays (Ref. 34)
Sleeping with another person	about eight months at eight hours/day	naturally occurring K-40 gamma rays (Ref. 35)
Living at the site boundary of a coal-fired plant	about two weeks	natural radioactivity emitted by coal combustion (Ref. 36)
Living in a tight, energy-efficient house	about one night	increased levels of Rn-222*

Assumes (a) one extra 0.001 μCi of Rn-222 per m^3 of room air (actual measurements have shown up to 0.03 μCi of Rn-222/m^3)* and 50% equilibrium for radon progeny, (b) 2×4^{-4} lung-cancer deaths per working-level month (WLM), and (b) being at home 100 hours per week (or approximately 15 hours per day). Therefore,

$$\left(\frac{2 \times 20^{-4}\ \text{lung cancer deaths}}{\text{WLM}}\right) \times \left(\frac{0.005\ \text{WL @ 50 percent equil}}{0.001\ \mu\text{Ci/m}^3}\right) \times \left(\frac{100\ \text{hrs/wk}}{40\ \text{hrs/wk}}\right)^{**} \times$$

$$\left(\frac{12\ \text{months}}{\text{yr}}\right) = \frac{30\ \text{deaths}}{\text{million people}}$$

or: 3 chances in 100,000

compare with (0.0002 rem) x (1.35×10^{-4} cancer deaths/(rem)

= 3 chances in 100,000,000

i.e., about 1,000 times greater risk for an energy efficient house

$$\sim \left(\frac{365\ \text{days}}{1000}\right) \times \left(\frac{24\ \text{hrs}}{\text{day}}\right) \sim 8.8\ \text{hrs (a good night's sleep)}$$

*Hallowel, et al., invited paper, 1979 Meeting of the American Nuclear Society, San Francisco, CA.

**Correction for differences in exposure periods at home compared with uranium miners.

Based on the cancer statistics just discussed, about 11 out of every 100 persons will develop a skin cancer during their lifetimes (Ref. 24). It is assumed that most of the current risk is due to exposure of the skin to ultraviolet rays from the sun. Since the current risk of skin melanomas among black persons is only about 18% that of white persons, it was assumed the difference is largely due to greater protection of the germinal layer of skin from UV by melanin pigments in the epidermis of black people. If it is conservatively assumed that the difference is due only to UV irradiation, then about 80% of all skin cancers in the U.S. would be due to exposure to the sun (i.e., about 9 cases per hundred persons).

Comparing these figures with the 1979 draft BEIR estimate of about one case per year per million person-rem (Ref. 25) indicates that background radiation accounts for less than 1% of the expected skin cancers.* This is further evidence that the skin is relatively insensitive to ionizing radiation.

Some people (for example, farmers, commercial fisherman) spend as much as a third of their lives exposed to the direct rays of the sun (primarily head, neck, arms, and hands). Others (e.g., miners, office workers, etc.) may spend less than one-tenth of each adult work day in the sun. It was assumed here that the average person spends about 3 hours per day (including weekends, childhood and retirement years) in the sun. The average risk of UV induced skin cancer is therefore:

$$\frac{0.09\ \text{skin cancers}}{(3\ \text{hrs/day})(365\ \text{days/yr})(75\ \text{yrs/person})},\ \text{or}\ 1.1 \times 10^{-6}\ \text{skin cancers/hour of sun.}$$

Using the 1979 draft BEIR estimate of 10^{-6} cases of radiogenic skin cancer per year per person-rem yields on estimated equivalence of 0.045 hours of exposure to sunlight and one millirem of skin dose (Ref. 25).**

Using the maximum individual skin dose estimated by NRC (11 mrem), the added average risk of skin cancer would be equivalent to spending 30 minutes in the sun. The average individual in the population would have an added risk of skin cancer equal to about a half-second of exposure to the sun's rays.

*Expected: 0.11 x 2.2×10^8 = 24 million cases of skin cancer. From 0.1 rem/yr of background radiation:

$$\left(\frac{\sim 75\ \text{years}}{\text{lifetime}}\right) \left(\frac{0.1\ \text{rem}}{\text{year}}\right) (2.2 \times 10^8\ \text{persons}) (\sim 50\ \text{years at risk}) \left(\frac{1 \times 10^6\ \text{skin/cancers/yr}}{\text{person-rem}}\right)$$

$$= 8 \times 10^4\ \text{skin cancers or,}\ \frac{8 \times 10^4 \times 100\%}{2 \times 10^7} \leq 0.4\%\ \text{of total expected}$$

$$^{**}\left(\frac{1 \times 10^{-6}\ \text{skin cancers/yr per person-rem}}{1.1 \times 10^{-6}\ \text{skin cancers/hour of sun}}\right) (50\ \text{years at risk}) = \frac{45\ \text{hours}}{\text{person-rem}}$$

7.2 Psychological Stress

7.2.1 Conclusion

The staff concludes that the psychological stress resulting from atmospheric purging will be less severe than from any of the other decontamination alternatives. Purging the reactor building is the quickest of the decontamination alternatives and will, therefore, result in stress of shorter duration relative to the other alternatives. Such alternatives would use considerably more complex equipment and processes and would thereby prolong the uncertainties and associated stress over the possibility of accidental releases. In addition, removing Kr-85 from the reactor building may be perceived as a crucial first step in progress toward overall decontamination of TMI-2 and elimination of the potential for future disruption from that unit.

The staff acknowledges that the purging recommendation may be unpopular to a segment of the local population and perceived as further evidence of NRC insensitivity to their apprehensions. Nonetheless, the staff believes that, given the absence of radiological risk from the purging option, in the long run, prompt decontamination of the reactor building atmosphere will substantially alleviate psychological stress due to a concern over unplanned radiological releases from the facility and doubts about the ability and decisiveness of the NRC to take affirmative measures.

7.2.2 Discussion

A number of studies reported psychological distress as widespread in the population around Three Mile Island at the time of the accident (Refs. 31, 37-39). Moreover, some level of psychological distress continues to be associated with various issues surrounding the current and future status of the facility (Refs. 38, 39). In particular, anxiety is high among some members of the population at the prospect of krypton-85 releases to the environment from the Unit 2 reactor building (Ref. 31). Recognizing this fact, the staff has explored the possible different levels and characteristics of psychological stress associated with each of the decontamination alternatives. In reaching conclusions on the relative psychological impacts among the alternatives, the staff considered several sources, including studies of psychological stress and psychological sequedea (of after effect) of disasters. Of particular relevance were studies, by experts on psychological stress (Refs. 31, 37-41), that specifically addressed conditions in the Three Mile Island area and an evaluation of public comments. The Human Design Group, assisted the staff's evaluation. The Human Design Group's principal members are affiliated with the Department of Medical Psychology, Uniformed Service University of the Health Services. Based on consultations with psychologists the staff concludes that the purging alternative has less potential for creating long-term psychological stress than those alternatives which take longer to implement.

Psychological stress is a complex set of mental, behavioral and physiological phenomena, a response pattern resulting from a person's appraisal of an event or situation that threatens some kind of danger, harm, or loss. These patterns include increased physical and psychological arousal, and a search for alternatives to cope with or reduce danger or loss. If a perceived threat is not controlled or reduced, a person affected may suffer psychological as well as physical strain and their consequences. Stress may be induced by a wide variety of situations or events. The level of stress is generally associated with a person's perreption of the severity of loss or harm. While most persons have the capacity to recover quite well from acute stress caused by a specific event, a small percentage of a population may experience lasting physical and/or emotional effects from the same event. Such chronic stress, however, is usually related to events which cause stress for long periods. While chronic consequenses of short-term events that cause stress are still an open question, the long and short-term symptoms are similar: emotional tension, cognitive impairment, and somatic complaints.

The conclusions on the psychological stress associated with atmospheric decontamination of the TMI-2 reactor building are, in part, based on three valuable studies that have received wide distribution. They are Dohrenwend's technical report (Ref. 37) for the Kemeny Commission, Houts' study (Ref. 38) for the Pennsylvania

Department of Health, and Flynn's preliminary report (Ref. 39) on the TMI telephone survey of residents around TMI for the NRC. Each of these studies attempts to answer in part the question, "What are the mental health consequences of the accident?" Each examined different indicators of psychological stress, some of which are reports by individuals on their physical or mental well-being. These reports, nevertheless, agree that there was an increase of psychological stress initially following the accident that had diminished by mid-summer, 1979. They felt that this drop indicated that stress linked with the accident was acute or event specific. Houts (Ref. 38) and others (Refs. 37-39), however, find several indicators of stress that remain high even after the accident. The continuing stress seems related to two issues: future decontamination plans for TMI-2, and a distrust of those responsible for these activites. These two interrelated issues represent a new source of stress that continues beyond the accident. The Kemeny Commission suggests that stress was induced and exacerbated by a lack of confidence in those currently in charge of TMI operations. These stresses are seen to be acute. In addition, the Commission[4] proposes that any increase in the incidence of long-term mental or physical health problems caused by the accident will be insignificant. The effects of stresses in the post-accident period are uncertain; however, several researchers (Refs. 40, 41) foresee no long-term stress-related health problems.

As a result of the above review, the staff suggests that current distrust of authority in a percentage of the population will be an important factor in the community's evaluation of any decontamination plan (Refs. 37-39). Such distrust can heighten a person's or a community's perception of potential danger and their feelings of lack of control, as was found in several studies (Refs. 38, 39). These feelings may cause some TMI residents to resist any agency-sponsored action. The level and duration of stress is determined in part by how long the source of the stress is present and by how people perceive their ability to cope with it. Perceived feelings of lack of control found in the TMI community are enhanced by previous conflicting and inconsistent stances made by the major organizations involved during and after the accident (Ref. 31).

In addition to stress related to distrust of authority, there is the issue of duration of stress and related stressors. Some stress will exist in the TMI area as long as decontamination is delayed and agencies are seen by some to lack credibility and are perceived as insensitive to the area's welfare. Acute stress for many residents could be elevated by the purging, but should diminish thereafter. Thus, three sources of stress seem pertinent to TMI-2 decontamination: (1) the duration of reactor building atmosphere decontamination operations; (2) the immediate fears purging arouses; and (3) distrust of authorities responsible for decontamination activities.

8.0 Radiological Environmental Monitoring Program

8.1 Introduction

The radiological environmental monitoring around the TMI site and nearby communities during decontamination of the reactor building atmosphere would be performed by (1) the U.S. Environmental Protection Agency (EPA), (2) The Commonwealth of Pennsylvania, (3) the U.S. Department of Energy, (4) the Nuclear Regulatory Commission, and (5) Metropolitan Edison Company (the licensee). Each program is summarized in the following subparagraphs; a more complete description is given in the EPA report, "Long-Term Environmental Radiation Surveillance Plan for Three Mile Island," March 17, 1980.

8.2 U. S. Environmental Protection Agency (EPA) Radiological Monitoring Program

EPA has been designated by the Executive Office of the President as the lead Federal Agency for conducting a comprehensive long-term environmental radiation surveillance program as a follow up to the accident at TMI-2. EPA has recently incorporated a separate section in their surveillance plan detailing the monitoring program to be implemented should the NRC staff proposal to purge the reactor building atmosphere be approved. EPA operates a network of 18 continuous air-monitoring stations at radial distances ranging from 0.5 mile to 7 miles from TMI. Seven miles was established as the point well beyond that which EPA expects to detect any emissions from TMI-2. Each station includes an air sampler, a gamma rate recorder, and three TLDs. A list of sampling locations is shown in Table 8.1. These stations constitute EPA's baseline, long-term monitoring program. The air sampler units sample at approximately 2 cfm and the samples are collected from each station and analyzed typically three times per week. All samples are analyzed by gamma spectroscopy at EPA's Harrisburg Laboratory using a Ge(Li) detector with a lower limit of detection for cesium-137 or iodine-131 of approximately 25 pCi (0.15 pCi/m3 for a 48-hour sample).

Each monitoring station is equipped with a gamma rate recorder for measuring and recording external exposure. Recorder charts are read on the same schedule used for air sample collection and the charts are removed weekly for review and storage at EPA's laboratory in Las Vegas, Nevada.

Thermoluminescent dosimeters have been placed at each monitoring station and at 0.25 mile intervals along roads immediately parallel to the Susquehanna River near TMI out to a distance of about 2.5 miles from the reactor. TLDs have also been placed on the islands located 0.5 miles to 1.5 miles west of the reactor site (Shelley, Hill, Henry, Kohr and Beech Islands). These dosimeters are read quarterly.

In addition to the above, a weekly compressed gas sample is taken at the Observation Center and sent to EPA Las Vegas for a determination of krypton and xenon.

The EPA's base long-term program discussed above will continue and will be augmented in the following manner if purging of krypton is approved.

A monitoring program consisting of survey meter and ion chamber measurements, collection of compressed air samples for Kr-85 analysis and intensified collection of samples from routine air monitoring stations will be implemented.

A. Mobile Monitoring - survey meter and ion-chamber

A minimum of three mobile radiation monitoring personnel equipped with survey instruments and one low range pressurized ion-chamber will be positioned in the predicted downwind trajectory during purging. Monitoring personnel will be drawn from other Federal agencies as well as from the EPA in order to provide 24 hour coverage. In addition to making radiation measurements throughout the day, personnel will be prepared to collect compressed air samples based on those measurements.

B. Krypton-85 Sampling

Four compressed air sampling units will be positioned at fixed locations for the collection of weekly samples. The units will be placed at Middletown, the Observation Center, Bainbridge and Goldsboro in order to provide representative coverage with emphasis in the predominant wind directions. Sampling will be conducted for one to two weeks prior to purging to provide background data for the TMI area. Samples routinely collected in Nevada will provide an indication of worldwide ambient Kr-85 levels for comparative purposes. In addition three compressed air sampling units will be deployed with the mobile monitors. A minimum of one sample will be collected each day (at the predicted offsite location of maximum plume concentration). Additional samples will be collected, when necessary, based upon survey meter and ion-chamber data. All samples will be analyzed at the EPA laboratory facilities in Harrisburg.

C. Tritium Monitoring

One molecular sieve sampler will be operated at the Observation Center for collection of atmospheric moisture for tritium analysis. Analyses will be performed at the EPA laboratory facility in Harrisburg.

D. Routine Air Monitoring Network

In order to verify that no radionuclides other than Kr-85 are released to the environment during purging, samples from the established network of eighteen operating stations will continue to be collected. Samples in the downwind sector will be collected every day, rather than the three times per week under normal conditions. In addition at least one sample from "control" stations in each quadrant not in the downwind trajectory will be collected and analyzed on a daily basis.

EPA reports all results of their monitoring measurements from their baseline program three times each week to the public and news media. If Krypton purging is approved, EPA will make daily reports to the public and news media starting approximately two weeks before intiation of purging, and continuing until purging is completed.

8.3 Commonwealth of Pennsylvania Radiological Monitoring Program

The Department of Environmental Resources of the Commonwealth of Pennsylvania operates three continuous air sampling stations; one at the Evangelical Press Building in Harrisburg, one at the TMI Observation Building, and one in Goldsboro near the boat dock. Each air sampling station consists of a particulate filter followed by a charcoal cartridge. The filters and cartridges are changed weekly; the particulate air samples are gamma scanned and beta counted for reactor-related radionuclides. The particulate air samples are composited quarterly and analyzed for Sr-89 and Sr-90. The charcoal samples are gamma scanned for reactor-related radionuclides. They do not, however, have the capability to sample or analyze for Kr-85.

8.4 U.S. Department of Energy

8.4.1 Community Monitoring Program

The Department of Energy and Commonwealth of Pennslyvania are sponsoring a Community Radiation Monitoring Program. This program has as its purpose to: (a) provide independent verification of radiation levels in the TMI area by trained local community people, and (b) to increase public understanding of radiation and its effects. The approach to achieve this purpose has involved the selection of individuals by local officials from the following 12 communities within approximately five miles around TMI.

East Manchester Twp.
Londonberry Twp.
York Haven
Lower Swatara Twp.
Conoy Twp.
Goldsboro
Fairview Twp.
Royalton
West Donegal Twp.
Middletown
Newberry Twp.
Elizabethtown

Approximately 50 individuals participated in training classes conducted by members of the Nuclear Engineering Department of the Pennsylvania State University. Approximately 15 training sessions were conducted involving classroom instructions, laboratory training, and actual radiation monitoring in the field. The teams utilized EPA gamma rate recording devices which are currently in place around TMI and will be supplemented by gamma/beta sensitive devices which are being furnished by DOE through EG&E Idaho, Inc. This training was structured to cover the following areas:

1. Classroom instruction

   - Introduction to radioactivity
   - Interaction of radiation with matter
   - Methods of radiation detection
   - Radiation counting variables
   - Radiation protection units
   - Health physics procedures
   - Radiation interaction with biological systems
   - Administrative procedures for Community Radiation Monitoring Program
   - TMI-2 accident and cleanup
   - Meteorological conditions

2. Laboratory instruction

   - G. M. (Geiger Mueller) counting experiments
   - Radiation counting statistics
   - Monitoring equipment familiarization

   - Argon-41 and Krypton-85 monitoring
   - Supervised area monitoring with actual procedures and equipment

At the completion of the instruction phase, a final examination was given. This was followed by field monitoring training of approximately one week.

The training sessions provided basic information on radiation, its effects, detection techniques, and included hands-on experience with monitoring equipment in the field. Citizens were expected to demonstrate competence in both the theoretical and practical aspects of the course before actual monitoring efforts begin. Following the completion of training in the third week of April, team representatives in each of the 12 selected areas began data acquisition from the gamma and gamma/beta sensitive instruments on a routine basis. Detailed procedures were developed to consolidate the information being obtained into a central point of contact in the Commonwealth of Pennslyvania for dissemination to the press, local officials, and other interested parties on a routine basis. Maintenance and calibration procedures were also developed and are in place prior to the initiation of routine field monitoring. The Community Monitoring Program was initiated on May 21 and the results of measurements from this program are reported daily to the public.

8.4.2 DOE - Atmospheric Release Advisory Capacity

The Department of Energy will make available during the purging operations its Atmospheric Release Advisory Capacity (ARAC). This ARAC system will provide independent predictions of the dispersion patterns for the krypton release based on local meteorological data and National Weather Service reports. These predictions will use atmospheric dispersion models which have been verified during many years of field experience and tests in Government programs. The predicted dispersion patterns will be provided to the Environmental Protection Agency to serve as a basis for their positioning of ground level monitoring teams. These predictions will also be provided to the utility and the NRC, as an additional means of assuring that the purging operation is being adequately controlled.

8.5 U.S. Nuclear Regulatory Commission Radiological Monitoring Program

The Nuclear Regulatory Commission (NRC) would operate one air sampling station located in the middle of the reactor complex. The air samples would be changed weekly and analyzed by gamma spectrometry. The NRC would place two sets of TLDs at 59 locations as shown in Table 8.2. Both sets would be read on a monthly basis; however, flexibility exists to read one set at more frequent intervals should conditions warrant.

8.6 Licensee's Radiological Environmental Monitoring Program

The licensee normally utilizes 72 radiological environmental monitoring locations to monitor plant releases with two thermoluminescent dosimeters (TLDs) at each location. In addition to these required TLDs, four additional TLDs will be placed in each of these locations during controlled purge; two for periodic readouts (frequency depends upon purge duration and the influence of plume) and the remaining two for assessment of the integrated dose over the entire purge period. In anticipation of certain sectors coming under the influence of the plume for a greater duration of purge period, additional TLDs will be placed in selected areas.

In addition to the TLD monitoring, grab air samples will be obtained by an individual(s) dispatched via two-way communications to the projected plume touchdown area during the controlled purge. The air sampler will be placed and operated such that a grab sample will be obtained over a 15-20 minute period while immersed in the plume. Hourly update of plume direction and touch-down area, utilizing real time monitoring and an assessment program, will be obtained and disseminated to field sampling teams.

Table 8.1
Three Mile Island
EPA Long-Term Surveillance Stations
Air Samplers, Gamma Rate Recorders, TLDS

STATION	AZ	DISTANCE (Miles)	ASSOCIATED TOWN
3	325	3.5	Meade Heights, PA - Harrisburg International Airport
4	360	3.0	*Middletown, PA - Elwoods' Sunoco Station
5	040	2.6	Royaltown, PA - Londonderry Township Building
9	100	3.0	Newville, PA - Brooks Farm (Earl Ninsley Residence)
11	130	2.9	Falmouth, PA - Charles Brooks Residence
13	150	3.0	Falmouth, PA - Dick Libhard Residence
14	145	5.3	*Bainbridge, PA - Bainbridge Fire Company
16	180	7.0	*Manchester, PA - Manchester Fire Dept.
17	180	3.0	*York Haven, PA - York Haven Fire Station
20	205	2.5	Woodside, PA - Zane Resner Residence
21	250	4.0	*Newberrytown, PA - Exxon Kwick Service Station
23	265	2.9	Goldsboro, PA - Muellar Resident
31	270	1.5	*Goldsboro, PA - Dusty Miller Residence
34	305	2.7	Plainfield, PA - Polites Residence
35	068	3.5	Royaltown, PA - George Hershberger Residence
36	095	0.5	TMI Observation Center
37	025	0.7	North Gate, TMI
38	175	0.8	South Gate, TMI

*Sampling stations located in indicated town. Other sampling stations are located near indicated towns.

Table 8.2

DESCRIPTION OF NRC TLD LOCATIONS

E1 - Hwy. 441 on Laurel Road 1st telephone pole on right outside vendor TLD box. 90° 0.45 mi

NE1 - On telephone pole by George Beyer Market, Geyers Church Road off 441. 25° 0.8 mi

NE2 - On telephone pole at intersection of Hillsdale and next road on left from Geyers Church Road (closed road to gold church) by yellowish red house. 19° 1.9 mi

N1 - On chain link fence for power substation, Middletown SE corner. 358° 2.6 mi

NE3 - On telephone pole on Rt. 230 directly across from Shady Lane Motel. 15° 3.05 mi

NE4 - On telephone pole on Rt. 743 just north of Texaco station, just north of Turnpike underpass. 55° 6.5 mi

N2 - On telephone pole on Middletown Road N of Rt. 283, directly across the street from childrens care center.

N3 - On sign pole on Middletown Road at intersection to Rt. 322 E. Signpole says 322 West. 0° 7.0 mi

N4 - On telephone pole on Hoe Road, just N. of intersection of Union Deposit Road. 2nd pole on left. 0° 9.0 mi

N5 - On telephone pole on Rt. 39 at intersection of Rt. 22 (Allentown Rd.) 0° 13 mi

NW5 - Environmental Station (Met Ed) at West Fairview, rear to Annex Building Fairview Fire Department, adjacent to tracks. 305° 15 mi

NW4 - On telephone pole on Meadowbrook just off Bridge Street, one block on N. side from Bridge Street. 300° 8.6 mi

NW3 - On telephone pole on Old York Road. 1st pole over turnpike overpass, west side. 295° 7.4 mi

NW2 - On telephone pole on Marsh Road by Culvert under RR tracks off Old York Road. 300° 5.9 mi

NW1 - On telephone pole directly in front of church at intersection of Rt. 262 E and Rt. 392 W (Valley Road and Yocumtown Road). 305° 2.6 mi

W1 - On "No Parking Any Time" sign within 18' of water at old boat ramp at Goldsboro. 264° 1.25 mi

W2 - On constant monitor inside chain link fence to Monitoring Station, Goldsboro on Rt. 262. By stream. 252° 1.3 mi

SW1 - On telephone pole approximately 25' from tracks in turn around full of flattened beer cans. Across from 2 small trailers (green and blue) in clearing (N end). 200° 2.1 mi

W3 - On telephone pole on Pines Road at intersection of 974 Red Mill Road. near Newberry. 264° 2.9 mi.

W5 - On telephone pole at intersection of Rt. 382 and Rt. 177 NW corner Lewisburg. 259° 7.3 mi.

W4 - On telephone pole on Rt. 392 (Pathshill Road) just beyond Ridge Road on S. side. Beyond sharp bend. 266° 5.9 mi

Table 8.2 (Continued)

SW2 - On telephone pole at intersection of 382 E and 295. Diagonally across from Texaco station, York Haven Road and Reeders Hill Rd. Pleasant Grove. 203° 2.5 mi

S-1 - On telephone pole at intersection of Rt. 181 and 382. Across street from York Haven Office. In front of Catholic church, York Haven. 168° 3.15 mi

S-2 - On telephone pole at intersection of Meeting House Road and N. George Street (Rt. 181 S), Manchester. 175° 5.1 mi

S-3 - On telephone pole on Rt. 238 at intersection to Rt. 181 S. By old brick and cement block building, Emigsville. 180° 9.1 mi

SW3 - On telephone pole at intersection of Lewisberry Road and Butter Road. By small frame house near Anderson town. 210° 8.1 mi

SW4 - On telephone pole at intersection of Butter Road and Bull Road 215° 10.1 mi

S-4 - York substation, sampling enclosure. 180° 12 mi

SE5 - On telephone pole at intersection of 441 N and Vinogary Ferry Road across entrance to Cargill Truck entrance.

SE4 - On pole at intersection of 441 N and 241 N. Pole next to fruit stand. 141° 4.6 mi

SE3 - On chain link fence on right side by Collins Substation sign at intersection of 441 and Falmouth Road. 160° 2.25 mi

SE2 - On telephone pole at intersection of 441 N and Turnpike Road. 162° 1.85 mi

SE1 - On telephone pole across from Red Hill Farm fruit stand 441 N, 1 mile from 3 Mile Island. 150° 1 mi

E2 - On telephone pole at Hillsdale Road and Turnpike Road. 110° 2.7 mi

E3 - On telephone pole at Turnpike Road and Bossler Road. 101° 3.7 mi

E4 - On telephone pole at intersection of W Hight Street and Mosorie Road, Elizabethtown. 90° 7.0 mi

E5 - *Meadow Lane, 1st house on south side of street.* 86° 0.4 mi

N - Rte 441	03°	1.8 mi
NE - Under TMI high tension lines	44°	1.1 mi
ENE - Rte. 230	64°	3.8 mi
SE - Rte. 411	130°	0.5 mi
SSW - Beech Island	203°	0.7 mi
SW - Newberry Township	227°	1.8 mi
NNW - Shelly Island	289°	0.3 mi

Table 8.2 (Continued)

WNW - Town of Plainfield	301°	1.3 mi
NW - Hill Island	316°	1.2 mi
NW - Highspire	326°	5 mi
NNW - Kohr Island	332°	0.5 mi

NRC - TLD SCHOOL LOCATIONS

N1a NORTHUMBERLAND SCHOOL
2.4 mi N

N1b MANSBERGER SCHOOL
2.7 mi NNW

N1c FEASER SCHOOL
3 mi N

N1d CAPITOL CAMPUS, PENN STATE U.
3.5 mi NW

N1e GRANDVIEW SCHOOL
3.5 mi NNW

N1f MIDDLETOWN HIGH SCHOOL
4 mi NNW

NE-3a TOWNSHIP SCHOOL
3.6 mi NE

W-3a NEWBERRY SCHOOL
4.4 mi W

S-1a YORK HAVEN-NEWBURG SCHOOL
3.3 mi S

SE-4a BAINBRIDGE SCHOOL
5.0 mi SE

9.0 Response to Comments

9.1 Introduction

The draft "Environmental Assessment for Decontamination of the Three Mile Island Unit 2 Reactor Building Atmosphere" (NUREG-0662) and two subsequent addenda were issued for public comment. The public comment period for these three documents ended May 16, 1980. At the close of the comment period approximately 800 responses had been received. Comments on the Environmental Assessment were received from various Federal, State, and local agencies and officials; from nongovernmental organizations, and from private individuals. All substantive comments received appear in Volume 2 of this Assessment. The comments received fell into one of three categories: (1) those supporting the purging alternative recommended by the NRC staff (approximately 195 responses), (2) those opposed to the purging alternative (approximately 500 responses), and (3) those who recommended decontamination alternatives other than those discussed in the Environmental Assessment or who otherwise commented on the assessment (approximately 105 responses). The third category also included all other comments on the five alternatives evaluated in the Environmental Assessment, as well as suggestions for additional methods for decontaminating the TMI-2 reactor-building atmosphere. Several of the responses included specific editorial comments. Where appropriate, these comments have been resolved by revision of appropriate sections of this final Environmental Assessment.

9.2 Comments Supporting the Recommended Purging Alternative

The NRC staff received approximately 195 responses supporting the purging alternative recommended in the Environmental Assessment.

9.2.1 President's Council on Environmental Quality (CEQ). CEQ stated that in their view the NRC staff's proposal to separate the decontamination of the reactor building atmosphere from the preparation of the Programmatic Environmental Impact Statement does not violate 40 CFR § 1506.1 (1979) (Limitations on actions during NEPA process) of the Council's regulations implementing the National Environmental Policy Act.

9.2.2 The U.S. Environmental Protection Agency (EPA). EPA stated that the most acceptable method for decontaminating the TMI-2 reactor building atmosphere is a controlled purge to the environment in as short a time as possible, when meteorological conditions most favor dispersion. EPA based its recommendation of this method on the very low environmental and public health impact that would result from the controlled release of the Kr-85 and stated that this method would eliminate the large occupational radiation exposure which could occur from use of the other decontamination alternatives. EPA also stated that their assessments of the offsite doses for the purging alternative were in general agreement with those calculated by the NRC staff and that the estimated health risk of releasing the Kr-85 was 0.0001 excess deaths to the 1,750,000 population within 80 kilometers (50 miles) of Three Mile Island.

9.2.3 U.S. Department of Health, Education and Welfare (HEW)

The HEW Bureau of Radiological Health commented that after reviewing the draft Environmental Assessment and its two addenda, it is their conclusion that the purging of the KR-85 in the TMI-2 reactor building to the atmosphere under controlled release is the prudent and proper course of action which provides minimal, if not zero, health impact. They further noted that although members of the public in the vicinity of TMI may call for alternatives

that do not release the KR-85 to the environment, the occupational workers are also members of the public and the health impact (if any) best relates to the total population dose in person-rem (both occupational and general public). In this regard, they stated that it would be appropriate for the NRC to provide estimates of the total population dose (both offsite and occupational). The NRC staff has included these recommended dose estimates in this Final Environmental Assessment.

9.2.4 The U.S. Department of Energy (DOE).

DOE submitted two responses. The Assistant Secretary for Nuclear Energy stated that his staff had performed an independent review of the matter and had concluded that a controlled purge was indeed the preferred method for decontamination since it would result in less public radiation exposure than accrues from many other power plants, both nuclear and fossil. This response urged the Commission to act promptly on the matter, and in the event of NRC approval, offered the resources of DOE to assist in monitoring off-site conditions during the purging process to help guarantee that conditions remain within acceptable limits. (See Section 8.0). Their support for the purging alternative was reiterated by a DOE representative on April 25, 1980 during a Commission briefing on Selective Absorption Process as an Alternative in Dealing with Krypton in TMI-2 Containment.

The second DOE response, from the Assistant Secretary for Environment, stated that their review had identified several areas where they felt that additional information or clarification would enable a more complete assessment of the potential effects of the removal of krypton gas from the reactor building. The following comments on NUREG-0662 were offered for consideration:

> The accident analysis for each alternative, including the proposed action, should include estimates of the probability of occurrence of the worst case scenarios. This would permit a more complete evaluation of the potential for adverse health and safety impacts.
>
> A more precise estimate of the time necessary to implement the various alternatives should be provided because of the importance of this factor in the overall decision-making process. Estimates should be based on realistic projections of an accelerated construction/testing program for each alternative.
>
> The potential hazards associated with the storage of Kr-85 should be quantified to the extent possible in order to better reflect the seriousness of problems associated with the storage.
>
> A more detailed description of the monitoring program for the proposed action would be helpful. Advanced monitoring to calibrate and verify analytical methods for predicting the incremental dose at the site boundary should be discussed. The ability to promptly and accurately determine off-site concentrations also should be discussed in more detail.
>
> The description of DOE's radiological monitoring program (Section 8.0) does not represent an accurate summary of our current efforts. An updated version of this section is enclosed for your information.
>
> The nature and extent of the controversy surrounding the proposed venting should be presented. The basis for the technical questions being raised by various segments of the public and scientific community along with a critical evaluation of their concerns would provide a more meaningful assessment of the significance of the impacts of the proposal.

The recommendation to include estimates of the probability of occurrence of the worst case scenarios for the various postulated accidents was considered by the NRC staff. Since the health effects resulting from worst case accident scenarios for any of the alternatives are negligible, the probabilities of occurrence are irrelevant. Although these probabilities have not been quantified, they are considered low. As for the proposed actions to be taken in the event of a postulated accident, the NRC staff will require that appropriate emergency and contingency procedures be prepared and approved pursuant to the requirements of the facility Technical Specifications prior to the implementation of any decontamination alternative.

The estimated times to implement the various decontamination alternatives, including the use of accelerated construction/testing programs, have been reviewed.

The potential hazards associated with long-term storage of Kr-85 and the NRC staff's reason for recommending against long-term storage of Kr-85 are discussed in Section 6.8.

The description of the monitoring program to be used if the purging alternative is approved, has been revised and updated to reflect the current monitoring program. Section 8.0 contains a detailed discussion of the planned monitoring program, including an updated version of the DOE sponsored portion.

In its preparation of this final Environmental Assessment, the NRC staff has again evaluated, as recommended, the nature and extent of the controversy surrounding its recommendation to decontaminate the TMI-2 reactor building atmosphere by purging to the environment as presented in draft NUREG-0662. An evaluation of the public comments and responses to this proposal is contained in Section 9.0 of this final Environmental Assessment while Section 7.2 contains a discussion of the psychological aspects of the proposal.

9.2.5 Advisory Committee on Reactor Safeguards.

In a joint meeting between the NRC Commissioners and the Advisory Committee on Reactor Safeguards (ACRS) on April 11, 1980, several members of the ACRS recommended that the reactor building atmosphere should be decontaminated soon by controlled purging to the environment. Their reasons for this recommendation were that a controlled purge would permit less restricted access to the reactor building for equipment and instrument maintenance and repair which may be required in the near future, and that the health effects of a controlled purge would be very small.

9.2.6 Governor of Pennsylvania.

The Governor's comments were contained in a letter submitted to Chairman Ahearne after the Governor received an independent assessment of the proposed decontamination effort from the Union of Concerned Scientists (UCS). The Governor had requested this independent assessment and had been granted an extension of the public comment period to permit the completion of this independent assessment. In his letter to Chairman Ahearne, the Governor stated:

> This is to notify you of my views, on behalf of the Commonwealth of Pennsylvania, regarding the proposal now before you to remove radioactive krypton 85 from the Three Mle Island Unit 2 containment building by the process of venting it into the atmosphere.
>
> I have sought and received assessments from the broadest range of knowledgeable sources available regarding potential health effects of that proposal. These sources have included:
>
> *Members of your own staff, and especially Mr. Harold Denton, your director of nuclear reactor regulation.
>
> *The Union of Concerned Scientists (UCS), the nation's foremost critic, I believe, of existing nuclear power safety levels.
>
> *The National Council on Radiation Protection and Measurements (NCRP), an organization of distinguished scientists and physicians which has been instrumental in setting radiation health standards in this country for nearly 20 years.
>
> *Representatives of the electric utility and nuclear industries.
>
> *The U.S. Department of Health, Education, and Welfare.
>
> *The Governor's Commission on Three Mile Island.
>
> *The Pennsylvania Departments of Health and Public Welfare, the latter of which has jurisdiction in the area of mental health in our state.
>
> *The Pennsylvania Department of Environmental Resources (DER), including its Bureau of Radiation Protection.
>
> The assessments of these various groups and institutions are being forwarded to you under separate cover, and I respectfully request that you enter them into your official record on this matter.

> There is, I have found a broad-based consensus among these sources that the venting proposal now before you would have, in the words of the Concerned Scientists, "no direct radiation-induced health effects on the residents of this area." Similarly, the NCRP concludes: "the exposures likely to be received as a result of venting are not a valid basis for concern with respect to health effects."
>
> There is a consensus on the accuracy of the radiation dose rate calculations made by your staff, in conjunction with the utility, and there is a consensus that those dose rates are "insignificant."
>
> I should point out that the Union of Concerned Scientists feels that the psychological stress already experienced by many residents of this area since March 28, 1979 should seriously be considered in any decision you make with regard to the cleanup operation on Three Mile Island, and I agree with that. As you know, I previously instructed attorneys for the Commonwealth to introduce stress as a legitimate factor for you to consider in other decisions growing out of this incident.
>
> I am advised and I believe, however, that the question of stress, as related to the venting plan, is directly linked to the question of its safety, and that the consensus finding that the plan poses no radiation threat to public health should, in itself, substantially reduce any stress that might have accompanied it.
>
> UCS also recommends that you consider two alternative venting plans described in its report, and that you reconsider two non-venting plans previously rejected by your staff. I am sure you will give due consideration to those recommendations. I do urge that any new assessments be completed as promptly as possible. I am advised and believe that the sooner this matter is resolved, the sooner any stress related to it will be dissipated.
>
> I recognize that part of the delay already experienced has been due to my effort to be assured of the safety of venting. I now have that assurance, and I feel that a safe cleanup plan should be implemented as quickly as possible.
>
> Should you proceed with the venting proposal advanced by your staff, be assured that I am prepared to support that decision. To minimize stress, I am prepared to commit all of the resources at my disposal to assure the residents of the area, as I am now persuaded, that this plan is, indeed, a safe one....

In his letter, the Governor noted that the UCS had recommended consideration of two alternative purging plans as well as consideration of the Cryogenic Processing System and the Selective Absorption Process System (Ref. 3). In preparing this final Environmental Assessment, the NRC staff has evaluated the two alternative purging plans suggested by the UCS and has also reconsidered use of the Cryogenic Processing System and the Selective Absorption Process System.

The first of UCS' proposed plans would use a tethered balloon to support a 2000-foot-high reinforced fabric stack, a discussion of which is given in Section 6.2.5. This technique is unique and untried, as stated by UCS.

In general, the staff finds the UCS proposal technically workable and probably capable of being implemented within a year from the time the decision to use it was made. However, the staff has examined Three Mile Island for unobstructed ground and air space to launch a tethered ballon. Adequate unobstructed land recommended for the ballon launch is not readily available on the island without substantial modification to the site.

The second proposal of UCS was that the reactor building atmosphere be heated in an incinerator and discharged through a 250-foot-high stack. The staff evaluated this proposal in Section 6.2.5. Reconsideration of the Cryogenic Processing and Selective Absorption Process Systems are contained in Sections 6.6 and 6.7, respectively. Having evaluated these proposals, the staff continues to believe that the Kr-85 should be purged to the environment through the hydrogen control system.

Finally, the staff and the Commonwealth of Pennsylvania would have to ascertain the psychological impact on the nearby residents regarding the Kr-85 purging techniques proposed by the UCS. This difficult task was recognized by UCS as a valid concern in its report to the Governor.

As enclosures to a subsequent letter, the Governor of Pennsylvania provided copies of the various reports and assessments he had referred to in his previous letters and stated that the joint press release which he had developed with the UCS contained a clarification regarding the first recommendation on page 57 of the UCS report. The subject UCS recommendation stated:

UCS recommends against any procedure that would result in citizens in the area around TMI being deliberately exposed to radiation from the plant at levels comparable to those expected from the Met Ed/NRC venting proposal.

Dr. Henry W. Kendall, UCS chairman, said the organization ultimately decided to recommend against implementation of the existing Met Ed/NRC venting plan, but he emphasized that this was primarily because of the stress problem.

The enclosed report of The Governor's Commission on Three Mile Island stated:

> In light of our review of the alternative risks, this Commission urges the NRC to make a prompt decision concerning the proposed venting of the Unit 2 containment building atmosphere. Avoidance of this decision by the NRC is unacceptable. This Commission would not oppose an NRC decision to vent the krypton gas, provided that dose levels projected in the environmental impact assessment are acceptable. This position is based on a careful review of the best evidence available at this time. (emphasis in original)

An enclosed memorandum to the Governor from the Pennsylvania Department of Environmental Resources stated that they had concluded that controlled purging using the hydrogen control system, as recommended by the NRC staff, was the preferred alternative for removing the krypton from the reactor building atmosphere.

An enclosed letter to the Governor from the Pennsylvania Department of Health recommended that in an effort to minimize stress, both present and accumulative, purging of the krypton from the reactor building be accomplished as soon as possible and in as brief a time period as possible.

An enclosed letter to the Governor from the Pennsylvania Department of Public Welfare stated that making a decision on purging and proceeding in a responsible fashion could in the long run minimize stress and reduce the potential for anxiety and depression among the population that lives near TMI.

9.2.6 State of Maryland.

The State of Maryland responded with two sets of comments. Their first response addressed the staff's recommendation in the basic Environmental Assessment (NUREG-0662), while their second response addressed Addenda 1 and 2 of NUREG-0662. In their first response (March 31, 1980), the State of Maryland agreed with the NRC staff recommendation that purging the reactor building atmosphere to the environment is the best available option. They did, however, recommend that real-time environmental and meteorological monitoring be used for dose-rate monitoring and reduction during purging operations to ensure that the offsite doses are estimated accurately and minimized. They also stated this was the proper time to make a decision regarding the decontamination of the reactor building atmosphere and that this action should be considered apart from the Programatic Environmental Impact Statement being prepared by NRC on all TMI-2 decontamination activities. They note that no benefit would be served by a delay and that, instead, delaying the decision would result in "a substantial loss." In their second response (April 22, 1980), they stated that the fast purge described in Addendum 2 of NUREG-0662 (a five-day purge over a two-week period) does not offer any net psychological advantage and that this option should be rejected in favor of a purge program which would use real-time meteorological data to minimize the highest offsite dose.

9.2.7 Member of the Pennsylvania House of Representatives.

One member of the Pennsylvania House of Representatives submitted as a comment a letter he had sent to all elected officials in his legislative district requesting that they join him in his call to come together and furnish the leadership necessary to accomplish a safe and expeditious cleanup at TMI. He also submitted several responses he had received in support of his call. Another member submitted a letter in which he stated: "Vent it!"

9.2.8 Commissioners of Cumberland County, Pennsylvania.

The Commissioners of Cumberland County, Pennsylvania, submitted a resolution supporting the recommended purging alternative. Their resolution stated that it is in the public interest to provide for the health and welfare of the people of Cumberland County by cleaning up TMI as soon as possible and that "the Government" should exert the necessary leadership to accomplish this action.

9.2.9 Middletown Borough Council, Middletown, Pennsylvania.

The Middletown Borough Council passed a resolution in support of purging the krypton-85 gas into the atmosphere. This resolution stated: "this council supports the venting (of krypton-85 gas in the atmosphere) as recommended by the NRC staff and calls for implementation as quickly as possible."

9.2.10 *Borough of Royalton, Pennsylvania*.

The Borough of Royalton, Pennsylvania submitted a resolution supporting the recommended purging alternative and the cleaning up of TMI as soon as possible. This resolution stated that their support was based on determinations by the NRC and EPA staffs that it is safe and proper to purge the Kr-85.

9.2.11 National Council on Radiation Protection and Measurements (NCRP).

The NCRP, in addition to the UCS, was specifically requested by the Governor of Pennsylvania to review the proposed purging operation. The NCRP submitted a response in which they stated:

> At the request of Governor Thornburgh of Pennsylvania, the National Council on Radiation Protection and Measurements (NCRP) has examined scientific material relating to the health effects of krypton-85, updated its Report No. 44 on krypton-85 published in 1975, and estimated the doses to the public and the risks associated with them for the amounts of krypton-85 expected to be released as a result of the proposed venting at the Three Mile Island nuclear power plant. The findings are that the maximum doses likely to be received by any person are very small.
>
> Superficial beta radiation to the skin is the primary potential health concern; however, in the total population within 50 miles no cases of skin cancer would be expected from the doses likely to be received. The risk to the maximally exposed individual member of the population at the plant boundary is estimated *to be equivalent to the risk of skin cancer resulting from exposure to a few hours of sunlight, which is* known to be the principal cause of skin cancer in the general population.
>
> The dose expected from the penetrating radiation is about 100 times less than that from the superficial radiation and the risk of inducing cancer is correspondingly smaller.
>
> The NCRP concludes that the exposures likely to be received as a result of venting are not a valid basis for concern with respect to health effects.

9.2.12 Natural Resources Defense Council (NRDC).

The NRDC provided a response by phone in which they supported the recommended purging operation by stating:

> Provided that the amount of radioactive materials to be vented are what they are reported to be (for example in NUREG-0662), and provided that the venting procedures are appropriately conducted, then the public health risks (somatic and genetic consequences) associated with venting the TMI-2 containment are not significant, that is, sufficient to warrant exclusion of this option.

9.2.13 Other Comments Supporting Controlled Purging.

In addition to the comments from these government agencies, officials, and scientific organizations, comments supporting the recommended purging alternative were also received from approximately 30 nongovernmental organizations. These included the Pennsylvania Chamber of Commerce, Lebanon Valley Chamber of Commerce, Greater

Harrisburg Area Chamber of Commerce, York Area Chamber of Commerce, Hanover Area Chamber of Commerce, Lancaster Association of Commerce & Industry, Manufacturers' Association of York, Pennsylvania, Greater and Central Pennsylvania Building and Construction Trades Council, Harrisburg-Hershey Area Tourist Promotion Agency, Harrisburg Hospital, American Association of Meat Processors, and various businesses in the TMI area, and approximately 150 private individuals and members of the professional community. Those commenting typically recommended that controlled purging be performed soon to permit continuation of the required cleanup activities.

9.2.14 Science Applications, Inc. (SAI).

At the request of the Commission, the NRC Office of Policy Evaluation (a Commission staff office), contracted with SAI to perform an independent technical evaluation of the purging alternative and Selective Absorption Process (Ref. 43). SAI's conclusions and recommendations were:

> From the points of view of feasibility, effectiveness practicality and the health and safety there is little to choose between the two alternatives.
>
> From the point of view of psychological stress on nearby populations, purging is the best alternative because it can be carried out in the least time with the fewest newsworthy incidents.
>
> From the points of view of schedule and cost, controlled purging is the best alternative because it is cheaper and can be started within days.
>
> Therefore it is our opinion that the SAP should not be adopted as a substitute for controlled purging.

9.3 Comments Opposing the Recommended Purging Alternative

Approximately 500 responses opposing the purging alternative recommended by the NRC staff were received. Included in these comments was a resolution by the County Commissioners of Dauphin County, Pennsylvania, opposing the release of the krypton-85. The reasons stated for their opposition were

> (a) the health of humans, animals and plants nearby cannot be fully guaranteed, (b) the full health implications of low level radiation exposure are not known, (c) health studies on human thyroids and various ailments afflicting animal life have not been completed to determine what effect, if any, previously released low level radiation has already had on humans and animals in the TMI area, (d) other options remain for the removal of the krypton-85 which have not been assessed independently by experts outside the NRC or Metropolitan Edison Company, (e) experience of the last thirty years from radiation exposure to indigenous populations near nuclear sites indicates clear health risk and resultant increased health problems from varying exposure levels to radioactive particles, (f) radiation and exposure measurement standards currently being used by the NRC and Metropolitan Edison Company are based on experiments and standards discredited by recently completed Heidelburg Studies and serious questions as to their accuracy and validity therefore exists in the scientific community.

The lower Swatara Board of Commissioners, Dauphin County, Pennsylvania, passed a resolution initially stating opposition to the purging into the atmosphere but further stating that they would accept the final recommendation of the Union of Concerned Scientists.

The Newbury Township Board of Supervisors, York County, Pennsylvania, also submitted a resolution which opposed the release of krypton-85 into the atmosphere; however, no specific reasons for their opposition were provided.

The Mayor of Lebanon, Pennsylvania, submitted a statement opposing the purging alternative and urging that alternative cleanup methods, which would not release radioactive material into the atmosphere, be employed without delay.

A member of the House of Representatives of the Commonwealth of Pennsylvania submitted a response in which he requested that the recommended purging operation be delayed at least until an independent assessment could be

performed. The Union of Concerned Scientists was suggested as a possible organization to perform such an assessment.

The TMI Legal Fund submitted a response in which they stated their opposition to the recommended purging operation. They summarized their opposition into the following three concerns:

1. There is no emergency at hand. Data may be collected and containment facility equipment may be inspected and maintained without removal of the krypton-85 gas. There is adequate time to implement an alternative system for krypton-85 removal from the containment building atmosphere.

2. Venting of krypton-85 gas into the air which surrounds TMI-2 carries definite genetic and carcinogenic risks to the people of nearby communities. For a population which has already endured severe psychological stress, the proposed venting will only exacerbate this state of stress.

3. The proposed venting cannot be controlled due to meteorologic uncertainty. The monitoring as described by the NRC is incapable of providing sufficient information for the protection of people in communities surrounding TMI-2.

They also urged that data collection be initiated, that the containment building equipment be inspected and maintenance begun at TMI-2, but that the krypton-85 gas be retained until an alternative system has been installed for its safe and efficient removal.

The TMI Legal Fund response also stated that (1) the draft Environment Assessment did not adequately evaluate the potential health effects of the purging operation, (2) an independent assessment of the purging operation should be obtained, (3) the segmentation of the reactor building atmosphere decontamination effort from the Programmatic Environmental Impact Statement was an illegal action, (4) the monitoring program and criteria were insufficient, and (5) the krypton being approximately five times denser than air will therefore settle into low-lying areas such as valleys and basements in the absence of adequate convection.

In addition to the above-noted comments, additional comments opposing the recommended purging alternative were received from approximately 10 nongovernment organizations (including the Office of the Provost, Capital Campus, the Pennsylvania State University; the National Audubon Society; Taxpayers Association of Lackawanna County; Heathcote Valley Alliance; Air and Water Pollution Patrol; Lehigh-Pocono Committee of Concern; and various businesses in the TMI area); and from approximately 485 private individuals. Their reasons for opposing the recommended purging operation included the following: (1) that the public be exposed to no additional radioactive effluents from TMI, (2) that one or more of the other alternatives for decontamination evaluated in the draft Environmental Assessment be used to eliminate or minimize the release of Kr-85 to the environment, (3) that there is no perceived or recognized need for the decontamination (several persons suggested that the facility be entombed in its present condition), (4) that any purging operation be delayed at least until students are released from the schools for summer vacation, (5) that any purging operation should be accompanied by a more extensive monitoring program, and (6) that an independent assessment of the recommended purging operation be first performed by a citizen-dominated group.

9.4 NRC Staff Responses to Comments Opposing the Recommended Purging Alternative

A detailed discussion of the health effects associated with the various alternatives for decontaminating the reactor building atmosphere has been incorporated into Section 7.0 of this document. The NRC staff has determined that the potential for adverse radiological health effects to the public due to utilization of any of the decontamination alternatives is negligible and that the public health and safety will not be adversely affected by the purging operation. Therefore, since the recommended purging operation can be accomplished without significant risk to the health and safety of the public, and since the purging operation can be implemented immediately as recommended in Section 5.0, the NRC staff recommends that use of the purging alternative be authorized soon, rather than waiting for installation of one of the other decontamination methods.

At the request of Governor Thornburgh of Pennsylvania, the public comment period for NUREG-0662 and its two Addenda was extended to May 16, 1980. The reason for the Governor's request was to permit sufficient time for completion of an independent assessment of the decontamination operation by the Union of Concerned Scientists (UCS). The Governor specifically requested the UCS to perform such an assessment so that he could receive information from the broadest range of knowledgable sources available. In their report to the Governor, the UCS stated:

> UCS concluded that direct radiation-induced health effects from exposure to Kr-85 even from the Met Ed/NRC proposed venting would be absent. These conclusions are similar to those reached by the NRC and Met Ed.

In Addendum 2 to NUREG-0662, the NRC staff evaluated and recommended a variation in the purging alternative which would permit the purge to be completed in an elapsed purging time of approximately 120 hours over a two-week period, provided it was performed before about mid-May to take advantage of expected favorable meteorology. However, because of the delays to permit comments on decontamination alternatives, the NRC staff no longer recommends this variation in the purging alternative. The extended comment period has also delayed the purging operation until at least the beginning of the school summer vacation period, a delay requested by several commentators. However, for the reasons described in Section 5.0, the NRC staff now recommends that the purging alternative evaluated in Section 6.2 be accomplished without further delay.

Although several commentators did not recognize or acknowledge the need for decontaminating the reactor building, the NRC staff believes that it is imperative that this action be taken. The staff's reasons for believing that this action must be taken are discussed in detail in Section 5.0. This staff position was also supported by the UCS in their report to the Governor of Pennsylvania:

> The Union of Concerned Scientists (UCS) Study Group believes that ultimate decontamination of the plant is an absolute necessity. Decontamination must include complete removal of the damaged fuel rods and of the contaminated water in the containment sump and elsewhere. The plant cannot be sealed and walked away from. This would constitute a negligent disposal means for a very large quantity of radioactivity. Important quantities of these toxic materials would ultimately find their way into the environment during the tens or hundreds of thousands of years that some of them will remain hazardous.
>
> Accordingly, UCS has concluded that the krypton must be removed from the TMI reactor building so that an orderly program of decontamination can be undertaken. The problem is how to do this in a manner which protects the safety of the workers who may be exposed to the krypton and also safeguards the physical and mental health of members of the public who may also be exposed.

The UCS did however conclude that in their opinion a delay in removal of the krypton of up to a year and a half would not pose an undue risk to the health and safety of the public. Such a delay would of course postpone any substantive progress in the overall cleanup program and as stated in Section 5.0, the NRC staff believes that the cleanup program should progress in a timely manner.

The radiological monitoring programs for the TMI site and surrounding area consist of several programs described in Section 8.0. In the opinion of the NRC staff, these programs with EPA having the lead for federal agencies, as designated by the Executive Office of the President) will provide an adequate monitoring of the recommended purge operation. The on-going monitoring programs will be supplemented by the DOE program described in Section 8.0 if the purging alternative is approved. A cadre of about 50 local residents have been trained to participate in the DOE monitoring program. EPA will supplement its existing fixed monitoring stations with mobile units positioned in areas of expected maximum dose. Reports of measurements will be made daily by EPA to the public and media.

Control of the purging operation will be accomplished through frequent (at least hourly) monitoring of the existing meteorological conditions and reactor building effluent flow rate. The DOE meteorological forecasting and monitoring capabilities will utilize this information in conjunction with radiological monitoring program results and will be communicated to the control room to assure that the cumulative doses to the public in any sector will not exceed those in Section 7.0 of this assessment.

The NRC staff disagrees with allegations that separating the reactor building atmosphere decontamination effort from the Programmatic Environmental Impact Statement was illegal. This is supported by CEQ's comments, noted in Section 9.2.1. The basis for the staff position is the Commission's November 21, 1979 Statement of Policy and Notice of Intent to Prepare a Programmatic Environmental Impact Statement, which clearly reserved the option to authorize such an action when it stated:

> The development of a programmatic impact statement will not preclude prompt Commission action when needed. The Commission does recognize, however, that as with its Epicor-II approval action, any action taken in the absence of an overall impact statement will lead to arguments that there has been an inadequate environmental analysis, even where the Commission's action itself is supported by an environmental assessment. As in settling upon the scope of the programmatic impact statement, CEQ can lend assistance here. For example should the Commission before completing its programmatic statement decide that it is in the best interest of the public health and safety to decontaminate the high level waste water now in the containment building, or to purge that building of its radioactive gases, the Commission will consider CEQ's advice as to the Commission's NEPA responsibilities. Moreover, as stated in the Commission's May 25 statement, any action of this kind will not be taken until it has undergone an environmental review, and furthermore with opportunity for public comment provided.

Although krypton gas is approximately five times denser than air, it will not settle into low-lying areas or basements as suggested by several commentators. The physical properties of gases (as expressed in the physical laws that describe the dispersion of gases) prevent the settlement of low concentrations of denser gases into low-lying areas. The krypton concentration in the reactor building atmosphere is at approximately the same concentration as naturally occurring krypton in the earth's atmosphere. The naturally occurring krypton is uniformly distributed throughout the earth's atmosphere as is the krypton in the reactor building's atmosphere; in neither case has the krypton settled into low-lying areas.

9.5 Other Comments on the Recommended Purging Alternative

9.5.1 Introduction

The NRC staff received approximately 105 responses providing either specific comments on the five alternative methods evaluated in NUREG-0662 for decontaminating the reactor building atmosphere or suggestions for additional methods for accomplishing the required decontamination.

9.5.2 Member of Congress

A Member of Congress from Pennsylvania submitted a comment opposing the purging operation and recommending that the Selective Absorption Process be used. This recommendation was based upon the Congressman's belief that the Selective Absorption Process could be placed into operation in six months and that except for the purging alternative, it would be the least expensive alternative to implement. The six-month implementation time was based on a review performed, at his request, by a member of the staff of the U.S. House of Representatives Committee on Science and Technology. The Congressman also requested Oak Ridge National Laboratory (ORNL) to reassess their time estimate for when a Selective Absorption Process system of adequate capacity could be placed into operation at TMI. ORNL subsequently reported that with "best efforts" being exerted by all concerned parties, such a system could be operational at TMI in 13 months. The TMI Program Office also requested an assessment of the proposed schedules for fabrication and installation of such a system by the Reactor Construction and Engineering Support Branch of the NRC's Office of Inspection and Enforcement. The Reactor Construction and Engineering Support Branch concluded that the six-month schedule proposed by the staff of the Committee on Science and Technology was unrealistic and that the 13-month ORNL schedule was optimistic. They further concluded that their minimum schedule estimate would be 16 months with their best estimate being even longer.

9.5.3 U.S. Department of the Interior

The Department of the Interior commented that the draft report did not discuss what effects, if any, the proposed release of krypton would have on fish and wildlife resources and their habitats. As noted in Section 7.1, the recommended purging operation will have no significant effect on fish or wildlife resources or on their habitats.

9.5.4 MITRE Corporation

The MITRE Corporation submitted a comment proposing to use a cryogenic air separation plant for removing the krypton from the reactor building atmosphere. This proposed method would be similar in operation to the Cryogenic Processing System described and evaluated in Section 6.6. An evaluation of the proposal submitted by the MITRE Corporation and the NRC staff reasons for not recommending its use are included in that section.

9.5.5 International Business Machines Corporation (IBM)

A technical report copyrighted in 1979 by IBM was submitted as a comment. This report, "Encapsulation of Radioactive Noble Gas Waste in Amorphous Alloy," describes a method for long-term storage of Kr-85. Use of this storage method requires that the Kr-85 first be separated from the reactor building atmosphere by use of a cryogenic distillation tower similar to the Cryogenic Processing System described in Section 6.6. As noted in that section, construction and operation of such a system would require a minimum 20 month delay which for the reasons discussed in Section 5.0 of this document are considered unacceptable. Therefore, no further actions have been taken on this comment.

9.5.6 Pennsylvania State University

The Pennsylvania State University submitted a comment suggesting the use of an oxygen liquefaction unit. This unit would concentrate more than 99% of the krypton in the liquid oxygen product. The liquid oxygen would then be passed through a bed of adsorbent material such as silica gel where the krypton would be selectively adsorbed. The separation of the krypton from the oxygen could be done either onsite or offsite. Such an oxygen liquefaction unit would be similar to the Cryogic Processing System evaluated in Section 6.6. Due to the time required for construction and operation of such a unit (a minimum of 20 months), use of this method is not recommended.

9.5.7 Science Applications, Inc. (SAI)

A comment in the form of a proposal to remove the krypton from the TMI-2 reactor building atmosphere was received from SAI. The proposed method would use a selective adsorption process. In their proposal, SAI estimated that such a system would require nine months for design, construction and checkout. Due to this delay in system availability, the NRC staff does not recommend further consideration of this proposal.

9.5.8 Environmental Policy Center

The Environmental Policy Center submitted a comment suggesting that rather than decontaminating the reactor building, it and the radioactive wastes within it should be entombed. However, since it is imperative that the damaged fuel be removed from the reactor to prevent either its potential recriticality or eventual escape to the environment over very long time periods, the entombent suggestion is not considered a viable alternative.

9.5.9 Environmental Coalition on Nuclear Power (ECNP)

A comment from the ECNP recommended that rather than implementing the purging alternative, the krypton be removed from the reactor building atmosphere by one of the other alternatives (charcoal adsorption, gas compression, cryogenic processing, or selective absorption) and then transferred to some unpopulated place for release under controlled conditions. Because of the negligible adverse radiological health effects of the proposed purging operation, and because of the delays (16 months or longer) associated with the implementation of any of the other decontamination alternatives which do not purge, the NRC staff continues to recommend that the purging alternative be selected as the method for decontamination of the reactor building atmosphere.

The ECNP further stated that if their recommendation was not implemented, there were at least two other alternatives which have not been evaluated by the NRC staff: (1) transfer the gas (the TMI-2 reactor building atmosphere) to the TMI-1 reactor building and store it there until removal could be accomplished by one of the other decontamination alternatives, and (2) purge the TMI-2 reactor building atmosphere to the environment rapidly, as in a "puff release."

The NRC staff has reviewed these suggested alternatives and considers both of them unacceptable for the following reasons. As noted in Section 6.2, to reduce the radioactivity in the TMI-2 reactor building atmosphere to maximum permissible concentrations would require the transfer of about 23 million cubic feet of air. This transfer would, in turn, pressurize the TMI-1 reactor building to 170 psig, a pressure significantly in excess of its design pressure of 60 psig. Therefore, transfer of the gas is not a viable alternative.

In preparing Addendum 2 to NUREG-0662, the NRC staff evaluated variations in the purging alternative in an attempt to minimize the duration of the recommended purge operation. In this evaluation, the staff determined that it would not be advisable to purge the reactor building as rapidly as physically possible since such a purge would most probably result in beta skin doses in unrestricted areas in excess of the design objectives of 10 CFR Part 50, Appendix I (Ref. 15).

9.5.10 Pennsylvania Dutch Visitors Bureau (PDVB)

The PDVB suggested that all future news releases relating to releases of radioactivity contain an explanation (in layperson's terms) of physiological and environmental impacts. The NRC TMI Program Office has issued an easy-to-understand report that answers questions most frequently asked about the proposed purge of krypton from the reactor building. This report states in layman's terms the potential health impacts likely to occur when the krypton is released. Copies of the report, "Answers to Questions about Removing Krypton from Three Mile Island, Unit 2 Reactor Building "(NUREG-0673) are available free of charge by writing to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20556. In addition, Section 1.0 was written to provide a fairly complete discussion of the entire final assessment report for the layperson. Section 7.0 of the final assessment also describes the health effects of the various alternatives for decontaminating the reactor building atmosphere.

9.5.11 Hershey Entertainment & Resort Company (HERCO)

HERCO requested that the purging operation be scheduled (consistent with safety) either prior to or just after the peak June - August tourism season. For the reasons described in Section 5.0, the NRC staff recommends that the purging operation be performed soon. The information in Section 7.0 is provided to alleviate public concerns about the health effects of the purging operation, which have been determined to be negligible.

9.5.12 Oak Ridge National Laboratory (ORNL)

ORNL suggested a possible mechanism for alleviating some of the public concern regarding the proposed purge operation. Their suggestion was to encourage and fund local radiation monitoring efforts for the duration of the planned release. They further suggested that the Commonwealth of Pennsylvania should be requested to assist or oversee this effort. The DOE monitoring program described in Section 8.0 will function essentially as suggested by ORNL. Approximately 50 local residents have been trained to participate in monitoring the recommended purge operation.

9.5.13 Councilman and Director Department of Public Safety, City of Lebanon, Pennsylvania

The Councilman and Director Department of Public Safety, City of Lebanon, Pennsylvania recommended a delay in the purging operation and asked for "a stronger, more concerted effort to establish a factual, responsible, public information source which may enjoy a greater degree of public confidence than that now experienced by the NRC. The Governor's request for participation by the Union of Concerned Scientists may be a step in this direction." Such a delay was granted and the UCS submitted their report to the Governor of Pennsylvania on May 15, 1980. The Governor subsequently stated that he was prepared to support the purging decision if the Commission proceeded with the purging proposal advanced by the NRC staff. He further stated: "To minimize stress, I also am prepared to commit all of the resources at my disposal to assure the residents of the area, as I am now persuaded, that this plan is, indeed, a safe one."

9.5.14 West Shore School District

The West Shore School District requested that approval of the purging operation be postponed until after the schools in the TMI area have closed for the summer. They further stated that most of these schools will close for the summer during the week of June 9. The decision to extend the public comment period on NUREG-0662 to May 16, 1980 effectively granted this request.

9.5.15 Regional Planning Council

The Regional Planning Council for the Baltimore, Maryland area commented that while in previous statements it has supported the position that there should not be a release of radioactive material from the cleanup process before the preparation of an Environmental Impact Statement, it does recognize the need for timely action by the NRC when it finds that public safety requires release of material before the EIS is completed. They also commented that the Environmental Assessment fails to mention a deadline for release of the gas. They recommended that the purge operation be delayed until the Union of Concerned Scientists study requested by the Governor of Pennsylvania was completed. Since the UCS study has now been completed, the NRC staff recommends, for the reasons stated in Section 5.0, that the purging operation be performed soon and prior to completion of the Programmatic Environmental Impact Statement.

They also requested that Maryland health officials be notified in advance of the purge operation so that monitoring stations can be established by Maryland officials. The NRC staff intends to provide at least a ten-day advance notice to all pertinent officials, to the press, and to the public for the controlled purging operation.

9.5.16 Additional Comments from Individuals

In addition to the above-noted comments, approximately 90 additional responses were received from individuals who provided specific comments on the alternative methods evaluated in NUREG-0662 or suggestions for additional methods for accomplishing the required decontamination. The additional comments or suggestions were broad

ranging. They included suggestions (1) to purge the reactor building atmosphere into balloons and release the contents at high elevations, (2) to evacuate the residents in the TMI area during the purging operation, and (3) to modify the charcoal adsorption process to minimize the quantity of charcoal required. Some persons urged that NRC staff members and officials be present in the TMI area during the purging operations, expressed concern about possible releases of other radioactive materials, questions differences in the quantities of Kr-85 reported by the licensee (44,000 curies) and by the NRC staff (57,000 curies) and worried that additional quantities of fission products are continuing to be generated. One person recommended that the cleanup operation be performed by the Naval Reactors Branch of DOE. Several other persons suggested that any necessary maintenance and repairs within the reactor building could be performed by workers dressed in protective clothing without prior removal of the Kr-85.

A number of letters suggested that the krypton gas be placed in high-altitude balloons and transported for release high in the atmosphere. Although high- altitude balloons are technically feasible as an alternative to controlled purging, their use could increase the risk of an uncontrolled release that could result in higher radiation exposures to the workers and the public than would occur from the alternatives discussed in this report.

A large number of balloons would be required and they would have to be of immense volume because krypton-85 is a heavier-than-air gas which would require the addition of helium gas or lift capability to the balloons as a volume ratio of approximately 30 times that of krypton-85. Moreover, the probability for a balloon burst is fairly high. Based on the National Oceanic and Atmospheric Administration experience with high-altitude weather balloons, the chance of no balloon burst is in the range between 75 to 85%, but can drop as low as 50% during periods of gusty winds. This probability, coupled with the large number of balloons that would be necessary (assuming krypton-85 is transported as a gas), would increase the overall probability of a premature balloon burst. Solutions would then need to be devised for retrieval and disposal of the contaminated balloons. Finally, use of balloons for transporting radioactive gas may further aggrevate the psychological stress of some residents in the TMI area due to the obvious visibility they would provide. In summary, since the radiological health effects associated with the recommended purging operation are negligible, and since the probable disadvantages outweigh the advantages of using balloons in transporting and remotely releasing the Kr-85 gas, use of this concept is not recommended.

Recommendations that local residents be evacuated during any purging operation were based on the assumption that an evacuation would protect residents from any radiological hazards associated with the release of the Kr-85. However, as discussed in Section 7.0, the adverse radiological health effects of the recommended purging operation will be negligible and, therefore, evacuation of the local residents is neither required nor recommended.

The suggested variation in the charcoal adsorption process recommends that three containers of charcoal to be used. In this variation, the reactor building atmosphere would be filtered, dried, refrigerated, and passed over refrigerated charcoal until krypton breakthrough occurred in the first container. The krypton in this first container would then be desorbed by admitting heated and humidified air. The desorbed krypton would be transferred to a second refrigerated container of charcoal for storage. The adsorption and desorption in the first container would then be repeated for several cycles. Although the charcoal loses its ability to adsorb krypton with increasing humidity, this ability is only decreased in magnitude, it is not eliminated. Significant holdup is still obtained at high humidity, and desorption would not be easy. Therefore, transfer of krypton, as the proposal suggests, cannot be expected as easily as stated. Since this concept is the basis for the entire proposal, the rest of the proposal simply does not follow and its further consideration is not recommended.

Several suggestions were made that NRC staff members and officials be present in the TMI area during the purging operations. The reasons for these suggestions included that their presence would be a demonstration of confidence in statements by the NRC staff that the radiological health effects are negligible. Members of the NRC professional staff would be at, and in the vicinity of, TMI during purging operations to oversee these operations.

Concerns were expressed regarding the possible releases of radioactive materials other than Kr-85 from the reactor building, especially radioactive isotopes of cesium and strontium. As noted in Section 4.0, the concentrations of airborne radioactive particulate matter in the reactor building atmosphere is low and the purge exhaust filter system will remove essentially all of the particulate matter in the exhaust stream, thereby ensuring that there will be no significant dose effects associated with the releases of other radioactive material.

Concerns were also expressed that additional quantities of fission products are continuing to be generated or released to the reactor building atmosphere and that this activity may be released during the purge. These concerns were based upon the variations between source terms used by the licensee in his submittal of November 13, 1979 (Ref. 1) and those used by the NRC in NUREG-0662 (March 1980). As noted in Section 4.2, these variations were not due to the generation of additional fission products or their release to the reactor building atmosphere but were due to improved techniques in sampling and analyzing the samples.

A suggestion was made that by Presidential Executive Order, complete responsibility for the cleanup program at TMI be assigned to the Naval Reactor Branch of DOE and that the cleanup decisions should be removed from public debate. The stated bases for these suggestions were that the cleanup action needs to progress immediately and that the TMI-2 plant was not designed to house large amounts of gaseous krypton, radioactive water, or damaged nuclear fuel for long periods of time. Although the TMI-2 facility was not specifically designed to accommodate all of the conditions encountered during and following the accident, it is now and is expected to continue to isolate the radioactive wastes from the environment provided necessary actions are taken on a timely basis. (See Section 5.0). The licensee, with appropriate support from the NRC, EPA and DOE professional staff, has sufficient expertise to perform the necessary cleanup operations. Therefore, there is no present need to assign the cleanup operation to another organization. Moreover, the U.S. Congress has enacted legislation making the NRC responsible for licensing activities pertaining to civilian nuclear power reactors and NRC regulations allow for public participation in the licensing process.

Several comments were made to the effect that any necessary maintenance and repairs within the reactor building could be performed by workers dressed in protective clothing prior to removal of the Kr-85. However, as noted in Section 5.0, only preliminary measurement and planning activities can be performed in the reactor building prior to the removal of the Kr-85. Therefore, the Kr-85 must be removed to permit any maintenance or repair activities within the reactor building.

10.0 Public Information Activities

In an effort to better inform the public in the area around Three Mile Island about the contents of the draft Environmental Assessment (NUREG-0662, and Addenda 1 and 2), NRC has conducted 38 informational meetings and activities. The staff also issued an easy-to-understand report that answers frequently asked questions about removing the krypton from the reactor building. Copies of the report, "Answers to Questions about Removing Krypton from the Three Mile Island Unit 2 Reactor Building" (NUREG-0673), are available free of charge by writing to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Most of the meetings held were planned by the NRC, although some were organized by other interested groups, at which NRC officials were invited participants. Members of the U.S. Environmental Protection Agency and the Pennsylvania Department of Environmental Resources (DER) were usually invited participants at these meetings. EPA officials outlined their agency's program and responsibilities for environmental monitoring in the vicinity of the TMI site, while state DER personnel explained the community monitoring program and other state functions related to the clean-up of TMI Unit 2. At these meetings, NRC officials expressed their willingness to meet with other groups of people who had an interest in receiving additional information on the Environmental Assessment or clean-up operations at Unit 2.

This effort of communicating with the public fell into three broad categories:

15 public meetings and meetings with interested citizens groups,
16 meetings with elected officials, and
7 press conferences and appearances on public information radio and television shows.

10.1 Public Meetings and Meetings with Interested Groups

On March 19, 1980, NRC conducted a public meeting in Middletown to inform local citizens of the contents of the draft Environmental Assessment. Following this initial meeting, NRC officials attended similar gatherings in surrounding communities at the request of state and local officials.

The NRC staff also met with a wide variety of interested groups which included:

Chambers of Commerce
Civic Service Organizations
Medical Associations
School Board Officials
Religious Leaders
Teacher Organizations
Three Mile Island Alert

Meetings with the Capital Forward Group and Three Mile Island Alert were attended by Chairman Ahearne and Commissioner Hendrie, respectively, in addition to NRC staff participation.

10.2 Briefings for Elected Officials

In addition to meeting with Governor Thornburgh, Harold Denton, Director of the Office of Nuclear Reactor Regulation, and other members of the NRC staff met with various city officials from major metropolitan areas surrounding Three Mile Island. Meetings were held with the Commissioners and other officials from the four counties closest to TMI: Dauphin, Lancaster, York, and Lebanon. Five briefings were also conducted in different geographic locations for elected officials from the Boroughs and Townships which surround Three Mile Island.

10.3 Press Conferences and Television and Radio Appearances

Harold Denton held several press conferences in central Pennsylvania, one of which was held jointly with Governor Thornburgh to discuss the Environmental Assessment. John T. Collins, Deputy Program Director, TMI Program Office, appeared on several television and radio talk programs where listeners or panel members asked questions concerning the Environmental Assessment. These appearances by Mr. Collins were in addition to his numerous other television and radio interviews concerning a wide range of topics relating to activities at the TMI site.

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NRC documents referenced in this report are available from the following sources:

(PDR) - USNRC Public Document Room, 1717 H Street, N.W., Washington, DC 20555. Available for inspection and copying for a fee.

(DTIDC) - Copies are available for sale from the Publications Sales Manager, Division of Technical Information and Document Control, USNRC, Washington, DC 20555. Single copies of draft reports are available free of charge from the same address.

(PDR, GPO) - Copies are available from the NRC PDR for inspection and copying for a fee, and from the U.S. Government Printing Office, Washington, DC 20402, Attn: Regulatory Guide Account.

(PL) - Available from a public library.

12. Glossary

Absorbed dose - The energy imparted to matter by ionizing radiation.

Anticipated Operational Occurrence - Miscellaneous conditions or actions such as equipment failure, operator error, administrative error, that are expected to occur that are not of magnitude great enough to be considered an accident.

Background radiation - Radiation arising from natural radioactive materials always present in the environment, including solar and cosmic radiation and radioactive elements in the upper atmosphere, the ground, building materials, and the human body. In the Harrisburg area the background radiation level is about 125 mrem per year.

Beta parcticles - Charged particles emitted from the nucleus of a atom, with a mass and charge equal in magnitude to that of the electron.

CFM - Cubic feet per minute

Control rod - A rod containing material that absorbs neutrons; used to control or halt nuclear fission in a reactor.

Core - The part of a nuclear reactor that contains the fuel (fissionable material). In a reactor like that at TMI, the region containing fuel-bearing rods.

Critical - Term used to describe the capability of sustaining a chain reaction at a constant level.

Cryogenic Processing - Low-temperatue separation processes whereby materials that are normally gases are isolated and recovered from other gases by liquifying them at low temperatures.

Cubic Centimeter (cc) - Unit for measuring volume. Approximately 947 cubic centimeters is equal to one U.S. quart.

Curie (Ci) - The special unit of radioactivity. Activity is defined as the number of nuclear transformations occurring in a given quantity of material per unit time.

Decay heat - Heat produced by the decay of radioactive particles; in a nuclear reactor this heat, resulting from materials left from the fission process, must be removed after reactor shutdown to prevent the core from overheating. See Radioactive decay.

Dose - Denotes the quantity of radiation or energy absorbed. For special purposes it must be appropriately qualified. If unqualified, it refers to absorbed dose. See Absorbed dose.

Dosimeter - Dose meter. An instrument that measures radiation dose. See TLD.

Gamma rays - Short-wave length electromagnetic radiation of nuclear origin emitted from the nucleus of an atom. A form of ionizing radiation.

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

HEPA - High-efficiency particulate filter.

Ionization - The process by which a neutral atom or molecule acquires a positive or a negative charge.

Ionizing Radiation - Any form of radiation that displaces electrons from atoms or molecules. The resulting atom or molecule is an ion. Ions become electrically charged as a result of this process.

Krypton-85 - An inert noble gas (it does not interact chemically with other chemical elements or compounds) with a half-life of 10.7 years.

LET - Linear energy transfer. A measure of the capacity of biological material to absorb ionizing radiation.

MDA - Minimum Detectable Activity. Minimum level of radioactivity detectable with monitoring instruments.

Meteorological dispersion factor (X/Q) - A factor (seconds/m^3) which accounts for site-specific meteorological data in relating the concentration (Ci/m^3) of radioactive materials, at a given location, to a release rate (Ci/sec) of radioactive material at another location.

Microcurie (mCi) - Unit for measuring radioactivity. One microcurie is one-millionth of a curie (1/1,000,000). See curie.

Millicurie (mCi) - Unit for measuring radioactivity. One millicurie is one-thousandth (1/1,000) of a curie.

Millirem (mrem) - One one-thousandth (1/1000) of a rem; see rem.

MPC - Maximum Permissible Concentration of radioactive exposure, as specified in Title 10 Code of Federal Regulations, Part 20, Table B.

Noble gases - Inert gases that do not readily react chemically with other elements. These gases include helium, neon, krypton, xenon, and radon.

Nuclear Regulatory Commission (NRC) - U.S. agency responsible for the licensing, regulation, and inspection of commercial, test, and research nuclear reactors, as well as nuclear materials.

Order of Magnitude - Within a factor of 10.

Person-rems - The sum of the individual doses received by each member of a certain group or population. It is calculated by multiplying the average dose per person by the number of persons. Consequently, the collective dose is expressed in person-rems. For example, a thousand people each exposed to one mrem would have a collective dose of 1 person-rem.

PSIG - Pounds per square inch gauge. A measure of the difference in pressure above or below normal atmospheric pressure.

rad - The basic unit of absorbed dose of ionizing radiation. A dose of one rad means the absorption of 100 ergs of radiation energy per gram of absorbing material.

Radiation - Energy in the form of rays (light, heat, X-ray, radio waves) sent out through space from atoms and molecules as they undergo internal change.

Radioactive decay - The spontaneous natural process by which an unstable radioactive nucleus releases energy or particles to become stable.

Radioactivity - The spontaneous decay of an unstable atom. During the decay process, ionizing radiation is usually given off.

Reactor (nuclear) - A device in which a fission chain reaction can be initiated, maintained, and controlled.

Reactor building - The structure housing the nuclear reactor. Also called containment building or reactor containment building.

Reactor vessel - The steel vessel containing the reactor core; also called pressure vessel.

Rem - A standard unit of radiation dose. Frequently radiation dose is measured in millirems for low-level radiation; 1,000 millirems equal one rem.

SCFM - Standard Cubic Feet Per Minute. "Standard" refers to standard conditions of pressure and temperature.

Selective Absorbtion Process - A separation process whereby a liquid is used to selectively absorb (separate) a selected material (gas) from a source gas stream (air).

Source Term - Defines an amount of radioactive material.

TLD (thermoluminescent dosimeter) - A solid-state device used to measure nuclear radiation doses. See Dosimeter.

Tritium - A radioactive isotope of hydrogen.

Wake-Cavity Effect - The region of turbulance immediately to the rear of a solid body, like a building, that is formed when wind currents flow over and around the object.

X/Q - See Meteorological Dispersion Factor.

APPENDIX D. "ENVIRONMENTAL ASSESSMENT--USE OF EPICOR-II AT THREE MILE ISLAND, UNIT 2," U.S. NUCLEAR REGULATORY COMMISSION, NUREG-0591, OCTOBER 3, 1979

ENVIRONMENTAL ASSESSMENT

USE OF EPICOR-II

AT

THREE MILE ISLAND, UNIT 2

PREPARED BY

OFFICE OF NUCLEAR REACTOR REGULATION

U. S. NUCLEAR REGULATORY COMMISSION

OCTOBER 3, 1979

ENVIRONMENTAL ASSESSMENT: USE OF EPICOR-II AT THREE MILE ISLAND

1.0 Proposed Action

The proposed action is to use a system, EPICOR-II, for the cleanup of radioactive contaminated waste water which has accumulated in the Unit 2 auxiliary building tanks because of the March 28, 1979 accident at Three Mile Island (TMI). The proposed action is limited to cleanup and storage of such waste and includes the impact of temporary storage, packaging, handling, transportation, and burial of the solid waste generated from the cleanup operation using EPICOR-II.

This action does not include the disposal of the decontaminated waste. As indicated in Section 2.0 below, the disposal of this water will be covered in a separate assessment. In addition, treatment and disposition of water in the reactor containment building will also be covered in a separate assessment.

This assessment is an evaluation of the effect that the proposed action will have on the public health and safety, and on the environment including a consideration of occupational exposures and the risk of accidental releases, and a discussion of alternatives to the EPICOR-II system.

2.0 Introduction

As a result of the March 28, 1979 accident at the TMI Unit 2 facility, a significant amount of radioactive contaminated water has been generated and collected in Unit 2 auxiliary building tanks. This waste water was produced primarily from the following four sources: (1) an inventory of waste water existed in Unit 2 auxiliary building tanks prior to the accident (approximately 130,000 gallons, some of which has been used as makeup (makeup is water which is normally added to the reactor coolant system for the purpose of controlling reactor coolant inventory) water to the Unit 2 reactor); (2) during the early phases of the accident, contaminated water from the reactor containment building sump was transported to the auxiliary building and collected in various tanks; (3) letdown (letdown is water which is normally removed from the reactor coolant system for the purpose of controlling reactor coolant inventory and chemical and radioactivity content; it is depressurized and cooled prior to reaching the auxiliary building tanks) from the reactor coolant system has resulted in a net increase to the inventory; and (4) normal leakage from system components in the auxiliary building has been a small but continuous source of waste water to the inventory which currently exists in all of the auxiliary building tanks (approximately 280,000 gallons). The level of contamination of the water in these tanks ranges from less than 0.1 to 35 uCi/ml of Cs-137. Because of the relatively short half-life of I-131 (8.1 days) compared to that of Cs-137 (30 years), Cs-137 has become the dominant isotopic contributor. The quantities and activity levels of the current inventories in the auxiliary building tanks are discussed in Section 3.3.3.

Following the March 28 accident, Metropolitan Edison Company (the licensee) initiated the design and construction of a system, the design basis of which was to decontaminate water with an activity level up to 100 uCi/ml of I-131 and Cs-137, the principal radionuclides present in the waste water for radiological dose considerations. As indicated in Table 2, the activity level of I-131 and Cs-137 in the water to be treated in EPICOR-II is less than 40 uCi/ml. The design and construction of a new processing system was necessary for the following reasons. The existing liquid waste processing systems for Units 1 and 2 were designed for processing water with significantly lower levels of activity than currently exist in the Unit 2 auxiliary building tanks. For example, the expected reactor coolant concentration of Cs-137 during normal operation of the plant is 0.018 uCi/ml or a factor of approximately 2,000 times lower than the highest Cs-137 concentration presently in the auxiliary building tanks. In addition, the contaminated condition of the Unit 2 auxiliary building after the accident rendered the building unusable for the purpose of continuous, planned processing of the inventory of waste water from the building radwaste control panel. The recognized need for a new processing system resulted in the development of the system which is now known as EPICOR-II.*

In response to a complaint for injunctive relief filed by the City of Lancaster, Pennsylvania, in the United States District Court for the District of Columbia, the United States Nuclear Regulatory Commission directed its staff to prepare an environmental assessment regarding proposals to decontaminate and dispose of radioactively contaminated waste water from the TMI 2 Unit 2 facility. The assessment is to be divided into several portions of which this is the first. This portion deals with the proposed decontamination of the intermediate-level**

*Epicor, Inc., Linden, N.J.

**Intermediate-level waste is defined as waste having I-131 and Cs-137 concentrations greater than 1 uCi/ml but less than 100 uCi/ml.

waste water in the Unit 2 auxiliary building tanks using the EPICOR-II system. This assessment includes discussion of potential risk of planned (gaseous) and accidental (gaseous and liquid) releases, and a discussion of alternatives to the EPICOR-II system. It does not consider the disposition of the decontaminated water following use of EPICOR-II since this is precluded pending an evaluation of the various disposal alternatives. Use of EPICOR-II does not preclude implementation of the various disposal alternatives.

This assessment is the formalization of the evaluations and regulatory guidance that have been provided at TMI from March 28 to the present. During that period, and on a continuing basis, the NRC on-site support staff has been engaged in design and safety evaluation of the licensee's proposed means for processing intermediate-level waste water, including an evaluation of the need for EPICOR-II (see Section 2.1). The NRC staff concurred with the licensee that design, construction, and operation of EPICOR-II should proceed on a high priority basis. The NRC staff has provided design guidance and criteria for the EPICOR-II processing system, the building housing the system, the building exhaust filtration system and the process vessel vent filtration system. The NRC staff has monitored and inspected the design, construction, and preoperational testing of EPICOR-II since its inception. The EPICOR-II system which has evolved from this regulatory effort has been designed for remote receipt, handling, and processing of contaminated water from the TMI Unit 2 auxiliary building with minimal occupational exposure and no adverse impact on the health and safety of the public.

2.1 Need for Decontamination

The March 28 accident at TMI Unit 2 and subsequent recovery operations have generated a substantial amount of contaminated water which is contained in the reactor building and in tanks in the auxiliary building (see Section 3.3.3). Although these buildings are of high integrity such that the contaminated water can be positively controlled for an indefinite period, there are several reasons why decontamination of the water would be beneficial. Available capacity of the tanks in the auxiliary building is needed in the event that pumping of water from the reactor building is necessary to protect the operability of reactor building components and systems which maintain continued safe shutdown of the facility. The waste water in the auxiliary building continues to be a source of exposure to personnel needing entry into the auxiliary building. The continued safe shutdown of TMI Unit 2 depends upon the operability of original plant equipment located in the auxiliary building and the use of additional equipment being installed in the course of completing modifications in progress. The surveillance and maintenance of this equipment and personnel exposures associated with these actions, which are necessary to assure maximum reliability, are adversely affected by radiation levels associated with stored liquid. Approximately 50 workers per day are currently provided access to the auxiliary building for decontamination, operations and construction purposes. Although occupational exposure to these workers (approximately 10 mrem/worker/day; or about 15 man-rem for each month that the situation remains unchanged) is within regulatory limits, any reduction in dose resulting from the removal of radioactive water stored in the auxiliary building tanks is considered a positive action. The total exposure from this source is primarily a function of the elapsed time to deciding to remove and process the water.

The removal of stored contaminated water will have the additional benefit of permitting decontamination - now precluded by high radiation levels - of some areas of the auxiliary building, including rooms housing reactor coolant bleed tanks, neutralizer tanks, and the miscellaneous waste holdup tank. Therefore, it is important to process the inventory of water in the Unit 2 auxiliary building tanks in order to immobilize the entrained activity and thereby reduce potential souces of environmental and occupational exposure and provide surge capacity for water transferred from the reactor building. The EPICOR-II processing system has been specifically designed and constructed for the purpose of processing TMI 2 intermediate-level waste water and represents the best alternative for desired decontamination of that waste (see Section 5.0, Alternatives to the Use of EPICOR-II).

3.0 EPICOR-II System

3.1 Housing of EPICOR-II in the Chemical Cleaning Building

The EPICOR-II system is housed in an existing on-site structure called the chemical cleaning building. This building was originally intended to be used in the chemical cleaning of the steam generators for TMI Units 1 and 2. It is a rectangular shaped building with dimensions of 48 feet wide by 60 feet long by 52 feet high. The foundation of the building and the walls up to a height of 13.5 feet above the basement floor are concrete and the upper walls and roof are of structural steel.

The foundation of the building is designed to seismic Category I criteria (i.e., able to withstand the effects of the safe shutdown earthquake) as are the primary concrete walls and structural steel frame.

A floor drain system is included in the design of the Chemical Cleaning Building. The drain system routes leakage from pumps, and other components, possible overflows from tanks, demineralizers, and the demineralizer/filter to a lined stainless steel sump. The floor of the Chemical Cleaning Building and up to a height of three feet on the walls is covered with a strippable coating. In the event of a spill, decontamination of the floor can be accomplished by flushing with clean water or a decontamination solution. The containments and decontamination solution are then routed to the sump for processing.

3.2 Modifications for EPICOR-II

In order to convert the chemical cleaning building for use in decontaminating intermediate-level waste, several modifications were made to the building. These included the following:

1. The installation of the EPICOR-II system (vendor supplied equipment) in the building. Specifically, a prefilter/demineralizer, a cation bed demineralizer, a mixed bed demineralizer, precoat and chemical addition tanks and associated pumps, pipes, valves, and instrumentation for the EPICOR-II system;

2. The addition of shield walls around EPICOR-II equipment. The shield walls were added for the protection of personnel involved in the operation of this system (a description of the shielding is contained in Section 4.0);

3. The addition of an overhead monorail hoist system. The hoist system was provided for removal and replacement of the demineralizers and prefilter/demineralizer. The monorail system extends from the north side of the building above the prefilter/demineralizer through the south end of the building extending 18 feet outside the building over a cask loading area at which point the shielded prefilter/demineralizer and demineralizer casks can be loaded onto a truck;

4. The chemical cleaning building was made into a low leakage confinement building by spraying the interior of the structural steel portion of the building with an epoxy sealant. The sealant was added to prevent air and radioactive material outleakage from the building;

5. The addition of an exhaust ventilation filtration system to maintain the chemical cleaning building at a negative pressure. This also minimizes air outleakage and directs air flow through the filtration system. This system includes filtration of the air through a

prefilter, a high efficiency particulate air (HEPA) filter, a charcoal adsorber and a final HEPA filter. The purpose of this filtration system is to remove radioiodine and radioactive materials in particulate form present in the air before it is released to the environment. A new building was constructed, directly adjacent to the east side of the existing chemical cleaning building, to house the air filtration equipment;

6. The addition of a TV monitor control building directly adjacent to the northwest section of the chemical cleaning building. Since operation of the EPICOR-II system is by remote means, this building is provided for remote system operations where the EPICOR-II system can be controlled. In addition, there are six TV monitors located at different points in the chemical cleaning building to provide for remote viewing of the system during normal operation.

3.3 Design of the EPICOR-II System

The EPICOR-II system is a liquid radwaste processing system supplied by EPICOR, Inc. The system is designed to decontaminate by filtration and ion exchange radioactive contaminated water contained in the auxiliary building tanks of TMI Unit 2 and to transfer this decontaminated water to Unit 1 or other tanks for storage. Plans are currently being formulated to allow for the disposition of the decontaminated water from Unit 2. Ion exchange is the process by which radioactive ions are removed from solution in the contaminated water by resins in the ion exchanger. The use of filtration and ion exchange in the treatment of radioactive waste water is standard practice in nuclear power plants and the principles upon which they are based are described in NUREG/CR-0141[1] and NUREG/CR-0143[2], respectively.

The EPICOR-II system is designed to function in such a manner as to limit gaseous releases of radioactive material to the environment to levels which are "as low as is reasonably achievable," in accordance with 10 CFR Part 50.34a[4] and 10 CFR Part 20[5]. In addition, it is designed to be operated and maintained in such a manner as to maintain exposures to plant personnel to levels which are "as low as is reasonably achievable," in accordance with the guidance given in Regulatory Guide 8.8[6].

3.3.1 Description of the EPICOR-II System

The EPICORE-II system consists of the following components, all of which are located in the chemical cleaning building except as noted. A functional description of these components is given in the discussion below:

1. Processing pumps (5)
2. Transfer pump
3. Prefilter/demineralizer - containing precoat material and cation bed resin
4. Demineralizers (2) - one cation bed followed by a mixed bed
5. Miscellaneous waste holdup tank - located in the TMI Unit 2 auxiliary building.
6. Clean wastes receiver tank (formerly the rinse hold tank)
7. Off-spec water receiving/batch tank (formerly the chemical cleaning solution tank)
8. Chemical cleaning building sump pump
9. Monorail hoist system
10. Ventilation filtration system

A simplified flow diagram of the EPICOR-II system is shown in Figure 1. The EPICOR-II liquid waste processing system operates at essentially atmospheric pressure in the following manner. The miscellaneous waste holdup tank (MWHT) is located in the auxiliary building of Unit 2 and receives water from the specific auxiliary building and fuel handling building tanks*. Water from tanks in the fuel handling building can be routed directly to the EPICOR-II system, however, for operational purposes water stored in the fuel handling building will be routed through the (MWHT) to EPICOR-II. Water in the Unit 2 auxiliary building tanks can reach the EPICOR-II system only by being routed to the MWHT. Prior to processing in EPICOR-II, the water is analyzed for radioactivity and chemical content to provide estimates of activity buildup on the ion exchange resins and the need for required chemical addition for system optimization.

The first processing pump is used to pump water from the MWHT to the prefilter/demineralizer in the chemical cleaning building through the yard piping. The piping is enclosed in a shielded guard pipe, the open end of which terminates inside the chemical cleaning building. The prefilter/demineralizer contains a precoat material which enables it to remove particulate radioactive wastes (e.g., activated corrosion products) and other suspended solids. The prefilter also contains cation bed resin which is highly efficient for the removal of cesium and other cationic radionuclides from the waste stream (removal efficiency greater than 90%). After passing

*It was realized during the early planning stages after the accident that additional liquid storage capacity would be required. Space was available in the Unit 2 fuel pool to locate six storage tanks with a combined volume of 110,000 gallons.

through the prefilter/demineralizer, the water is circulated by the processing pumps through the two demineralizers arranged in series. The first demineralizer also contains cation resins which also makes it highly efficient for removal of cesium and other cationic radionuclides from the waste stream (removal efficiency greater than 90%). The second demineralizer contains mixed resins (cation and anion) which are efficient for removal of both cationic and anionic radionuclides, including cesium and iodine (removal efficiency greater than 90%). After processing, the water is collected in the clean water receiving tank (CWRT) which has a capacity of 133,000 gallons. In the CWRT the water will be sampled and analyzed for nuclide identification. If the analysis shows that the processed waste contains concentration of radioactivity below predetermined limits, the water will then be transferred to the TMI Unit 1 or 2 liquid waste management system to be held for ultimate disposition. These predetermined limits will be specified in the system operating procedures and in the plant radiological effluent technical specifications. Processed waste which is not suitable for transfer to TMI Unit 1 or 2 liquid waste management system will be pumped to the off-spec water receiving/batch tank (OWRT) which has a capacity of 95,000 gallons. Water in this tank will be recycled through the EPICOR-II system for additional processing.

The monorail hoist system consists of a 20-ton hoist mounted on a monorail which extends from above the prefilter/demineralizer, across the top of the demineralizers and to approximately 18 feet outside of the chemical cleaning building over the cask loading area. The purpose of the hoist system is to provide for removal and replacement of the demineralizers and prefilter/demineralizers when they have reached the maximum radioactivity loading permitted by the operating procedures or become chemically depleted. The radioactivity loading is limited by contact radiation dose rate readings on the vessel to meet personnel handling requirements as discussed in Section 4.0. The operation of the monorail hoist system is done remotely by use of a closed circuit TV system located in the control building adjacent to the chemical cleaning building.

The chemical cleaning building ventilation system maintains a negative pressure in the building. The exhaust ventilation system consists of a heating unit, moisture separator, a filtration unit, a fan assembly, a radiation monitor, and a weatherproof enclosure. Building exhaust air is passed through a moisture separator and an 80 KW heater to remove moisture from the air and lower its relative humidity to improve the iodine removal capabilities. The air is then passed through the filtration unit which consists of a prefilter, a high efficiency particulate air (HEPA) filter, a charcoal adsorber and a final HEPA filter. The HEPA filters are used to remove radioactive material in particulate form, while the charcoal adsorber is used to remove any

radioiodine that may be present in the offgas. The fan assembly draws air from the building and exhausts it through ducting to a local stack at the roof line of the chemical cleaning building. The radiation monitor installed in the discharge duct from the fan samples the air in the fan discharge line. Measurement of the ventilation system exhaust radioactivity is provided both locally and remotely in the control building in the event that radiation levels in the effluent stream exceed a predetermined level. These predetermined levels will be specified in the system operating procedures and in the plant radiological effluent technical specifications.

The chemical cleaning building sump is a stainless steel lined pit located in the northwest corner of the building. Any water from process vessel overflow or from other equipment leakage is collected in the sump. A sump pump transfers water from the sump to the OWRT. The sump pump starts automatically on a high level indication in the sump.

3.3.2 Sources of Radioactive Water

The EPICOR-II system will process the approximately 400,000 gallons of intermediate level waste water currently contained in TMI Unit 2 auxiliary building tanks. Waste water that is acceptable for processing in the EPICOR-II system is that which has Iodine-131 and Cesium-137 concentrations of less than 100 uCi/ml (intermediate level waste). Water that has higher radioactivity than intermediate level waste will be the subject of a separate environmental assessment. The tanks in TMI Unit 2 auxiliary building which are to be processed using the EPICOR-II system are the following:

1. Reactor coolant bleed tanks (3);
2. Miscellaneous waste holdup tank;
3. Auxiliary building sump;
4. Auxiliary building sump tank;
5. Neutralizer tanks (2);
6. Waste evaporator condensate tanks (2);
7. Contaminated drain tanks;
8. Miscellaneous sumps (4);
9. Fuel Handling Building tanks; (tank farm).

3.3.3 Volume and Activity of the Water to be Processed by the EPICOR-II System

Table 1 contains a listing of waste water inventories stored in TMI Unit 2 auxiliary building tanks which are intended to be processed by the EPICOR-II system. Table 2 contains a listing of principal radionuclide concentrations present in the waste water for radiological dose considerations for each of the sources in Table 1. Table 3 lists the half-lives of the principal radionuclides listed in Table 2.

The liquid volumes are established from tank level measurements taken by plant personnel. Activity levels are established from liquid samples analyzed by in-plant staff, as well as by Babcock & Wilcox. All liquids processed through the EPICOR-II system will have activity levels of less than 100 uCi/ml of Cs-137. Cs-137 will be the predominant and controlling isotope at the time these liquids are processed.

3.4 Design Features for Spill Prevention

There are a number of design features built into the EPICOR-II system to prevent spills of radioactive water. The following is a listing of these features and a discussion of each:

1. The piping carrying radioactive contaminated water from the miscellaneous waste holdup tank in the auxiliary building through the yard to the EPICOR-II system in the chemical cleaning building is enclosed within a four-inch diameter guard pipe. Radiation shielding has been provided around the guard pipe to minimize personnel exposure (see Section 4.0 for a discussion of radiation shielding and personnel exposure);

2. All system overflow lines run to the chemical cleaning building sump. The sump pump routes all collected leakage to the off-spec water receiving/batch tank. The sump pump is started either manually from the control panel or automatically. If pump start is automatic, it occurs when the sump level reaches a preset height. A high sump level alarm is also provided on the control panel in the control building;

3. Water level in the prefilter/demineralizer is maintained by a level probe and a solenoid valve. On high level, an alarm will sound at the pump control panel in the control building;

4. Level instrumentation in the demineralizers is similar to that for the prefilter/demineralizer. The high level alarm for the demineralizer will annunciate in the control building;

5. For the clean water receiving tank and the off-spec water receiving/batch tank, an overflow line with a loop seal is provided near the top of the tank. The overflow line routes any tank overflow to the chemical cleaning building sump. Tank level indication is provided on the control panel in the control building;

6. All system components which have flexible hose connections are provided with drip trays to collect leakage. Tubing from these drip trays is routed to the nearest floor or equipment drain;

7. All system liquid piping is welded stainless steel to prevent system leakage. All installed fittings and hoses have pressure ratings that exceed the maximum discharge pressure of the pumps used. All discharge hoses have a pressure rating of 600 psig or greater. All hoses and fittings will be hydrostatically tested prior to use. Pump diaphragms are designed to rupture at pressure greater than 125 psig. The maximum available air pressure to drive the pumps is 100 psig (thus protecting diaphragm integrity). All hose connections are taped and wrapped with plastic to contain drips from fittings.

8. All auxiliary building tanks are vented and operate at atmospheric pressure.

There are also design features to prevent spills of radioactive contaminated water from the tanks in the auxiliary building which are to be processed in EPICOR-II. These features have been previously evaluated and found acceptable in the Safety Evaluation Report related to the operation of the Three Mile Island Nuclear Station, Unit 2.[7] As indicated in that document, these design features will include level instrumentation which will alarm in the control room, and curbs and drains which will collect liquid spillage and retain it for processing. Also, the release of all processed liquids from the site is through the TMI Unit 1 or 2 discharge lines. Piping systems are designed so that transfers of processed water can be made between the EPICOR-II system, Unit 1, and Unit 2. In addition the capability also exist for transferring water to on site tanks outside the plant and not interfaced with discharge pathways. Water transferred to Unit 1 or back to Unit 2 will be placed in tanks and isolated from all other plant liquid systems. However, it is possible for valves to leak and for operators to make errors in valve line-up and recontaminate the processed water. To prevent the unauthorized release of liquids from the site, existing radiation monitors in the discharge lines from Units 1 and 2 which alarm and automatically initiate closure of discharge valves will be used.

We have also evaluated the potential consequences of a pipe break in the EPICOR-II system inside the chemical cleaning building. From a radiological standpoint, the worst case pipe break is a break in the liquid waste inlet pipe to the EPICOR-II prefilter/demineralizer. We conservatively assumed that during the accident, the EPICOR-II system operator would not monitor the system parameters for loss of liquid flow or processing pump shutoff from each of the three process vessels, or notice any abnormalities on the remote TV viewing system. Further, we assumed that the entire contents of approximately 20,000 gallons from the miscellaneous waste holdup tank would spill on the floor and partition iodine with a factor of 0.0075. The partition factor (the ratio of the quantity of a nuclide in the gas phase to the total quantity in both the liquid and gas phases when the liquid and gas are at equilibrium) value of 0.0075 is based on data presented in NUREG 0017.[3]

We assumed that the water is from the "C" reactor coolant bleed tank and that the iodine concentration in the spilled water is 3 uCi/cc (the highest concentration as of June 15, 1979). The building air is ventilated through the chemical cleaning building air filtration system consisting of HEPA filters and charcoal adsorbers and the iodine is subjected to an assumed decontamination factor (DF) of 20. Assuming a conservative meteorological dispersion factor (derived from R. G. 1.4)[8]. The calculated inhalation thyroid dose to an individual at the site boundary is less than 0.001 of the 10 CFR Part 20 limit.

We have also considered the potential consequences of a failure of the monorail system resulting in the dropping of a liner of demineralizer media during liner transfer operations. We conservatively assumed that, even though the liner is a carbon steel vessel, it ruptures when dropped releasing its contents to the truck loading pad. Since the demineralizer media will be dewatered prior to removal, the contents will be a relatively dry material which will remain on the loading pad.

In addition, we conservatively assumed that, even though there is no driving force for the radioactivity to be removed from the resins, the iodine partitions from the resin beads in a manner similar to that discussed above for water partitioning and becomes airborne. Based upon the specific activity of iodine on the resin corresponding to the iodine inlet concentrations of 3 uCi/ml (the highest concentration as of June 15, 1979) and the meteorology discussed above, the calculated inhalation thyroid dose to an individual at the site boundary is less than 0.01 of the 10 CFR Part 20 limit.

3.5 Design Features to Minimize Gaseous Releases

There are a number of design features built into the EPICOR-II system to minimize gaseous releases to the environment. The following is a listing of these features and a discussion of each:

1. The chemical cleaning building has been sealed with an epoxy sealant to minimize both inleakage and outleakage of air;

2. An exhaust ventilation system has been added to the building to maintain the building at a negative pressure. This prevents outleakage of air from the building and also routes any airborne radioactivity in the building to the exhaust ventilation filtration system;

3. The filtration system, consisting of HEPA filters and a charcoal adsorber provides removal of radioactive particulates and radioiodine, respectively, from the building air before it is released to the environment;

4. A radiation monitor in the ventilation system ductwork provides an indication of radiation levels both locally and in the control building. In addition, the radiation monitor will provide an alarm if the radioactivity in the release exceeds a predetermined level (this predetermined level will be specified in the system operating procedures and in the plant radiological effluent technical specifications). In this manner, releases of radioactivity will be carefully controlled within the predetermined limits set forth in the system operating procedures and the plant radiological effluent technical specifications;

5. Within the plant, the system tank vents are provided with in-line heaters, moisture separators, HEPA filters, charcoal adsorbers, and HEPA filters to adsorb evolved iodine and remove particulates. The vents from the prefilter/demineralizer and demineralizers are vented to the off-spec water receiving/batch tank;

6. The building sump will be a covered sump.

We have calculated gaseous releases as a result of operation of the EPICOR-II system based on the design capabilities of the system and the contaminants in the waste water. Based on these calculations, we estimate the release of Xe-133 will be less than 1 Ci and the release of I-131 will be less than 1×10^{-4} Ci as a result of processing all of the auxiliary building water. The off-site dose, as a result of such releases, would be insignificant (i.e., a total body dose of less than 0.0001 mrem and a thyroid dose of less than 0.01 mrem; these doses are less than 0.01% and 0.1%, respectively, of the total body and thyroid dose design objectives of 10 CFR Part 50, Apendix I[13]).

At the time of the initial writing of this environmental impact assessment iodine-131 and Cs-137 were the principal radionuclides considered for radiological dose considerations. As of September 28, 1979 approximately ten half-lifes for iodine 131 have passed, thus removing iodine-131 from the waste. The dissolved noble gases of xenon have likewise decreased to insignificant levels due to radioactive decay. Since the only release pathway considered in this assessment are gaseous releases, the removal by radioactive decay of iodine-131 and short half life noble gases have further reduced the risks of possible releases via the gaseous pathway. The calculated gaseous releases provided above establishes bounding values for estimating the maximum impact of I-131 and Xe-133 releases. Due to radioactive decay the impact of off-site doses will be significantly less than the calculated values above. The basis used for estimating bounding values follows:

1. Data obtained on nuclide activity levels in the reactor coolant and the reactor coolant bleed tanks as of June 15, 1979;
2. Data on EPICOR-II system flow rate and chemical cleaning building ventilation rate;
3. Design of charcoal adsorbers on the off-spec receiving tank vent and in the chemical building ventilation exhaust filtration system.

3.6 Conformance of EPICOR-II System Design with NRC Regulatory Guides

1. The EPICOR-II liquid waste processing system and building housing the system meet the design criteria of Regulatory Guide 1.143.[9]
2. The building ventilation system for the building housing EPICOR-II is designed in conformance with Regulatory Guide 1.140.[10]
3. The effluent monitor for the building ventilation exhaust system for EPICOR-II is in conformance with the requirements of Regulatory Guide 1.21.[11]
4. The radiation protection design of the EPICOR-II system, the chemical cleaning facility, and the spent filter and resin handling systems are consistent with the guidance of Regulatory Guide 8.8, "Information Relevant to Insuring that Occupational Radiation Exposure at Nuclear Power Systems will be as Low as is Reasonably Achievable."

4.0 Occupational Exposure

A design criterion for the facility was that occupational exposure should be maintained "as low as is reasonably achievable." Therefore, the design was made consistent with the guidance of Regulatory Guide 8.8. The sections below describe the design and operational features included to minimize occupational exposure. The anticipated dose rates and occupational exposures are also described.

Concrete shield walls, 12 inches thick and 13.5 feet high, surround the EPICOR-II processing area. The prefilter/demineralizer is installed inside a cylindrical concrete cask, 12 inches thick. The cask is then surrounded by a rectangular lead brick wall, 5 inches thick. The top of the prefilter/demineralizer is covered with a portable lead shield. The prefilter/demineralizer is also covered by a steel lid, 5 inches thick. The lid has cutouts for the hose connections. The cation bed demineralizer is installed inside a cylindrical concrete cask, 12 inches thick. The cask is surrounded by a portable lead shield and by a steel lid, 5 inches thick. The lid has cutouts for hose connections. Shield collars will be installed around the pipes in these cutouts on the prefilter/demineralizer and cation demineralizer. The mixed bed demineralizer is also surrounded by a rectangular lead brick wall, 3 inches thick. The strainer is shielded with 8 inches of concrete block. The post-filter is shielded with 3 inches of lead brick. The feed line from the TMI Unit 2 auxiliary building is shielded by lead bricks, 4 inches thick. The shield bell used to transfer the spent prefilter/demineralizer and cation bed demineralizer onto the transport vehicle and cask provides 3-1/2 inches of lead shielding. Concrete walls, 24 inches thick, separate the rooms through which the building is accessed from the room containing the prefilter/demineralizer and demineralizers. A water box window, 18 inches thick, is included in this wall to allow direct viewing of the system from a shielded area.

The EPICOR-II facility has radiation monitors mounted inside the lead brick walls around the prefilter/demineralizer and the demineralizers. The design criteria call for the prefilter/demineralizer to be changed if the prefilter/demineralizer reaches a dose rate at contact of 1000 rem per hour. The cation bed demineralizer, mixed bed demineralizer, strainer, and post-filter will be changed when dose rates at contact reach 400, 20, 3, and 3 rem per hour, respectively. We estimate that there will be approximately 50 changes of prefilter/demineralizers and demineralizers as a result of EPICOR-II processing of the intermediate level waste water in the auxiliary building. This estimate is based on the prefilter capacity and the demineralizer ion exchange capacity. The total volume of solid radwaste generated is estimated to be approximately 2500 cubic feet based on 50 changes of prefilter/demineralizers and demineralizers.

The truck which is used to transfer the spent prefilters/demineralizers and demineralizers to a temporary on-site storage facility has a cylindrical reinforced concrete shell 15 inches thick. The transfer shield bell holding the spent prefilter/demineralizers or cation bed demineralizer will be placed inside this concrete shell for additional shielding. The mixed bed demineralizer will be lifted into this shell without a transfer bell. After transport from the chemical cleaning building to the temporary on-site storage facility, the spent filters and liners will be transferred from the tranfer bell to individual shielded cells for temporary storage prior to shipment to a low level waste burial facility. As shipping casks become available, the liners will be hoisted from the storage cell into the transfer bell, and, thence, to a licensed shipping cask for off-site disposal in an approved facility.

The control building for EPICOR-II is located outside of the chemical cleaning building. The operators can control the system in the facility from this control building by means of remote cameras, controls and readouts from instrumentation. Using the crane and transfer bell, the spent prefilter/demineralizers and demineralizers can be removed from the facility without entering the EPICOR-II room. Since the hose connections and disconnection of the prefilter/demineralizer and demineralizer process vessels will require direct handling by personnel, quick connect/disconnect hoses and caps will be used. Ladders will be provided to facilitate access to the tops of the prefilter/demineralizer and demineralizers to make connections. Features are included to allow flushing of piping and hoses and to allow sampling to be performed from the outside of the EPICOR-II room.

The operators for EPICOR-II will be trained in the operations of the system. This training will include numerous trial operations of the various systems before radioactive water is processed. The EPICOR-II system uses the same type of equipment that the operators are already experienced in operating. Coverage by health physics personnel will be provided whenever the EPICOR-II building is accessed.

Based on the contact dose rate limits on the prefilter/demineralizer and demineralizers, the shielding provided for the process vessels, and the thickness of the lead brick walls, the following is a discussion of estimated radiation dose rates.

The estimated radiation dose rates outside of the lead brick walls surrounding the prefilter/demineralizers, cation bed demineralizer and mixed bed demineralizer are 30, 1 and 10 millirem per hour, respectively. The estimated dose rate on top of the steel cover plates above the prefilter/demineralizer and cation bed demineralizer is 100 and 40 millirem per hour, respectively, with approximately 1 rem per hour above the cutouts due to streaming. The estimated dose rate above the mixed bed demineralizer

is 20 rem per hour. The estimated dose rate at contact with the strainer and post-filter is 3 rem per hour. The estimated maximum dose rate outside the facility is 1 millirem per hour except during prefilter/demineralizer or demineralizer removal by crane. The estimated dose rate outside of the the facility is 1 millirem per hour except during prefilter/demineralizer or demineralizer removal by crane. The estimated dose rate outside of the transfer bell is 60 millirem per hour with the prefilter/demineralizer in the bell and 25 millirem per hour with the cation bed demineralizer in the bell. The estimated dose rate outside of the shield shell on the truck is 4 millirem per hour with the prefilter/demineralizer in it, 2 millirem per hour with the cation bed demineralizer in it, and 700 millirem per hour with the mixed bed demineralizer in it. The estimated dose rate at a distance of 50 feet from the truck for each type of vessel is less than 1 millirem per hour. For a very short time during placement into and removal from the truck or storage cell, the mixed bed demineralizer could have a maximum dose rate on contact of 20 rem per hour. As discussed in Sections 5.2.1 and 5.2.2, the estimated dose rate in both the interim storage facility and concrete storage facility areas is 5 millirem per hour. To reduce occupational exposures in the interim storage facility and concrete storage facility areas, these areas will be roped off, thus not permitting normal personnel access. In this way, there will be very low levels of occupational exposures while the liners are stored onsite.

The estimated maximum dose to an individual at the site boundary on a continuous basis is less than 1 millirem. This dose includes all of the handling operation and is less than 4% of the 25 millirem annual limit in 40 CFR 190.

Disconnections of hoses and capping of spent prefilters/demineralizers and demineralizers will be the highest occupational dose activity associated with EPICOR-II operation. These activities require direct handling by personnel in radiation fields above the prefilter/demineralizer, cation bed demineralizer and mixed bed demineralizer of 100 millirem per hour, 40 millirem per hour and 20 rem per hour, respectively. Although radiation levels above the cutouts in the steel plates above the prefilter/demineralizer and cation bed demineralizer will be higher due to streaming, use of proper tools for disconnections will make exposure to these streaming fields unnecessary. We estimate that a prefilter/demineralizer or demineralizer can be disconnected and capped by a trained operator in an average time of about 30 seconds.

Based on the frequency that these activities will be necessary, we estimate that operation of EPICOR-II will cause 1-5 man-rem of occupation dose. This exposure can be related to an increasd cancer death probability by use of the linear, non-threshhold, dose-rate independent, dose-effect relationship. This relationship defines the probability that an individual dies of cancer from radiation exposure as 10^{-7} per year-rem. This results in a probability of 5 x 10^{-7} per year that someone dies of cancer from the 5 person-rem occupational exposure, a number much closer to zero than to one, hence, it is expected that no cancer deaths will result from this exposure. This estimate includes all activities involved in the operation of EPICOR-II, the handling and transfer of liners to and from the temporary storage facility, up to the time when the spent prefilter/demineralizer liner and cask or spent demineralizer liner and cask is loaded on the truck for shipment to an approved burial facility. This estimate is a very small percentage (less than 1%) of the total annual occupational dose at a nuclear power plant. The dose to individuals involved in the operation of EPICOR-II will be within the limits of 10 CFR Part 20 and maintained as low as is reasonably achievable. The dose to individuals will be of similar magnitude to that normally received by individual workers at a nuclear power plant (i.e. approximately 700 millirem/year).

5.0 Management of Solid Waste

5.1 Introduction

The operation of EPICOR-II will generate approximately 50 liners of dewatered solid waste (prefilter media and ion exchange resin) which will require on-site handling, temporary on-site storage, packaging, transportation, and ultimate burial in an approved low level waste burial facility. The prefilter media and ion exchange resins will be changed well before any resin degradation could occur due to radiation levels. The 50 liners will include approximately 32 prefilter/demineralizer liners, 8 cation bed liners, and 6 mixed bed liners. The prefilter/demineralizer and cation bed liners are 4' diameter by 4' high cylindrical vessels and the mixed bed liner is a 6' diameter by 6' high cylindrical vessel. Since spent liners will be generated at a faster rate than they can be packaged and shipped off-site, due to limited shipping cask availability, they will be temporarily stored in an on-site facility and shipped as casks become available. An interim storage facility has been constructed for temporary on-site storage of spent liners until a larger concrete, weather-protected (from freeze-thaw cycles) facility can be constructed (estimated completion is November 1, 1979). The NRC on-site staff has provided design criteria and guidance for both storage facilities from initial conceptual design to final design approval. For the interim storage facility, the staff provided daily monitoring and inspection of the construction activities to ensure conformance with design criteria.

5.2 On-Site Storage of Solid Waste

5.2.1 The Interim Storage Facility

An interim storage facility has been constructed in the Unit 2 cooling tower desilting basin which can provide shielded storage for 28 spent liners from the operation of EPICOR-II. The facility is located inside the diked area of the station and is protected against the station design basis flood (1,100,000 cubic feet per second of river flow). The facility consists of sixteen cells 4.5' in diameter by 8' high and twelve cells 7' in diameter by 8' high. The smaller diameter cells are sized to accommodate spent prefilter/demineralizer and cation demineralizer liners from EPICOR-II and the larger diameter cells are sized to accommodate the spent mixed bed liners from EPICOR-II. The cells consist of galvanized corrugated metal cylinders which have been provided with welded steel plates to act as a base. The base plates are painted on the outside surface to inhibit metal corrosion and the cylinder/plate weld joint was epoxied for the same purpose. The inside surface of the cell is coated, up to a height of several feet, with a special paint that permits the surface to be easily decontaminated. In addition, each cell is provided with a galvanized drip pan in which the liner is placed to collect any leakage or drippage. The leak integrity of the liner, the cells and the drip pan will prevent migration of radioactivity from the liners to the groundwater. In addition to that protection, a well will be drilled in the proximity of the storage facility which will be monitored to assure that no activity migrates from the liners to the groundwater. The cells are placed on compacted earthen fill in the Unit 2 desilting basin and backfilled with compacted earth to provide stability and shielding for the cells. The area around the cells is provided with a gravel base and topped with several inches of asphalt. The area around the cells is also graded to direct rain water away from the cells. Each cell is provided with a 16-ton rectangular concrete shield plug (3' thick). The storage cell and plug are designed to limit the contact dose rate to 5 mrem/hr or less. All transfers of spent liners into and out of the storage cells, including removal of and placement of the shield plugs, will be made with a mobile crane (100-ton capacity with 110' boom) which is dedicated to the facility.

We considered the effect of dropping of a liner in the interim storage facility. The radiological effect of this accident will be the same as the liner drop accident in Section 3.4.

5.2.2 The Concrete Storage Facility

The concrete storage facility will be a modular structure with each module consisting of approximately 60 storage cells. The modules will be built on an as-needed basis. The module will be located in the proximity of the interim storage facility and sufficient space exists to construct up to six modules. The module design will resemble a rectangular-shaped concrete tube with dimensions of 57' wide by 91' long by 19' high. The module base will be 3' thick and walls will be 4' thick for required shielding (i.e. less than 5 mrem/hr from all surfaces). The concrete storage facility is also located in the diked protected area of the station and is protected from the station design basis flood.

In addition to the dike, the elevation of the structure will be sufficient to accommodate the station design basis flood. The module cells will consist of concrete shielded, galvanized, corrugated steel cylinders with welded steel base plates. The cell dimensions will be 7' in diameter by 13' high. The top shielding for the cells will be 3' thick rectangular concrete plugs. The plugs will be needed to prevent rain water inleakage to the cells. The cell interior surface will be painted with a coating which will facilitate decontamination. The leak integrity of the liner and the cells will prevent migration of radioactivity from the liners to the groundwater. In addition to that protection, the cell base plates will be provided with a drain line leading to a sump to collect washdowns or liner drippage. The sump will hold approximately 1000 gallons and will be equipped with level indication and alarm on high level. All liquids collected in the sump will be sampled and analyzed for radioactivity and processed as required (for example, through EPICOR-I). Non-radioactive sump water (for example, rain water) will be discharged through a radiation monitor to the station drainage system. The sump will be designed to the seismic criteria of Regulatory Guide 1.143. The module will be serviced by the same mobile crane which is utilized for the interim storage facility. The module will be capable of housing one liner 6' in diameter by 6' high per cell or two liners 4' in diameter by 4' high per cell, thus providing considerable flexibility in the storage scheme. All liner transfers into or out of the cell will be as described for the interim storage facility. The module will be designed to protect the stored liners from the freeze-thaw cycle and the sump will be protected from freezing. Shipment of liners to an approved burial facility will occur as licensed shipping casks become available.

We considered the effect of dropping of a liner in the concrete storage facility. The radiological effect of this accident will be the same as that discussed for the liner drop accident in Section 3.4.

5.2.3 Packaging and Transportation of Solid Waste

All solid waste from the operation of EPICOR-II will be packaged and transported in accordance with existing DOT and NRC regulations (i.e. 49 CFR Parts 171-179 and 10 CFR Parts 20 and 71) to a licensed burial facility for ultimate disposition. Section V-E of the Final Environmental Statement (FES)[12] for Three Mile Island Nuclear Station, Units 1 and 2, provides a discussion of the potential hazards associated with the transport of radioactive materials and estimates of the radiological impact to members of the general public. Section 5.4 of the Final Supplement (NUREG-0112) to the FES, dated December 1976, provides an update of this discussion. The planned shipment of packaged solid waste from the operation of EPICOR-II does not alter the discussion of the radiological impact associated with the transportation of solid waste already provided in the FES and the supplement to the FES.

5.2.4 Burial of Solid Waste

Section 5.4.3 of the Final Supplement to the FES provides a discussion of the environmental effects of the uranium fuel cycle, including burial of solid waste. The planned burial of solid waste generated from the operation of EPICOR-II does not alter the discussion of the impact associated with the burial of solid waste already provided in the supplement to the FES.

6.0 Alternatives to Water Processing and the Use of EPICOR-II

There are three basic alternatives for handling the TMI Unit 2 intermediate level radioactive waste water. One is transport of liquids offsite, a second is continued storage of liquid in TMI Unit 2 auxiliary building tanks, and the third is processing to clean the water for ultimate disposition. First, we considered the shipment of contaminated water directly off-site. Because of the hazards involved, such as potential spillage due to transportation accidents and shielding requirements, and because the low level waste burial grounds will not accept free liquid wastes for burial, the staff concludes that packaged liquid wastes would not be an acceptable alternative.

The second alternative considered, the continued storage of water in either the TMI Unit 2 auxiliary building tanks or additional new storage tanks, would result, first of all, in a continued accumulation of occupational exposure in order to maintain the plant in a safe shutdown condition. The continued storage of liquid in the TMI Unit 2 auxiliary building tanks, or in additional new storage tanks, represents a source of direct and airborne radiation to the workers who must occupy the auxiliary building to maintain the plant in a safe shutdown condition including such activities as taking samples, making plant modifications, operating the gaseous radwaste system, taking radiation surveys, performing maintenance activities on system components, and decontaminating the affected areas of the entire building. The worker problems associated with water storage are exacerbated by required water movements due to water inleakage or the need to move water from one tank to another to provide surge capacity. The staff estimates this is presently resulting in an occupational exposure of about 15 man-rems for each month this situation remains in its present state. Furthermore, the inability to perform required maintenance activities in the auxiliary buidling has an ultimate, deleterious impact on releases of radioactive materials in gaseous effluents to the environment because of leakage from components which contain affected gas. Second, and more important, there is little remaining surge capacity for additional liquid waste left in the TMI Unit 2 tanks. As of July 3, 1979, a total of about 280,000 gallons of waste water had been collected in TMI Unit 2 tanks, leaving approximately 25,000 gallons of available surge capacity. (The surge capacity is the amount of tank storage capacity available to receive additional inputs). With daily water inleakage rates ranging from 0.2 to 1.0 gpm from components within the auxiliary building, the waste water inventories are increasing on a daily basis, further reducing the available surge capacity. If surge capacity is lost, this creates potential problems such as tank overflows, system spillage, etc.. Available surge capacity is needed not only for daily inleakage, but also for receipt of containment building water, should the need arise for transfer. The level of water in the containment building is also rising (due to continuous component leakage) and poses a threat to components in the lower elevations of the building. Should a contingency arise, some water in the containment building may have to be transferred to available TMI Unit 2 tankage to prevent the failure of components necessary for the continued safe shutdown and rehabilitation of the facility.

Storage of water could be accomplished in additional new storage tanks, which would have to be constructed especially for this purpose, but these new storage tanks would represent a source of occupational exposure similar to that for the Unit 2 auxiliary building tanks. In addition, the addition of new tanks would do little to relieve the immediate surge capacity problem discussed above since it would take a long period of time to construct tanks, and a building to house these tanks, which would meet the design criteria required for components to hold this radioactive water.

The third alternative is processing the water to remove the radioactivity. By processing the waste water in the auxiliary building tanks, the major

source of direct and airborne radiation is removed and chemically bound on an immobile matrix (i.e. prefilter and resin material). Processing of waste water also reduces the likelihood of tank overflows (due to limited surge capacity) and subsequent transport of the contamination to the environment. There exists three (3) options for processing the water:

1. Existing Radwaste Systems

   TMI Unit 2 water can be processed in the existing TMI Unit 1 or 2 radwaste systems. However, since these systems are not specifically designed for handling intermediate-level wastes, the systems are not capable of producing water of sufficient quality for discharge. In addition, the overall recovery would likely be delayed since water recycling back through the system would have to occur to achieve water capable of satisfying release requirements. The effects of the overall accident would be expanded to equipment and plant systems (Unit 1) not now exposed to the accident produced intermediate-level waste.

2. New EPICOR-II Radwaste System

   The new EPICOR-II Radwaste System is specifically designed to process intermediate-level waste and, therefore, it is capable of producing discharge quality water by means of a proven technology (i.e., ion exchange methodology). The system is operational allowing a recovery sequence to proceed in an orderly, timely fashion. Although it is a newly constructed system, sufficient time is available to fully test it and demonstrate its operability, reliability, and operator proficiency.

3. New Radwaste Systems

   The most viable alternative to a filtration/demineralization process for the cleanup of intermediate-level waste is the process of evaporation and subsequent condensation of the distilled water. An evaporation process was rejected on the basis of the long lead time required to make the system available (at least six months). In addition, systems employing evaporators are not as reliable as filtration/demineralization systems due to such evaporator problems as pump failure and tube failure, resulting in evaporator outages approximately 30% of the time.[3] Thus, a system employing evaporators would be less efficient in reducing the large inventory of intermediate-level waste. Based on operating experience at other plants, the required additional maintenance on an evaporator system due to the evaporator outages would result in higher occupational exposures than for a filtration/demineralizer system. Special design provisions could mitigatge this difference, however.

It is therefore concluded that protection of the public health and safety would be enhanced by the processing of the contaminated water to the maximum extent possible since immobilization of the activity currently held in the liquid would render this activity a less likely source of public or occupational exposure. It is also concluded that the best alternative is to process intermediate-level waste through a system specifically designed for that purpose, namely, the EPICOR-II processing system. The earlier the decision to proceed with water processing (irrespective of the method) is made, the less the total accumulated exposure, occupational and public, is likely to be. Once the water is removed from the auxiliary building tanks , the dose resulting from the ultimate decontamination of structures and components will be incurred regardless of the method used for processing of the water.

7.0 Evaluation of Impacts

The processing of contaminated waste by the EPICOR-II system will entail exposure to workers as described above and releases of small amounts of Xe-133 and I-131 to the environment. Occupational exposures of less than 5 man-rem constitute about 1 percent of the anticipated man-rem exposure for one year of normal facility operation. Off-site exposure is expected to be less than one mrem which is well within applicable NRC and EPA guidelines.

Since the major source of direct and airborne radiation in the auxiliary building will be removed by processing the intermediate-level waste water through EPICOR-II, the occupational exposure would be less than the exposure incurred by leaving the waste water in storage. Also, by processing the waste water to allow for component maintenance and decontamination activities, the off-site releases in gaseous effluents can be reduced from current levels. Therefore, we conclude that the processing of the auxiliary building contaminated water through EPICOR-II will not have an adverse impact and will probably lessen the impact of the already contaminated water.

8.0 Summary

Our evaluation supports the conclusion that the proposed EPICOR-II system is acceptable because:

1. The design of the EPICOR-II system meets or exceeds the guidance given in Regulatory Guide 1.143, 1.140 and 1.21;
2. The system design is such as to prevent spills of radioactive water; even in the unlikely event of a spill, our evaluation of the consequences of this event show that they are insignificant;
3. The system design is such that releases of radioactive material in gaseous effluents will be insignificant;

4. The design and operational considerations to minimize occupational exposure are consistent with the guidance given in Regulatory Guide 8.8;
5. The occupational exposure due to system operation and handling and storage of solid waste corresponds to less than 1 percent of the normal annual average for a nuclear power plant;
6. The dose at the site boundary due to direct radiation from the system operation and handling and storage of solid waste will be a small percentage of the limits of 40 CFR 190.

Based on our estimate of gaseous releases during operation of the EPICORE-II system, including a release due to an accidental spill, and our estimate of occupational dose and our estimate of direct radiation off-site, we conclude that the operation of this system does not constitute a significant environmental impact. We further conclude that the health and safety of the public will not be endangered by operation of the system in the proposed manner and that such activities will be conducted in full compliance with the Commission's regulations.

9.0 Conclusion

We have determined, based on this assessment, that the proposed use of EPICOR-II for the processing of contaminated waste from the TMI Unit 2 auxiliary building will not significantly affect the quality of the human environment. Therefore, the Commission has determined that an environmental impact statement need not be prepared, and that, pursuant to 10 CFR 51.5(c), issuance of a negative declaration to this effect is appropriate.

TABLE 1

RADIOACTIVE WATER VOLUMES FOR TMI UNIT 2 WHICH WILL BE PROCESSED BY EPICOR-II

	VOLUME (gallons)
Reactor Coolant Bleed Tank A	77,250
Reactor Coolant Bleed Tank B	77,250
Reactor Coolant Bleed Tank C	77,250
Neutralizer Tank A	8,780
Neutralizer Tank B	8,780
Miscellaneous Waste Holdup Tank; Auxiliary Building Sump and Sump Tank; Miscellaneous Sumps	13,500
Waste Evaporator Condensate Tanks; Contaminated Drain Tanks	16,200
Fuel Handling Building Tanks (Tank Farm)	110,000

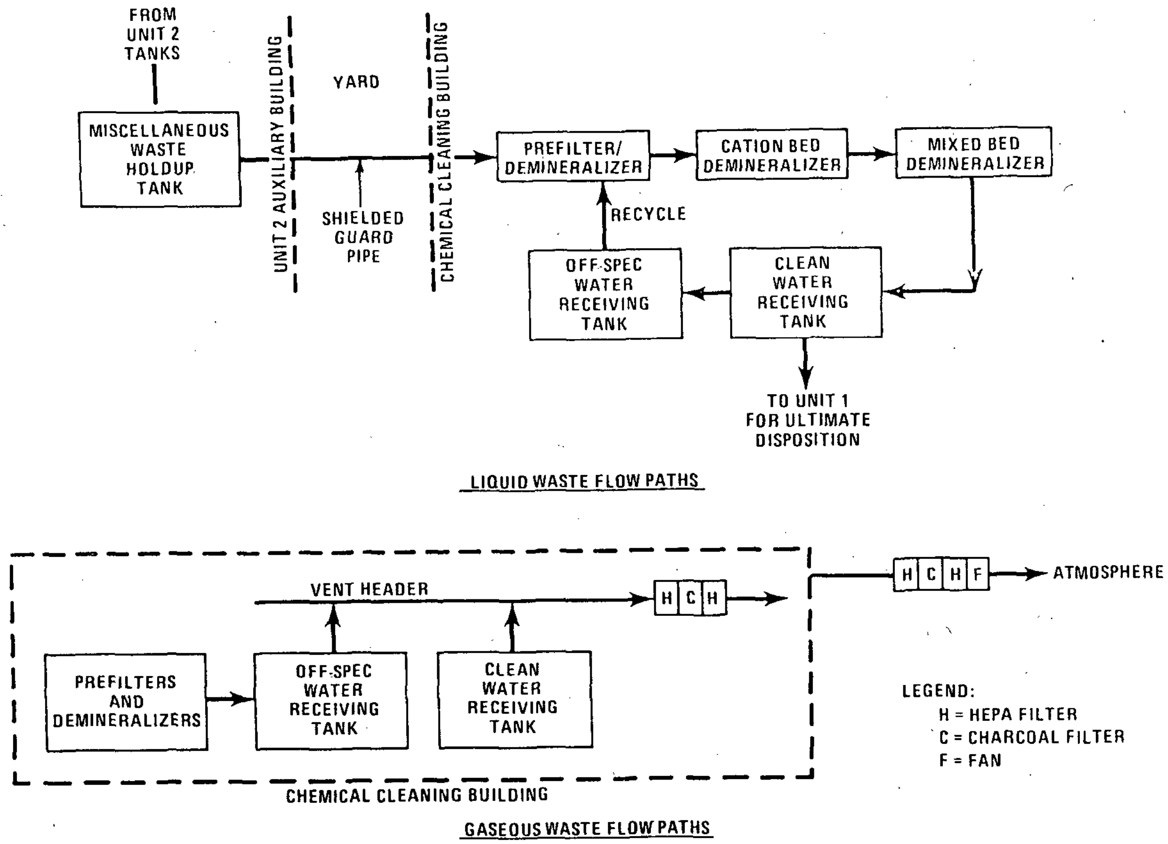

Figure 1. Flow Schematic of EPICOR II Processing System

TABLE 2

CONCENTRATIONS OF PRINCIPAL NUCLIDES IN TMI UNIT 2
AUXILIARY BUILDING TANKS TO BE PROCESSED BY
EPICOR-II CORRECTED FOR RADIOACTIVE DECAY TO 6/15/79
uCi/ml

	Reactor Coolant Bleed Tank A	Reactor Coolant Bleed Tank B	Reactor Coolant Bleed Tank C
I-131	1.9	2.8	3.0
Cs-134	6.5	7.6	7.7
Cs-136	0.28	0.29	0.28
Cs-137	28	35	35
Ba-140	0.09	0.3	0.29
H-3	0.23	0.27	0.29

	Neutralizer Tank A	Neutralizer Tank B	Miscellaneous Waste Holdup Tank Auxiliary Building Sump and Sump Tank; Miscellaneous Sumps	Evaporator Condensate Tanks; Contaminated Drain Tanks
I-131	0.15	0.18	1.0	10^{-1}
Cs-134	0.56	0.72	2.4	10^{-1}
Cs-136	0.01	0.02	0.08	10^{-1}
Cs-137	2.5	3.3	10.1	10^{-1}
Ba-140	.01	0.03	0.8	10^{-1}
H-3	*NA	*NA	0.98	*NA

*Not analyzed as yet. H-3 levels are estimated to be less than 0.2 uCi/ml.

TABLE 3

RADIOACTIVE HALF-LIVES
OF PRINCIPAL NUCLIDES

	Radioactive Half-Lives
I-131	8.08 days
Cs-134	2.07 years
Cs-136	12.9 days
Cs-137	30 years
Ba-140	12.8 days
H-3	12.2 years

REFERENCES

1. NUREG/CR-0141, "Use of Filtration to Treat Radioactive Liquids in Light-Water-Cooled Nuclear Reactor Power Plants," September 1978.

2. NUREG/CR-0143, "Use of Ion Exchange to Treat Radioactive Liquids in Light-Water-Cooled Nuclear Reactor Power Plants," August 1978.

3. NUREG-0017, "Calculation of Releases of Radioactive Material in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," April 1976.

4. 10 CFR 50.34a, "Design Objectives for Equipment to Control Releases of Radioactive Material in Effluents, Nuclear Power Reactors".

5. 10 CFR 20, "Standards for Protection Against Radiation".

6. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be as Low as is Reasonably Achievable", Rev. 3, June 1978.

7. NUREG-0107; Safety Evaluation Report related to operation of Three Mile Island Nuclear Station, Unit 2, Docket No. 50-320, September 1976.

8. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences for a Loss of Coolant Accident for PWRs".

9. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Power Plants", July 1978.

10. Regulatory Guide 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants", March 1978.

11. Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants", Revision 1, June 1974.

12. Final Environmental Statement Related to the Operation of Three Mile Island Nuclear Station Units 1 and 2, NUREG-0552, December 1972.

13. Code of Federal Regulations, Title 10, Part 50, Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operations to Meet the Criterion 'As Low As is Reasonably Achievable' for Radioactive Material in Light-Water-Cooled Nuclear Power Plant Effluents."

APPENDIX E. FISH AND FISHERIES OF YORK HAVEN POND AND CONOWINGO POND OF THE SUSQUEHANNA RIVER AND UPPER CHESAPEAKE BAY

E.1 THE YORK HAVEN POND FISH COMMUNITY

Fifty-six species of fishes were recorded in York Haven Pond during the period 1974-1978.[1,2] Catches by seine, trapnet, and electrofisher have shown the most abundant were spotfin shiner, spottail shiner, tessellated darter, sunfishes (redbreast, pumpkinseed), rock bass, smallmouth bass, channel catfish, quillback, carp, walleye, black crappie, white crappie, white sucker, and bluntnose minnow.[1] Some species show patterns of abundance or distribution that correspond with preferred habitat or spawning period.[2] For example, the relative abundance of sunfishes and smallmouth bass (especially juveniles) is greater in the east channel (Fig. E.1) than in other areas studied in the York Haven Pond, perhaps because of the shallow, slow-moving nature of the east channel and to the food resources that are abundant there.

York Haven Pond fish larvae first appear in mid- to late April with peak densities occurring about one month after the first larvae are taken, generally late May to mid-June.[3,4] The most abundant species have been carp, spottail shiner, spotfin shiner, quillback, channel catfish, pumpkinseed/bluegill, tessellated darters, and banded darter. In 1978 and 1979, respectively, 32 and 30 total species were recorded during ichthyoplankton sampling. Generally, larval densities have been highest in the east and west channels. Carp, quillback, and banded darter have been in relatively high abundance in the center channel along the western shore of Three Mile Island.

An annual tagging program has been used to study the movements of York Haven Pond fishes since 1974.[3,4] Most recaptures of tagged fish have been within York Haven Pond (bounded by Fall and Hill islands to the north and Red Hill and York Haven dams to the east and south--Fig. E.1), and all the species studied have exhibited movements upstream, downstream, and across channels within the pond. Fishes also have moved out of the pond both upstream beyond Fall Island and downstream over the York Haven Dam.[2,4] Movements out of the pond have been most frequent among smallmouth bass, rock bass, and walleye. Downstream movements have been to within a few kilometers of the York Haven Dam. Upstream movements have been primarily within the river proper, but movements into tributaries (Swartara Creek, Juanita River, west branch Susquehanna River, Chenango River) also have occurred. Upstream angler recaptures of tagged smallmouth bass and rock bass have been principally in the river between Fall Island and Harrisburg. Most walleye recaptures have been in the river near Sunbury, Pennsylvania, about 105-107 km upstream from TMI, although a few walleye have been taken in the Susquehanna River and the Tioughnioga River in New York State (428 km and 468 km distant, respectively).

Food Habits of York Haven Pond Fishes

The predominant source of food for the fishes of York Haven Pond is the bottom invertebrate community, primarily aquatic insects, crayfish, and amphipods (scud). Other categories of food items are filamentous algae, detrital material, oligochaetes (aquatic worms), molluscs (snails), and small crustacean species (copepods, ostracods, cladocerans). Fish also serve as a food source, but are secondary to the invertebrates, except for walleye, which is a strict carnivore of fishes.[2-7]

The basic food web of the fishes is simplified in Figure E.2 into categories of "eater types" based upon the food organisms that predominate in stomachs of the species studied. Most of the fishes eat a wide variety of organisms, but usually a few types (e.g., crayfish) or groups (e.g., insects) dominate the diet.

The next and highest link in the food web of York Haven Pond is man, through the recreational fishery.

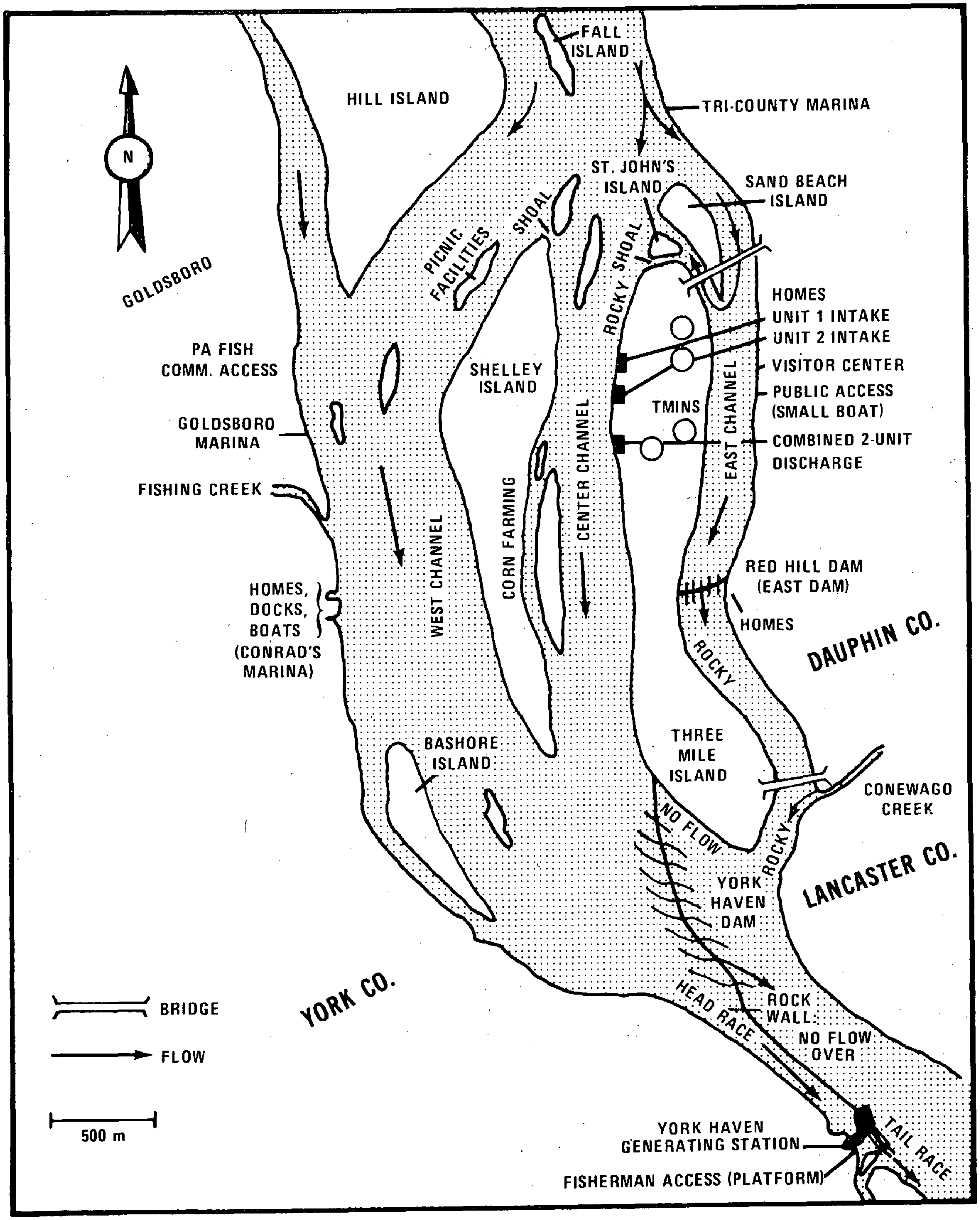

Figure E.1. York Haven Pond of the Susquehanna River Showing the Location of Three Mile Island and the Nuclear Station, the Generalized Flow Patterns in the Channels and over the Dams, and the Peripheral Facilities that Contribute to Use of the Pond by Fishermen and Boaters.

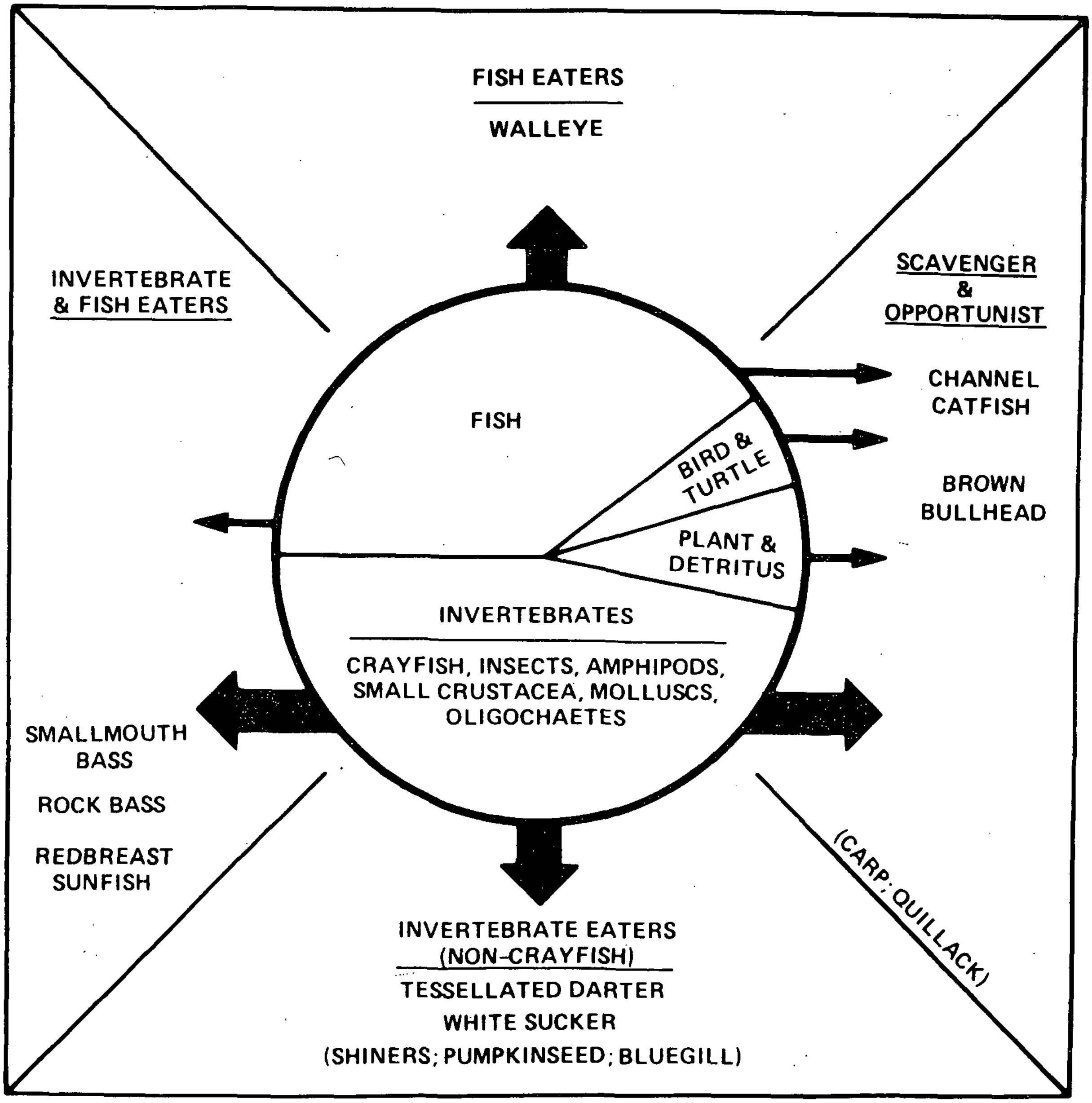

Figure E.2. Generalized Categories of "Eater Groups" of the Fishes in York Haven Pond of the Susquehanna River. The circle in the center represents the food resources consumed by the pond fishes that are listed by eater group around the periphery. The large dark arrows indicate the major food resource of each group, while the small arrows indicate the secondary food resource(s) of a group. The fishes in parentheses are species that occur in York Haven Pond but for which the food preference studies were conducted in the North Branch Susquehanna River upstream of Three Mile Island.

Fisheries

The recreational fisheries of the Three Mile Island vicinity have been studied since 1974.[2-7]

Angler creel surveys have been conducted on two weekend days and two weekdays per month in four areas near Three Mile Island: the York Haven Pond (including the waters of the east, center, and west channels from Fall and Hill islands at the north to Bashore Island and the York Haven Dam at the south--Fig. E.1); the Red Hill Dam; the York Haven Dam; and the York Haven Generating Station (hydroelectric) tailrace. Fishing at the Red Hill Dam, York Haven Dam, and in the tailrace area occurs on the downstream sides and thus is not within the pond formed by the York and Red Hill dams. Data on recreational fishing in the TMI vicinity (at all four survey areas) during 1974-1979 are given in Table E.1.

Table E.1. Estimates of Recreational Fishing in Vicinity of TMI, 1974-1979[a]

Year	Anglers	Fish Caught	Fish Kept	Hours Fished	c/e[b]
1979	13,962	29,396	7,306	24,546	1.20
1978	14,089	27,976	9,490	27,992	1.00
1977	7,791	12,089	5,341	14,773	0.82
1976	12,265	19,992	6,623	21,341	0.94
1975	11,287	16,253	8,578	21,220	0.77
1974	10,837	15,714	7,044	19,940	0.79

[a]Based on data from four survey areas: York Haven Pond, Red Hill Dam, York Haven Dam, and York Haven Generating Station. (From: G.A. Nardacci and Associates, "An Ecological Study of the Susquehanna River near the Three Mile Island Nuclear Station, Annual Report for 1979," Ichtyological Associates, Inc., Etters, PA, April 1980.)

[b]c/e = catch/effort, or the number of fish caught divided by the number of hours fished.

The most frequently caught species have been smallmouth bass, channel catfish, walleye, rock bass, sunfishes, carp and suckers. The bulk of the harvests in the pond during 1977 and 1978, respectively, were smallmouth bass (44% and 61%), channel catfish (25% and 13%), sunfishes (15% and 14%), and rock bass (15% and 9%).

Smallmouth bass, rock bass, and sunfishes (predmoninantly bluegill, pumpkinseed, and redbreast) have been caught in greater numbers in the pond than below either dam or in the tailrace, although smallmouth bass frequently are taken in all survey areas. Walleye are commonly taken below the dams and at the tailrace area but have been caught infrequently in the pond, based on creel surveys. Channel catfish have been caught relatively infrequently at the east dam, but have been common in other areas surveyed, with the most caught in the tailrace area. The pond has accounted for about 36% and 31% of all fishes caught in the vicinity during 1977 and 1978, respectively, for 29% and 40% of the total anglers, and 29% and 44% of the total hours fished. Overall, smallmouth bass catches have been greatest during May-June, rock bass during May, channel catfish during July, walleye during May, and sunfishes during June-July.

Fishing localities within York Haven Pond are indicated by the places of angler recaptures of tagged fishes. The concentration of recaptures in specific areas could be related to availability of fishes and nearness to access facilities (Fig. E.1).

The fishing year on York Haven Pond in the Three Mile Island vicinity extends principally from April through November; some fishing occurs prior to April and after November, but is dependent on weather and river flow conditions. Fishing effort on the pond, in terms of number of anglers and number of hours fished, is at a maximum during June and August. The fishery harvest for anglers on the pond has been highest during spring and fall. The monthly catches and harvests on the pond relative to the total of all areas surveyed have been lowest during spring and late fall and highest during summer and early fall. The majority of anglers are fishing on the pond then, so that the relative catches and harvests are highest on the pond at that time. During 1977 and 1978 about 75% of the anglers were from York and Dauphin counties in Pennsylvania. By creel survey area fished, the angler residence tended to reflect their proximity and access to the river. At least nine other Pennsylvania counties were represented by anglers fishing in the vicinity. There were only a few out-of-state anglers. Of the anglers interviewed in 1977, 65% reported that they ate their catch (or at least some of their catch), 17% released all they caught, and 3% gave away their catch. In 1978, the percentages were 74%, 26% and 9%.

E.2 THE CONOWINGO POND FISH COMMUNITY

The common fishes in Conowingo Pond are the gizzard shad, white crappie, channel catfish, bluegill, pumpkinseed and spotfin shiner. The largemouth and smallmouth basses and walleye are important species to the recreational fishery, although their population abundance is small relative to the commonly occurring species. Fifty-six species were collected from the pond and tributaries during a nine-year study period (1966-1974). Some additional species and hybrids have been introduced in planned stocking programs.

The gizzard shad, which was accidently introduced in 1972, has increased in abundance, while the white crappie has declined drastically in recent years. The gizzard shad competes with the white crappie for the same zooplankton food resource. Two hybrids, striped bass X white bass and the tiger muskie, were introduced by the Pennsylvania Fish Commission during 1977-1978 in an attempt to control the expanding gizzard shad population. Although the mean density of gizzard shad young declined in 1977-1978, it is too early to give unqualified credit to the hybrid introduction program in bringing about this reduction. The white crappie population has not rebounded to levels recorded in 1972 and prior years.

The common species (gizzard shad, white crappie, channel catfish, pumpkinseed, bluegill, and spotfin shiner) are widely distributed in the pond. Less common but important game species, such as walleye and smallmouth and largemouth bass, are more limited in distribution. The largemouth bass is more common in the lower part of the pond, while smallmouth bass and walleye are found primarily in the upper part of the pond, between Holtwood Dam and the Muddy Run Pumped Storage Plant. During winter, the thermal plume produced by the Peach Bottom Atomic Power Station (located at about mid-pond) appears to be attracting gizzard shad and, their predator, the walleye.

Of the species studied in tagging experiments, white crappie was the only one to exhibit an obvious seasonal movement pattern within the pond. In mid-spring, movement is generally upstream. Approaching winter, the white crappie move to the lower part of the pond and congregate at the mouths of creeks.

Materials that are transported into Conowingo Pond and incorporated in the food web may ultimately be removed, in part, via the recreational fishery, to man. The food habits of selected important fish species illustrates the various pathways (Table E.2).

Fisheries

The fisheries of Conowingo Pond have been described from studies made in 1958-1960,[8] 1966-1970,[9] the winters of 1973 through 1977,[10] and the 13-month period from August 1977 through August 1978.[11]

Based on the studies conducted in 1958-1960, it was concluded that white crappie had the greatest influence on the average catch per effort and resulting harvest from Conowingo Pond. The crappies (mostly white crappie) made up 48 to 55 percent of the catch during the study period, the catfishes (channel, white, brown bullhead and yellow bullhead) contributed 27 to 37 percent, and sunfishes (bluegill, pumpkinseed, rock bass, green and redbreast) contributed 6 to 16 percent. Only three other species constituted more than 1 percent of the catch for any one year of the study period-- smallmouth bass (2.6 percent in 1960), largemouth bass (1.5 percent in 1960) and yellow perch (2.5 percent in 1958). Catch per effort for white crappie ranged from 0.49 fish per hour in 1959 to 0.27 fish per hour in 1960.

Table E.2. Food Habits of Conowingo Pond Fishes

Species/Size or Age Group	Food Items[a]									
			Zooplankton				Insect Larvae			
	Detritus	Phytoplankton	Amphipoda	Cladocera	Copepoda	Rotifera	Chironomids	Others	Fish	Other
White Crappie										
Young		R	R	A			A	R		
Adult			A	A	A	A	C	C	C	
Gizzard Shad										
6-25 mm				A	A	A				
26-50 mm		C		C						
51-80 mm	A	A								
Channel Catfish										
<190 mm				A			A	C		
>190 mm	C							C	A	
Bluegill										
<10 mm			R	A	A		A			
41-100 mm				A	A		A			
>100			A	A						C (terrestrial insects)
Pumpkinseed										
<110 mm				A	A		A			
>110 mm				A				A		
Smallmouth Bass										
21-80 mm			C	C	C	C	A			
>80 mm									A	A (crayfish)
Walleye									A	

[a]Table entries indicate frequency with which fish of a given size or age utilize the specified food item: A = abundant, C = common, R = rare.

Observations made in the period 1966-1970 indicated no substantial change in the nature of the recreational fishery as had been described from the 1958-1960 study. Although no creel survey was made in the 1966-1970 period, it was observed that most fishing was done from small boats in shallow water along shore or from shore at a limited number of accessible sites. During this period it was observed also that a substantial winter fishery existed in the lower part of the pond.

Results of the winter fishery survey indicate that a total of 18 species were caught during the months of December through March, with white crappie making up 91 percent of the average winter harvest (Table E.3). Next in average relative abundance was the bluegill at 7 percent. The other 16 species contributed the remaining 2 percent of the average winter harvest. The winter catch per effort (number caught per angler-hour) averaged 2.03 for all species combined and 1.85 for white crappie (Table E.4). The estimated winter fishing pressure averaged 9202 anglers. Of the anglers interviewed, more than half were from the Baltimore area, and most of the others lived within 15 miles of Conowingo Pond. Winter angling was primarily from shore (61 percent) and through the ice (33 percent), as compared with boatfishing (6 percent). The concentration of winter fishing in the lower pond reflects the movement pattern of white crappie as previously noted.

The winter fishery of Conowingo Pond was compared to the year-round fishing through the creel survey made over the 13-month period from August 1977 through August 1978. Results indicate that the winter angling from December 1977 through March 1978 accounted for 11 percent of the effort expended over the 13-month survey period. Angler-hours were estimated at 303,980 for the 13 months. The harvest rate (fish kept per angler-hour) was much higher during winter than during the rest of the year.

For the 13 months, a total of 5305 fish representing 22 species and 2 hybrids were counted in the creel samples (Table E.5). Of those fish caught, an average of 45.5 percent were kept (i.e., harvested). Using the catch and harvest rates, the 13-month harvest was estimated to total 113,981 fish weighing 25,381 kg.

White crappie and sunfishes dominated the catch in the lower pond. The catch in the upper pond was dominated by smallmouth bass and channel catfish.

The angler population was primarily local residents (42 percent), but included some Baltimore area residents (25 percent). The rest were about equally divided between residents from distances of 15 to 40 miles (17 percent) or from distances greater than 40 miles (16 percent).

In comparison with the recreational fishing in the vicinity of TMI (see Table E.1), the estimated number of fish harvested in Conowingo Pond is 15 times greater than the six-year average value for the TMI vicinity. The hours fished in Conowingo Pond were 14 times greater than the six-year average value for the TMI vicinity. The harvest rate in Conowingo Pond (i.e., number of fish kept ÷ number of hours fished) for the 13-month survey was 0.38 fish/hour. A similar calculation using the average values from columns 4 and 5 of Table E.1 indicates that the harvest rate in the TMI vicinity is 0.34 fish/hour. Though the harvest rates are comparable, the species dominating the harvests are different between the Conowingo Pond and the York Haven Pond. The Conowingo Pond harvest is typically dominated by white crappie (which contributed 51 percent of the harvest in the August 1977-August 1978 survey period). In the York Haven Pond, smallmouth bass was the dominant species harvested in the calendar years 1977 (44 percent) and 1978 (61 percent).

E.3 THE UPPER CHESAPEAKE BAY FISH COMMUNITY

Fifty-one fish species have been recorded for the lower ten miles of the Susquehanna River from the Conowingo Dam to the river mouth (Fig. E.1).[12] The most abundant have been the anadromous clupeids (alewife, blueback herring, American shad), white perch and channel catfish.[12,13] Included in the species inventory are freshwater families of salmonids (trout), esocids (pikes), catsotomids (suckers), cyprinids (minnows and carp), ictalurids (catfish), centrarchids (sunfish and bass), and percids (perches and darters); brackfish water families of antherinids (silversides) and cyprinodontids (killifish); anadromous families of clupeids (shad and river herrings), percichtyids (striped bass; and white perch--a freshwater species); and one catadromous family of anguillids (American eel).

This stretch of the river is used for spawning by several species of fishes during the spring, including the anadromous clupeids[12,13] and striped bass (rockfish). The fish community of the upper Bay (Susquehanna River mouth to Annapolis) consists of many species and is seasonally

Table E.3. Species Composition of Fish Kept by Anglers in Conowingo Pond Based on 1973-1977 Winter Fishery Survey[a]

Species	1973	1974	1975	1976	1977	Grand Total Number	Grand Total Percentage
White crappie	5,998	3,130	489	3,599	649	13,865	91.1
Bluegill	411	36	546	40	31	1,064	7.0
Largemouth bass	12	1	5	85	8	111	0.7
Channel catfish	11	24	-	2	3	40	0.3
Brown bullhead	27	-	2	4	1	34	0.2
Black crappie	17	2	2	4	2	27	0.2
Other[b]	21	13	2	21	17	74	0.5

[a]Modified from Table 4.6-4 of "Peach Bottom Atomic Power Station Post-operational Report No. 9 on the Ecology of Conowingo Pond for the period of July 1977-December 1977," Muddy Run Ecological Laboratory, March 1978.

[b]Carp, yellow perch, gizzard shad, smallmouth bass, pumpkinseed, yellow bullhead, golden shiner, white sucker, brown trout, muskellunge, redbreast sunfish, and rock bass.

Table E.4. Winter Fishing Pressure and Catch per Hour of Fishes in Conowingo Pond, 1973-1977[a]

	1973	1974	1975	1976	1977	Total	Avg.
Number of anglers interviewed	1077	813	423	881	489	3683	736.6
Number of anglers counted	1937	1072	673	1715	724	6121	1224.2
Number of hours fished (angler-hours)	2099.0	1441.0	673.4	2256.7	1035.3	7505.4	1501.1
Number of fish caught	6497	3206	1046	3755	711	15215	3043
Number of fish (all species)/hour	3.10	2.22	1.55	1.66	0.69	-	2.03
Number of white crappie/hour	2.86	2.17	0.74	1.60	0.63	-	1.85

[a]Modified from Table 4.6-1 of "Peach Bottom Atomic Power Station Post-operational Report No. 9 on the Ecology of Conowingo Pond for the Period of July 1977-December 1977," Muddy Run Ecological Laboratory, March 1978.

Table E.5. Species Composition and Estimated Harvest by Anglers in Conowingo Pond, August 1977-August 1978[a]

Species	Number Caught	Percentage Kept	Estimated Harvest Number	Number/hr	Weight (kg)	kg/hr
White crappie	1437	79.9	57,296	0.19	11,440	3.14
Sunfishes[b]	1268	30.7	16,564	0.05	1,748	0.48
Smallmouth bass	781	44.3	15,035	0.05	6,191	1.70
Channel catfish	1281	24.6	14,599	0.05	2,095	0.57
Carp	181	34.2	2,641	0.01	2,147	0.59
Largemouth bass	161	28.0	2,366	0.01	1,089	0.30
Yellow perch	60	61.7	1,880	0.01	246	0.07
Bullheads[c]	43	74.4	1,260	e	-	-
Walleys	50	42.0	677	e	425	0.12
Other[d]	43	46.5	943	e	-	-
Total	5305	45.5	113,891	0.38	25,381	6.97

[a]Modified from Table 4.6-3 of "Peach Bottom Atomic Power Station Post-operational Report No. 9 on the Ecology of Conowingo Pond for the Period of July 1977-December 1977," Muddy Run Ecological Laboratory, March 1978.

[b]Includes rock bass, redbreast sunfish, green sunfish, pumpkinseed, and bluegill.

[c]Includes white catfish, yellow bullhead, and brown bullhead.

[d]Includes American eel, gizzard shad, goldfish, golden shiner, white sucker, shorthead redhorse, black crappie, striped bass x white bass hybrid, and tiger muskie.

[e]Less than 0.01.

composed of freshwater, estuarine, and anadromous forms. The more freshwater areas at the head of the Bay will have a species assemblage similar to that of the lower Susquehanna River.[12,13]

Forty species have been recorded from the Susquehanna Flats, with less than half that number comprising the majority of individuals taken, both in number and weight.[13] The most abundant species are white perch, bay anchovy, blueback herring, alewife, killifish, spottail shiner, sunfish, silversides, striped bass, spot, and hogchoker. Annual shorezone seining is conducted in many areas of the Chesapeake Bay, Maryland, by the Maryland Fisheries Administration.[14] The most abundant species found in 1977 and 1978 included Atlantic menhaden, Atlantic silversides, bay anchovy, gizzard shad, rough silversides, spot, spottail shiner, striped bass, and white perch.[14] The less-salinity tolerant fishes occur in the tributaries and on the flats, and to a lesser degree into the bay (i.e., yellow perch). Other more estuarine or marine species occur as far up the bay as the Sassafras River or to the southern limits of the flats (i.e., bluefish, winter flounder).[15]

Many truly estuarine and anadromous fishes occur throughout this upper Bay area and many use it as spawning and nursery grounds. Prominent among the spawners there are the freshwater residents plus such species as the herrings (American shad, alewife, blueback), white perch, striped bass, sliversides, winter flounder, hogchoker, and bay anchovy.[15] In addition to the use of this area as a nursery by those species that spawn there, several species that spawn either in the ocean or much farther down the Bay near the mouth also utilize this upper Bay area as nursery grounds. Spot, croaker, and weakfish have concentrated nursery areas in the Elk River and in the Bay proper between Poole's Island at the south and Spesuite Island at the north.[15] Hogchoker spawn over much of the Chesapeake Bay, including the southern limits of this upper Bay area (Magothy

River-Chester River area), but have concentrated nursery areas in the upper Bay tributaries and in the Bay proper from about Poole's Island at the south to the Susquehanna Flats.[15]

The Chesapeake and Delaware Canal also supports fish populations similar in composition to those of the northern Bay tributaries.[16] Several species spawn in the canal, most notably white perch and striped bass.[17,18] The canal appears to have become one of the most important striped bass spawning grounds in the entire Chesapeake Bay region, and it has been suggested that the canal provides a favorable alternative to the now-destroyed historical spawning grounds in the lower Susquehanna River.[17] Striped bass spawning stocks occur in several aquatic systems throughout the mid-Atlantic and northeast regions, but the major contributor to the Atlantic coastal fishery is the Chesapeake Bay stock.[19]

The most productive areas of the Bay are those areas of low salinity in the upper bay and the corresponding portions of the major tributaries.[20] The upper Bay is a major spawning and nursery area, and together with the Chesapeake and Delaware Canal, probably is the largest of all spawning areas in the Bay.[16] Biomass per unit of area, particularly of marsh plants and fishes, is vastly greater on these nursery grounds than it is seaward.[21] These low salinity areas of the upper bay are rich in food resources for young fishes[15,21] and contain the largest populations of important phytoplankton and zooplankton during the seasonal occurrence of larval and juvenile fishes.

Endangered fish species for the Chesapeake Bay area include the Maryland darter (Etheostoma sellare) and shortnose sturgeon (Acipenser brevirostrum).[20] The Maryland darter occurs in the eastern Piedmont drainage to the Bay,[22] but not the Bay proper. Presently, it is known only from Deer Creek, a tributary to the Susquehanna River 3 to 3.5 miles downstream of the Conowingo Dam.[23] It has not been recorded in the Susquehanna River proper in the vicinity of Deer Creek. Shortnose sturgeon has been recorded from the Potomac River during the latter 1800s from Stillpond Neck (just south of the Sassafras River) in 1976 (one specimen), and from the Elk River in 1978 (four specimens).[24,25] Shortnose sturgeon are present in the Delaware River and Delaware Bay.[26] Although no specimens have been recorded from the Chesapeake and Delaware Canal, the possibility exists for migratory movements between the two estuaries.[26] Therefore, the specimens recorded during 1976 and 1978 from the Chesapeake Bay might have been of Delaware River origins.

Some other important species of Bay fishes, although not considered endangered, have become severely reduced in number during recent years. Commercial catches of American shad have declined severely in recent years[12,27-29] prompting the State of Maryland to close the fishery (sport and commercial) during 1980, beginning on April 8 and continuing for 120 days. Hickory shad, blue-back herring, and alewife also are at very low population levels in the Bay. Populations of striped bass have declined in recent years.[30]

The Upper Chesapeake Bay Shellfish Community

Soft-shelled clams (Mya arenaria) generally occur in water with a depth less than 20 ft near the shoreline of both sides of Chesapeake Bay. They are found from the northern Bay generally below Poole's Island south to about the Potomac River.[15] Hard clams (Mercenaria mercenaria) are limited to the higher salinity areas of the lower Bay, but extend into Maryland in the Tangier and Pokomoke Sound areas of the eastern shore[15,31] They are not found in water where the salinity is less than 15 parts per thousand.[15] The American oyster (Crassostrea virginica) is distributed throughout much of Chesapeake Bay and occurs in Maryland waters from the Maryland-Virginia border north to about the Poole's Island area, as well as into most of the more saline tributaries upstream to a mean salinity of about 7-8 parts per thousand.[15] Oysters require firm bottom to prevent sinking and smothering and normally are found attached to shells, stones, and other hard objects. They are subtidal and generally occur in water between 8 and 25 ft deep.[15] Great accumulations of oyster shells are a significant bottom feature of the Chesapeake Bay. Perhaps the greatest contribution any single mollusc makes toward the ecology of the Bay is the formation of shell bars and reefs made by oysters.[31] Individual molluscan species utilize varied means of obtaining nutrition. Some are filter-feeders (soft-shelled clam, oyster) and/or detrital feeders. They, in turn, provide food for a variety of animals, including other molluscs, fish, crabs, and waterfowl, as well as for man.[31]

The blue crab (Callinectes sapidus) is widely distributed along the Atlantic and Gulf coasts, but is most abundant and best known from the Chesapeake Bay.[15] Blue crabs occur from areas of nearly fresh water to full-strength sea water. In the low salinity areas of the upper Bay and its tributaries, male crabs predominate. Females tend to congregate farther downstream and down-bay where salinities are greater. Mating occurs in the middle and upper Bay and its tributaries from June through October. After impregnation, the females migrate toward the lower Bay and the higher salinity spawning grounds. Female crabs will not return to northern Bay areas until the following spring, while the majority of males remain in the fresher waters, most overwintering in the muddy bottoms of deeper channel waters. Blue crabs spawn in the high salinity waters near the mouth of the Bay during the summer. At hatching, the larval crabs become planktonic.[15] Blue crabs occur to the head of the Bay, including the Susquehanna Flats area and in the lower portions of its tributaries.[15]

Food Habits of Upper Chesapeake Bay Fishes

The fish fauna of the lower Susquehanna River downstream of Conowingo Dam consists of a broad compliment of "eater types", including fish eaters, fish and invertebrate eaters, bottom feeders, and plankton/invertebrate eaters.

Food habits have been studied for only a few species of fish in this stretch of the river--white crappie, gizzard shad, white perch, and channel catfish.[12] They rely predominantly on bottom invertebrates, plant material, and fish as food sources. In decending order of occurrence in stomachs: white crappie ate insects, crustaceans, fish, and plant material; gizzard shad ate plants, insects, detritus, and crustaceans; white perch ate insects, crustaceans, plants, and fish; and channel catfish ate plants, insects, fish, crustaceans, and detritus. Other studies of fishes in freshwater areas surrounding the Chesapeake Bay describe the food sources of alewife as predominantly crustaceans (copepods and ostracods) and those of American shad as insects and ostracods.[24] White perch feed on fish, crustaceans, worms, insects, and to a much lesser degree on plant material.[24] Striped bass are carnivorous, feeding on fish, crustaceans, worms, and insects,[24] and in the lower portion of the Susquehanna River they forage on spawning clupeids.[12] The walleye is noted as being the only truly piscivorous (fish eater only) resident species in this stretch of the river.[12]

The food habits of fish in the less saline areas of the upper Bay (especially the Susquehanna Flats and nearby tributaries) will be similar to those described for the lower ten miles of the Susquehanna River, with benthic invertebrates as a primary food source.[12] In the Chesapeake and Delaware Canal, benthos also are of considerable importance as food for resident and migratory fishes.[32] The fish fauna of the upper Bay consists of a broad compliment of "eater types" across many trophic levels, including fishes that feed on plankton, invertebrates, other fish, plant material, and detritus.[24] Feeding habits vary between species and with the size of a given species. Larval fishes feed on small forms, notably on zooplankton. In this upper Bay area, copepod and cladoceran zooplankters are important food sources for larval fishes.[15] One copepod species, Eurytemora affinis, is especially important because it is most abundant at the same place and time as the newly hatched larvae of many species of fish. As fish grow, food preferences often change from small organisms--to larger ones (invertebrates or small fish)--to still larger forms (fish, crabs, molluscs), depending on the species and its trophic level or "eater group".

General Distribution of Major Fishery Harvests

The soft-shelled clam is found in the bay almost exclusively in Maryland waters. Commercial harvest concentrations occur only in certain areas between the Chester River at the north and the Potomac River at the south.[15] Virginia reported no landings of soft-shelled clams for 1975 or 1976,[33,34] while Maryland's exceeded 1.2 million and 1.7 million pounds for those two years.

Hard clams are found in Maryland waters only near the Maryland-Virginia border in the Tangier and Pokomoke Sounds. A small fishery exists there based on the use of escalator harvesters.[15] Maryland reported only a small harvest of hard clams in 1975 (13,900 pounds)[33] and no harvest in 1976.[34] Virginia's reported landings were in excess of 600,000 pounds and 800,000 pounds in 1975 and 1976 respectively.

Oyster beds occur in the Bay generally beginning at the north near Poole's Island and extending southward into most of the sounds, lower tidal creeks, and lower portions of the major tributaries. The majority of oysters harvested within the Bay come from Maryland waters.

Blue crabs are harvested in vast quantities throughout most of Chesapeake Bay and in the middle and lower portions of most tidal creeks and tributaries.[15] Commercial potting for crabs begins near the Spesutie Island area at the lower end of the Susquehanna Flats and occurs throughout most of the Bay proper and the tidal portions of the Potomac River.[15] Recreational crabbing in Maryland waters occurs primarily in nearshore areas and in tidal creeks, beginning at about the

Aberdeen-Sassafras River area and extending southward along much of the Bay shoreline area.[15] Although no figures are available on the total recreational crab harvest levels, it is substantial.

Fishing (commercial and recreational) tends to be located in the areas where concentrations of fishes exist, and usually is seasonal in nature. Fishing for anadromous species (shad, herrings, striped bass) occurs in the tributaries and other spawning areas during the spawning runs. Other species are fished when they enter the Bay waters for summer and fall feeding, such as menhaden and bluefish.

Fisheries of The Susquehanna from Conowingo Dam to the River Mouth

Commercial fishing occurs in the lower ten miles of the Susquehanna River for American shad, striped bass, river herrings (alewife, blueback herring), catfish, and baitfish.[12,28,29] The fishery is ranked as "excellent" and the usage as "heavy".[29] In recent years, catches of shad have declined baywide,[12,27-29] thus more emphasis has been placed on striped bass, with shad becoming more of an incidental catch in the Susquehanna River.[29] Recreational fishing occurs in this reach of the river for several species by both river bank and boat anglers.[13] A creel survey conducted during the spring of 1970 recorded the capture of 7738 fishes (4705 kept, or a harvest rate of 60.1%) by 1607 anglers who fished for a total of 8315 hours (0.93 fish caught per angler hour).[13] Of those anglers who responded, 52.4% resided in Maryland, 45.2% resided in Pennsylvania, and 2.4% were from other states. The predominant species caught were white perch (41.3% of the total), river herring (28.0%), American shad (9.0%), channel catfish (6.4%), striped bass (4.3%), yellow perch (3.5%), bullhead catfish and hickory shad (1.8% each), sunfishes and crappies (1.5% total), largemouth and smallmouth bass (0.9%), and others (1.4%, including walleye, carp, eel, suckers, quillback).

Fisheries of the Upper Bay

Soft-shelled clams are harvested generally beginning at about the Chester River in the southern portion of the upper Bay area; the northern-most Chesapeake Bay distribution of oyster beds is in the area between Poole's Island and Annapolis; and blue crabs are harvested (commercial and recreational) throughout most of this area from the southern flats to Annapolis.

Finfish are commercially harvested in almost all waters of the upper Bay region, including the Susquehanna Flats, many tidal creek areas, and the Chesapeake and Delaware Canal.[16,28,29] Fishing in the flats area is principally for striped bass (rockfish), shad and herrings, eels, catfishes, white perch, and menhaden. The area has been rated as "fair" to "excellent" for commercial fishing.[29] Commercial fishing also occurs in the open Bay proper south of the flats for striped bass, perch, shad, alewives, eels, and blue crabs.[29] These areas are heavily fished and provide nearly year-round fishing for various species. Winter fishing primarily is for striped bass.[29] Fishing is rated as "fair" to "excellent".

The most recent data available on the sport fishery are for the year 1976 for the upper Bay area from Poole's Island at the north to the Choptank River at the south.[35] The total harvest by anglers fishing from private and charter boats was estimated to be about 4.5 million pounds, of which about 2.9 million pounds were bluefish. Blue crabs ranked second in abundance, with striped bass third. Based upon the data derived during the 1976 sport fishery survey plus the results of previous surveys, an estimate of the total sport fishery was made for all Maryland waters of the Chesapeake Bay.[35] The total 1976 sport fishery harvest for finfish was estimated to be about 14.4 million pounds, while the sport harvest for blue crabs was estimated to be about 3.2 million pounds. Within the 1976 survey areas, the commercial harvest was less than the sport catch for striped bass, bluefish, white perch, spot, and croaker.

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APPENDIX F. REUSE OF ACCIDENT WATER

Large volumes of contaminated water were generated by the accident, and treatment of this accident water, using the systems discussed in Section 7.1, could result in equally large volumes of liquid effluents in the form of processed accident water. However, large amounts of water will be needed for decontamination and defueling operations and to shield systems and equipment. If processed water meets certain criteria, it may be used to satisfy these water needs and thus minimize the volume of additional water contaminated during the cleanup. The NRC has requested the licensee minimize the use of water and cross-contamination.[1]

In this appendix, the processed accident water available for reuse is characterized, potential reuse applications and the limitations associated with reuse are identified, and the environmental impacts of reuse are assessed.

F.1 EFFORTS TO DATE AND SPECIFIC CONSIDERATIONS

As of September 1, 1980, about 501,000 gallons of AFHB accident water had been processed through the EPICOR II system. An additional 68,000 gallons had been processed through November 1980. This processed accident water, plus an additional 174,000 gallons of slightly contaminated water, is currently stored within the plant for reuse. The characteristics, volumes and storage locations of this water were presented in Table 7.3. The average concentrations and radioactivity inventories for all significant isotopes in this 743,000-gallon inventory are presented in Table F.1. As shown, this water contains 359 Ci of tritium and about 0.8 Ci of cesium. The quantities of other isotopes present are less than 10 percent of the cesium content. As discussed in Section 7.1, there are about 700,000 gallons of unprocessed accident water in the reactor building sump plus another 96,000 gallons in the reactor coolant system. Thus, about 1,540,000 gallons of processed water could be available for reuse. Since there are no practical industrial-scale systems available that can remove tritium from this accident water, it will be tritiated.

Reuse of processed accident water could result in occupational radiation exposure during the reuse application. To ensure compliance with "as low as reasonably achievable" (ALARA) principles, guidelines for reuse of processed accident water have been established for the following two applications:

- <u>Remote and Semiremote Decontamination</u>

  The gross specific activity and tritium concentrations of processed accident water used for these applications should be maintained at levels below those that could lead to worker exposure in excess of guidelines established in 10 CFR Part 20.

- <u>Shielding</u>

  The average gross activity of all radionuclides except tritium should be less than 0.01 μCi/mL. This ensures that the radiation level at the surface of the spent fuel pools and fuel transfer canal is below 2 to 3 mrem/hr. The average tritium concentration in this water shall be maintained to ensure airborne activities will be less than the 10 CFR Part 20 limit for worker exposure.

Comparison of these guidelines to the characteristics of the 743,000 gallons of processed accident water in storage indicates that this water is suitable for reuse in both applications.

F.2 ALTERNATIVES CONSIDERED

The management of processed water to maximize reuse during the cleanup requires consideration of the volume of water available, its suitability for general reuse and the specific reuse applications, and the relationship between the time when it becomes available and the time

Table F.1. Radionuclide Inventory of Processed AFHB Water in Storage[a]

Major Radionuclides	Average Concentration[b] (μCi/mL)	Total[b,c] Curies
H-3	1.28×10^{-1}	3.59×10^{2}
Cr-51	$< 8.4 \times 10^{-6}$	$< 2.4 \times 10^{-2}$
Co-58	$< 8 \times 10^{-6}$	$< 2.3 \times 10^{-2}$
Co-60	$< 9.7 \times 10^{-6}$	$< 2.7 \times 10^{-2}$
Ru-106	$< 7.4 \times 10^{-6}$	$< 2.1 \times 10^{-2}$
Sb-125	$< 6.1 \times 10^{-6}$	$< 1.7 \times 10^{-2}$
Cs-134	$< 9.1 \times 10^{-5}$	$< 2.5 \times 10^{-1}$
Cs-137	2×10^{-4}	5.7×10^{-1}
Ce-144	$< 6.6 \times 10^{-6}$	$< 1.8 \times 10^{-2}$

[a]Average in all tanks shown on Table 7.3.

[b]All values except tritium (H-3) are rounded to two significant figures.

[c]Based on volume of 743,000 gallons.

when it is needed for a particular reuse application. These parameters are, in turn, affected by a wide range of conditions that could arise during the cleanup. Thus, all the alternative combinations of availability versus reuse applications cannot be addressed. Those sets of alternatives which bound availability and also bound potential reuse applications can be considered. These sets of bounding conditions are presented below.

F.2.1 Availability

Processed accident water availability is shown as a function of time in Figure F.1. Time "zero" corresponds to initiation of reactor building sump water processing. About 743,000 gallons of processed AFHB accident water are in storage. This represents the volume currently available for reuse. The maximum volume shown is about 1,540,000 gallons. This represents the additional processed water that could result from processing reactor building sump water and reactor coolant system water. Two alternatives for processing this accident water are shown in Figure F.1 to bound the time frame for availability. As shown, the maximum volume will be available between about 6 months and 13 months after processing is initiated.

F.2.2 Potential Reuse Applications

Processed accident water could be used for many of the operations that require large volumes of water. The potential uses include:

- Decontamination of the Reactor Building. Between 70,000 and 230,000 gallons may be required to perform the semiremote decontamination operations on the reactor building interior as described in Section 5.2. The most likely volume is about 150,000 gallons.

- Shielding for Processing Equipment. If a zeolite-based system is used to treat reactor building sump water, the equipment will be installed in spent fuel pool B. About 230,000 gallons of water will be needed to shield this equipment during operation.

- Defueling. Prior to removal of the reactor vessel head and during defueling operations, about 1,040,000 gallons of borated water will be needed to fill spent fuel pool B (230,000 gallons), the cask pit (30,000 gallons), spent fuel pool A (440,000 gallons) and the fuel transfer canal (350,000 gallons).

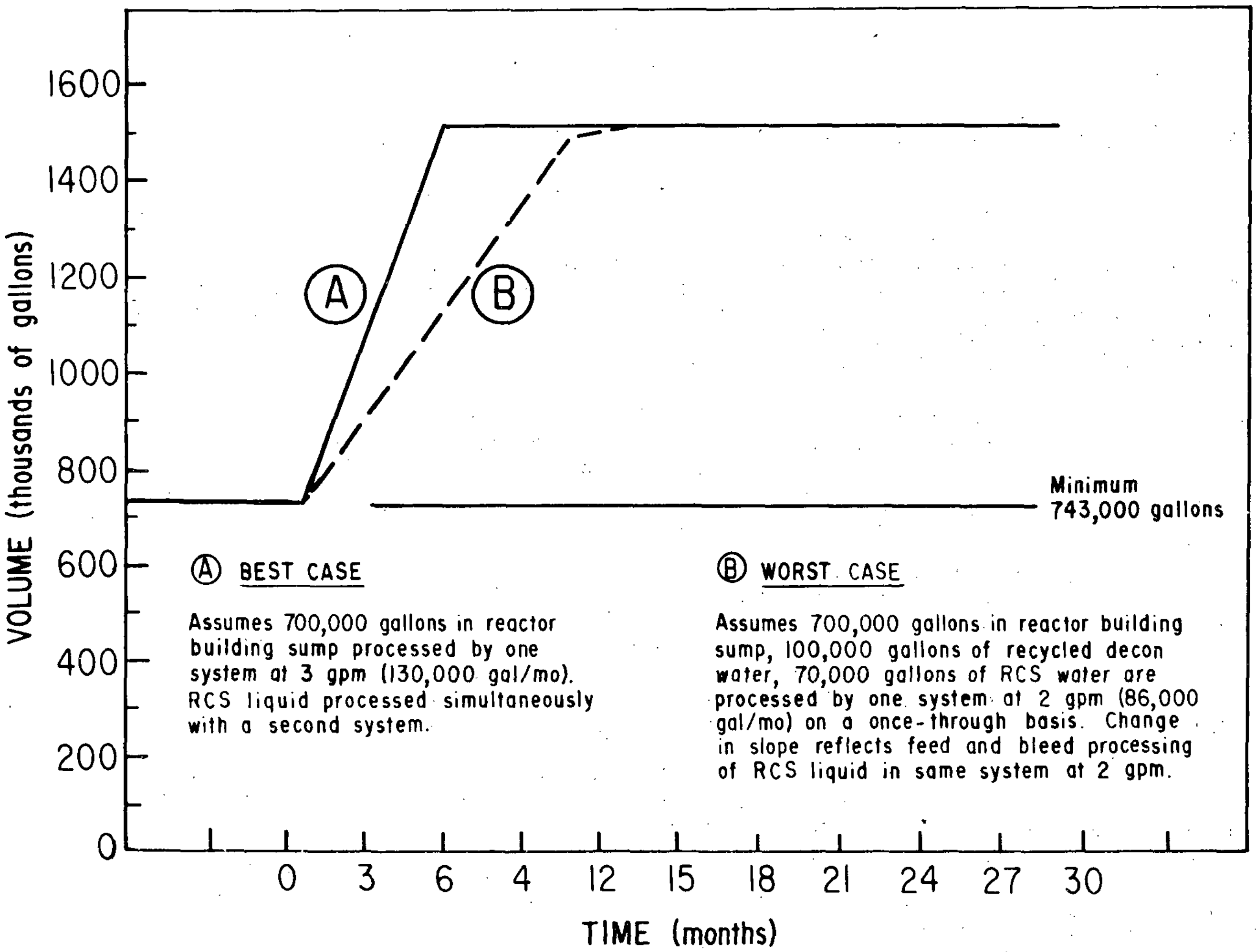

Figure F.1. Processed Accident Water Availability.

- RCS Flushing. Following defueling, the reactor coolant system will be flushed with water to attempt to remove particulates and radioactivity that could be mobilized during defueling. About 250,000 gallons of water will be needed for this flushing.

- RCS Decontamination. After flushing, the reactor coolant system will be decontaminated. The volume of water needed depends on the techniques used. The staff estimates that about 100,000 gallons will be needed if the CAN-DECON technique is used. If the other techniques being considered are used, e.g., AP-Citrox, APAC, NS-1, or OPG, about 500,000 gallons, or about five reactor coolant system volumes, of water will be required.

Processed accident water also could be used to satisfy post-cleanup program needs. The potential uses include:

- Shielding. Spent fuel assemblies and high-radiation-level packaged waste could be stored underwater in the spent fuel pools and cask pit. About 690,000 gallons of water would be required.

Startup Inventories. Refueling and startup, if such activities are permitted, would require a minimum inventory of 100,000 gallons to refill the reactor coolant system and about 300,000 gallons in the borated water storage tank to meet technical specifications.

These potential uses of processed accident water are summarized in Table F.2. The needs vary with time, and processed water used to satisfy one need can be processed again and recycled to satisfy a future need. The extremes considered for water volumes and timing of these reuse applications during the cleanup program are illustrated in Figure F.2. Time "zero" shown on this figure represents the initiation of processing water in the reactor building sump.

The major difference between the two cases considered is the elapsed time to complete decontamination of the RCS. Under assumed best-case conditions, this can be accomplished over a 24-month period; worst-case conditions require a 36-month period. For both cases the staff has assumed that water used for shielding can be used during defueling without retreatment, that only the fuel transfer canal is emptied after defueling, and that primary system flush water is retreated and used during primary system decontamination.

Table F.2. Summary of Potential Uses of Processed Accident Water

Potential Use	Volume (gallons)	Remarks
During Cleanup Program		
1. Decontamination of building surfaces	150,000	Can be processed with sump liquids.
2. Shielding for processing equipment	230,000	Can also be used for defueling without treatment.
3. Defueling	1,040,000	Borated water needed.
4. RCS flushing	250,000	Can be treated and used for decontamination in Item (5).
5. RCS decontamination	100,000 to 500,000	
After Cleanup Program		
1. Shielding in spent fuel pools	690,000	Borated water.
2. Startup inventory	≧ 100,000	Depends on whether TMI-2 is restarted.

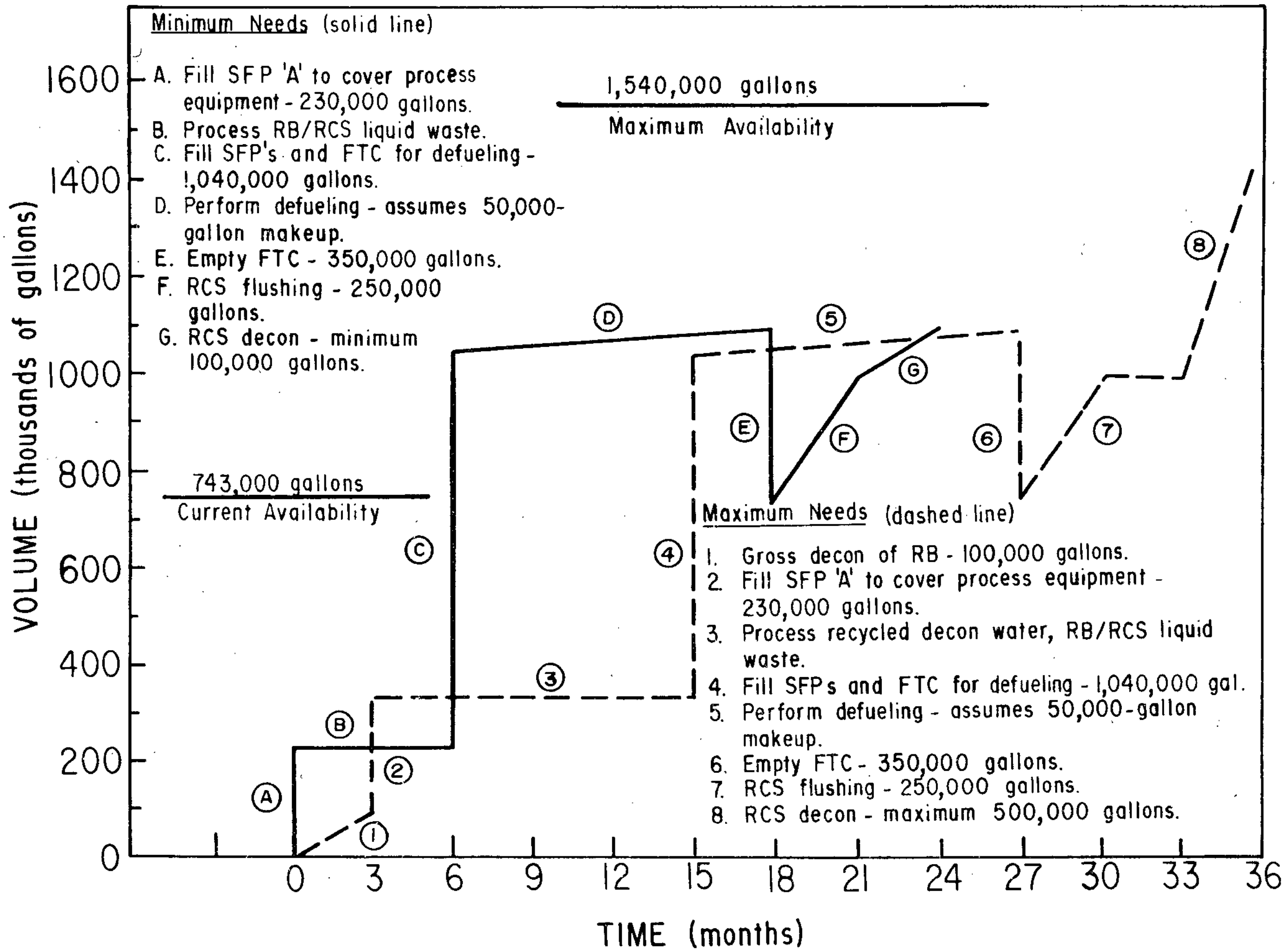

Figure F.2. Potential Processed Accident Water Needs.

Reference

1. Letter from J. Ahearne, U.S. Nuclear Regulatory Commission, to H. Dieckamp, GPU, January 12, 1981.

APPENDIX G - ENGINEERING CONSIDERATIONS FOR TREATMENT OF TMI-2 ACCIDENT-GENERATED LIQUID WASTE

G.1 INTRODUCTION AND SUMMARY

Nine alternative systems were considered for treatment of TMI-2 liquid wastes: (1) the submerged demineralizer system (SDS), (2) a modified SDS, (3) the EPICOR II system, (4) a modified EPICOR II system, (5) a zeolite/evaporator system, (6) a zeolite/EPICOR II system, (7) an SDS/EPICOR II system, (8) an evaporator/resin system, and (9) a bitumen/resin system. The data and assumptions used to characterize the liquid waste to be treated by these systems and the performance characteristics of system components and overall systems are presented in this appendix. The assumptions used to estimate the quantities and characteristics of the process solid wastes generated through use of these systems are also presented.

A matrix of the liquid waste sources that could require treatment and the alternative treatment systems evaluated in this Appendix for treatment of these liquids is presented in Table G.1.* As shown, 27 liquid waste/treatment system combinations were evaluated.

The data and/or assumptions used to characterize liquid waste prior to treatment are presented in Section G.2. The data and assumptions used to characterize the performance of the alternative treatment systems are presented in Section G.3. These data and assumptions characterize representative performance parameters for the systems described; the actual performance of a particular system will vary from the assumed parameters. However, the assumed performance parameters have been applied consistently and provide a reasonable basis for comparing the relative performance of the systems considered.

The assumptions used to characterize the process solids wastes that could be generated from each system/liquid waste source combination are presented in Section G.4. Summaries of the processed water characteristics are presented in tabular form in Section G.5. Similar tables are used to characterize process solid waste in this section. To simplify the presentation of information in this Appendix, all radionuclide inventories are presented in curies and volumes are presented in gallons.**

G.2 BASIS FOR LIQUID WASTE CHARACTERISTICS

The gross curie content of the various sources of liquid waste that could be treated during cleanup of TMI-2 are shown in Table G.2. The suitability of these liquids for treatment depends on their physical and chemical characteristics. The characteristics of reactor building sump water given in the table are based on the analysis of reactor building sump water samples. Similar sample data were available for RCS primary system water. For the other sources of liquid waste shown in Table G.2, the characteristics of and the distribution of radionuclides in the liquid were either inferred from other available data or were assumed. The assumptions used to characterize sources of liquid waste are discussed below.

G.2.1 Reactor Building Sump Water

The reactor building basement contains about 700,000 gallons of sump water containing fission products, borates, sodium hydroxide, and sediment and debris from the accident. The pH of the water is 8.6.[1] Estimates of the amounts of dissolved and filterable materials in the water, based on published analyses of the sump water composition,[1,2] are given in Tables G.3 and G.4. These values have been updated to September 1, 1980, to account for additional radioactive decay. The radionuclide inventory is about 500,000 Ci and the principal radionuclides of concern are cesium and strontium.

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*Tables, figures, and references follow text.

**To obtain concentrations in μCi/mL, divide the curie content by the volume in gallons and multiply the result by 264.

The volume of additional liquids that may be added to the sump from early reactor building decontamination operations is estimated by the staff to be 100,000 to 200,000 gallons. Therefore, the sump could contain as much as 900,000 gallons. The estimated radionuclide content of these additional liquids is about 90 Ci, so their contribution to the sump inventory is negligible. Oil and grease are likely to be present in the sump liquids. A conservative estimate of the amount of such materials is 2.4 mg/mL of liquid.

G.2.2 Reactor Coolant (Primary) System Water

About 96,000 gallons of reactor coolant system (primary) water will require treatment. The radionuclide concentrations for the primary water are given in Table G.5. The average concentration of radionuclides in this water is about 5.9×10^1 µCi/mL,[3] and the total radionuclide inventory is about 20,000 Ci.

G.2.3 Reactor Coolant System Flush and Drain Water

The reactor coolant system (RCS) water is contaminated with fission products and core debris as a result of the accident. Particulate material would be removed by filtration using a core filter within the reactor vessel and additional filters on the reactor coolant system drains in order to trap particulates during the flush and drain activities. The RCS flush and drain operations will produce contaminated water that will require decontamination. It was assumed by the staff that the effluent from all the flush and drain operations will be pumped into the reactor coolant bleed holdup tank, from which water will be taken for decontamination. The exact volume of water that will be processed during the RCS flush and drain operation is unknown, as is the exact radionuclide concentration of that water. The staff has estimated that 2.5 RCS volumes, or 250,000 gallons of contaminated liquid, will be processed. It is further estimated that the liquid will contain between 20,000 Ci and 100,000 Ci of contaminants distributed in the same proportion as in the primary water. It is also estimated that about 2000 Ci of solid debris will be collected on the prefilters preceding each ion-exchange treatment alternative. The assumed characteristics of these liquids and solids are given in Tables G.6 and G.7, respectively.

G.2.4 RCS Decontamination Solutions

The decontamination of the reactor coolant system components can be considered principally as removal of fission-product plateout. The staff expects that particulates would be removed during draining and flushing, and plateout would be removed by use of decontamination reagents.

The liquid capacity of the reactor coolant system of TMI-2 without fuel is about 96,000 gallons. The radioactive contamination level of the reactor coolant surface is estimated by the staff to range from 10 $\mu Ci/cm^2$ to 100 $\mu Ci/cm^2$. This range is based upon the RCS surfaces being contaminated by a factor of 100 to 1000 times greater than horizontal surfaces in the reactor building. The surface area of the reactor vessel and heat exchanger tubing is about 2.25×10^8 cm^2; therefore, the staff expects total radioactivity on the reactor coolant system surfaces to range from 2000 Ci to 20,000 Ci. This quantity of radioactivity could be removed during decontamination operations.

The estimated volume of liquid waste varies with the technique used. It was assumed that if the CAN DECON technique is used, about one RCS volume of liquid waste--100,000 gallons--would be generated on a feed and bleed basis. It was assumed that if the more aggressive chemical techniques are used, about five RCS volumes--500,000 gallons--would be generated. The distribution of radionuclides in these liquids (exclusive of tritium), regardless of the volume generated, was assumed to be the same as that in the RCS primary system water.

G.2.5 AFHB Chemical Decontamination Solutions

About 2200 gallons of these liquids were generated through September 30, 1980. Through this same period about 80 percent of the areas requiring "hands on" cleanup were finished. Since the remaining areas have higher levels of contamination and are more difficult to decontaminate, it was assumed that about three times as much liquid, or about 7000 more gallons, would be generated through completion. The estimated activity to be removed was 60 Ci, which is about 50 percent of the activity in the liquids already generated.

G.2.6 RB Chemical Decontamination Solutions

The estimated volume of these liquids is 30,000 to 50,000 gallons, the average volume of 40,000 gallons is assumed in this appendix. The radionuclide distribution in these liquids was inferred from swipe samples taken during reactor building entries. The major contaminants considered were cesium and strontium.

G.2.7 Summary

The estimated curie content in each of the liquid waste sources described above is listed in Table G.8. Tritium is shown only for reactor building sump water and primary system water, since these sources plus the AFHB water already processed comprise the accident-produced tritium inventory. If processed water is reused for the other applications shown on Table G.8, the tritium content present in the effluent after treatment will correspond to what was in the processed water prior to reuse.

G.3 BASIS FOR TREATMENT SYSTEM PERFORMANCE CHARACTERISTICS

To compare alternative treatment systems on a relative basis, the performance of the systems considered was inferred from (1) the performance of the EPICOR II system used to cleanup AFHB liquids, (2) laboratory-scale tests on zeolite-based ion-exchange systems, and (3) the performance of similar systems used to treat liquid wastes containing radionuclides and chemical contaminants of the same or similar species to those present in TMI-2 liquids. The assumptions used to characterize treatment system performance are conservative relative to the decontamination factors that could be achieved. Moreover, the actual performance of any treatment system can be adjusted by varying operating criteria to achieve the decontamination factors desired for a particular source of liquid waste. Therefore, while the performance of the systems described in this appendix will vary, the staff believes that the performance characteristics presented below are representative and provide a consistent basis for comparing alternative treatment systems. The performance parameters which characterize each of the systems considered are discussed below.

G.3.1 Submerged Demineralizer System (SDS)

One treatment process considered for decontaminating the sump water is the submerged demineralizer system (SDS) described by Met-Ed and (with chemical engineering in greater detail) by Brooksbank and Armento[1] and by Campbell et al.[2] The process consists of removal of solids by filtration, followed by removal of cesium and part of the strontium by use of an inorganic zeolite ion exchanger The remaining ionic radionuclides are removed by use of a cationic resin bed followed by a mixed resin bed. A process flow diagram is shown in Figure G.1.

Filtration would be accomplished by the use of disposable cartridge filters.[2] The volume of filter waste was calculated by assuming a filter loading of 2.8×10^{-1} m^3 per Ci.[4] As further characterization of sump particulate progresses, the exact filtration media may be modified.

The results of laboratory tests suggest a modified submerged demineralizer system would improve the removal of cesium, strontium, and antimony, which are the major radionuclides in the effluent of the SDS process.[4] The modification involves the expansion of cation resin volume to 40 ft^3 (a fivefold increase). This modification is expected to change the character of the waste solution by adsorbing sodium on the cation column, releasing H^+ to change the acidity of the waste solution entering the polishing column. According to laboratory tests, the polishing column as modified is expected to absorb antimony and effect further reduction of cesium and strontium. A process flow diagram is shown in Figure G.2.

In the preparation of this flowsheet and in the analysis of the application of this process to specific liquid waste sources, the staff made several assumptions concerning decontamination factors (DFs) and breakthrough volumes for various ions.[5,6] These assumptions for both systems, along with pertinent references, are given in Table G.9.

G.3.2 EPICOR II System

This system has been used to decontaminate AFHB water and is described fully in Appendix D. Actual performance data for a batch of AFHB water processed through this system is shown in Table G.10. The decontamination factors used to evaluate EPICOR II on a comparative basis that were inferred from these data are shown in Table G.11. A process flow diagram for EPICOR II is presented in Figure G.3.

G.3.3 Modified EPICOR II

This system uses a zeolite ion exchanger in place of the EPICOR II first-stage prefilter ion exchanger.[7,8] Since the EPICOR II cation exchange vessel is comparable in size to the cation vessel in the modified SDS, and the size of the mixed-bed ion exchanges are also comparable, the performance of this system should be comparable to the modified SDS. Therefore, the inferred performance characteristics of this system are the same as those shown in Table G.9 for the modified SDS. A process flow diagram for this system is shown on Figure G.4.

G.3.4 Zeolite/Evaporation

The zeolite/evaporation process consists of removal of solids by filtration (when necessary), followed by removal of cesium and part of the strontium and other radionuclides by use of an inorganic zeolite ion exchanger. The radionuclides remaining after this step are removed by an evaporation treatment process. The relevant evaporator properties are given in Table G.12. The performance characteristics of the mixed-bed ion exchanger used to polish condensate were assumed to be the same as those shown in Table G.9 for the modified SDS system. A process flow diagram for this system is shown on Figure G.5.

G.3.5 Zeolite/EPICOR II

The zeolite/EPICOR II process consists of removal of solids by filtration, followed by removal of cesium and part of the strontium by use of an inorganic zeolite ion exchanger. The zeolite treatment reduces the radioactivity levels of the process stream for input to the EPICOR II system. EPICOR II is an ion-exchange system designed to process liquid waste with radionuclide concentrations between 1 and 100 µCi/mL. A process flow diagram is shown in Figure G.6, and assumed decontamination factors are shown in Table G.13.

G.3.6 SDS/EPICOR II

The combination of two complete treatment systems can be used, as demonstrated by the SDS/EPICOR II alternative, to offset process characteristics that may exclude either process alone as a feasible alternative. In this case, the SDS system may not provide adequate decon-tamination factors, and the radionuclide concentration of the sump liquids exceeds the specification for influent liquids to EPICOR II. The SDS system was discussed previously in Section G.3.1 and the EPICOR II system was discussed in Section G.3.2. A process flow diagram for the combined systems is shown in Figure G.7 and combined decontamination factors are shown in Table G.14.

G.3.7 Evaporator/Resin

The evaporator/resin process consists of evaporation followed by treatment of the condensate by use of a cation resin and a mixed-bed ion-exchange resin. The relevant evaporator properties and the ion exchanger decontamination factors are given in Table G.15. A flow sheet for this process is given in Figure G.8. Filteration would be a preliminary step to diminish formation of foam.[9] It is assumed by the staff that 0.1 percent of the radionuclides contained in the condensate stream would be carried off as aerosols or gaseous material that would have to be treated. The volume of this stream was not estimated, but it should be possible to remove this material by filtration of the off-gases.

G.3.8 Bitumen/Resin

In the bitumen/resin process alternative, liquids would be concentrated by evaporation and directly incorporated into bitumen.[11,12] The bitumen product would be formed during the evaporation step by mixing the waste stream with bitumen. The evaporator condensate would be treated further by cation and mixed-bed resins. A flow diagram for this process is given in Figure G.9. The decon-tamination factors and other relevant parameters assumed for the evaporation/bituminization step and for the ion-exchange steps of this process are given in Table G.16. As with evaporation, it was assumed that a gaseous effluent carrying 0.1 percent of the condensate would be formed.

G.3.9 Summary

The systems characterized above are composed of successive treatment stages or components, with each stage contributing to the overall performance of the system. The performance parameters for each component in each system are summarized in Table G.17.

The overall performance of a system can be characterized by the decontamination factor achieved by all components in a system. The overall decontamination factors for all the treatment systems considered are summarized in Table G.18. This table was used to determine the characteristics of effluents that would arise when systems are used to treat various liquid waste sources.

G.4 BASIS FOR PROCESS SOLID WASTE ESTIMATES

Treatment of liquid waste with the systems described above will lead to the generation of process solid waste. This waste will consist of expended zeolites, expended organic resins (cation and mixed bed), filter cartridges, evaporator bottoms, and bituminized liquids. The basis for estimating the characteristics of these wastes is discussed below.

G.4.1 Expended Zeolites

Zeolites are used for first-stage removal of gross amounts of cesium and strontium. For cleanup of reactor building sump water, these water ion-exchange media are used in lots of six vessels containing 8 ft^3 of zeolites each. Thus, waste volumes were estimated in lots of 48 ft^3 zeolite each. Each vessel was assumed to contain a minimum of 10,000 Ci and a maximum of 120,000 Ci. The distribution of the Cs and Sr radionuclides in the waste was obtained from the curie differential across the ion-exchange vessels using the zeolite decontamination factors in Table G.9.

For liquids other than reactor building sump water, the estimated loading was 10,000 Ci per vessel. Where SDS-type systems were used, waste was generated in lots of six vessels, but the modified EPICOR II system was assumed to generate vessels one at a time. The radionuclide distributions of Cs and Sr were obtained from curie differentials across the vessel using zeolite decontamination factors in Table G.9.

G.4.2 Organic Resins

The organic resins that could be generated from treatment of liquids with the EPICOR II system were estimated from experience to date. This experience indicated that about 99.5 percent of the activity was removed by the prefilter vessels and 0.5 percent was removed by the cation and mixed-bed vessels. Of the 0.5 percent removed in the last two stages, it was assumed that 0.475 percent (95 percent) of the activity was removed by the cation vessel. The distribution of the radionuclides in EPICOR II waste was inferred by assuming that the last two stages of an EPICOR II system had the same decontamination factors as the cation and mixed-bed ion-exchangers in the modified SDS (see Table G.9).

For SDS type systems, cation organic resins were assumed generated in lots of two beds each (2 at 8 ft^3 or 2 at 40 ft^3) and mixed-bed vessels were generated in lots of one bed or 115 ft^3 each. Vessels were replaced based on curie loading, not breakthrough. The distribution of radionuclides in these wastes was determined from the curie differential across the vessels using the decontamination factors in Table G.9. For modified EPICOR II systems, both cation and mixed-bed vessels were assumed to be generated in lots of one bed each--30 ft^3 for cation and 110 ft^3 for mixed bed.

For other systems where organic resins were used for polishing, such as evaporator/resin and bitumen/resin, the polishing train was assumed to consist of one 30-ft^3 cation vessel and one 110-ft^3 vessel, and one vessel of each type was required for distillate/condensate polishing.

G.4.3 Filters

Filtration was considered necessary for pretreatment of reactor building sump water and RCS flush and drain water.

For reactor building sump water, filter performance was based on the solids content of the reactor building sump water (see Table G.4), the size, and the assumed filter loading of 2.8 x 10^{-1}m per Ci.

For RCS flush and drain water, it was assumed that 2 percent of the influent curie inventory for Cs, Sr, Ce, Ru, Co, Te, Zr, and Nb would be suspended solids removable by these same filters.

G.4.4 Evaporator Bottoms

Evaporators were considered for first-stage treatment of certain liquids, as well as for polishing.

For first-stage treatment, it was assumed that the volume reduction factor varied between 10 and 30 for chemical-based liquids and was 100 for aqueous liquids. The curie content and radionuclide distribution in the bottoms was determined from the differential between the radionuclide inventory in the influent and that in the distillate. The gross concentration of the bottoms was obtained by dividing the bottoms radionuclide inventory by the reduced volume.

G.4.5 Bituminized Solids

An extruder/evaporator is considered for first-stage treatment of certain liquids. To characterize the waste from this system, it was assumed that the volume reduction factor was 20 and that one part by volume of the evaporator bottoms was combined with one part asphalt. Thus, 100 gallons of influent would produce 10 gallons of bituminized solids consisting of 5 gallons of concentrated waste and 5 gallons of asphalt.

The curie content and radionuclide distribution in the bituminized solids was determined from the differential between the radionuclide inventory in the influent and that in the distillate. The gross concentration in the bituminized waste was obtained by dividing the bottoms radionuclide inventory by twice the bottoms volume.

G.5 SUMMARY OF RESULTS

The liquid and process solid waste effluents that could arise from treatment of TMI-2 liquids with various treatment systems were characterized by liquid waste source. These characterizations, in terms of radionuclide inventories, are presented below.

The characteristics of the process solid waste characteristics are based on the individual stage decontamination factors presented in Table G.17 and the assumptions described above in Section G.4.

Characteristics of Liquid Effluents (processed water)

Source	Volume (gal)	Reference
RB Sump Water	700,000	Table G.19
RCS Primary System Water	96,000	Table G.20
RCS Flush & Drain Water	250,000	Table G.21
RCS Aqueous Decon Solutions*	100,000	Same as Table G.20
RCS Chemical Decon Solutions*	500,000	Table G.22
RB Chemical Decon Solutions	40,000	Table G.23

*Mutually exclusive alternatives

Table G.1. Treatment Alternatives Suitable for TMI Liquids[a]

Treatment System Alternative	(A) AFHB Chemical Decontamination Solutions	(B) Reactor Building Sump Water	(C) Reactor Building Decontamination Water	(D) Reactor Building Decontamination Chemicals[c]	(E) Reactor Coolant System: Cooling Water[d]	(F) Reactor Coolant System: Flush and Drain Water[d]	(G) Reactor Coolant System: Decontamination Water[e]	(H) Reactor Coolant System: Decontamination Chemicals[c]
1. Zeolite Alternatives								
(a) Zeolite/resin (SDS)		*	*		*	*	*	
(b) Zeolite modified resin (Mod SDS)		*	*		*	*	*	
(c) Zeolite/evaporator		*	*		*	*	*	
(d) Zeolite/EPICOR II		*	*		*	*	*	
(e) SDS/EPICOR II		*	*		*	*	*	
(f) Modified EPICOR II					*	*	*	
2. EPICOR II			(f)		*	*		
3. Evaporator/resin	*			*				*
4. Bitumen/resin	*			*				*

[a]Note: * indicates system to be discussed as an alternative method.

[b]Alternative in the event this water is not processed along with reactor building sump water.

[c]Chemical properties of these liquids are not compatible with purely ion-exchange alternatives.

[d]Ion-exchange processes provide adequate alternatives.

[e]Processing of CAN DECON decontamination solutions will probably require system alignment changes.

[f]Only if reactor building decon water collected separately from the reactor building sump water.

Table G.2. Estimated TMI-2 Liquid Waste Summary

Source of Liquid Waste	Volume (gallons)	Curie Inventory In Untreated Liquid	
		Minimum	Maximum
1. AFHB chemical decon solutions	7,000	60	60
2. Reactor building sump water	700,000	500,000	500,000
3. RCS water	96,000	20,000	20,000
4. RCS flush and drain water	250,000[a]	20,000	100,000
5. Reactor building decon solutions			
(a) Water based	150,000[a]	90	90
(b) Chemical	40,000	10	10
6. RCS decon solutions[b]			
(a) Water based	100,000[a]	2,000	20,000
(b) Chemical	500,000[a]	2,000	20,000

[a]Processed water could be used for these cleanup activities.

[b]The RCS water-based and chemical decontamination processes are mutually exclusive. Either the water-based or chemical process will be used in the decontamination of the RCS.

Table G.3. Estimated Concentrations of Dissolved Contaminants in Reactor Building Sump Water as of September 1, 1980[a,b]

Contaminant	Sump Water Concentration (μCi/mL)	Contaminant	Sump Water Concentration (μg/mL)
H-3	9.5×10^{-1}	U	2.8×10^{-2}
Cs-137	1.6×10^{2}	Pu	3.3×10^{-5}
Cs-134	2.4×10^{1}	Na	1.2×10^{3}
Sr-90	2.6	B	2.0×10^{3}
Sr-89	7×10^{-2}	Cl	1.5×10^{1}
Zr-95	2×10^{-5}	Al	3
Nb-95	1×10^{-5}	Ca	10
Ru-106	3×10^{-3}	Cu	10
Sb-125	2×10^{-2}	Fe	1.8
Te-125m	5×10^{-4}	K	4
Te-127m	5×10^{-4}	Li	1.6
Te-129m	2×10^{-4}	Ni	3
Ce-144	2×10^{-3}	P	3×10^{-1}
I-129	1.2×10^{-5}	Rb	3×10^{-1}
		S	9
		Zn	5×10^{-1}

[a]The reactor building sump water volume is 700,000 gallons.

[b]From R.E. Brooksbank and W.J. Armento, "Post Accident Cleanup of Radioactivity at the Three Mile Island Nuclear Power Station," Oak Ridge National Laboratory, ORNL/TM-7091, February 1980; and D.O. Campbell, Hot Cell Studies," Oak Ridge National Laboratory, presentation to Central Public Utilities and U.S. Dept. of Energy staff members, January 31, 1980, corrected for decay.

Table G.4. Filterable Solids in Reactor Building Sump Water as of September 1, 1980[a,b]

Radionuclide	Sump Water Concentration (μCi/g)
Cs-137	7.1×10^{-1}
Cs-134	1.1×10^{-1}
Nb-95	1.7×10^{-3}
Zr-95	3.7×10^{-3}
Ru-106	1.8×10^{-1}
Ru-103	1.4×10^{-4}
Ce-141	3.8×10^{-6}
Ce-144	8.3×10^{-2}
Co-58	7.7×10^{-4}
Co-60	1.1×10^{-2}
Sr-90	8.6
Ag-110m	5.9×10^{-3}
Sb-125	2×10^{-1}
Te-127m	2.7×10^{-1}

[a]Total solids = 13×10^{3} kg (assuming solids content of approximately 0.5%).

[b]From R.E. Brooksbank and W.J. Armento, "Post-Accident Cleanup of Radioactivity at the Three Mile Island Nuclear Power Station," ORNL/TM-7081, February 1980, corrected for decay.

Table G.5. Estimated Concentrations of Contaminants in the Reactor Coolant System as of September 1, 1980

Radionuclide	Concentration[a] (μCi/mL)
H-3	8×10^{-2}
Cs-137	2.9×10^{1}
Cs-134	4.5
Sr-90	2.3×10^{1}
Sr-89	2.4
Zr-95	5×10^{-4}
Nb-95	8×10^{-4}
Ru-106	1×10^{-1}
Sb-125	4×10^{-3}
Te-125m	6×10^{-3}
Te-127m	3×10^{-1}
Te-129m	1×10^{-3}
Ce-144	3×10^{-2}
Co-58	2×10^{-4}

[a]From "TMI-2 Data Base Update," released by Argonne National Laboratory, J.E. Robinson, December 23, 1980.

Table G.6. Estimated Concentrations of Contaminants in Reactor Coolant System Flush and Drain

Radionuclide	Concentration[a] (μCi/mL)
Cs-137	5.2×10^{1}
Cs-134	8.1
Sr-90	4.1×10^{1}
Sr-89	4.3
Zr-95	9.0×10^{-4}
Nb-95	1.4×10^{-3}
Ru-106	1.8×10^{-1}
Sb-125	7.2×10^{-3}
Te-125m	1.1×10^{-2}
Te-127m	5.4×10^{-1}
Te-129m	1.8×10^{-3}
Ce-144	5.4×10^{-2}

[a] Concentrations based on maximum inventory of 100,000 Ci, with radionuclide distribution the same as primary system water.

Table G.7. Estimated Radioactivity Contained in Solid Debris in Reactor Coolant System Flush and Drain Water as of September 1, 1980

Radionuclide	Total Curies[a]
Cs-137	7.4×10^{1}
Cs-134	1.5×10^{1}
Sr-90	1.5×10^{2}
Sr-89	1.2×10^{1}
Zr-95	7.2×10^{1}
Nb-95	8.5×10^{1}
Ru-106	2.5×10^{2}
Ce-144	1.4×10^{3}
Total	$\sim 2.1 \times 10^{3}$

[a] Based on assumption that input stream has been filtered to remove essentially all of the fuel debris prior to processing.

Table G.8. Summary of Liquid Waste Radionuclide Inventories

Major Radionuclide	Reactor Building Sump Water	Reactor Coolant System Water	RCS Flush and Drain Water[a]	RCS Decontamination solutions[b]	Reactor Building Decontamination Solutions	AFHB Decontamination Solutions
H-3	2.5×10^{3}	2.7×10^{1}	-	-	-	-
Cs-137	4.3×10^{5}	9.9×10^{3}	4.9×10^{4}	9.9×10^{3}	8	51
Cs-134	6.6×10^{4}	1.5×10^{3}	7.5×10^{3}	1.5×10^{3}	2	8
Sr-90	7.0×10^{3}	7.8×10^{3}	3.9×10^{4}	7.8×10^{3}	-	1
Sr-89	1.9×10^{2}	8.2×10^{2}	4.1×10^{3}	8.2×10^{2}	-	-
I-129	3.2×10^{-2}	NA	NA	NA	-	-
Zr-95	5.3×10^{-2}	1.7×10^{-1}	8.5×10^{-1}	1.7×10^{-1}	-	-
Nb-95	4.9×10^{-2}	2.7×10^{-1}	1.4	2.7×10^{-1}	-	-
Ru-106	1.0×10^{1}	3.4×10^{1}	1.7×10^{2}	3.4×10^{1}	-	-
Ru-103	1.8×10^{-3}	NA	NA	NA	-	-
Sb-125	5.6×10^{1}	1.4	7	1.4	-	-
Te-125m	1.3	2	10	2	-	-
Te-127m	4.8	1×10^{2}	5×10^{2}	1×10^{2}	-	-
Te-129m	5.3×10^{-1}	3.4×10^{-1}	1.7	3.4×10^{-1}	-	-
Ce-144	1.6	1×10^{1}	5×10^{1}	1×10^{1}	-	-
Ce-141	4.9×10^{-5}	NA	NA	NA	-	-
Co-60	1.4×10^{-1}	NA	NA	NA	-	-
Co-58	1×10^{-2}	6.8×10^{-2}	3.4×10^{-1}	6.8×10^{-2}	-	-
Aq-110m	7.7×10^{-2}	NA	NA	NA	-	-
Total (rounded)	5×10^{5}	2×10^{4}	1×10^{5}	2×10^{4}	10	60

[a]Maximum inventory of 100,000 Ci. If minimum of 20,000 Ci removed values shown will be reduced by a factor of 5.
[b]Maximum inventory of 20,000 Ci. If minimum of 2000 Ci removed values shown will be reduced by a factor of 10.

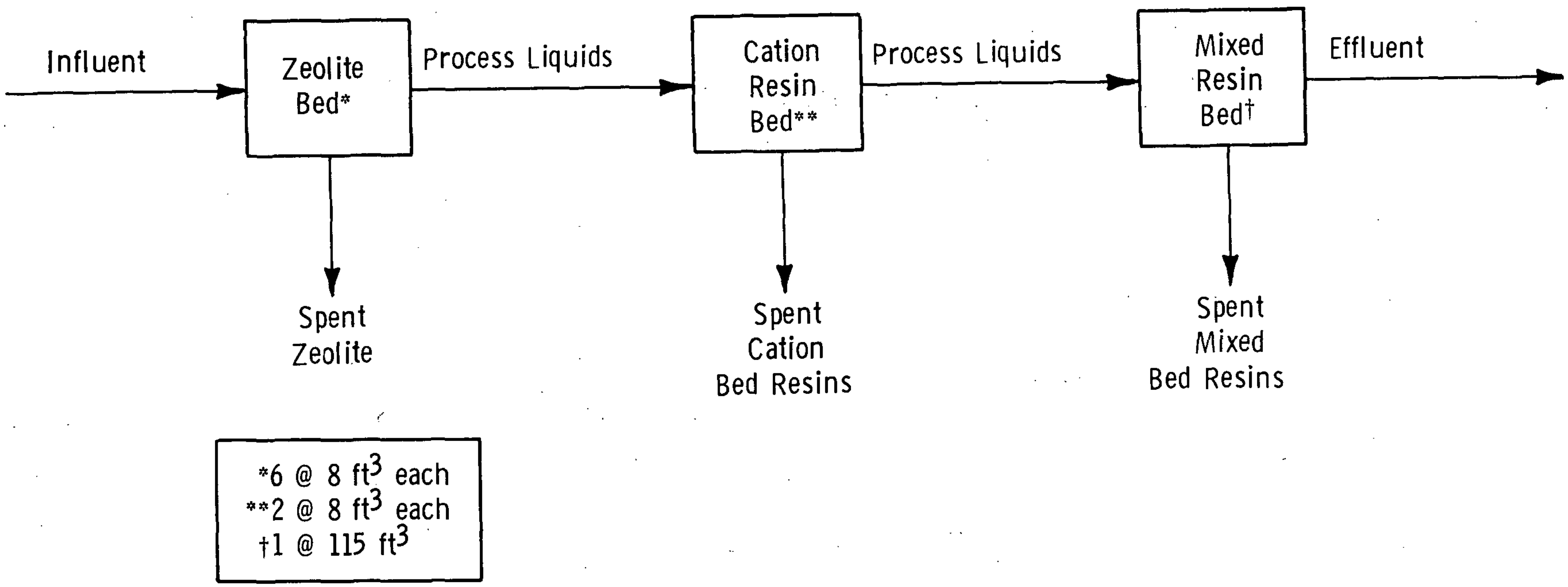

Figure G.1. Process Flow Diagram for Submerged Demineralizer System.

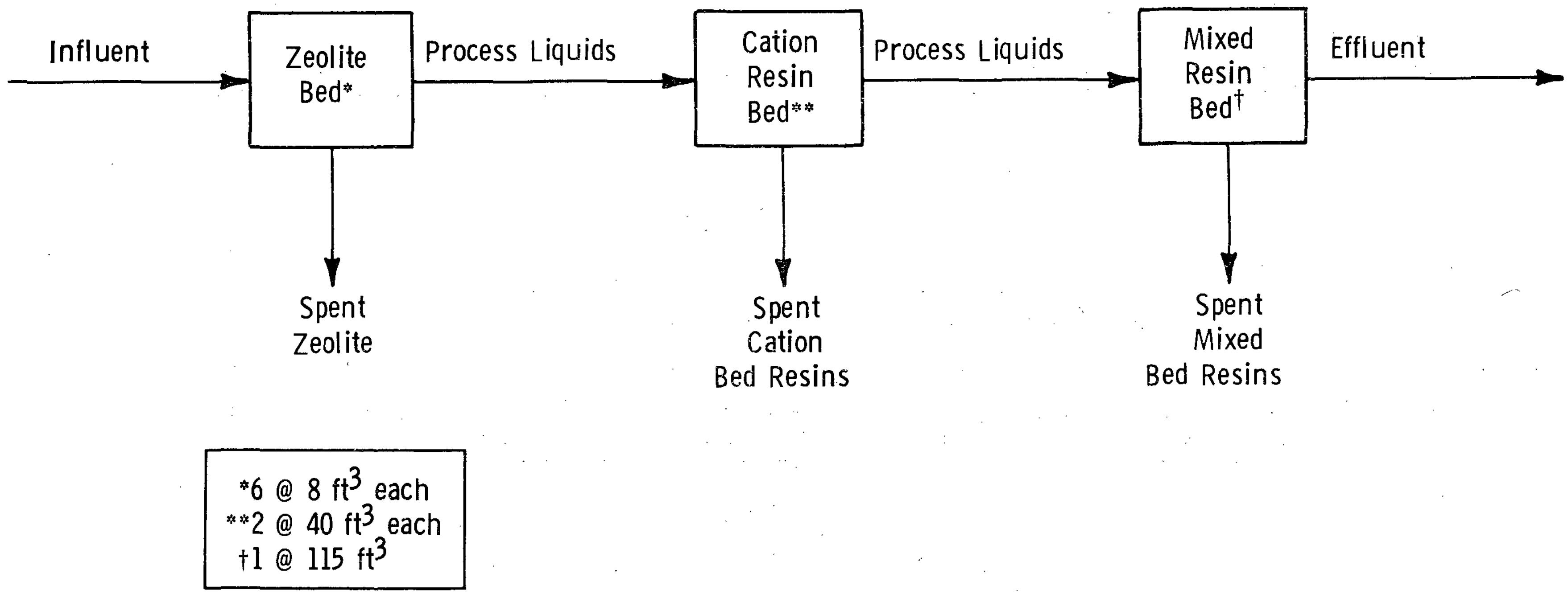

Figure G.2. Process Flow Diagram for Modified Submerged Demineralizer System.

Table G.9. Process Decontamination Factors and Breakthrough Volumes for Submerged Demineralizer Type Systems[a]

Exchange Material	SDS Value	Modified SDS Value
Zeolites		
Breakthrough volume[b]	200 column volumes	200 column volumes
Decontamination factors		
Cs	5×10^4	5×10^4
Sr	8.5×10^2	8.5×10^2
Other cations	1	1
Anions	1	1
Cation Exchange Resin (H^+ form)	8 ft^3 volume	40 ft^3 volume
Decontamination factors		
Cs	1	10
Sr	1	3
Ru	1	3
Ce	1	2.5
Sb	1	1
Other cations[c]	1	1
Anions	1	1
Mixed-Bed		
Decontamination factors		
Cs	2	6
Sr	2	2
Ru	2	5
Ce	2	2
I	2	2
Sb	1	100
All other soluble species[d]	2	2

[a]References:

D.O. Campbell, E.D. Collins, L.J. King, and J.B. Knaver, "Evaluation of Submerged Demineralizer System (SDS) Flow Sheet for Decontamination of High-Activity-Level-Water at the Three Mile Island Unit 2 Nuclear Power Station," Oak Ridge National Laboratory, ORNL/TM-7448, July 1980.

R.E. Brooksbank and W.J. Armento, "Post-Accident Cleanup of Radioactivity at the Three Mile Island Nuclear Power Station," Oak Ridge National Laboratory, ORNL/TM-7081, February 1980.

R.L. Schwoebel, "The Management of Radioactive Waste: Waste Partitioning as an Alternative," PB-254737, pp. 307-323, 1976.

K.H. Lin, "Use of Ion Exchange for the Treatment of Liquids in Nuclear Power Plants," Oak Ridge National Laboratory, ORNL-4792, December 1973.

[b]"Breakthrough volume" is the processing volume that necessitates replacement or regeneration of the resins; 200 column volumes for all data.

[c]Except H^+, Na^+, and Li^+.

[d]Except H^+.

Table G.10. EPICOR-II Performance for Batch No. 41--AFHB Water

Isotope	μCi/cc Influent	μCi/cc Effluent	Approximate DF
H-3	4.3×10^{-2}	4.3×10^{-2}	1
Cs-137	5.6×10^{1}	$< 3.4 \times 10^{-6}$	10^{7}
Cs-134	9.2	$< 5 \times 10^{-6}$	10^{7}
Sr-90	5.9×10^{-1}	1.8×10^{-6}	10^{5}
Sr-89	6×10^{-1}	8.6×10^{-6}	10^{5}
I-129	ND	ND	ND
Nb-95	1.9×10^{-5}	$< 4 \times 10^{-8}$	10^{3}
Zr-95	1.2×10^{-4}	$< 5.9 \times 10^{-8}$	10^{3}
Ru-103	9.9×10^{-5}	$< 9.4 \times 10^{-8}$	10^{3}
Ce-144	1.7×10^{-3}	$< 8.5 \times 10^{-7}$	10^{3}
Ce-141	1.6×10^{-5}	$< 1.9 \times 10^{-7}$	10^{3}
Co-58	2.1×10^{-4}	$< 2.9 \times 10^{-6}$	10
Co-60	8.7×10^{-5}	$< 4.6 \times 10^{-6}$	10
Ag-110m	1.8×10^{-5}	$< 4.1 \times 10^{-7}$	10
Sb-125	1.2×10^{-3}	$< 3.1 \times 10^{-8}$	10^{4}
Te-125m	2.7×10^{-4}	$< 7 \times 10^{-9}$	10^{3}
Te-127m	ND	ND	ND
Te-129m	ND	ND	ND
Ru-106	5.1×10^{-4}	$< 6.9 \times 10^{-7}$	10^{3}

ND - Not Detected.

Table G.11. Decontamination Factors Assumed for EPICOR-II System[a]

Radionuclide	Decontamination Factor
Cs	10^{7}
Sr	10^{5}
Ru	10^{3}
Ce	10^{3}
I	10[b]
Sb	10^{3}
All Other Soluble Species	10^{3}

[a]Inferred from EPICOR II performance on AFHB water.

[b]Inferred from EPICOR-I processing experience.

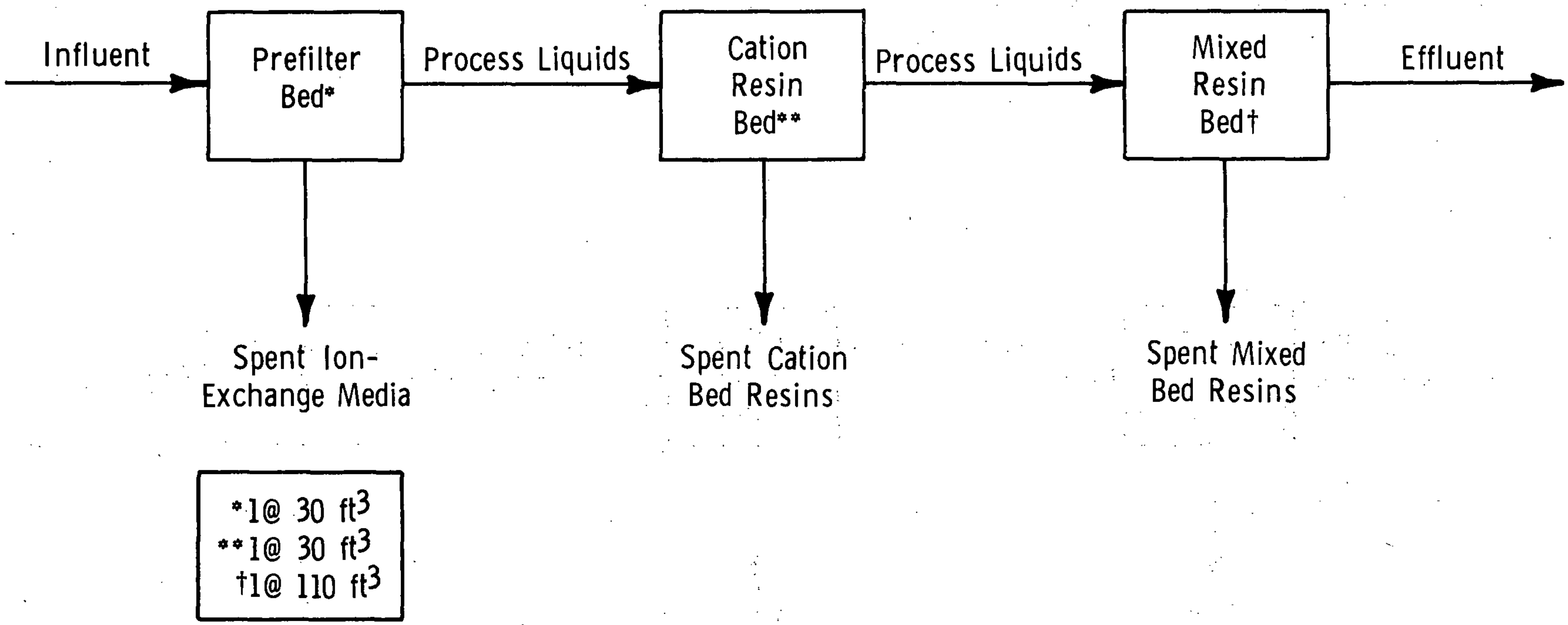

Figure G.3. Process Flow Diagram for EPICOR II System.

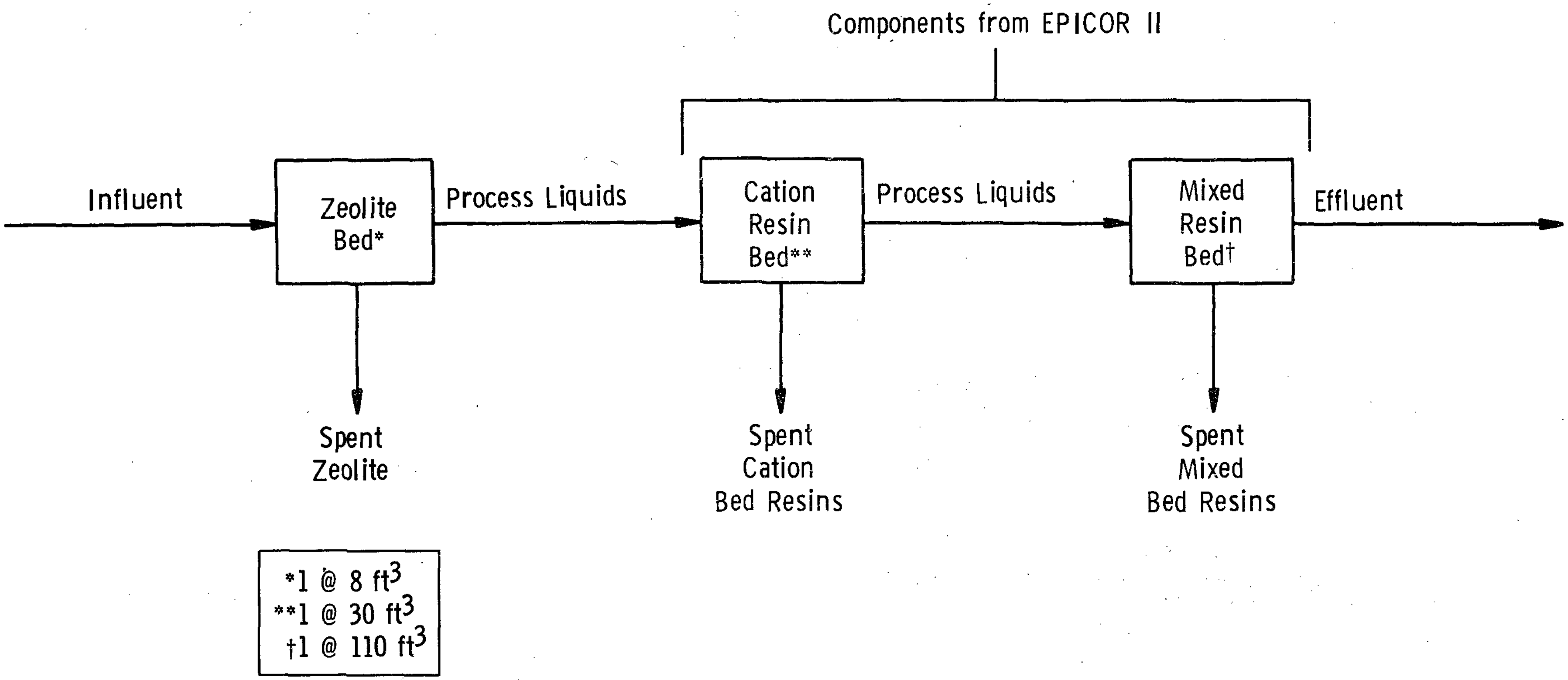

Figure G.4. Process Flow Diagram for Modified EPICOR II System.

Table G.12. Decontamination Factors, Volume Reduction Factors and Breakthrough Volumes Assumed for Zeolite/Evaporation Processing

Factor	Value
Zeolites	
Breakthrough volume[a]	200 column volumes
Decontamination factors	
Cs	5×10^4
Sr	8.5×10^2
Other cations	1
Anions	1
Evaporator[b]	
Volume reduction	100
Decontamination factor	
Anions	10^3
All other ions	10^4
Cation Exchange Resin (H^+ form)	
Decontamination factors	
Cs	10
Sr	3
Ru	3
Ce	2.5
Sb	1
Other cations[c]	1
Anions	1
Mixed-Bed	
Decontamination factors	
Cs	6
Sr	2
Ru	5
Ce	2
I	2
Sb	100
All other soluble species[d]	2

[a] "Breakthrough volume" is the processing volume that necessitates replacement or regeneration of the resins; 200 column volumes for all data.

[b] From H.W. Godbee, "Use of Evaporation for the Treatment of Liquids in the Nuclear Industry," Oak Ridge Laboratory, ORNL-4790, September 1973; and American Nuclear Society, "American National Standard Liquid Radioactive Waste Processing System for Pressurized Water Reactor Plants," ANSIN199-1976, ANS-55.1.

[c] Except H^+, Na^+, and Li^+.

[d] Except H^+.

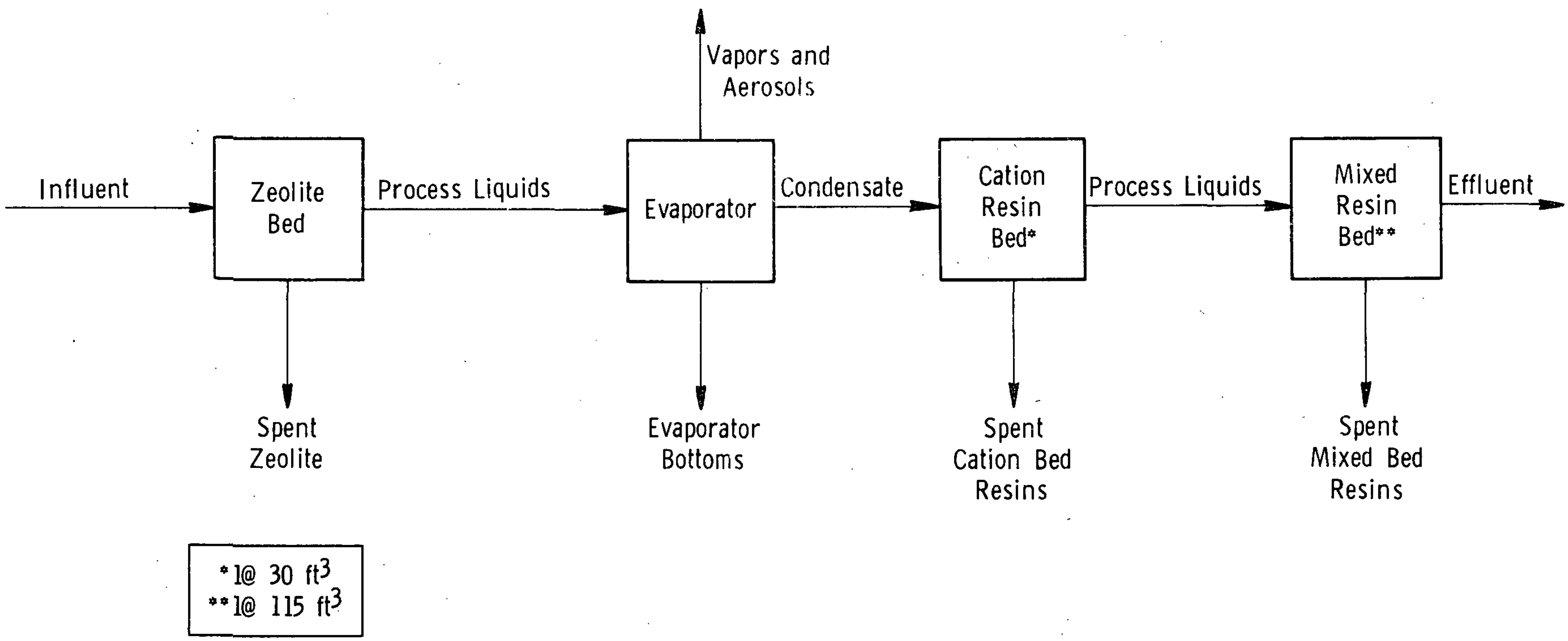

Figure G.5. Process Flow Diagram for Zeolite/Evaporation System.

ZEOLITE/EPICOR II ALTERNATIVE

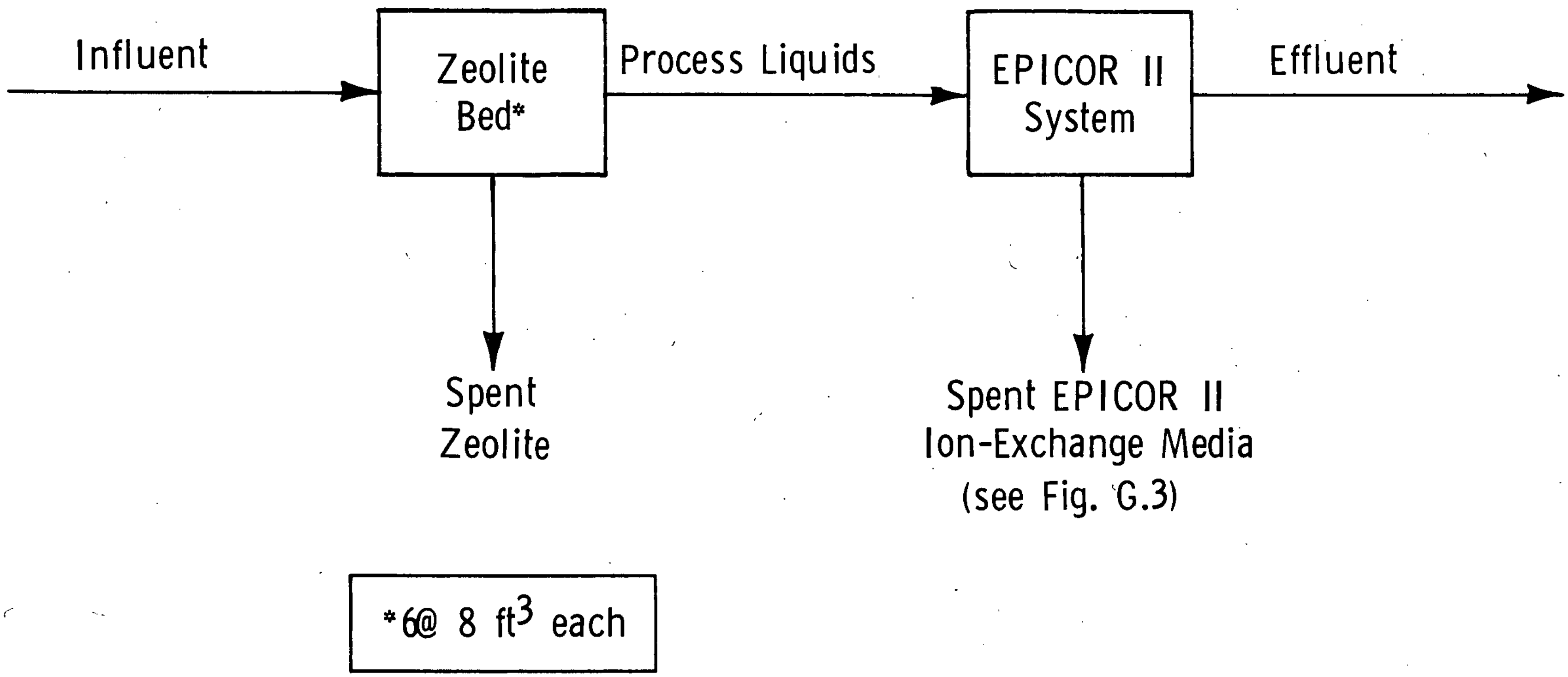

Figure G.6. Process Flow Diagram for Zeolite/EPICOR II System.

Table G.13. Decontamination Factors and Breakthrough Volume Assumed for Zeolite/EPICOR II Process

Factor	Value
Zeolites	
Breakthrough volume	200 column volumes
Decontamination factors	
Cs	5×10^4
Sr	8.5×10^2
Other cations	1
Anions	1
EPICOR II	
Decontamination factors[a]	
Cs	10^7
Sr	10^5
Ru	10^3
Ce	10^3
I	10[b]
Sb	10^3
All other soluble species	10^3

[a] Inferred from EPICOR II performance on AFHB water.

[b] Inferred from EPICOR I processing experience.

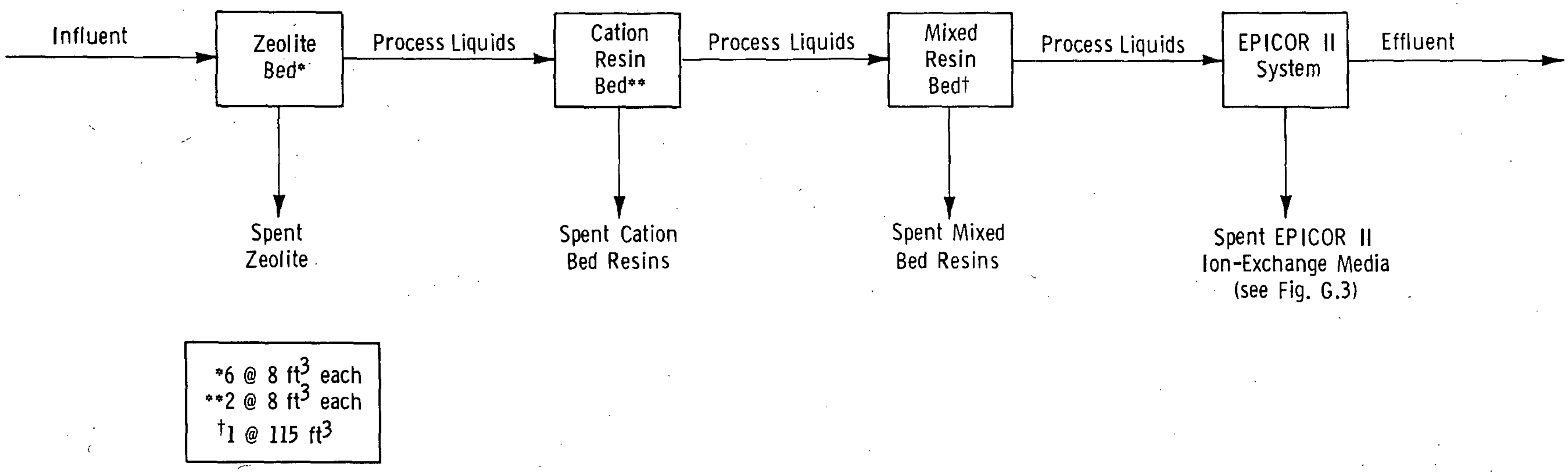

Figure G.7. Process Flow Diagram for SDS/EPICOR II System.

Table G.14. Decontamination Factors and Breakthrough Volumes Assumed for SDS/EPICOR II Process

Factor	Value
<u>SDS</u>	
Zeolites	
Breakthrough volume	200 column volumes
Cs	5×10^4
Sr	8.5×10^2
Other cations	1
Anions	1
Cation Exchange Resin (H^+ form)	8 ft^3 volume
Decontamination factors	
Cs	1
Sr	1
Ru	1
Ce	1
Sb	1
Other cations	1
Anions	1
Mixed-Bed	
Decontamination factors	
Cs	2
Sr	2
Ru	2
Ce	2
I	2
Sb	1
All other soluble species	2
<u>EPICOR II</u>	
Decontamination factors[a]	
Cs	10^7
Sr	10^5
Ru	10^3
Ce	10^3
I	10[b]
Sb	10^3
All other soluble species	10^3

[a]Inferred from EPICOR II performance on AFHB water.

[b]Inferred from EPICOR I processing experience.

Table G.15. Volume Reduction Factor and Decontamination Factors Assumed for Evaporation/Resin Process

Factor	Value
Evaporator	
Volume reduction	10^{2}[a]
Decontamination factor	
Iodine	10^{3}[b]
All other ions	10^{4}[b]
Cation Exchange Resin (H^+ form)	
Decontamination factors	
Cs	10
Sr	3
Ru	3
Ce	2.5
Sb	1
Other cations[c]	1
Anions	1
Mixed-Bed	
Decontamination factors	
Cs	6
Sr	2
Ru	5
Ce	2
I	2
Sb	100
All other soluble species[d]	2

[a]Factor of 100 for water-based influents. For chemical decontamination solutions with relatively high solids/chemical content range of 10 to 30 is more appropriate

[b]For detergent wastes the decontamination factors for all species are assumed to be 100.

[c]Except H^+, Na^+, and Li^+.

[d]Except H^+.

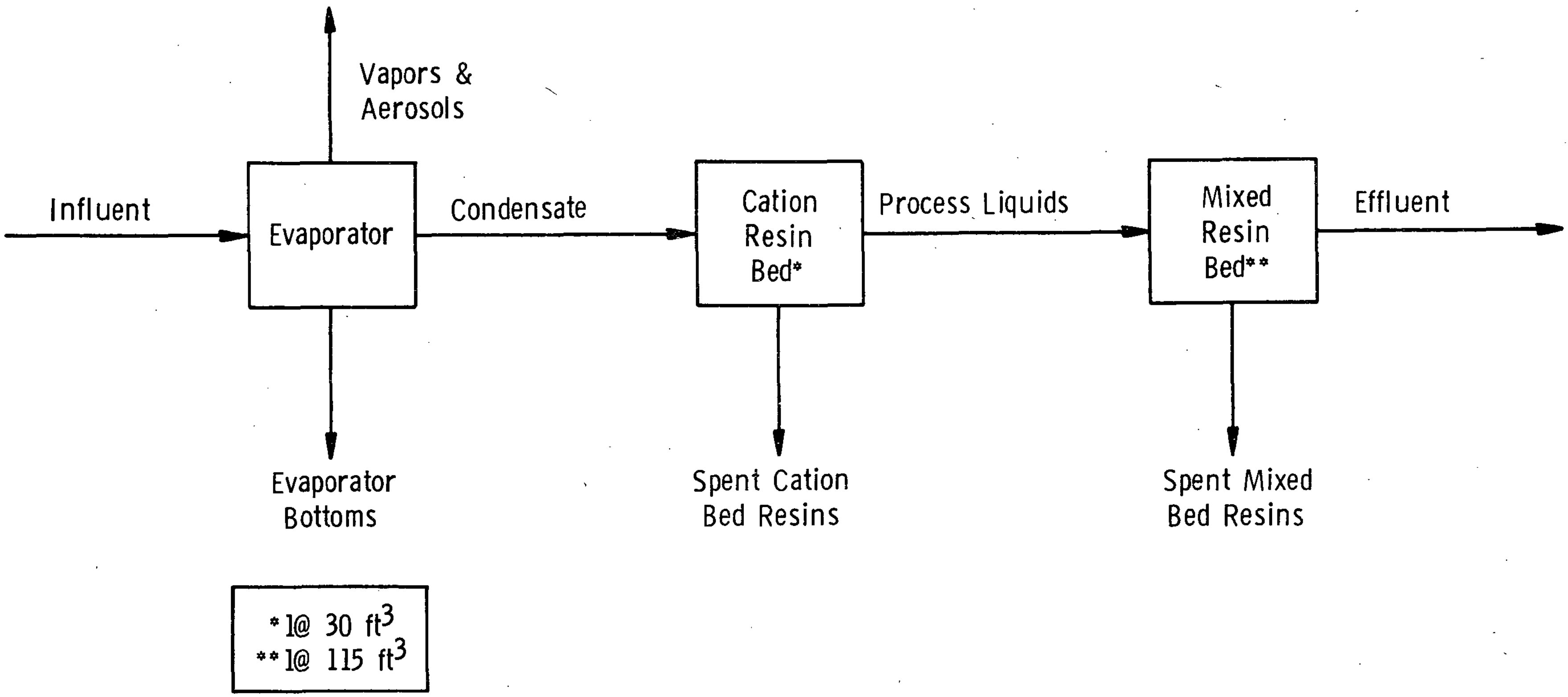

Figure G.8. Process Flow Diagram for Evaporator/Resin System.

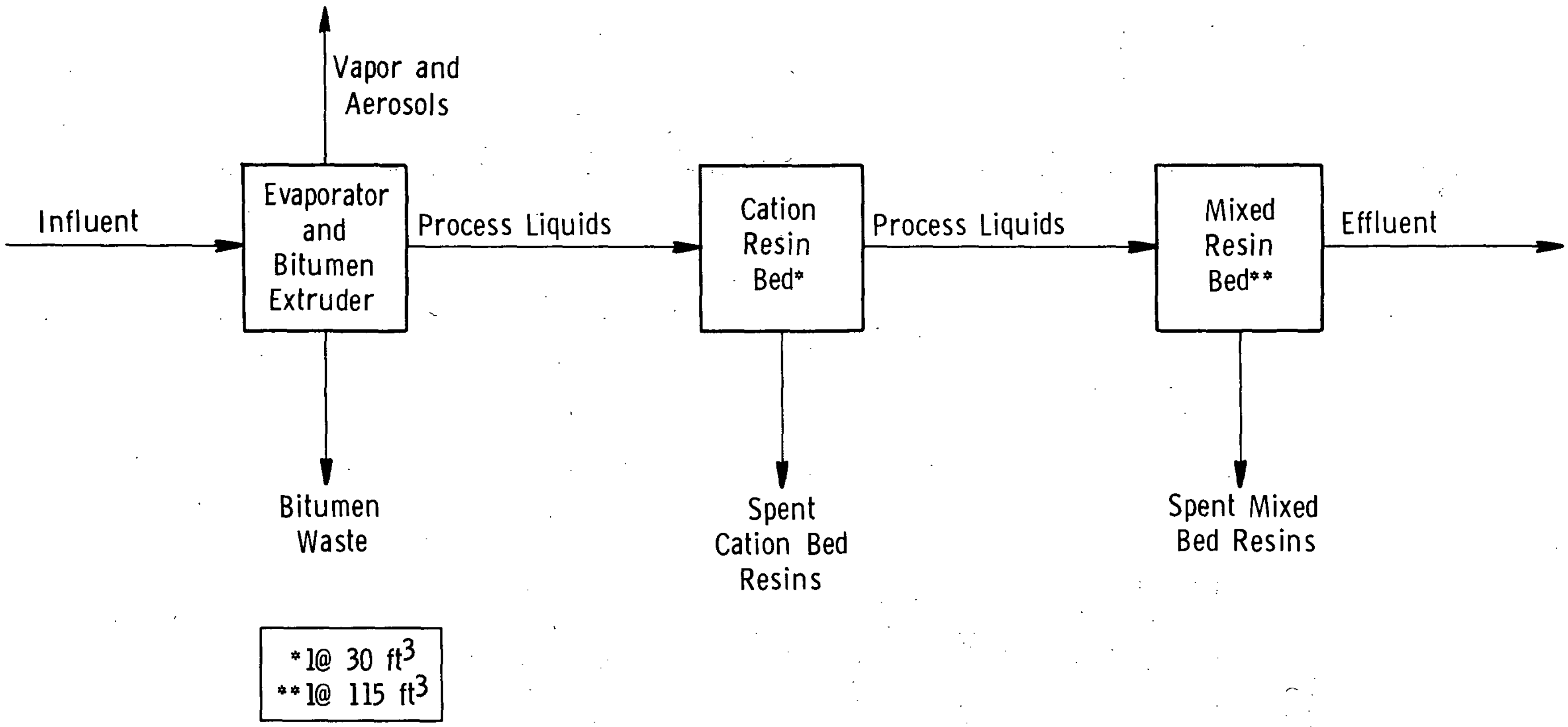

Figure G.9. Process Flow Diagram for Bitumen/Resin System.

Table G.16. Decontamination Factors and Volume Reduction Factors Assumed for Bitumen/Resin Process[a]

Factor	Value
Evaporation and Bitumenization	
Concentration factor	3 to 20
Decontamination factors	
Cs	2×10^{3}[b]
Sr	1×10^{4}[b]
Ru	10^{2}
I	10^{2}
B	10^{2}
Other cations	10^{2}[c]
Other anions	10^{2}[c]
Cation Exchange Resin (H^+ form)	
Decontamination factors	
Cs	10
Sr	3
Ru	3
Ce	2.5
Sb	1
Other cations[d]	1
Anions	1
Mixed-Bed	
Decontamination factors	
Cs	6
Sr	2
Ru	5
Ce	2
I	2
Sb	100
All other soluble species[e]	2

[a]Based on G. Lefillatre, "Progress in the Techniques of Bituminizing Liquid Effluents of Pressurized Water Nuclear Power Plants," BNWL-TR-196, August 1976.

[b]Based on CRNL/SUB-79/13837/2, "State of the Art Review of Radioactive Waste Volume Reduction Techniques for Commercial Nuclear Power Plants".

[c]Assumed.

[d]Except H^+, Na^+, and Li^+.

[e]Except H^+.

Table G.17. Summary of Decontamination Factors for TMI-2 Treatment System Components

Radionuclide	Zeolite First-Stage	SDS Cation	SDS Mixed Bed	Modified SDS and Other Cation Beds	Modified SDS and Other Mixed Beds	Evaporator[a]	Extruder/ Evaporator
Cs	5×10^4	1	2	10	6	1×10^4	2×10^3
Sr	8.5×10^2	1	2	3	2	1×10^4	1×10^4
Ru	-	1	2	3	5	1×10^4	1×10^2
Ce	-	1	2	2.5	2	1×10^4	1×10^2
I	-	-	2	-	2	1×10^3	1×10^2
Sb	-	1	1	1	1×10^2	1×10^3	1×10^2
Other cations	-	1	-	1	-	1×10^4	1×10^2
Anions	-	1	-	1	-	1×10^3	1×10^2
All other soluble species	-	-	2	-	2	-	1×10^2

[a]For detergent wastes all decontamination factors are 100.

Table G.18. Summary of Overall Decontamination Factors for TMI-2 Treatment Systems

Radionuclide	SDS	Modified SDS	Zeolite/ Evaporator	Zeolite/ EPICOR II	SDS EPICOR II	EPICOR II	Modified EPICOR II	Evaporator/ Resin (non detergents)	Bitumen/ Resin	Evaporator/ Resin (de-tergents)
Cs	1×10^5	3×10^6	3×10^9	5×10^{11}	1×10^{12}	1×10^7	3×10^6	6×10^5	1.2×10^5	6×10^3
Sr	1.7×10^3	5.1×10^3	1.7×10^7	8.5×10^7	1.7×10^8	1×10^5	5.1×10^3	6×10^4	6×10^4	6×10^2
Ru	2	1.5×10^1	5×10^4	1×10^3	2×10^3	1×10^3	1.5×10^1	1.5×10^5	1.5×10^3	1.5×10^3
Ce	2	5	2×10^4	1×10^3	2×10^3	1×10^3	5	5×10^4	5×10^2	5×10^2
I	2	2	2×10^3	10	10	10	2	2×10^3	2×10^2	2×10^2
Sb	1	1×10^2	1×10^5	1×10^3	1×10^3	1×10^3	1×10^2	1×10^5	1×10^4	1×10^4
Other cations	1	1	1×10^4	1	1	1	1	1×10^4	1×10^2	1×10^3
Anions	1	1	1×10^3	1	1	1	1	1×10^3	1×10^2	1×10^2
All other soluble species	2	2	2	1×10^3	1×10^3	1×10^3	2	2	2×10^2	2

Table G.19. Radionuclides in Liquid Effluents from Treatment of Reactor Building Sump Water

Major Radionuclides in Stream	Total Curies of Radio-activity in Influent (Ci)	Total Curies of Radioactivity in Spent Filters (Ci)	Pre-processed Liquid (Ci)	Treatment Alternatives					
				SDS (Ci)	Modified SDS (Ci)	Zeolite Evaporation (Ci)	Zeolite EPICOR II (Ci)	SDS EPICOR II (Ci)
H-3	2.5×10^{3}	-	2.5×10^{3}	2.5×10^{3}	2.5×10^{3}	2.5×10^{3}	2.5×10^{3}	2.5×10^{3}
Cs-137	4.3×10^{5}	9.2	4.3×10^{5}	4.3	1.4×10^{-1}	1.4×10^{-4}	8.6×10^{-7}	4.3×10^{-7}
Cs-134	6.6×10^{4}	1.4	6.6×10^{4}	6.6×10^{-1}	2.2×10^{-2}	2.2×10^{-5}	1.3×10^{-7}	6.6×10^{-8}
Sr-90	7.0×10^{3}	1.1×10^{2}	6.9×10^{3}	4.1	1.4	4.1×10^{-4}	8.1×10^{-5}	4.1×10^{-5}
Sr-89	1.9×10^{2}	-	1.9×10^{2}	1.1×10^{-1}	3.7×10^{-2}	1.1×10^{-5}	2.2×10^{-6}	1.1×10^{-6}
I-129	3.1×10^{-2}	-	3.2×10^{-2}	1.6×10^{-2}	1.6×10^{-2}	1.6×10^{-5}	3.2×10^{-3}	3.2×10^{-3}
Zr-95	5.3×10^{-2}	4.8×10^{-2}	5.0×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	2.5×10^{-3}	5.0×10^{-6}	5.0×10^{-6}
Nb-95	4.9×10^{-2}	2.2×10^{-2}	2.7×10^{-2}	1.4×10^{-2}	1.4×10^{-2}	1.4×10^{-2}	2.7×10^{-5}	2.7×10^{-5}
Ru-106	1.0×10^{1}	2.3	7.7	3.9	0.51	1.5×10^{-4}	7.7×10^{-3}	3.9×10^{-3}
Ru-103	1.8×10^{-3}	1.8×10^{-3}	0.0	0.0	0.0	0.0	0.0	0.0
Sb-125	5.6×10^{1}	2.6	53	53	5.3×10^{-1}	5.3×10^{-4}	5.3×10^{-2}	5.3×10^{-2}
Te-125m	1.3	-	1.3	0.7	0.7	0.7	1.3×10^{-3}	1.3×10^{-3}
Te-127m	4.8	3.5	1.3	0.7	0.7	0.7	1.3×10^{-3}	1.3×10^{-3}
Te-129m	5.3×10^{-1}	-	5.3×10^{-1}	2.7×10^{-1}	2.7×10^{-1}	2.7×10^{-1}	5.3×10^{-4}	5.3×10^{-4}
Ce-144	1.6	1.1	0.5	0.25	0.10	2.5×10^{-5}	5.0×10^{-4}	2.5×10^{-4}
Ce-141	4.9×10^{-5}	4.9×10^{-5}	0.0	0.0	0.0	0.0	0.0	0.0
Co-60	1.4×10^{-1}	-	1.4×10^{-1}	0.7×10^{-1}	0.7×10^{-1}	0.7×10^{-1}	1.4×10^{-4}	1.4×10^{-4}
Co-58	1.0×10^{-2}	-	1.0×10^{-2}	0.5×10^{-2}	0.5×10^{-2}	0.5×10^{-2}	1.0×10^{-5}	1.0×10^{-5}
Ag-110m	7.7×10^{-2}	-	7.7×10^{-2}	3.9×10^{-2}	3.9×10^{-2}	3.9×10^{-2}	7.7×10^{-5}	7.7×10^{-5}
Total	5×10^{5}	-						

Table G.20. Radionuclides in Liquid Effluents from Treatment of RCS Primary System Water[a]

Major Radionuclides in Stream	Total Curies of Radio-activity in Influent (Ci)	Treatment Alternatives						
		SDS (Ci)	Modified SDS (Ci)	Zeolite Evaporation (Ci)	Zeolite EPICOR II (Ci)	SDS EPICOR II (Ci)	EPICOR II (Ci)	Modified EPICOR II (Ci)
H-3	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}	2.7×10^{1}
Cs-137	9.9×10^{3}	9.9×10^{-2}	3.3×10^{-3}	3.3×10^{-6}	2.0×10^{-8}	9.9×10^{-9}	9.9×10^{-4}	3.3×10^{-3}
Cs-134	1.5×10^{3}	1.5×10^{-2}	5.0×10^{-4}	5.0×10^{-7}	3.0×10^{-9}	1.5×10^{-9}	1.5×10^{-4}	5.0×10^{-4}
Sr-90	7.8×10^{3}	4.6	1.5	4.6×10^{-4}	9.2×10^{-5}	4.6×10^{-5}	7.8×10^{-2}	
Sr-89	8.2×10^{2}	0.48	0.16	4.8×10^{-5}	9.6×10^{-6}	4.8×10^{-6}	8.2×10^{-3}	0.16
I-129	NA	NA	NA	NA	NA	NA	NA	NA
Zr-95	1.7×10^{-1}	8.5×10^{-2}	8.5×10^{-2}	8.5×10^{-2}	1.7×10^{-4}	1.7×10^{-4}	1.7×10^{-4}	8.5×10^{-2}
Nb-95	2.7×10^{-1}	1.4×10^{-1}	1.4×10^{-1}	1.4	2.7×10^{-4}	2.7×10^{-4}	2.7×10^{-4}	1.4×10^{-1}
Ru-106	3.4×10^{1}	1.7×10^{1}	2.3	6.8×10^{-4}	3.4×10^{-2}	1.7×10^{-2}	3.4×10^{-2}	2.3
Ru-103	NA	NA	NA	NA	NA	NA	NA	NA
Sb-125	1.4	1.4	1.4×10^{-2}	1.4×10^{-5}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-2}
Te-125m	2.0	1.0	1.0	1.0	2.0×10^{-3}	2.0×10^{-3}	2.0×10^{-3}	1.0
Te-127m	1.0×10^{2}	50	50	50	1.0×10^{-1}	1.0×10^{-1}	1.0×10^{-1}	50
Te-129m	3.4×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	3.4×10^{-4}	3.4×10^{-4}	3.4×10^{-4}	1.7×10^{-1}
Ce-144	1.0×10^{1}	5.0	2.0	5.0×10^{-4}	1.0×10^{-2}	5.0×10^{-3}	1.0×10^{-2}	2.0
Ce-141	NA	NA	NA	NA	NA	NA	NA	NA
Co-60	NA	NA	NA	NA	NA	NA	NA	NA
Co-58	6.8×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	3.4×10^{-2}	6.8×10^{-5}	6.8×10^{-5}	6.8×10^{-5}	3.4×10^{-2}
Ag-110m	NA	NA	NA	NA	NA	NA	NA	NA
Total	2.0×10^{4}							

[a]Based on assumptions RCS aqueous decontamination solutions will be the same for maximum 20,000 Ci case.

Table G.21. Radionuclides in Liquid Effluents from Treatment of RCS Flush and Drain Water

Major Radio-nuclides in Stream	Total Curies of Radioac-tivity in Influent	Total Curie Activity in Spent Filters (Ci)	Total Curie Activity in Filtered Water (Ci)	Treatment Alternative						
				SDS (Ci)	Modified SDS (Ci)	Zeolite Evaporator (Ci)	Zeolite EPICOR II (Ci)	SDS EPICOR II (Ci)	EPICOR II (Ci)	Modified EPICOR II (Ci)
H-3	-	-	-	-	-	-	-	-	-	-
Cs-137	4.9×10^{4}	9.8×10^{2}	4.8×10^{4}	4.8×10^{-1}	1.6×10^{-2}	1.6×10^{-5}	9.6×10^{-8}	4.8×10^{-8}	4.8×10^{-3}	1.6×10^{-2}
Cs-134	7.5×10^{3}	1.5×10^{2}	7.4×10^{3}	7.4×10^{-2}	2.5×10^{-3}	2.5×10^{-6}	1.9×10^{-8}	7.4×10^{-9}	7.4×10^{-4}	2.5×10^{-3}
Sr-90	3.9×10^{4}	7.8×10^{2}	3.8×10^{4}	2.2×10^{1}	7.5	2.2×10^{-3}	4.5×10^{-4}	2.2×10^{-4}	3.8×10^{-1}	7.5
Sr-89	4.1×10^{3}	8.2×10^{1}	4.0×10^{3}	2.4	0.78	2.4×10^{-4}	4.7×10^{-5}	2.4×10^{-5}	4.0×10^{-2}	0.78
I-129	NA	NA	-	-	-	-	-	-	-	-
Zr-95	8.5×10^{-1}	1.7×10^{-2}	8.2×10^{-1}	4.1×10^{-1}	4.1×10^{-1}	4.1×10^{-1}	8.2×10^{-4}	8.2×10^{-4}	8.2×10^{-4}	4.1×10^{-1}
Nb-95	1.4	2.8×10^{-2}	1.4	7.0×10^{-1}	7.0×10^{-1}	7.0×10^{-1}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	7.0×10^{-1}
Ru-106	1.7×10^{2}	3.4×10^{-2}	1.7×10^{2}	85	11	3.4×10^{-3}	1.7×10^{-1}	8.5×10^{-2}	1.7×10^{-1}	11
Ru-103	NA	-	-	-	-	-	-	-	-	-
Sb-125	7	1.4×10^{-1}	6.9	6.9	6.9×10^{-2}	6.9×10^{-5}	6.9×10^{-3}	6.9×10^{-3}	6.9×10^{-3}	6.9×10^{-2}
Te-125m	10	2.0×10^{-1}	9.8	4.9	4.9	4.9	9.8×10^{-3}	9.8×10^{-3}	9.8×10^{-3}	4.9
Te-127m	5×10^{2}	10.0	490	250	250	250	4.9×10^{-1}	4.9×10^{-1}	4.9×10^{-1}	250
Te-129m	1.7	3.4×10^{-2}	1.7	8.5×10^{-1}	8.5×10^{-1}	8.5×10^{-1}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	8.5×10^{-1}
Ce-144	5×10^{1}	1.0	49	25	10	2.5×10^{-3}	4.9×10^{-2}	2.5×10^{-2}	4.9×10^{-2}	10
Ce-141	NA	-	-	-	-	-	-	-	-	-
Co-60	NA	-	-	-	-	-	-	-	-	-
Co-58	3.4×10^{-1}	6.8×10^{-3}	3.3×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	1.7×10^{-1}	3.3×10^{-4}	3.3×10^{-4}	3.3×10^{-4}	1.7×10^{-1}
Ag-110m	NA	-	-	-	-	-	-	-	-	-
Total	1×10^{5}									

NA means information not available.

Table G.22. Radionuclides in Liquid Effluents from Treatment of RCS Chemical Decontamination Solutions

Major Radionuclides in Stream	Total Curies of Radio-activity in Influent	Treatment Alternatives: Evaporation Resin (Ci)	Bitumen Resin (Ci)
H-3	-	-	-
Cs-137	9.9×10^{3}	1.7	8.3×10^{-2}
Cs-134	1.5×10^{3}	2.5×10^{-1}	1.3×10^{-2}
Sr-90	7.8×10^{3}	13	1.3×10^{1}
Sr-89	8.2×10^{2}	1.4	1.4×10^{-2}
I-129	NA	-	-
Zr-95	1.7×10^{-1}	8.5×10^{-2}	8.5×10^{-4}
Nb-95	2.7×10^{-1}	1.4×10^{-1}	1.4×10^{-3}
Ru-106	3.4×10^{-1}	2.3×10^{-4}	2.3×10^{-4}
Ru-103	NA	-	-
Sb-125	1.4	1.4×10^{-4}	1.4×10^{-4}
Te-125m	2.0	1.0	1.0×10^{-2}
Te-127m	1×10^{2}	50	5.0×10^{-1}
Te-129m	3.4×10^{-1}	1.7×10^{-1}	1.7×10^{-3}
Ce-144	1.0×10^{1}	2.0×10^{-2}	2.0×10^{-2}
Ce-141	NA	-	-
Co-60	NA	-	-
Co-58	6.8×10^{-2}	3.4×10^{-2}	3.4×10^{-4}
Ag-110m	NA	-	-
Total	2×10^{4}		

NA means information not available.

Table G.23. Radionuclides in Liquid Effluents from Treatment of AFHB/Reactor Building Decontamination Solutions

Major Radionuclides in Stream	Total Curies in Influent	Treatment Alternatives: Evaporator/Resin	Bitumen/Resin
Cs-137	5.9×10	9.8×10^{-3}	4.9×10^{-4}
Cs-134	1×10	1.7×10^{-3}	8.3×10^{-5}
Sr-90	1	1.7×10^{-3}	1.7×10^{-4}
Total	7×10		

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APPENDIX H. ENGINEERING CONSIDERATIONS RELATED TO IMMOBILIZATION OF RADIOACTIVE WASTES

The primary waste streams from a radwaste water-treatment facility are liquids containing concentrated radioactive elements, wet solid wastes and particulate solids. Immobilization of these wastes (e.g., to a monolithic form) may be required prior to offsite shipment and disposal. This immobilization step may be accomplished by a variety of processes. The technologies currently in use are applied almost exclusively to liquids, sludges, ion-exchange resins, and similar water-containing wastes. The characteristics of four major systems are compared in Table H.1.

Cement solidification and bitumen solidification are mature technologies. Cement systems are used worldwide; bitumen systems have not been used in the United States, but are in use at several foreign nuclear facilities. The characteristics of the two systems are summarized in Table H.2; differences are discussed later. The urea-formaldehyde (U-F) polymerization reaction produces a corrosive liquid by-product, which is a major problem with that system. Polymeric systems other than U-F based systems are being investigated and their development is continuing.

H.1 UREA-FORMALDEHYDE

Immobilization of radioactive wastes in urea-formaldehyde (U-F) is a well-developed technology. Several U.S. companies market U-F systems that have been used extensively on wastes from various nuclear fuel cycle sources,[1] thus providing many years of operational experience.

The U-F system is a polymeric process. There is no chemical reaction between U-F and the radioactive wastes. The matrix materials, after being mixed with radioactive waste, are made to form long-chain molecules of organic polymer that trap the waste within their structure.[2] An acidic catalyst such as H_3PO_4, $NaHSO_4$ or H_2SO_4,[3] which adjusts the pH to 1.5 ± 0.5, is used to achieve polymerization. Additional process modifications have been proposed to reduce the generation of liquids formed in polymerization. The effectiveness of these process modifications have not been fully evaluated at this time.

H.1.1 Process Alternatives

The waste and polymer are combined in one of the following types of mixers:[2] the in-line static mixer, the in-line mechanically driven mixer, the in-drum compressed air sparge mixer, or the in-drum paddle mixer. For in-line mixing, after a good mix of the monomer and waste has been obtained, the mixture is delivered to a drum for filling. As filling takes place, the catalyst is added. The mixture will start to gel immediately. The gel times vary, depending on temperature and pH, but range from a few minutes to several hours.[1,3] For the in-drum mixing, the catalyst, polymer, and radioactive waste are added to the drum and then mixed.[1]

H.1.2 Product Formulations

Aqueous waste solutions are mixed with the U-F in the proportions dependent on the specific waste streams. To minimize the amount of catalyst required, dilute solutions of strong acids may be used to adjust the pH for highly buffered solutions, such as partially neutralized boric acid.

U-F is also used to encapsulate solid waste materials such as filter sludge and ion-exchange resins. The waste solid is usually slurried with a small amount of liquid waste before being mixed with the U-F, to improve both the handling properties and the volumetric efficiency of the solidification process. Typically, about one volume of the U-F is used for each four to six volumes of slurry. Because the U-F and slurry water essentially fill the pore spaces between the solid particles, little or no volume increase is incurred.

Certain wastes, including soap solutions and concentrated sodium sulfate, are difficult to entrap in U-F. However, monolithic sodium sulfate products can be obtained using fresh U-F, by diluting to less than 10 wt % sodium sulfate before adding the U-F, or by adding calcium chloride to precipitate excess sulfate.[4,5]

Table H.1. Comparison of Available Radwaste Immobilization Technologies[a]

Comparison Factor	Urea-Formaldehyde	Cement[b]	Bitumen	Vinyl Ester Styrene[c]
Product form	Monolith	Monolith	Monolith	Monolith
Product density, kg/m^3	1000-1300	1500-2000	1000-1300	1100-1300
Volumetric efficiency[d]	Moderate (0.6-1.0)	Moderate (0.75)	High (>2)	Moderate
Mix fluidity	Good	Poor	Fair	Good
Mixer cleanability	Good	Poor	Fair	Fair to good
Product quality				
Boric acid solution	Good	Fair	Good	Good
Na_2SO_4 solution	Reduced efficiency	Good	Fair	Good
$NaNO_3$ solution	Fair	Good	Not recommended	Good
Alkaline solution	Reduced efficiency	Good	Good	Good
Laundry detergent solution	Poor	Poor	Fair	Good
Organic liquids	Poor	Fair	Fair	Good
Ion-exchange resins	Good	Fair	Fair	Good
Sludges	Good, may require pH adjustment	Fair	Good; hazardous with MnO_2 sludge	Good
Safety and handling				
Product stability	Fair[e]	Very good	Good	Very Good
Shelf life of agent	Fair	Good	Fair	Fair
Conveyance/metering	Good	Fair	Fair	Good
Toxic/breathing hazard	Acceptable	Acceptable	Marginal/poor	Acceptable
Product flammability	No	No	Yes	Not ignitable
Agent flammability	No	No	Yes	Flammable
Off-gassing	Poor	Acceptable	Poor	Acceptable

Table H.1. Continued

Comparison Factor	Urea-Formaldehyde	Cement[b]	Bitumen	Vinyl Ester Styrene[c]
Long-term product storage				
Leach resistance	Moderate	Moderate to high	High	High
Tensile/compressive strength	Fair	Good	Good	Good
Product corrosiveness	Fair	Good	Good	Fair
Biodegradability	Fair	Good	Fair	Fair
Residual free liquid	Always	Seldom	Should not occur	Should not occur
Water-holding capability	Poor	Good	Water evaporation during preparations	Good
Freeze/thaw resistance	Fair	Good	Good	Good

[a] From "Alternates for Managing Wastes from Reactors and Post-fission Operations in the LWR Fuel Cycle," ERDA 76-43, Energy Research and Development Administration, Washington, DC, May 1976.

[b] M. Brownstein, "Radwaste Solidification with Cement," in "Waste Management '79," Proceedings of the Symposium on Waste Management held at Tucson, Arizona, February 26-March 1, 1979. Rates cement having additives.

[c] From R.M. Neilson, Jr., and P. Colombo, "Solidification of Liquid Concentrate and Solid Waste Generated as By-products of the Liquid Radwaste Treatment Systems in Light Water Reactors," in "Management of Low-level Radioactive Waste, Vol. 1, Pergamon Press, Elmsford, New York, 1979. [These characteristics of the vinyl ester styrene process are presented here as an example of the organic polymer immobilization method.]

[d] Ratio of the as-generated waste volume to the solidified waste volume.

[e] Loses water and strength in open system.

Table H.2. Summary of Bitumen and Cement Immobilization System Characteristics[a]

Characteristic	Bitumen	Cement
Facility Performance		
Drums processed/plant-yr	2,530	5,590
Hours processed/plant-yr	3,130	1,880
Capacity factor	0.36	0.21
Unit processing time, drums/hr	0.81	3.0
Experience	Proven	Proven
Effluents		
Direct		
Airborne (to environment)	I_2 - 1×10^{-4} of input H_3 - 1×10^{-4} of input Other - 1×10^{-13} of input	I_2 - 1×10^{-4} of input H_3 - 1×10^{-4} of input Other - 1×10^{-13} of input
Secondary radioactive wastes, volume/plant-yr		
Trash	10 m^3	10 m^3
HEPA filters	2 m^3	3.2 m^3
Waste concentrate	1 m^3	1 m^3
Process Distillate	560 m^3	None
Scrap	1 m^3	2.4 m^3
Oil filters	0.3 m^3	None
Indirect		
Heat	2×10^6 MJ/plant-yr	3×10^5 MJ/plant-yr
Airborne (to environment)	I_2 - 1×10^{-6} of input H_3 - 1.0 of input Other - 3×10^{-12}	I_2 - 1×10^{-6} of input H_3 - 1×10^{-3} Other - 3×10^{-12}
Utility Requirements, volume/plant-yr		
Electricity	3×10^5 kWh	1×10^5 kWh
Water	5×10^2 m^3	1×10^2 m^3
Process air	2×10^4 m^3	2×10^4 m^3
Process steam	1×10^6 kg	None
Personnel, man-yr/plant-yr	3.5	3.5
Safety[b]		
Chronic occupational	Exposure = 1	Exposure = 1
Acute occupational	Potential > 1 (slightly)	Potential = 1
Chronic public	Exposure > 1 (slightly)	Exposure = 1
Acute public	Potential > 1 (slightly)	Potential = 1
Product Characteristics[c]		
Average drum dose rate	Dose rate > $(\frac{800}{250})$	Dose rate = 1
Weight	450 kg/drum	390 kg/drum
Leach resistance	Leach rate = 1	Leach rate = 1
Radiation resistance	Radiation resistance = 1	Radiation resistance = 1
Combustibility	Combustible	Non-combustible
Mechanical shock resistance	Plastic	Friable

[a]From J.W. Voss, "Comparison of Bitumen and Cement Immobilization of Intermediate- and Low-level Radioactive Wastes," in "Waste Management, '79," Proceedings of the Symposium on Waste Management held at Tucson, Arizona, February 26-March 1, 1979.

[b]Chronic and acute exposures are ranked here as one for cement. For bitumen, except for chronic occupational, these quantities are expected to be larger, and are listed as being greater than one.

[c]The dose rate of the cement product is assigned a value of one. The bitumen product is expected to be substantially higher, and is listed as being greater than one. The leach and radiation resistances of the product are estimated to be equal, and are listed as being one.

A number of materials can be added to the U-F formulation to improve its strength or leaching characteristics.[6]

H.1.3 Product Properties

The properties of the solidified waste depend on the amount of liquid and/or solid immobilized within the U-F. In an open system, the solid readily loses liquid by evaporation at the surface. Some drying of the product does not affect the mechanical integrity of the block, but the solid may become friable if completely dehydrated.

The properly solidified U-F product is a homogeneous monolithic solid. It has a density slightly greater than water.[1] Generally, as the ratio of liquid to U-F increases, the product strength decreases and leachability increases.[7] During immobilization, no detectable exothermic reaction occurs that might cause radionuclide volatilization.[2] U-F solidified products are not considered flammable because of their water content.

Free standing liquid is always observed in U-F waste forms. The quantity of free standing liquid increases over a period of time as the U-F polymerization continues, and also is a function of the waste/U-F ratio employed.[8] Free standing liquid in U-F has essentially the same concentration of Cs-137, Co-60, and Fe-59 as the input waste stream, independent of waste/U-F ratio. A small decontamination factor has been observed in the case of strontium.[8]

Free standing U-F liquid has also been observed to be acidic, having approximately the same pH as the waste/U-F mixture after catalyst addition. This has resulted in cases of rapid corrosion of steel containers and premature loss of container integrity.

H.1.4 Summary[9]

Useful features of the U-F radwaste solidification systems that make its use attractive are as follows:

- The U-F and catalyst can be stored as liquids, and transfered by simple pumping,
- The system uses in-line rather than powered mixers,
- The system is adaptable to use of air sparge mixing systems,
- Volumetric packaging efficiencies are generally in the range of 55% to 65%.

Problems with the use of U-F as a radwaste solidification agent are:

- U-F is a condensate polymer; water is produced as a by-product of polymerization, and this water becomes contaminated by the waste and is corrosive.
- U-F physically encapsulates the waste; therefore, the waste is not chemically bound, the U-F matrix is subject to shrinkage, and waste liquid is released from the matrix due to shrinkage.
- The solidified product is not of uniform quality; mixing ratios are difficult to control; the acid catalyst must be uniformly mixed; and free acid will attack shipping containers, causing leakage.
- Agent has a short shelf life; an increase in the viscosity occurs with age and this decreases the agent feed rates during polymer addition to the waste.

The overall considerations with regard to use of the U-F solidification system are that it is the lowest-cost chemical solidification agent presently available, its price is competitive with cement and additive systems at current prices. However, even though the free liquid may be drained, subsequent generation of liquid will continue. It is unlikely that current U-F products can meet free standing liquid criteria at the commercial low-level disposal sites. Thus, this alternative has little practical application to TMI.

H.2 CEMENT IMMOBILIZATION

Cement solidification of radioactive wastes, both with and without additives, has been common practice internationally for many years in order to simplify transport and storage and to reduce the possibility of release of radionuclides to the environment. Portland cements are most commonly used for wet solid waste solidification, although high-alumina and pozzolana cements are also used.

Cement normally is used with an inert aggregate to form concrete, and the nature of the aggregate largely determines the strength of the concrete. Cement blocks prepared from waste concentrates and sludges will generally have less strength than conventional concrete. The strength is particularly dependent on the total salt content of the waste solution and of the cement block. A fairly narrow range exists for the described values of the ratio of basic and acidic oxides in the final product. If the ratio is reduced too much by the constituents of the waste, the strength of the cement block will decrease significantly. Poor mechanical strength can result in cracking and spalling of the cement, thus increasing the surface area available for possible leaching.

The cement systems that are commercially available use external, in-line, or in-container mixers.[3] Each supplier of commercial cement systems offers variations in process equipment, immobilization agent and additives.

H.2.1 Process Alternatives

Wet solid wastes, or liquid wastes, can be mixed with cement either by an in-line or an in-drum process. The basic differences between the two process approaches are illustrated in simplified form in Figure H.1. For the in-line process, cement and wet waste are introduced into the mixer/feeder unit for intimate mixing. Discharge of the mixture to the solidification container is the final step after mixing has been accomplished. For the in-drum mixing system, drums are gravimetrically prefilled with cement and a mixing weight added. The drums are transferred to the waste fill mixing station, filled with waste, capped and mixed. A second filling procedure is offered to improve drum capacity utilization to more than 75% capacity limit.

The solid waste materials are pre-conditioned within a waste tank to provide proper waste chemistry and sufficient moisture for mixture with the dry cement. Binding agents such as portland type II or type III cement, or sodium silicate in either dry or liquid form, are injected by means of a separate feed system.

The continuous in-line mixer approach offers several advantages. Filling is rapid, an empty container can be filled at approximately 1.5 cubic foot per minute. The in-line system permits filling of both 55-gallon drums and large-volume containers, and also permits radioactive filter cartridge packaging for disposal, but involves a mixer feeder. For an in-drum system, cycle time in the drum station is about two or three drums per hour.

Certain coating materials, such as polymers or bitumen, can be applied to cement to cover or fill the pores and thus lower the leach rate. Soak techniques have been developed at Brookhaven National Laboratory[10,11] to impregnate the pores of concrete with a styrene monomer which is then polymerized in situ by heating to 50° to 70°C. This system has been demonstrated to be effective for the immobilization of high-level tritiated aqueous waste in polymer-impregnated concrete.[12] Shales also can be added to improve Cs leach rates.

H.2.2 Product Formulations

The optimum proportions of cement and waste vary with type of waste to be immobilized. Maximum waste contents are typically 75 wt % for solid waste materials or 33 wt % for aqueous solutions and slurries. Cements require a minimum proportion of water to obtain a workable mix; minimum water/cement weight ratios are about 0.22 and 0.25 for high-alumina and portland cements, respectively. Some waste solids (e.g., ferric and aluminum hydroxide sludges, filter sludges, zeolites, and ion exchange resins) will absorb or retain large amounts of water. Water must be supplied with the solid to prevent these wastes from sequestering the required water from the cement and producing a dry, unworkable mix.

Excess water will result in a layer of free water on the surface of the solidified product. Absorbents such as vermiculite can be added to the cement to increase the amount of water that can be solidified. Without absorbents, the maximum water/portland cement weight ratio is about

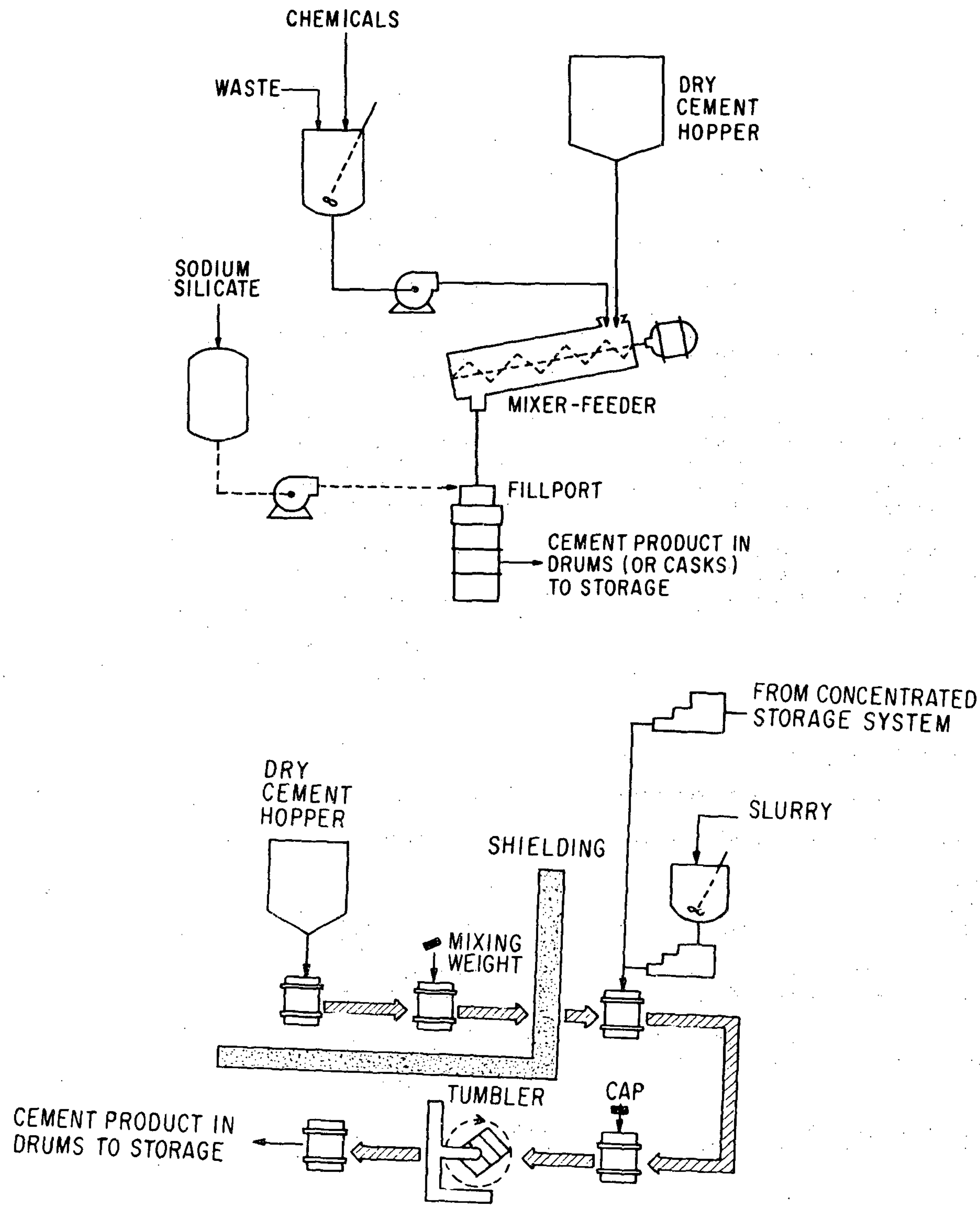

Figure H.1. In-Line (top) and In-Drum (bottom) Mixing Process for Incorporating Radwaste in Cement. Source: M. Brownstein, "Radwaste Solidification with Cement," in "Waste Management '79," Proceedings of the Symposium on Waste Management, Tuscon, AZ, 1979.

0.5; with vermiculite, diatomaceous earth, or similar absorbents, the maximum weight ratio can be as high as 0.7 to 1.1. For cement solidification, free standing water is avoidable. Minimization of free-standing water is primarily a matter of proper selection of the waste/binder ratio, taking into account the water content of the waste.

Limited amounts of organic liquids can be incorporated in cement by addition of a dispersing agent. Aqueous concentrates containing up to 15% dispersed organic liquid have been solidified.[6] Small amounts of organic liquids absorbed on vermiculite can also be incorporated in cement.

Typical published waste/cement formulations are presented in Table H.3. The data show that solutes of waste solutions and slurries can be incorporated in cement products at salt/cement weight ratios up to about 0.5, although the more typical ratios are about 0.15 to 0.3 Typical formulations of the portland cement-sodium silicate process are shown in Table H.4.

H.2.3 Product Properties

For radwaste/cement immobilization processes the characteristics of each waste must be considered individually because of the possible interaction between the waste constituents and the cement. One such interaction is the effect on the setting of the cement matrix. Setting may be unaffected, accelerated or retarded by the waste components. For example, boric acid retards the setting of portland cement and if sufficient boric acid is added, the cement may never harden. The degree to which the waste interacts with the cement depends both upon the amount of the interacting constituent and the manner in which it is added (e.g., solid salt addition as opposed to salt in solution; mixing mode).

Special additives can be used to improve the setting properties and/or the volumetric efficiency of the cementing process. Sodium silicate, added as a concentrated solution at about 10% of the waste volume, has shown considerable promise for this purpose.[5,13] Not only does sodium silicate provide a good set for boric acid solutions, it also lowers the volume-increase factor from about 2 with conventional cement formulations to about 1.4 when solidifying reactor waste concentrates. The sodium silicate formulations are designed to minimize waste product volumes and are not intended to produce high-strength products. Densities of the products with sodium silicate additives are in the range of 1300 to 1500 kg/m^3. Other solidified product densities range from about 1500 to 2000 kg/m^3, depending primarily on water content.

It was demonstrated that boron-containing radwaste sludge (36,000 ppm boron) from PWR's can be incorporated into cement by addition of slaked lime because in the presence of sufficient calcium the formation of tri-calcium aluminate is not inhibited by the boric acid.[14] Other additives, listed in Table H.5, were determined by laboratory experiment to also overcome the inhibiting properties of boric acid.

Cement is an open-cell structure because of the porosity that develops while the cement cures. As such, it is permeable to water and susceptible to radionuclide loss by leaching and exchange. Certain isotopes are more firmly fixed in the cement matrix than others, and are less leachable.

Strontium, cobalt, rare earths, plutonium and americium are tightly bound, whereas cesium is less tightly bound. However, certain species of clay, such as bentonite and Grundite (commercial name for a type of illite clay), can be added to the formulation to improve the cesium retention.[6] Leach rates ranging from 2×10^{-9} to 0.1 g/cm^2-day, based on studies with radioactive tracers, have been measured for cement. The leach rate depends on factors, including the tracer used, the leachant, the waste type, and the cement-waste formulation.[15,16]

An experiment[8] was conducted in which portland cement was used employing waste/binder ratios that resulted in the presence of free standing water that had essentially the same concentration of Cs-137 as the input waste stream; however, significant decontamination occurs with Sr-85 and Co-60, presumably due to ion exchange effects in the cement.

The radiation stability of cement in some cases is excellent. No deterioration in strength or leachability occurs at an integrated dose of 10^9 rads (Co-60 gamma rays) for cement products containing up to 30 wt % sodium nitrate.[10] Although the presence of water, nitrates and other radiation-unstable compounds can create gaseous radiolysis products, this is not a serious problem because the gases produced are absorbed in the porous cement matrix.[6]

Table H.3. Typical Cement/Radwaste Formations

Waste Type	Weight Ratio of Waste Constituent to Cement: Dry Waste Salt	Total Water
	SOLUTIONS AND SLURRIES	
25 wt% Na_2SO_4[a]	0.12	0.37
70 wt% $NaNO_3$ slurry[b,c]	0.52	0.22
30 wt% $NaNO_3$ solution[b,c]	0.15	0.35
Neutralized HNO_3-$Al(NO_3)_3$[d]	0.37	0.37
20%-25% water treatment sludge[d,e]	0.09-0.17	0.27-0.51
30%-40% evaporator sludge[f]	0.28-0.35	0.42-0.53
Conc. BWR reactor waste[g,h]	0.17	0.51
400 g/L evaporator concentrate[d]	0.33[i]	0.70

	Weight Ratio of Waste Constituent to Cement				
	Dry Solid Basis		Wet Solid Basis		Wt% Water in Wet Sludge
	Solid	Water	Solid	Water	
			SOLIDS AND WET SLUDGES		
Acid digestion process residue[j]	0.12	0.37	--	--	--
Al_2O_3-ZrO_2 calcine[b,c]	2.4	0.25	--	--	--
Fly ash[b,c]	0.33	0.30	--	--	--
Fe/Al hydroxide sludge[b,c]	3.1	2.0	4.9	0.22	50
Diatomaceous earth[b,c]	0.42	1.1	1.3	0.25	67
Linde AW-500 zeolite[b,c]	1.21	1.0	2.0	0.23	39
Amberlite 200 cation resin[b,c]	0.83	1.1	1.7	0.23	∿ 50
BWR bead resins, recommended[g,k]	0.25	0.56	0.51	0.31	50
BWR bead resins, range[g,k]	0.25-1.0	0.45-1.3	--	--	50
BWR filter sludge, recommended[g,l]	0.26	1.19	0.51	0.94	50
BWR filter sludge, range[g,l]	0.04-0.28	0.48-1.3	--	--	50

[a] From H.W. Heacock and J.W. Riches, "Waste Solidification - Cement or Urea-Formaldehyde," Paper 74-WA/NE-9 presented at the American Society of Mechanical Engineers' Winter Annual Meeting, New York, November 17-22, 1974.

[b] From Brookhaven National Laboratory Progress Reports for "Development of Durable Long-term Radioactive Composite Materials," Report Nos. 1 through 10, Upton, New York, July 1972 through April 1975.

[c] From Brookhaven National Laboratory Progress Reports for "SRL Long-term Waste Storage Support Progress," Report Nos. 1 through 8, Upton, New York, July 1973 through January 1975.

[d] From "Treatment of Low- and Intermediate-level Radioactive Waste Concentrates," Technical Report Series No. 82, STI/DOC/10/82, International Atomic Energy Agency, Vienna, Austria, 1968.

[e] Miscellaneous flocculating and scavenging agents.

[f] From R.H. Burns, "Solidification of Low- and Intermediate-level Wastes," Atomic Energy Review 9:547-599, 1971.

[g] From H.L. Loy and D.C. Saxena, "Processing and Packaging of Solid Wastes from BWR's," in "Proceedings of the Third International Symposium on Packaging and Transportation of Radioactive Materials," held in Richland, Washington, August 15-20, 1971, CONF-71081, Vol. 1, pp. 478-489, U.S. Atomic Energy Commission, Washington, DC, 1971.

[h] Assumed to be ∿ 25% sodium sulfate.

[i] Plus 0.13 kg of vermiculite per kg cement.

[j] From "Commercial Alpha Waste Program Quarterly Progress Report, October-December 1974," HEDL-TME 74-41, C.R. Cooley, compiler, Hanford Engineering Development Laboratory, Richland, Washington, February 1975.

[k] Preneutralized with sodium hydroxide to prevent swelling and crumbling.

[l] Cellulose fiber filter aid, powdered resins, etc.

Table H.4. Formulations for Solidifying Radwastes with Portland Cement-Sodium Silicate[a]

Waste Type	Weight Ratio of Waste to Solidifying Agents		Volume Increase Factor	
	Dry Waste	Total Water[b]	With Silicate	Without Silicate
Bead resins (50 wt% water)	0.77	1.1	1.04	1.00
Powdered resin sludge (50 wt% water)	0.81	1.3	1.03	1.19
Diatomaceous earth (60 wt% water)	0.54	2.1	0.77	1.54
10 wt% boric acid	0.11	0.99	1.46	1.92[c]
25 wt% Na_2SO_4	0.46	1.4	1.33	1.92

[a]"Alternates for Managing Wastes from Reactors and Post-Fission Operations in the LWR Fuel Cycle," ERDA 76-43, Energy Research and Development Administration, Washington, DC, May 1976.

[b]Excludes water added with sodium silicate solution.

[c]Free water is absorbed at this formulation, but the cement remains soft.

Table H.5. Portland Cement Admixtures to Overcome Boric Acid Inhibiting Properties[a]

Chemical Formula	Common Name	Gram Molecular Weight
NaOH	Caustic soda	40.0
CaO	Calcium oxide	56.1
$Ca(OH)_2$	Slaked lime	74.1
Na_2CO_3	Washing soda	106.0
Na_2SiO_3	(Metal) sodium silicate	122.1

[a]From M. Brownstein, "Radwaste Solidification with Cement," in "Waste Management '79," Proceedings of the Symposium on Waste Management held at Tucson, Arizona, February 26 to March 1, 1979.

Also, portland type II cement waste forms containing BWR precoat filter cake with diatomaceous earth (slurry) were prepared and exposed to Co-60 gamma radiation, and the effect of irradiation on the subsequent leachability of cesium and strontium was determined.[18] Total doses of 10^5 to 10^8 rad were employed. An exposure rate of 1.3×10^6 R/hr was used. Irradiation appeared to have no effect on the rate of cesium or strontium release from portland type II cement waste form.

Because of the complex chemistry involved in cement solidification, laboratory tests are recommended for each new waste requiring solidification.

H.2.4 Summary of Cement Solidification System

Features of cement/radwaste solidification systems that make its use attractive are as follows:

- Can produce a monolithic structure of adequate strength with no free liquid,
- Adaptable to reliable, easily operated, and proven processing systems,
- May produce a homogeneous reproducible product from batch to batch without extensive modification to the operations system,
- Can be designed into an operating system so that the operating environment is non-explosive, non-flammable and free from other chemical hazards,
- Can be designed to use in-liner mixing without expensive processing equipment.

Problem areas which have been reported are as follows:

- Difficulty with mixing equipment,
- Difficulty with dusting and spread of cement to floor drains,
- Batch type systems require greater personnel experience during filling and capping operations,
- Difficulty in cleaning mixing equipment; use of excessive flush water for cleaning equipment and spills, and
- Reduced packaging efficiency.

Considerations for the use of cement solidification systems are:

- Complex equipment is not required,
- Most systems offered are fully automatic and remotely operated and meet current ALARA criteria,
- Cement offers greater self-shielding, which allows for reduced transportation and disposal costs,
- Inexpensive additives are available to insure complete solidification with highly concentrated salts that are produced by waste volume reduction systems and to improve leach rates.

H.3 BITUMEN IMMOBILIZATION

Bitumen is a term used for a mixture of high-molecular-weight hydrocarbons found in natural beds but more commonly obtained as a residue in petroleum or coal-tar refining. Bitumen has certain properties that are advantageous for immobilizing low- and intermediate-level radioactive wastes. It is chemically inert, insoluble in water, has good coating properties and possesses a degree of plasticity and elasticity. These properties have led to several applications in foreign nuclear facilities, but the use of bitumen in the United States has been limited to laboratory and pilot plant development studies.[19-31] Several types of bitumen are available. They are obtained by direct distillation of petroleum, air-injection oxidation of petroleum oils (blown bitumen), and cracking of heavier fractions (cracked bitumen). Direct distillation bitumen is the most widely used. Blown bitumen is more radiation resistant but has a lower ignition temperature. Bitumen emulsions in water are available and may provide some advantage in the initial mixing of waste and bitumen. As any substance found in nature, bitumen can vary from batch to batch. Adverse effects are minimized by using named products that are produced in various grades, depending on such physical properties as softening point, flash point, ductility, and hardness.

The working temperature for waste bituminization processes is 150° to230°C. Although the elevated temperature is a disadvantage when compared with the cement or U-F solidification processes, the high temperature eliminates most of the water originally present in the waste and significantly reduces the waste volume to be stored. The resulting condensate is, however, an addition low-level liquid waste requiring treatment for disposal.

H.3.1 Process Alternatives

Both batch and continuous bituminization units have been developed for the immobilization of radioactive wastes. A batch stirred-evaporator process has been developed in Europe; a continuous turbulent film evaporator process has been developed by several interests worldwide; and a screw extruder process has been developed in Europe at Marcoule, France, and Karlsruhe, Germany.[1] Chemically treated wastes and bitumen are fed separately into the extruder. Oils and tars are separated out as a condensate, and the bitumen-immobilized product is discharged into drums for disposal.

H.3.2 Product Formulation

Bituminization processes have been used to immobilize the solids content of a wide variety of wastes, including neutralized evaporator concentrates and sludges, ion-exchange materials and resins, incinerator ashes, sand, vermiculite and others.[6] In general, bitumen products with satisfactorily high mechanical strength and low leach rates may contain about 40 to 60 wt % solids. Although ion-exchange resins have been incorporated into bitumen, they have a tendency toward excessive frothing on mixing with hot bitumen. Nitrate-form anion resins in bitumen decompose during storage. Therefore, incineration of resins prior to incorporation into bitumen may be preferred, though this would require a separate facility.

Bitumen can also be used as a coating or sealing material for wastes. The Atomic Energy Research Establishment, Harwell, U.K., has demonstrated incorporation of up to 50 vol % plastic waste in bitumen by allowing hot bitumen-sludge mixtures to flow onto the waste contained in the product storage drum.[6] This technique can also be used to encapsulate other solid wastes.

H.3.3 Product Properties

The bitumen products are normally noncorrosive to mild steel. Bacterial attack on bitumen products appear insignificant although long-term tests are needed to confirm this.[32] The thermal stability of bitumen products is good at ambient to moderate temperatures, fair at moderate temperatures (they soften), and poor at high temperatures (they ignite).[33-38]

Certain salts can have adverse effects on the properties of the product. The most widely studied are the nitrates and nitrites because of their wide usage and their potential as oxidants that increase the fire hazard. The base bitumen alone does not spontaneously ignite at temperatures up to 450°F.[30] The bitumen burns more vigorously if appreciable quantities of oxidizing compounds are present (e.g., sodium nitrate, sodium nitrite, and manganese dioxide) that decompose at temperatures encountered during combustion.[33-38]

To avoid volatilization, boric acid must be neutralized before being incorporated in bitumen; however, sufficient sodium hydroxide must be added to form the metaborate (Na/B=1) rather than the tetraborate (Na/B=0.5) to avoid hardening problems.[30]

Bitumen products have leach rates, based on actinide tracers, of 10^{-3} to 10^{-7} g/cm^2-day; leach rates based on alkali and alkaline earth tracers are up to 1000-fold greater. Cesium leach rates can be lowered by a factor of 2 to 10 by incorporating 2 wt % Grundite (commercial name for a type of illite clay) and sodium metasilicate in the bitumen.[39] Addition of coprecipitants and neutralization to form hydroxides are also beneficial in reducing leach rates. Storage temperatures should be kept below 60°C to avoid separation of salts and bitumen.[30] Some products containing high sodium hydroxide contents have been shown to degrade following immersion in water.

The radiation stability of bitumen products is adequate to about 10^9 rads but should be evaluated for each case. The characteristic effect of radiation damage is swelling of the product (up to

70% volume increase at 10^9 rads for the less porous products) as a result of the generation of gases such as hydrogen, methane, carbon dioxide, and carbon monoxide. To accomodate potential swelling, storage containers are not completely filled (typically 60% to 80%). The high flammability of some of the radiolytic gases may possibly be a detonation problem with storage containers or areas containing hydrogen or methane.

H.3.4 Summary of Bitumen Solidification System

Useful features of bitumen radwaste solidification systems that make it attractive are:

- Bitumen is a thermoplastic material which solidifies naturally upon removal of process heat, guaranteeing solidification and recoverability.
- Bitumen is a naturally waterproof material and is highly resistant to leaching.
- Produce products by mechanical mixing bitumen with wastes. No chemistry or additives are required to complete the solidification process.
- Oil in the feed can be tolerated.
- Bitumen systems can provide volume reduction due to water evaporation, but water must be contained and recycled or treated as waste.

Problem areas which have been reported are as follows:

- Bitumen is combustible, and there is evidence that the incorporation of oxidizing agents increases the fire risk,
- Bitumen systems require heat input to sustain fluidity during processing,
- Properties of bitumen vary from batch to batch,
- Solvents may cause solubilization of the bitumen product.
- Generation of detonable gases.

Considerations for the use of bitumen solidification systems are:

- The product is low in weight but has a high volumetric efficiency,
- Bitumen is a nonstratifying binder that produces a homogeneous product,
- The product has excellent environmental stability and is noncorrosive,
- Bitumen is low in cost and readily available.

H.4 ORGANIC POLYMER IMMOBILIZATION PROCESS

Several U.S. companies are actively marketing polymeric processes for radioactive waste immobilization.[9] In most of these processes, radioactive waste is homogeneously mixed with organic polymer. The mixture is fed to a drum, a catalyst and promoters are added, and the product solidifies by polymerization. Each vendor offers variations in polymers and catalysts, as well as in processing characteristics. Detailed information on product characteristics is limited because of the lack of extensive commercial experience with them.

H.4.1 Process Alternatives

Both organic and inorganic waste materials have been satisfactorily incorporated in thermoplastic polymers such as polyethylene.[30,40] Most of this work has been performed by a batch process in laboratory equipment. Bitumen systems require heat input, while polymer processes are exothermic.

Simulated wastes typical of those generated in light-water reactors (e.g., boric acid, ion-exchange resins, and filter sludges) have been incorporated in water-extensible polyster resin.[41] The polyesters are supplied with contained promoters to decompose any peroxides present, until organic peroxide catalysts are added to initiate polymerization and gelling of the resin. The feasibility of the process has been demonstrated, but further work is needed to commercialize the process.

A proprietary promoter-catalyst polymer system is being marketed. Operations have been carried out using this process to solidify radioactive wastes in 55-gallon drums at five U.S. facilities and at three Japanese facilities.[9] In all cases, the process produced a homogeneous monolith with no free liquid.

The polymer is a vinyl ester styrene which is used in combination with a promoter and a catalyst to produce a solidified waste product. The vinyl ester is an addition polymer and does not produce free water. The principal features of this solidification process that have been reported[9] are as follows:

	Principal Features: Vinyl Ester Styrene Solidification
Chemical:	Vinyl ester plus promoter and catalyst.
System:	Batch process using in-container mixing.
Waste Adaptability:	Handles liquid and slurry wastes with pH in the range of 2.5 to 11.0.
Packaging Efficiency:	60 to 70 volume percent.
Transport Efficiency:	Solidified waste density in the range of 60 to 80 pounds per cubic foot.
Radiation Stability:	No significant physical degradation of solidified waste from doses in excess of 10^9 rads.
Heat Resistance:	Solidified waste does not melt, sublime or ignite at 1,000°F for 10 minutes.
Leach Resistance:	Solidified waste meets or exceeds leach requirements of DOT and IAEA transportation requirements. Leach resistance is better than UF and cement products.

These solidification process systems are batch processing with in-container mixing. In laboratory work, test specimens were made using simulated boiling water reactor and pressurized water reactor evaporator bottoms, mixed-bed ion-exchange resins, filter aid materials and decontamination solvent wastes.[42] In addition, samples obtained from actual power plant operations were successfully solidified.[43]

The vinyl ester styrene solidification process utilizes chemicals which are more expensive than the materials required for U-F, cement, or bitumen solidification. Laboratory testing, however, has indicated the process produces stable products with low leachability for a variety of waste streams. There is, though, a lack of experience with full-scale solidification systems using vinyl ester styrene.

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42. H. E. Filter, "The Dow System for Solidification of Low-Level Radioactive Wastes from Nuclear Power Plants," NP-21742, The Dow Chemical Co., Midland, MI, 1976.

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APPENDIX I. JUSTIFICATION FOR RADIATION FIELDS USED IN SECTION 6

I.1 BASIS FOR DOSE RATES

A value of 10 mR/hr has been used as representative of the time-integrated average radiation field to which a worker would be exposed during work within the reactor building for the following operations:

- Reactor coolant system inspection (Sec. 6.2)
- Reactor pressure vessel head and upper internals removal (Sec. 6.3)
- Reactor defueling (Sec. 6.4)

The staff used the following basic assumptions in making estimates of radiation fields inside the reactor building for these operations:

1. The reactor building, including all structures and the exterior of reactor components, will have been decontaminated so that a worker's dose contribution from residual reactor-produced radioactivity inside the building is very low.*

2. The reactor primary coolant water will have been decontaminated to a level of 0.01 μCi/cm^3, exclusive of tritium. This residual radioactivity will produce a background field of 2 to 3 mR/hr to workers performing operations above the surface of the water around the reactor vessel, spent fuel pool, and fuel transfer canal.

3. Over 80 percent of the operations involved in inspecting, opening the primary system, and removing the fuel and internals will be conducted underwater with many feet of water shielding.

4. Specific radioactive hot spots within the primary system, caused by plateout of fission-product-bearing materials and/or fuel debris, will be shielded if necessary to reduce fields to acceptable levels for working.

Because the condition of the TMI-2 core and the exact locations of fuel debris within the primary system are unknown, a series of scoping calculations were performed to estimate radiation field levels that might be encountered at various points around primary system components. These calculations, reported in Reference 1, considered a number of different cases for relocation of fuel debris and for the quantities of plateout material. All of the radioactive source terms were based on a decay of 460 days from the accident, that is, to July 1, 1980. The results of the calculations for various cases are presented in Table I.1.

As indicated in the table, the contribution to the worker exposure rate from the reactor core in a normal configuration is less than 1 mR/hr as long as there is at least 6½ ft of decontaminated water above the upper internal structure. In practice, the amount of water will be considerably greater than this, and exposure rates will be correspondingly less.

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*Survey data from the reactor building entry of July 23, 1980, indicate general area radiation levels of about 250 mR/hr on the 347-ft elevation. A significant contribution to these levels is from the sump water. 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.

Table I.1. Summary of Results of Gamma Exposure Rate Calculations for TMI-2 Primary System[a]

Case	Description	Location	Exposure Rate	Location	Exposure Rate
a	Intact core in normal configuration	6.5 ft above core upper internals	1 mR/hr	At PV radial surface on core center	<1 mR/hr
b	6-inch-thick fuel debris bed atop upper plenum plate (19% of total core fuel)	Outside surface of RV head (air inside)	1.1 R/hr	Outside surface of RV head (H_2O inside)	1.5 mR/hr
c	0.25-inch-thick fuel debris bed atop steam generator tube sheet (~ 90% of a fuel assembly)	Outside surface of SG head (air inside)	3.2 R/hr	Outside surface of SG head (H_2O inside)	0.12 mR/hr
d	0.050-inch-thick plateout layer inside RV head	Outside surface of RV head (air inside)	266 mR/hr	Outside surface of RV head (H_2O inside)	128 mR/hr
e	0.050-inch-thick plateout layer inside 28-inch-diameter RV inlet pipe	Outside surface of pipe (air inside)	205 R/hr	Outside surface of pipe (H_2O inside)	73 mR/hr

[a]Calculations for less severe conditions also were made and the exposure rates were correspondingly lower.

One of the uncertainties is the exact location of fuel debris within the TMI-2 primary system. To scope this situation, two limiting cases were calculated, cases b and c in Table I.1.* For case b it was assumed that there is a six-inch-thick bed of UO_2 fuel debris (corresponding to 19 percent of the entire core) on top of the upper plenum plate (see Fig. 6.1). The resulting maximum exposure rate adjacent to the reactor vessel head from this source was calculated to be 1.1 R/hr if the reactor vessel head contained air rather than water. If the vessel head were flooded with water, the exposure rate would be reduced to 1.5 mR/hr.

Case c in Table I.1 involves a situation in which fuel debris are located in the upper portion of the steam generator. For purposes of the calculation it was assumed that a 0.25-inch-thick bed of UO_2 debris was spread uniformly across the upper header of the steam generator (corresponding to about 90 percent of the fuel in a single assembly or 0.5 percent of the total core inventory). As shown in the table, the exposure rate immediately outside the steam generator head was calculated to be 3.2 R/hr when the head contains air, and 0.12 mR/hr with the head flooded with water. The estimated exposure rates with the steam generator inspection hatch open were excessively high (greater than 1000 R/hr).

Cases d and e in Table I.1 were developed to analyze the effect of varying amounts of plateout of fission-product-containing material at different points in the system. In case d, it was assumed that a 50-mil-thick layer** of material was spread uniformly on the inside surface of the reactor

*The estimates of UO_2 debris bed thicknesses for these two cases should be considered "upper limits" based upon present knowledge of the condition of the TMI-2 reactor core. It is expected that the amount of fuel debris in these locations is actually considerably less than the values used in this analysis.

**These estimates of plateout material thicknesses should be considered to be "upper limits" based upon the total quantities and rates of settling of suspended material. In fact, layers (exclusive of trapping in crevices) more than a few mils thick are unlikely.

pressure vessel head. The exposure rate at the outside surface of the RV head was calculated to be 266 mR/hr with air inside the vessel head and 128 mR/hr with the head flooded with water. For a section of 28-inch-diameter primary system inlet piping with a 50-mil-thick* layer of plateout material (case e) an exposure rate of 204 R/hr was calculated when the pipe was filled with air. This would drop to 73 R/hr if the pipe were flooded with water. For a 10-mil thickness* of plateout material, the exposure rate was about 15 R/hr.

These calculations indicate that the exposure rates adjacent to various components in the TMI-2 primary system depend upon the locations of fission product plateout and/or fuel debris within the system. The significant factor is that for the most part, these exposure rates are relatively low and can be further reduced to acceptable levels by flooding with water, even for the extreme situations that were analyzed. Based on the results of these calculations, on the assumptions listed above about containment building background levels, and on the exposure to be expected from the primary system water, it is the staff's engineering judgment that a time-integrated value for an exposure rate to a typical worker during the time he is actually performing work within the TMI-2 reactor building on the operations under discussion would be no greater than 10 mR/hr. This is believed to be conservative because:

1. The exposure calculations, described above, are for source terms as of July 1, 1980, and will be further reduced by the time the actual work starts because the fuel fission product activity is currently decaying with a half-life of about 7.6 months.
2. The hot spots probably will give dose levels lower than those given in the scoping calculations since the amount of fuel displaced to other parts of the system is not likely to be as large as assumed.
3. The plateout hot spots should be much less than that estimated in the scoping calculations since it is expected that most of this material will be removed during the primary system cleanup.
4. In practice, the hot spots will be shielded.

The assumption that the reactor building has been decontaminated is based upon the staff's belief that reactor defueling and subsequent decontamination will be lengthy operations, lasting perhaps one to three years, and will require a large number of skilled and well-trained workers. Clearly, the decontamination of the reactor building will be a difficult job and will require a large work force (see Sec. 5.2). The effort to decontaminate the reactor building first, and then to defuel and decontaminate the reactor, is expected to yield a significant reduction in both total occupational dose and in the time required to complete the reactor defueling and cleanup, (as compared to what would be expected for a partial or limited reactor building cleanup).

It is desirable to minimize the number of people that exceed their dose limits before the work is complete. This means that the work must be conducted in as low a radiation field as is practical. For this reason, partial or incomplete decontamination of the reactor building before reactor defueling and RCS decontamination has not been considered practical. Additionally, it may be appropriate to use special tooling and equipment if general radiation levels are higher than 10 mR/hr.

As a practical matter (in addition to being good radiation protection practice), the average radiation that skilled workers can operate in over long periods of time performing complex operations should be relatively low. This is because of the limits on the number of skilled workers and their availability for a large project like the TMI-2 cleanup. For example, based upon a quarterly occupational dose of 1 rem (see Appendix L), the continuous exposure rate would be 2 mR/hr. If an average worker availability (to work in radiation areas) factor of 25 percent over a quarter-year is used, the exposure rate increases to 8 mR/hr. Similarly, for an availability of 10 percent, the exposure rate increases to 20 mR/hr.

Because of the considerable additional training and preparation required for the skilled workers who will perform the primary system inspection, decontamination, and core removal, it is necessary that the radiation fields for the bulk of the operations be kept relatively low (< 10 mR/hr) so as to maintain a reasonably high individual worker availablility. This is because of the

*These estimates of plateout material thicknesses should be considered to be "upper limits" based upon the total quantities and rates of settling of suspended material. In fact, layers (exclusive of trapping in crevices) more than a few mils thick are unlikely.

limited size of the pool of reasonably skilled personnel available, plus the significant investment in training and preparation that must be made in each worker before he can perform any useful work.

In summary, the actual radiation fields that workers will be operating in during the inspection, primary vessel opening, and core and reactor internal removal phase of the TMI-2 cleanup will range from a few mR/hr to as high as perhaps several R/hr (for short time periods), based upon detailed calculations of expected gamma dose rates at various parts of the primary system. The net effect of working in these fields for a typical worker over the work shift is an average field of 10 mR/hr (and a corresponding dose rate of 10 mrem/hr) based upon evaluations of the work to be performed, the area where the worker would be, and how long the work might take. As stated above, this is believed to be a conservative (overestimate) calculation of the actual average field to which a worker would be exposed.

I.2 EXPERIENCE WITH SURRY STEAM GENERATOR REPLACEMENT

For the steam generator replacement activities at the Surry Power Station Unit 2 (a 775-MWe Westinghouse PWR), the cumulative occupational dose was 2140 person-rem for a labor effort of 871,600 person-hours, or an average rate of about 2.5 mrem/hr. On this particular project, the original estimated labor and exposure was 233,600 person-hours and 2060 person-rem, respectively, for an average rate of about 9 mrem/hr. So in practice, the estimated average dose rate of 9 mrem/hr was a significant overestimate.

At Surry the specific steps taken to maintain ALARA exposures were:

1. Periodic working area cleanup in the containment building.
2. Maintaining a high water level in the steam generator as long as possible--this resulted in a dose-rate reduction of about a factor of ten and saved about 630 person-rem.
3. Use of temporary shielding in the lower steam generator cubicles resulted in a significant reduction of exposure and saved about 2700 person-rem.
4. Decontamination of parts that were to be reused resulted in savings of many person-rem.
5. To reduce the radiation exposure time, the various crafts involved received extensive training in the activities to be performed by making "dry runs" on full-scale piping mock-ups.

Reference

1. Memorandum from D.J. Malloy to J.B. Heineman, "Dose Rate Calculations for Selected Illustrative Examples in the Primary System of TMI-2," Argonne National Laboratory, April 4, 1980.

APPENDIX J. DOSE CONTRIBUTION FROM VARIOUS NUCLIDES IN GASEOUS RELEASES

The inhalation or ingestion of a given radionuclide at a concentration equivalent to the maximum permissible concentration (MPC) will cause the recipient to incur what is termed the maximum permissible dose. Thus, MPCs are a measure of dose potential and in a mixture of nuclides, the MPC of a nuclide may be used as a measure of the dose contribution of that nuclide to the total dose potential from a mixture of nuclides that may be inhaled or ingested.

In this appendix, gaseous effluent streams that are known to contain radionuclides other than H-3, Cs-137, Cs-134, Sr-90, and Sr-89 are analyzed for relative contributions of individual radionuclides to the dose potential. Potential doses from the respective constituents are treated as being proportional to the number of MPCs represented by those constituents using the MPC values for unrestricted release to air given in 10 CFR Part 20, Appendix B. The most restrictive MPC value (either for the soluble or insoluble radionuclide) was used for each constituent.

The technique used for the analyses was to calculate the number of MPCs represented by a particular nuclide. The concentration of each nuclide was divided by its MPC value to obtain the number of MPCs. The number of MPCs for all nuclides was summed and the percentage contribution of each determined. Cesium and strontium contributed more than 99% to the total.

Tables J.1 through J.3 show the analyses for airborne releases attributable to the formation of aerosols from the processing of contaminated liquids. The effluents analyzed arise from the processing of the following contaminated liquids: those from the sump water in the reactor building, the primary water in the reactor coolant system, and sump water that was in the AFHB. Because of the assumptions made in calculating releases for any given contaminated liquid, the release values are considered applicable to each of the alternative processes considered.

In the case of effluents resulting from the processing of the sump water from the reactor building, it is notable that the actinides, uranium and plutonium, were not found to be significant.

Table J.1. Analysis of Potential Dose Contribution of Radionuclides in Airborne Effluents (due to aerosol formation) from Processing Reactor Building Sump Water

Radionuclide	Concentration (μCi/mL)	MPC (μCi/mL)	Number of MPCs	Percentage of Total MPCs
H-3	9.5×10^{-1}	2.0×10^{-7}	4.8×10^{6}	< 0.1
Cs-137	1.6×10^{2}	5.0×10^{-10}	3.2×10^{11}	68
Cs-134	2.4×10^{1}	4.0×10^{-10}	6.0×10^{10}	13
Sr-90	2.6	3.0×10^{-11}	8.7×10^{10}	19
Sr-89	7.0×10^{-2}	3.0×10^{-10}	2.3×10^{8}	< 0.1
I-129	1.2×10^{-5}	2.0×10^{-11}	6.0×10^{5}	< 0.1
Zr-95	2.0×10^{-5}	1.0×10^{-9}	2.0×10^{4}	< 0.1
Nb-95	1.0×10^{-5}	3.0×10^{-9}	3.3×10^{3}	< 0.1
Ru-106	3.0×10^{-3}	2.0×10^{-10}	1.5×10^{7}	< 0.1
Sb-125	2.0×10^{-2}	9.0×10^{-10}	2.2×10^{7}	< 0.1
Te-125m	5.0×10^{-4}	4.0×10^{-9}	1.3×10^{5}	< 0.1
Te-127m	5.0×10^{-4}	1.0×10^{-9}	5.0×10^{5}	< 0.1
Te-129m	2.0×10^{-4}	1.0×10^{-9}	2.0×10^{5}	< 0.1
Ce-144	2.0×10^{-3}	2.0×10^{-10}	1.0×10^{7}	< 0.1
U	9.3×10^{-9}	3×10^{-12}	3.1×10^{3}	< 0.1
Pu(α)	3.3×10^{-6}	6×10^{-14}[a]	5.5×10^{7}	< 0.1
Pu-241	1.7×10^{-5}	3×10^{-12}	5.7×10^{6}	< 0.1
Total				100

[a]Pu-238, Pu-239, Pu-240, and Pu-242. MPC values for these isotopes are the same.

Table J.2. Analysis of Potential Dose Contribution of Radionuclides in Airborne Effluents (due to aerosol formation) from Processing of Primary Water from the Reactor Coolant System

Radionuclide	Concentration (μCi/mL)	MPC (μCi/mL)	Number of MPCs	Percentage of Total MPCs
H-3	8.0×10^{-2}	2.0×10^{-7}	4.0×10^{5}	< 0.1
Cs-137	2.9×10^{1}	5.0×10^{-10}	5.8×10^{10}	7
Cs-134	4.5	4.0×10^{-10}	1.1×10^{10}	1
Sr-90	2.3×10^{1}	3.0×10^{-11}	7.7×10^{11}	91
Sr-89	2.4	3.0×10^{-10}	8.0×10^{9}	1
I-129	0	2.0×10^{-11}		
Zr-95	5.0×10^{-4}	1.0×10^{-9}	5.0×10^{5}	< 0.1
Nb-95	8.0×10^{-4}	3.0×10^{-9}	2.7×10^{5}	< 0.1
Ru-106	1.0×10^{-1}	2.0×10^{-10}	5.0×10^{8}	< 0.1
Sb-125	4.0×10^{-3}	9.0×10^{-10}	4.4×10^{6}	< 0.1
Te-125m	6.0×10^{-3}	4.0×10^{-9}	1.5×10^{6}	< 0.1
Te-127m	3.0×10^{-1}	1.0×10^{-9}	3.0×10^{8}	< 0.1
Te-129m	1.0×10^{-3}	1.0×10^{-9}	1.0×10^{6}	< 0.1
Ce-144	3.0×10^{-2}	2.0×10^{-10}	1.5×10^{8}	< 0.1
Total				100

Table J.3. Analysis of Potential Dose Contributions of Radionuclides in Airborne Effluents (due to aerosol formation) from Processing AFHB Sump Water

Radionuclide	Concentration (μCi/mL)	MPC (μCi/mL)	Number of MPCs	Percentage of Total MPCs
H-3	4.3×10^{-2}	2.0×10^{-7}	2.2×10^{5}	< 0.1
Cs-137	5.6×10^{1}	5.0×10^{-10}	1.1×10^{11}	71
Cs-134	9.2	4.0×10^{-10}	2.3×10^{10}	15
Sr-90	5.9×10^{-1}	3.0×10^{-11}	2.0×10^{10}	13
Sr-89	6.0×10^{-1}	3.0×10^{-10}	2.0×10^{9}	1
I-129		2.0×10^{-11}		
Zr-95	1.2×10^{-4}	1.0×10^{-9}	1.2×10^{5}	< 0.1
Nb-95	1.9×10^{-5}	3.0×10^{-9}	6.3×10^{3}	< 0.1
Ru-106	5.1×10^{-4}	2.0×10^{-10}	2.5×10^{6}	< 0.1
Sb-125	1.2×10^{-3}	9.0×10^{-10}	1.3×10^{6}	< 0.1
Te-125m	2.7×10^{-4}	4.0×10^{-9}	6.7×10^{4}	< 0.1
Te-127m		1.0×10^{-9}		
Te-129m		1.0×10^{-9}		
Ce-144	1.7×10^{-3}	2.0×10^{-10}	8.5×10^{6}	< 0.1
Total				100

APPENDIX K. ECONOMIC COST BASIS

The cost estimates contained in this statement are intended to indicate the relative magnitude of the costs for the various alternatives. The estimates are not intended, nor should they be used, for detailed planning. Constant calendar year 1980 dollars have been utilized in these cost estimates, with no attempt being made to account for the time value of money or potential inflationary factors.

The economic costs are based upon estimates of costs for various operations, equipment, and facilities that can be directly related to a given alternative. Operations, equipment, and facilities that are not alternative-dependent are not included in the main text of the PEIS. Further, no attempt has been made to anticipate costs that could be incurred because of regulatory or licensing actions, availability of financial resources, and cost of replacement power.

Thus, the economic data presented here and elsewhere in the PEIS are for the purpose of comparison among alternatives. No attempt has been made to develop an overall consistent set of coasts that can be summed to arrive at a total cost estimate for the entire cleanup. In particular, contingency costs have not been included.

Where cleanup operations have already been completed (such as the AFHB water decontamination using the EPICOR II system) actual costs based on licensee data are included for completeness. For cleanup work not yet initiated, costs have been estimated on the basis of best information available. The quality of this information is quite variable, ranging from highly reliable costs for transportation to highly speculative costs for defueling. Much of the economic cost information in this statement is in the highly speculative area because many of these operations have never been performed and the working environment has not yet been fully characterized. As a result, many of the costs have been estimated without benefit of any actual experience; nevertheless, the staff believes that these cost data should be useful as relative cost comparisons.

K.1 KEY ASSUMPTIONS AND DEFINITIONS

The following key assumptions and definitions have been applied to the development of all costing data.

Manpower Rates. For purposes of estimating costs, manpower rates have divided into two categories--professional and hourly. A rate of $60,000 per man-year has been used for professional effort rates. The professional category includes management, technical professions, supervisors, and consultants. A rate of $40,000 per man-year has been used for hourly effort rates. The hourly category includes: common labor, clerical, maintenance, crafts, and equipment operators. These rates have been estimated by the licensee to be reasonably representative for these two cost categories.[1]

Direct Costs. Direct costs are defined as those costs that are directly associated with a physical activity or alternative. The basis for this cost element is the person-hour numbers found in the PEIS as they relate to the individual alternatives.

Indirect Costs. Indirect costs are defined as those costs associated with supporting a given cleanup activity. This cost element includes items such as certain types of health physics support (some health physics costs are considered as direct costs, depending on the activity), crane operators, plant operators, training, testing, procedure preparation, etc. Indirect costs are added to the associated direct costs to obtain the manpower costs when they appear in the "Economic Costs" sections of the PEIS.

Consumables. Consumable costs are those associated with expendible items, such as protective clothing, boots, gloves, face masks, rags, mops, brushes, chemicals, small hand tools, etc.

Equipment. Equipment consists of special tooling and commercially available hardware that will be needed for the cleanup. When available, commercial rates have been used. For special tooling, the staff has estimated the cost based upon tooling that is similar in complexity and function to the special tooling that may be needed. In all cases where special tooling may be needed, the costs included engineering design, materials, fabrication, and checkout testing.

Overhead Costs. The cost estimates cited in this document include only direct costs of cleanup, not associated overhead. In the context of the PEIS, overhead includes all of the costs to maintain and operate the plant in a safe shutdown condition regardless of the particular alternatives employed to clean up the plant. As an example of this division of costs, Section K.3 of this appendix includes a list of the various facilities that have been provided, are being constructed, or may be constructed in the future in support of the overall cleanup program. This listing does not include those that are alternative-dependent, meaning that the needs would vary depending on what cleanup alternatives are selected. These facilities are listed in Section K.2 with the appropriate cleanup activity. The listing in Section K.3 includes those facilities that are of a general support nature and yet are clearly necessary to support the cleanup program in total. In a similar fashion, costs associated with the following functions have been classified as overhead.

- Maintaining the plant in a safe shutdown condition
- Plant security costs
- Licensing costs
- Operating and maintenance costs for equipment and facilities not required to maintain the plant in safe shutdown condition or directly related to cleanup alternatives
- General plant support services, including laundry services, general plant stores, materials handling, receipt, inspection, general plant engineering, medical services, reproduction services, and general housekeeping.
- Administrative functions, including plant management, plant planning and scheduling, purchasing, quality assurance, personnel administration, and contract administration
- Certification testing in support of licensing requirements.

The dominate cost factor in cleanup of the TMI-2 plant most likely will be overhead. By their very nature, the overhead costs are highly sensitive to the cleanup schedule, and are thus further dominated by regulatory actions and the availability of financial resources. Since regulatory actions and the availability of financial resources cannot be realistically anticipated at this time, no attempt has been made to project an overall cost for the cleanup of TMI-2.

K.2 COSTING METHODS EMPLOYED FOR SECTIONS 5 THROUGH 9

K.2.1 Section 5--Auxiliary and Reactor Building and Equipment Decontamination

Cost estimates for Section 5 were developed by two different methods. Where costs have already been incurred by the licensee, such as cleanup of the AFHB, costs estimates have been based upon percentage of the work completed and information supplied by the licensee. For cleanup operations still in the planning stages, costs have been developed based upon estimated direct person-hours and upon the following cost elements: tooling design and fabrication, personnel training, procedure preparation, operation of direct support facilities, expendable equipment and materials, and essential services.

Tooling Design and Fabrication. Compared to the total cost, tooling is not expected to be a major expense item. The tooling for the AFHB and reactor building decontamination consists of hydrolasers, modified vacuums, special rigging, and an assortment of small hand tools. Other than minor modifications to adapt commercially available tooling for special use, design engineering is quite modest.

Personnel Training. The staff has only included training costs that are associated with the specific work activity to be performed. Because the large majority of the work is manual labor, extensive special training is not anticipated. A major exception is for work that will require large numbers of people in relatively high radiation fields. This major exception is the worst-case reactor building decontamination. The staff has assumed a $400/worker training and processing burden because of the large number of workers involved.

Procedure Preparation. Depending upon the particular activity, the staff has estimated procedure preparation effort as a percent of direct effort. As an example, the staff has estimated that 30 percent of the operating effort for the reactor containment service building would be needed to prepare the operating maintenance procedures.

Operation of Support Facilities. Operation of these facilities has also been included in the cost estimates. The principal facility in this category is the reactor containment service building. Costs were developed for the following elements: work control, material handling, health physics monitoring, building maintenance, plant engineering, receipt inspection, tool decontamination, tooling repair, building supervision, quality assurance, records, and contamination control.

Expendable Materials and Equipment. Expendable materials and equipment costs include such items as chemicals, tenting, filters, and cask liners.

Essential Services. Essential services were estimated for electrical power, steam, plant air, and ventilation. In all cases, the staff assumed that the basic service was available onsite and would have to be modified or rerun to the point of need.

K.2.2 Section 6--Reactor Defueling and Primary System Decontamination

Development of cost estimates for this section were made using the person-hours of work estimated for the various alternatives described in the section. In addition to the direct person-hours, the following cost elements were included: tooling design and fabrication, mockup costs, training, procedure preparation, and expendable materials and equipment.

Tooling Design and Fabrication. Several special purpose tools will be required for this activity. Because serious design of these tools will require a better knowledge of the potential damage to the reactor core; very little preliminary design has thus far been accomplished. The staff has, however, examined the range of core conditions that may exist and has determined that adequate technology exists for developing the required tooling.

The method used to estimate the tooling costs was to look at the functions to be performed, visualizing the tool(s) needed to perform each function, and then drawing a comparison, based upon engineering judgment, between previously developed tooling of a similar function and complexity.

As an example, the tooling costs for the hydraulic suction equipment consisted of:

Item	Cost (thousands of dollars)
Conceptual design	10
Engineering and drafting	100
Design review	10
Testing	30
Modifications after testing	30
Fabrication and procurement	100
Installation and checkout	100
Subtotal	380
Additional tooling for training and backup	200
Total	580

Mockup Costs. The use of mockups for engineering design aids and the training of operators is considered vital. Costs for these mockups also have been included in the staff's estimates. The staff has assumed that mockups would be needed for portions of the RPV, core, core support structure, and upper internals.

Training. Costs for training of the operating crews were estimated by determining the number of crews that would be required, outlining the generic subject to be covered by the training, then estimating the training time required. As an example, the staff estimated that about 40 hours of training will be required for each crew member during defueling.

Procedure Preparation. Procedure preparation costs estimated by the staff varied widely, depending on the activity involved. The staff estimated that for defueling the costs for procedure preparation would probably exceed the costs for the actual physical labor required to remove the fuel.

Expendable Materials and Equipment. When the staff judged that expendable materials and equipment would be needed to conduct an activity that was unique to the particular activity, the costs of such expendables were also included. Examples included are: in-line filters, cask liners, special cleaning chemicals, and debris containers. Expendable materials and equipment that would normally be available from plant stores were not included.

K.2.3 Section 7--Liquid Processing and Disposal

K.2.3.1 Processing Cost Estimates

The processing costs were developed from the Appendix G process flow-sheets. Based upon these flow-sheets, a hypothetical operating crew was established with appropriate allowances made for process system maintenance and downtime. Consumable materials, such as ion-exchange media, filter cartridges, and chemicals, were estimated on a perunit volume of process influent. Finally, services were estimated for such items as water, electrical power, and other utilities. The net result of this technique was calculation of a cost per unit-volume of process liquid influent. As an overcheck, these unit volume costs were compared to actual costs of operating EPICOR II as provided by the licensee.

The cost per gallon of influent to be processed is summarized in Table K.1. The unit costs consist of two components: (1) the actual labor of operating the facility, and (2) the materials consumed in the process, such as zeolites, filters, and resins. The major variation in these unit costs is in the consumable component.

The capital costs for the alternative facilities are shown in Table K.2.

Indirect support costs have also been included and are tabulated in Table K.3. These indirect costs consist of operating, maintenance, procedure preparation, engineering, surveillance, and health physics assistance.

K.2.3.2 Disposal Cost Estimates

Processed liquid disposal costs were developed on a unit-volume basis for onsite operations and transportation/disposal costs. The results of these unit volume costs are presented in Tables K.4 and K.5.

Estimated facility costs for cases in which an alternative required an onsite facility for either storage, treatment, or immobilization prior to disposal are presented in Table K.6.

The unit operating costs presented in Table K.4 are composed of direct labor, indirect labor, and material costs. The direct labor costs were developed by analyzing the process and establishing a hypothetical operating crew to perform the work, and then, based upon an influent volumetric rate, establishing a cost per unit volume. Appropriate allowances were made for supervision, health physics coverage, engineering surveillance, and direct analytical support where needed. Indirect labor costs were developed based upon estimates of support activities that would be needed. The support activities included items such as preparation of operating procedures, process qualification runs, and technical support by engineering and quality assurance.

Needs for materials, principally cement, were estimated based upon material mix ratios and then converted to material cost per unit of influent volume.

The transportation and disposal cost per unit volume of influent are shown in Table K.5. Transportation costs were based upon commercial rates assuming one-way unshielded shipments to either Richland, Washington, or West Valley, New York. Disposal Costs were based upon NECO burial charges in effect as of October 1980.

Table K.1. Costs of Liquid Processing per Gallon of Influent (dollars/gallon)

Process Alternative Considered	AFHB	Reactor Building Sump	Reactor Building Decontamination (Water)	Chemical Decontamination of AFHB and Reactor Building	RCS	RCS Flush and Drain	RCS Decontamination (Mild Chemical)	RCS Decontamination (Chemical)
1. Zeolite Alternatives								
(a) Zeolite/Resin (SDS)	-	1.65	-	-	1.60	1.55	1.60	-
(b) Zeolite/Modified Resin (Mod SDS)	-	1.65	-	-	1.65	1.60	-	-
(c) Zeolite/Evaporator	-	2.05	-	-	1.80	1.90	1.90	-
(d) Zeolite/EPICOR II	-	1.85	-	-	1.60	1.80	1.80	-
(e) SDS/EPICOR II	-	1.90	-	-	2.10	1.90	-	-
(f) Mod EPICOR II	-	-	-	-	1.50	1.85	-	-
2. EPICOR II	1.75	-	2.00	-	2.70	4.35	-	-
3. Evaporator/Resin	-	-	-	1.00	-	-	-	1.00
4. Bitumen/Resin	-	-	-	2.25	-	-	-	2.25

Table K.2. Costs of Liquid Processing Facilities (thousands of dollars)

Process Alternative	Cost
1. Zeolite Alternatives	
(a) Zeolite/Resin (SDS)	6,000
(b) Zeolite/Modified Resin (Mod SDS)	6,500
(c) Zeolite/Evaporator	9,000
(d) Zeolite/EPICOR II	12,200
(e) SDS/EPICOR II	12,200
(f) Mod EPICOR II	7,200
2. EPICOR II	6,200
3. Evaporator/Resin	3,000
4. Bitumen/Resin	7,500

K.2.4 Section 8--Solid Waste Packaging and Handling Costs

The costs of waste management depend on the characteristics of the waste generated and on the alternative steps in the waste management cycle. These costs include the considerations discussed below.

Conditioning. Conditioning is a step which refers to those operations that transform either concentrates produced during treatment or untreated materials into forms suitable for transportation or disposal. Conditioning includes immobilization, which converts radioactive waste material in the form of liquid and process solids into a stable monolithic form with the radioactive materials homogeneously dispersed within it. Conditioning costs include labor, services, and consumables such as immobilization materials.

Packaging and Handling. Packaging refers to placement of the radioactive material into a disposable container. Package handling refers to those operations that involve movement of containers within the facility. The costs include labor and disposable containers, as appropriate.

Unit costs for the various alternative processes associated with a given waste type are given in Tables K.7 and K.8. These costs were developed using applicable assumptions described in the text of this document and from data available from similar radioactive waste management operations. Materials, services, and direct effort costs were prepared for these major steps in the waste management cycle. An applicable multiplier was then applied to the resulting person-hours of work effort to obtain the additional effort required from supporting groups, such as indirect operations, supervision, training, procedure preparation, maintenance, health physics, engineering, laboratory, and analysis. The summation of these costs was then reduced to dollars per unit volume of waste generated.

The cost evaluation of services included items such as electrical power, steam, instrument air, demineralized water, cooling water, etc. Packaging and handling include the costs of disposable containers (materials), effort required to move packaged waste within the plant, and effort required to load it on or into a vehicle for transport. Effort requirements for handling packaged waste are shown in Appendix N as a function of waste and package type.

K.2.4.1 Process Solids Waste

Waste volumes resulting from application of a given treatment process for the various waste types shown are given in Table K.9. The costs of associated facilities are given in Table K.10. The applicable waste volumes were multiplied by the associated unit cost numbers presented in Tables K.7 and K.8 with appropriate facility costs added, to develop the bounding costs described in Sections 8.1.6 and 8.2.6 of the PEIS.

Table K.3. Indirect Manpower Cost Estimates (thousands of dollars)

Process Alternative Considered	AFHB	Reactor Building Sump	Reactor Building Decontamination (Water)	Chemical Decontamination of AFHB and Reactor Building	RCS Low	RCS High	RCS Flush and Drain	RCS Decontamination (Mild Chemical)	RCS Decontamination (Chemical)
1. Zeolite Alternatives									
(a) Zeolite/Resin (SDS)	-	685	-	-	407	724	384	283	-
(b) Zeolite/Modified Resin (Mod SDS)	-	700	-	-	427	752	403	-	-
(c) Zeolite/Evaporator	-	798	-	-	516	866	503	383	-
(d) Zeolite/EPICOR II	-	848	-	-	593	910	590	476	-
(e) SDS/EPICOR II	-	883	-	-	621	1040	599	-	-
(f) Mod EPICOR II	-	-	-	-	434	734	416	-	-
2. EPICOR II	529	-	336	-	404	704	386	-	-
3. Evaporator/Resin	-	-	-	155	-	-	-	-	306
4. Bitumen/Resin	-	-	-	310	-	-	-	-	650

Table K.4. Unit Operating Cost for Disposal of TMI-2 Liquids (dollars/gallon)

Disposal Alternative Considered	Direct Labor Cost	Indirect Labor Cost	Materials	Estimated Total Operating Cost
1. Long-term onsite storage				
(a) Stored in tanks[a]	NA	NA	NA	NA
(b) Immobilized in concrete[a]	0.42	0.12	0.56	1.15
2. Discharge to the environs				
(a) River discharge	0.095	0.011	NA	0.106
(b) Evaporation ponds	-	-	NA	-
3. Offsite disposal				
(a) Immobilized and shipped[b]	-	-	0.56	-
(b) Immobilized and shipped[c]	-	-	0.56	-
(c) Deep well injection	0.10	NA	NA	0.10
(d) Ocean disposal	0.10	NA	NA	0.10

[a]Costs of surveillance and storage included in Table K.5.
[b]Richland, Washington.
[c]West Valley, New York.

Table K.5. Transportation and Disposal Costs for TMI-2 Liquids (dollars/gallon)

Disposal Alternative Considered	Transportation and Disposal Costs	Other Costs
1. Long-term onsite storage		
(a) Stored in tanks	NA	34,000[a]
(b) Immobilized in concrete	NA	35,000[a]
2. Discharge to the environs		
(a) River discharge	NA	NA
(b) Evaporation ponds	NA	240[f]
3. Offsite disposal		
(a) Immobilized and shipped[b]	3.54	NA
(b) Immobilized and shipped[c]	2.25	NA
(c) Deep-well injection[d]	3.50	-
(d) Ocean disposal[d]	4.60	2.80[e]

[a]Onsite storage and maintenance cost (dollars/year).
[b]Richland, Washington.
[c]West Valley, New York.
[d]Assumes 500-mile trip.
[e]Cost for offsite solidification in concrete prior to ocean disposal.
[f]Surveillance and maintenance cost for four-year period.

Table K.6. Facility Costs for Disposal of TMI-2 Liquids (thousands of dollars)

Disposal Alternative Considered	Facility Cost Estimate
1. Long-term onsite storage	
(a) Stored in tanks	4,700
(b) Immobilized in concrete	250
2. Discharge to the environs	
(a) River discharge	NA
(b) Evaporation ponds	258
3. Offsite disposal	
(a) Immobilized and shipped[a]	250
(b) Immobilized and shipped[b]	250
(c) Deep-well injection	NA
(d) Ocean disposal	NA

[a]Richland, Washington.

[b]West Valley, New York.

Table K.7. Waste Conditioning--Unit Costs

	Conditioning Cost[a]					
		Immobilization				
Waste Type	Direct Packaging	Dewatering	Cement	VES	Compaction	Incineration
Sludge	-	Negligible	$\$26.50/ft^3$	$\$60.00/ft^3$	-	-
Zeolites[b]	-	$\$1000/ft^3$	-	-	-	-
Organic resins	-	Negligible	$\$26.50/ft^3$	$\$60.00/ft^3$	-	-
Filters	Negligible	-	-	-	-	-
Evaporator bottoms	-	-	$3.09/gal.	$6.10/gal.	-	-
Chemical decontamination solutions	-	-	$3.09/gal.	$17.60/gal.	-	-
Trash					$\$0.32/ft^3$	$\$1.48/ft^3$

[a]Includes labor, materials, and services, does not include facility cost.

[b]Includes treatment and handling at an interim DOE facility prior to final disposal.

Table K.8. Waste Packaging and Handling--Unit Costs

Waste Type	Packaging and Handling Cost			
	Direct Packaging	Immobilization		
		Dewatering	Cement	VES
Sludge	-	$8/ft^3$	$11/ft^3$	$11/ft^3$
Zeolites	-	$106/ft^3$	-	-
Organic resins	-	$145/ft^3$	$145/ft^3$	$145/ft^3$
Filters	$43/ft^3$	-	-	-
Evaporator bottoms	-	-	$1.50/gal.	$1.70/gal.
Chemical decontamination solutions	-	-	$1.25/gal.	$1.25/gal.
Contaminated equipment[a]	$3/ft^3$	-	-	-
Irradiated hardware[a]	$3/ft^3$	-	-	-
Noncompactable trash	$3/ft^3$	-	-	-
Noncompactable/noncombustible trash	$3/ft^3$	-	-	-

[a]For waste of greater than 200 mR/hr use $800/liner.

Table K.9. Process Solid Waste Volumes Considered in Costing

Waste Form	Volumes	
	Minimum	Maximum
1. Accident sludge	250 ft^3	250 ft^3
2. Zeolites	80 ft^3	430 ft^3
3. Organic resins		
High-specific-activity resins	1000 ft^3	2400 ft^3
Low-level resins	2220 ft^3	5310 ft^3
4. Filters	470 ft^3	560 ft^3
5. Evaporator bottoms	0	6154 gal

Table K-10. Waste Facility Costs (thousands of dollars)

Waste Type	Direct Packaging	Immobilization			Interim Liner Storage	ISWSF[a]
		Dewatering	Cement	VES		
Sludge	-	100	3,720	3,320	-	775
Zeolites	-	100	-	-	6,300	775
Organic resins	-	100	3,720	3,320	6,300	775
Filters	Negligible	-	-	-	-	775
Evaporator bottoms	-	-	3,720	3,320	-	775
Chemical decontamination solutions	-	-	-	3,320	-	775

[a]Interim solid waste staging facility.

K.2.4.2 Decontamination Solutions

The costs involved in the conditioning of the liquid chemical decontamination solutions and subsequent packaging and handling were developed by estimating the unit costs for conditioning (Table K.2-7) and the unit costs for packaging and loading (Table K.2-8). Based upon quanity estimates that varied from 47,000 gallons to 550,000 gallons, costs were developed. Costs for the processing facilities, cement and vinyl ester styrene immobilization are presented in Table K.2-11.

It was assumed that the decontamination solution wastes would be immobilized with either vinyl ester styrene or cement, and packaged in 55-gallon drums. It should be noted that depending upon the quantities to be immobilized, vinyl ester styrene immobilization produces both the highest cost and the lowest cost. Cement immobilization techniques lie within the bounding cases. The reason for this apparent inconsistency is that for the case where a rather small quantity (47,000 gallons) is to be immobilized, the facility costs are relatively inexpensive compared to the cement facility.

Table K.11. Decontamination Solution Immobilization Costs (thousands of dollars)

Cost Element	VES Immobilization		Cement Immobilization	
	Best Case	Worst Case	Best Case	Worst Case
Facility	828	3,320[a]	3,720	3,720
Operating cost	886	10,311	204	2,374
Totals	1,714	13,631	3,924	6,094

[a]This facility was previously estimated for the worst case cost in Section 8.1.6; thus the maximum cost for bounding estimates is the dewatering cost of $10,311.

K.2.4.3 Solids

Solid waste materials consist of trash, contaminated equipment, irradiated hardware and fuel assemblies. These wastes are described in Section 8.3, and the estimated costs for their management are presented below.

Trash

To quantify management costs, this solid waste was divided into three categories:

- Combustible--Trash that can be processed through the incinerator, with incinerator ash immobilized, packaged in 55-gallon drums, and shipped in a shielded or unshielded configuration as dictated by radioactivity level. This material would be incinerated in a small unit with a throughput of 250 pounds per hour. At an average trash density of 8 lb/ft^3, this throughput corresponds to about 33 ft^3/hr. The estimated cost of this incinerator is $5.6 million. The crew was assumed to consist of one operator. After incineration, the ash would be immobilized. Costs were based on using cement for the binder material.

- Compactible--Trash that can be processed through a compactor, packaged in 55-gallon drums, and shipped unshielded. The staff has estimated the cost of this compactor to be about $180,000.

- Noncombustible, noncompactible--No treatment or conditioning is required for these materials. This trash is packaged in LSA boxes and shipped unshielded. The operator labor required to package these materials in such boxes and to handle them was estimated from Appendix N, Table N.2.

The unit costs for these three categories of trash are shown in Table K.12. These unit costs are in dollars per cubic foot of material prior to treatment.

Table K.12. Estimated Unit Costs for Management of Trash (dollars/ft^3)

Waste Type and Container	Treatment	Conditioning	Packaging & Handling
1. Combustible trash (55-gallon drum)	1.30	0.18[a]	0.09
2. Compactible trash (55-gallon drum)	0.32	NA	0.71
3. Noncombustible, noncompactible trash (LSA box)	NA	NA	2.97

[a]Cement immobilization of ash. Use of vinyl ester styrene increases cost by about $0.70/ft^3.

K.2.4.4 Contaminated Equipment and Irradiated Hardware

Some of the contaminated equipment and irradiated hardware can be packaged in wooden LSA boxes and shipped in an unshielded configuration. The unit costs for management of these materials are essentially the same as those described above. Thus, for these low-activity materials, the total estimated costs in Section 8.3.6 were based on costs of $930 and $1130 per LSA box.

Some of these materials could have radioactivity levels that require shielded shipment. The operator labor required to package and handle these materials was estimated from Appendix N, Table N.4. As shown, about 3.5 operator hours would be required to package and handle the volume of material compatible with shipment in a 70-ft^3 liner.

K.2.5 Section 9--Cost of Storage, Transportation and Disposal of Solid Waste

The cost elements in this final step of the radioactive waste management cycle cover the incremental and total costs involved in the transportation of the solid waste from TMI and the subsequent offsite storage, treatment (if applicable) and disposal charges. In general, the cost elements are (1) shipping cask use or rental, (2) transportation, and (3) commercial burial. The basic approach and methodologies used to quantify these cost elements and the incremental values are discussed below.

For the purpose of bounding disposal costs, the costs associated with both the maximum transit distance to Hanford (Richland), Washington, and the minimum distance to West Valley, New York, are determined for both the best- and worst-case number of shipments.

The shipment and disposal costs for low-level waste (LLW) are based on direct shipment offsite to a disposal facility and include shipping cask use charges, transportation charges, and emplacement costs. The estimated bounding costs for transportation and disposal of the various types of LLW are shown in Table K.13.

Table K.13. Low-Level Waste Transportation and Disposal Costs (thousands of dollars)

	Number of Shipments		Transportation and Disposal Cost Ranges	
Type of Waste	Best Case	Worst Case	West Valley	Hanford
Unshielded waste	148	295	1196 - 2471	1,509 - 3,327
Ion-exchange material (shielded)				
EPICOR II (AFHB)	69	84	865 - 1000	1,331 - 1,615
Zeolite/resin (reactor building)[a]	9	37	115 - 490	176 - 741
RCS processes	12	65	145 - 713	225 - 1,154
Shielded drums	41	91	225 - 500	487 - 1,081
Miscellaneous shielded waste	17	206	61 - 1104	177 - 2,850
Totals			2607 - 6278	3,905 - 10,768

[a]Transportation and disposal costs for the zeolite liners have been assumed to be the same as those used for the high activity prefilters.

K.3 FACILITIES

A tabulation of the various facilities that may be needed to support the TMI-2 cleanup is presented in Table K.14. Provided is a tabulation of those facilities that are classified as general support and those that are directly associated with a given alternative. The general support facilities are those considered as being needed to support cleanup regardless of the alternatives selected. They consist of such facilities as hot chemistry laboratory, laundry, etc. Because these facilities are independent of the alternatives selected, no attempt has been made to establish costs.

The staff used four methods to develop cost data for the facilities discussed in Section K.2: (1) when costs have already been incurred by the licensee, costs and/or cost-to-complete data have been used (examples are EPICOR II and the SDS); (2) when facilities have not yet been designed and engineering specifications not yet developed, but have been identified by the licensee as possibly needed, the licensee's cost estimates have been used after review by the staff. Facilities such as the containment service building is an example; (3) when facilities have been identified by the staff as possibly needed, but for which little or no information exists regarding specifications, the staff has used engineering judgement based upon previous construction costs of somewhat similar facilities (examples of these types of facilities are mockup pools and filter backflush facilities); and (4) in the case of facilities for which little or no information exists but which are single-process oriented, the staff has used a standard procedure developed by the U.S. Environmental Protection Agency to estimate costs.[2]

Table K.14. General Support Facilities[a]

Liquid Radwaste Processing Building (Evap)
Personnel Access Facility (PAF)
Decontamination Demonstration Facility (DDF)
Low Level Counting Facility (LLC)
Sewage Treatment Facilities
Search-Entry Facility
Warehousing
Administration Building
Security Administration Facilities
TLD Facilities
Time Office and Brass Alley
Resin Solidification Facility (RSF)
Equipment and Material Radwaste Staging: Medium-High (RSFH)
Equipment and Material Radwaste Staging: Low (RFSL)
Laundry Facility (LF)
Low Level Waste Processing (LLWP)
Hot Chemistry Laboratory (HCL)
Proposed Processed Water Storage Tanks (Up to 8 additional tanks)
New Permanent Security Fence
Interim Security Fence

[a]Based on BECHTEL Drawing No. 2-COA-0001, Rev. 3.

References--Appendix K

1. Memorandum from R.J. McConnell, Argonne National Laboratory, to Distribution, "PEIS Costing Discussion at TMI, September 24, 1980," dated October 2, 1980.

2. "A standard Procedure for Cost Analysis of Pollution Control Operations," U.S. Environmental Protection Agency, EPA-600/8-79-018AB, June 1979.

APPENDIX L. AVERAGE INDIVIDUAL QUARTERLY DOSE LIMITS USED IN DETERMINATIONS OF WORK FORCE ESTIMATES

In 10 CFR Part 20.101(b), the occupational dose of radiation workers of up to 3 rem whole-body per quarter (three months) is permitted if the workers meet certain conditions relative to previous cumulative dose record, age, and the licensee's determination of the workers' cumulative occupational dose to the whole body. Those who do not meet these conditions are restricted to much lower doses.

In its radiological protection program, the licensee has established administrative check points for occupational dose which are more stringent than the regulatory limits of 10 CFR Part 20. These administrative check points indicated in the licensee's Radiation Protection Manual, Administrative Procedure 1003, are stepped to make it difficult for individuals to approach the 3 rem per quarter regulatory limit and thus greatly reduce the potential for violating this limit:

0 - 1 rem per quarter	Administrative check point to ensure compliance with 10 CFR Part 20
1 - 2 rem per quarter	Written authorization required from Radiation Protection Supervisor (RPS)
2 - 3 rem per quarter	Written authorization required from RPS and Unit Supervisor

The NRC staff recognizes the value of this approach and the fact that its application results in occupational doses that rarely exceed about 1 rem per quarter. Therefore, for the purpose of estimating the major work force requirements for the decontamination operations, the staff allowed for an average individual dose of 1 rem per quarter in TMI-2 cleanup operations. However, by use of 1 rem per quarter for its calculations, the staff does not intend to preclude individuals being allowed to receive up to 3 rem per quarter, should it be necessary, nor are such doses prohibited by the licensee's procedures. Indeed, for some special operations, it may be prudent to allow individuals to receive up to (but not over) the 3 rem per quarter limit to accomplish a task in the optimal manner and reduce overall person-rems (e.g., a highly skilled employee).

Use of a higher individual dose would result in a reduction in the number of exposed individuals required to do the work, but these trained personnel would then be expended earlier in the decontamination process and would be unavailable for further radiation work during the quarter.

APPENDIX M. "LONG-TERM ENVIRONMENTAL RADIATION SURVEILLANCE PLAN FOR THREE MILE ISLAND"

U. S. ENVIRONMENTAL PROTECTION AGENCY

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FOREWORD

The protection of people and the environment from unnecessary exposure to ionizing radiation from radioactive material that may yet be released from the Unit II reactor at the Three Mile Island nuclear generating station is of utmost importance to the Federal Government as well as to the Commonwealth of Pennsylvania.

It is essential that the involved Federal agencies work closely together to provide the most credible environmental radiation monitoring data. To this end, the Executive Office of the President designated the U. S. Environmental Protection Agency as the lead agency for monitoring radiation in the environment surrounding Three Mile Island.

The technical staffs of the Nuclear Regulatory Commission, the U. S. Public Health Service (of the Department of Health and Human Services, formerly the Department of Health Education & Welfare), the U. S. Department of Energy, the Commonwealth of Pennsylvania, and the State of Maryland participated with the U. S. Environmental Protection Agency in the preparation of, and have concurred with, this plan.

Stephen J. Gage
Assistant Administrator for
Research and Development
U. S. Environmental Protection Agency

INTRODUCTION

The U.S. Environmental Protection Agency was named by the White House as the lead Federal agency for conducting a comprehensive long-term environmental radiation surveillance program as followup to the March 28, 1979, accident at the Unit II reactor of the Three Mile Island nuclear generating station (Appendix A). Before implementing this long-term plan, the Federal agencies followed the general plan outlined in the White House Memorandum, dated April 13, 1979, modifying it occasionally as required by the changing conditions at the reactor. The U.S. Environmental Protection Agency has coordinated the efforts of the involved Federal agencies and the Commonwealth of Pennsylvania.

The public release of data obtained by the Federal agencies involved in the long-term monitoring program will be through the U.S. Environmental Protection Agency (EPA). However, data will simultaneously be provided to the other Federal participants and to the Bureau of Radiation Protection (BRP) of the Pennsylvania Department of Environmental Resources (DER). In no way will this preclude any agency from fulfilling its statutory responsibility.

The purpose of the long-term environmental radiation surveillance program is fourfold:

1) to provide a measure of the radiological quality of the environment in the vicinity of the Three Mile Island nuclear power facility during a period when large quantities of radioactive material will be dealt with during cleanup of the facility,

2) to provide a basis for informing the public as to the environmental levels of radioactivity,

3) to provide confirmation and feedback regarding the success in controlling releases of radioactive material to the environment, and

4) to provide an in-place monitoring program ready for immediate use if an accidental release should occur.

This long-term surveillance program is not a subsitute for, but is in addition to and independent of, the environmental surveillance program conducted by the Metropolitan Edison Company, operators of the nuclear power station.

The uncertainty of the type and timing of cleanup operations as well as the changing concentrations of radionuclides in containment necessitates periodic reassessment of any monitoring plan. This document represents the second revision of the Long-Term Environmental Radiation Surveillance Plan for Three Mile Island dated September 27, 1979. The first revision is dated March 17, 1980.

In developing the original plan, careful consideration was given to the types and quantities of radionuclides that were in the Reactor Containment Building, the Auxiliary Building, and the Fuel Handling Building. The licensee's surveillance plan (Appendix B), which is closely monitored by the Nuclear Regulatory Commission (NRC), was also considered.

The long-term surveillance plan provides for increased surveillance if a release is anticipated, if planned activities increase the potential for a release, or if a release occurs unexpectedly.

Since the purging or venting of Krypton-85 was completed in July 1980, there are two compartments of radioactivity remaining in the Reactor Containment Building: (1) the sump water on the floor and (2) the core and primary coolant.

There are approximately 650,000 gallons of contaminated water in the Reactor Containment Building (approximately eight feet deep). The concentrations of radionuclides in this water as of 7/14/80, according to the NRC[1], are shown in Table 1.

TABLE 1

CONCENTRATIONS OF MAJOR RADIONUCLIDES IN WATER WITHIN THE REACTOR CONTAINMENT BUILDING*
7/14/80

Radionuclide	Concentration (uCi/cc)	Half-Life
^{3}H	0.98	12.16 years
^{89}Sr	0.63	52.7 days
^{90}Sr	2.75	27.7 years
^{134}Cs	29.6	2.05 years
^{137}Cs	172.8	30.0 years

*The concentrations of radioisotopes listed in this Table are "best estimates" based upon a limited sampling program. More precise measurements will be made as the decontamination process continues.

[1]Letter dated July 18, 1980 from John T. Collins, Deputy Program Director, TMI Program Office to Erich Bretthauer, Project Director, EPA, Middletown, PA.

Plans for treatment of water in the Reactor Containment Building and the Reactor Cooling Water are being developed. These plans will be implemented in late 1980 at the earliest.

There is always an extremely remote possibility that contaminated water in the Reactor Containment Building could accidentally be released to the Susquehanna River prior to removal of contaminating radionuclides. This plan provides for prompt determination of the extent of any release followed by notification of appropriate authorities responsible for taking protective actions.

The radionuclide concentrations, as provided by NRC, of approximately 96,000 gallons of primary coolant in the Reactor, as of July 21, 1980 are shown in Table 2.

TABLE 2

CONCENTRATIONS OF MAJOR RADIONUCLIDES IN THE PRIMARY REACTOR COOLANT*

7/21/80

Radionuclide	Concentration (uCi/cc)	Half-Life
^{3}H	.09	12.26 years
^{85}Kr	.05	10.76 years
^{89}Sr	2.4	52.7 days
^{90}Sr	23	27.7 years
^{134}Cs	4.9	2.05 years
^{137}Cs	30	30.0 years

The concentrations of radioisotopes listed in this Table are "best estimates" based upon a limited sampling program. More precise measurements will be made as the decontamination process continues.

ROUTINE SURVEILLANCE PROGRAM

The normal or routine surveillance responsibilities of the various Federal agencies are as follows:

Environmental Protection Agency

EPA will operate a network of eighteen continuous air monitoring stations (Figure 1) at radial distances ranging from 0.5 miles to 3.5 miles from TMI. (After January 1, 1981, it is planned to reduce this network to thirteen stations.) Each station will include an air sampler and a gamma rate recorder. A list of sampling locations is shown in Appendix C. The air sampler units sample at approximately 2 cfm and the samples will be collected from each station and analyzed on at least a weekly basis. Currently the particulate filters are changed three times weekly and the charcoal cartridges (iodine analysis) are changed weekly. All samples are analyzed by gamma spectroscopy at EPA's TMI Field Station in Middletown using a Ge(Li) detector with a lower limit of detection for ^{131}I, or ^{137}Cs of approximately 25 pCi (0.15 pCi/m^3 for a 48 hour sample).

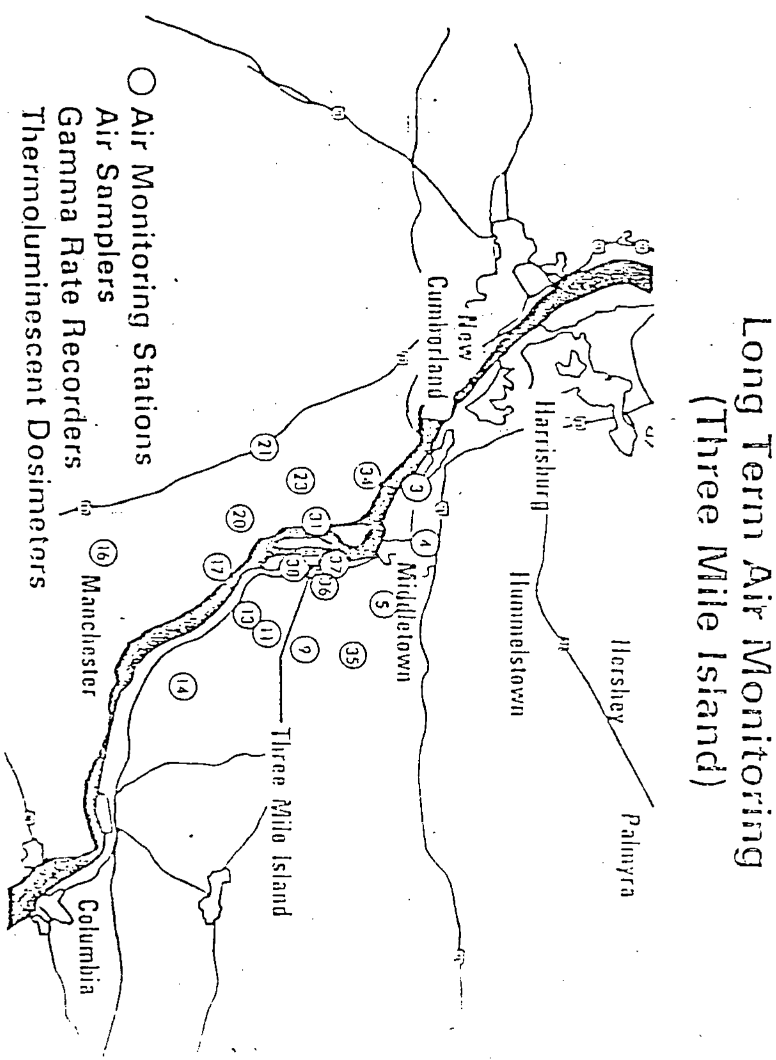
Each monitoring station will have a gamma rate recorder for measuring and recording external exposure. Recorder charts will be collected and read on the same schedule used for air sample collection. Charts will be reviewed in Middletown and storaged at EPA's Environmental Monitoring and Support Laboratory in Las Vegas, Nevada.

Thermoluminescent dosimeters (TLD's) will be placed at each monitoring station as well as at a representative number of population centers surrounding TMI. Locations are shown in Appendix D. These dosimeters will be read on a quarterly basis.

Additional air samples will be collected and analyzed for ^{3}H and ^{85}Kr at the TMI Observation Center, Goldsboro, Middletown and Bainbridge stations. Effective January 1, 1981 the Bainbridge sampler will be shifted to York Haven.

Continuous monitoring of the radiological outfall to the Susquehanna River will also be conducted as an alert mechanism to avoid contamination of downstream drinking water supplies. An EPA system which continuously draws water from the outfall and provides a graphic presentation of the count rate (or concentration) in a holding reservoir is operational. The system has a sensitivity of less than 100 pCi/l for ^{131}I or ^{137}Cs for the concentration of the liquid in the counting reservoir. A two-stage pumping system is used, with water from the outfall being collected in a sediment trap, prior to being pumped to the counting reservoir. At a flow rate of 1.0 l/minute from the outfall to the sediment trap and 0.5 l/minute to the counting reservoir, 90% of equilibrium between the outfall and the counting reservoir will be reached in approximately 17 minutes. Thus an outfall concentration of approximately 1,200 pCi/l of ^{137}Cs will initiate the alarm system in 17 minutes. A concentration of 3,000 pCi/l in the outfall will initiate the alarm in less than 5 minutes. At the present time the alarm level is set at 1,000 pCi/l based on ^{137}Cs as the limiting radionuclide. This corresponds to 1/20 of the maximum permissible concentration as specified in the Code of Federal Regulations, Title 10, Part 20.

Figure 1



Samples will also be collected and analyzed from other TMI outfalls as appropriate. The outfall samples will be gamma scanned in EPA's TMI Field Station Laboratory where the minimum sensitivity for these samples is about 35 pCi/l for ^{131}I or ^{137}Cs for a 10-minute count. EPA will also analyze Susquehanna River water sampled daily by the Commonwealth of Pennsylvania at the City of Lancaster intake, as well as River water sampled upstream from TMI (City Island). These samples will be analyzed at the EPA TMI Field Station which has a minimum sensitivity for ^{131}I of 10 pCi/l for a 100-minute count. The Commonwealth will then perform ^{3}H, gross-alpha and gross-beta analyses on these samples. Strontium-89 and Strontium-90 analyses will be performed on weekly composite samples by EPA. Detection limits for ^{89}Sr and ^{90}Sr are 5 pCi/l and 1 pCi/l, respectively. Weekly grab samples of water and sediment will be collected from the east sedimentation pond on TMI and analyzed for gamma emitting radionuclides at the TMI Field Station and for tritium at the DER Laboratory.

Department of Energy

The Department of Energy (DOE) will provide soil and vegetation analyses at seven sites semiannually. In-situ gamma spectrometry analyses will be conducted at these seven plus one additional site. TLDs are also in place at these sites as well as at four state monitoring locations. If levels of radionuclides demonstrate any increase above background levels, the samples will be subjected to detailed radiochemical analyses. DOE will also continue to supply accident response services such as meteorological modeling support and area radiological monitoring.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) will operate one air sampling station located in the middle of the reactor complex. The air sample will be changed weekly and be analyzed by gamma spectrometry. The NRC will place two sets of TLDs at 59 locations as shown in Appendix E. Each set contains two lithium borate and two calcium sulfate phosphors. Both sets will be read on a monthly basis, however, flexibility exists to read one set at more frequent intervals should conditions warrant.

U.S. Public Health Service

The U.S. Public Health Service (PHS), Food and Drug Administration (FDA) will defer further monitoring of foodstuffs and milk in favor of a close following of the Commonwealth of Pennsylvania's Department of Environmental Resources (DER) routine surveillance program. FDA may, at its option, split appropriate samples with the Commonwealth for confirmation.

PHS/FDA will, however, be prepared to reinstitute and/or upgrade its former foodstuffs and milk sampling program in the event of an unexpected release from Unit II.

Commonwealth of Pennsylvania

The Department of Environmental Resources of the Commonwealth of Pennsylvania will operate three continuous air sampling stations; one at the Evangelical Press Building in Harrisburg, one at the TMI Observation Center and one in Goldsboro. Each air sample will consist of a particulate filter followed by a charcoal cartridge. The samples will be exchanged weekly, the particulate air samples will be gamma scanned and beta counted for reactor related radionuclides.

The Commonwealth's milk sampling has reverted to its routine surveillance program, which consists of monthly milk sampling at two dairy farms near the site. The milk samples will be gamma scanned for all reactor related gamma emitting radionuclides.

The Commonwealth will place TLDs at 10 locations shown in Appendix VI. The TLDs will be read monthly.

As part of a routine QA/QC program with the licensee, the Commonwealth will also collect local produce and fish in season. The produce and fish samples will be analyzed by gamma spectroscopy for any reactor related radionuclides.

The Commonwealth also participates with EPA, as previously discussed, to monitor the principal aqueous outfalls of the Reactor.

State of Maryland

The Maryland Department of Natural Resources is conducting approximately quarterly sampling of fish, shellfish, aquatic vegetation and sediments in the lower Susquehanna River and upper Chesapeake Bay. Stations begin in Holtwood Reservoir and terminate below the mouth of the Sassafrass River. The sampling strategy is primarily to detect the environmental distribution of radionuclides discharged during the normal operations of the Peach Bottom Atomic Generating Station. Knowledge of the levels of discharge from Peach Bottom and the resulting environmental concentrations provides an empirical basis for the prediction of effects from any discharges proposed from the Three Mile Island. The Holtwood Reservoir Station provides opportunity for detection of TMI effects prior to interference by Peach Bottom effluents, thus providing a basis for estimating the fractions of downstream detectable concentrations that are due to TMI.

In the event of an emergency, MD DNR will duplicate the routine sampling at the anticipated time of maximum impact.

CONTINGENCY SURVEILLANCE PROCEDURES

Contingency planning for the protection of the public must address the possibility of unplanned releases of airborne radioactivity to the general environment, as well as liquid releases to the Susquehanna River.

In the event of a release of airborne radioactivity in excess of the licensee's Technical Specifications limits, the Director, EPA-TMI Field Station will be notified by the NRC and an EPA health physics technician may be deployed. Positioning the EPA health physics technician will be the responsibility of the Director, EPA-TMI Field Station until additional NRC personnel can be summoned to the site from the NRC Regional Office in King of Prussia, Pennsylvania. The NRC health physics personnel would be supported by radiation monitoring equipment and analytical capabilities, including the NRC Region I mobile laboratory. Additional NRC personnel would be on-site within two hours; the location of the mobile laboratory at the time of the occurrence would dictate its response time. The Senior NRC Site Representative will assure that the Director, EPA-TMI Field Station has access to current release data and meterological information. In addition, the Emergency Coordination Center of the DOE will be notified by the NRC and may be requested to provide aerial measurements and plume tracking. The response time for an aircraft to reach TMI can be expected to be from 2-3 hours under normal conditions with a 6 hour maximum under virtually any condition.

Pennsylvania Department of Environmental Resources (PA DER) Health Physics personnel may also provide monitoring capability as appropriate.

During certain in-plant cleanup operations where an increase in the rate of gaseous releases may be expected, additional survey teams may be deployed to TMI by the EPA, the PHS, the NRC and PA DER. The DOE helicopter may also be on standby in the Harrisburg area for such operations. (These critical points in the cleanup will be identified by the NRC as much in advance as possible.)

Air sampling will serve as a measurement of inhalation exposure as well as an indicator of potential contamination of milk and food crops. Should a prolonged airborne release occur, supplemental air monitoring stations will be established.

The contingency plan for release of contaminated water above the licensee's permitted level for discharge to the Susquehanna River is set forth in Appendix G. The plan includes prompt confirmation of the released activity by analyses of grab and composite samples followed by notification of the impact of the release to downstream users. Details of the joint EPA-Commonwealth of Pennsylvania plan are described in Appendix G. In addition to the notification procedures of appropriate Pennsylvania agencies described in Appendix G, the Director, EPA TMI Field Station will notify EPA's Region III Office and EPA's Office of Radiation Programs of the details of the release including anticipated impact to the adjoining states. EPA's Region III Office will then be responsible for notifying adjoining states. This plan does not alter the NRC standard operating procedures for notification of the EPA Regional Office.

The Maryland State Department of Health and Mental Hygiene Office of Environmental Programs will provide additional monitoring capability as appropriate. Water samples will be taken at all Maryland drinking water intakes from the Susquehanna River. These intakes are:

1. Baltimore Big Inch Intake - located immediately above Conowingo Dam

2. Conowingo Intake

3. Bainbridge, Md. - Port Deposit Intake

4. Perry Point Veterans Hospital

5. City of Havre de Grace

Milk samples will be taken at farms in Pennsylvania which are operating under Maryland Department of Health and Mental Hygiene permits.

A list of phone numbers of individuals responsible for the various monitoring programs at TMI is shown in Appendix H.

REPORTING PROCEDURES

There will be two types of data reporting procedures. The first type is designed to distribute information upon which immediate action might be taken and consists of informal reporting methods, while the second procedure is designed to provide a verified data base.

IMMEDIATE REPORTING PROCEDURES

Each of the monitoring agencies will inform the other monitoring participants of confirmed, positive levels of reactor-related radionuclides through the Director, EPA TMI Field Station or his designated alternate. He will promptly relay the information by telephone or in person to each Federal Agency involved, the Commonwealth of Pennsylvania, and the State of Maryland followed in either case by written documentation of the event. If concentrations of radionuclides in excess of those permitted in the environment by 10CFR20, Appendix B, Table 2, Column 2, are found outside the controlled area, EPA shall be notified within 2 hours of discovery. Otherwise notification shall be made by noon of the working day following discovery.

Periodic meetings may be called by EPA at TMI to discuss proposed and ongoing operations which could impact the off-site agencies and to exchange information.

Reporting Data into the Data Base

All data will be reported in the format previously specified by EPA. Data from PHS, NRC, DOE and the Commonwealth of Pennsylvania and State of Maryland will be submitted to EPA monthly for inclusion in the data base. EPA data will also be placed in the data base monthly.

On a monthly basis, EPA will place data obtained from Metropolitan Edison and the Commonwealth of Pennsylvania, as well as relevant data from other organizations into the data base. EPA will then use computer transfers to transmit monthly updates to the data base to the originating organizations for verification. All data will be verified by the originating organization within 15 days of receipt. Any errors will be referenced by sample number for correction. Periodic updates will be made available to all participants.

REPORTING INFORMATION TO THE MEDIA

The EPA will be the lead Federal agency responsible for distribution of environmental data to the media. All participants in this plan will keep each of the other participants advised in advance of pending media releases concerning TMI. Releases will also be furnished to Metropolitan Edison Co.

QUALITY ASSURANCE

In addition to the internal quality control activities practiced by the Federal agencies and the Commonwealth of Pennsylvania, organizations involved in TMI monitoring will participate in the intercomparison studies listed below. Samples will be prepared and distributed by the Quality Assurance Division of EPA's Environmental Monitoring Systems Laboratory - Las Vegas (EMSL-LV). The intercomparison samples and the schedule for their distribution are as follows:

Milk

Four-liter milk cross check samples containing potassium-40, strontium-89, strontium-90, iodine-131, and cesium-137 will be distributed in January, April, July and October of 1981 to PHS, EPA, NRC, the Commonwealth of Pennsylvania, and the State of Maryland.

Water

The following cross-check water samples will be distributed to PHS, EPA, NRC, the Commonwealth of Pennsylvania, and the State of Maryland.

Four-liter samples containing a mixture of photon emitting radionuclides (Cobalt-60, Ruthenium-106, Cesium-134, Cesium-137, Chromium-51, and Zinc-65) will be distributed during February, June and October of 1981.

Four-liter samples containing strontium-89 and strontium-90 will be distributed in January, May and September of 1981.

Four-liter samples containing Iodine-131 will be distributed in April, August and December of 1981. Fifty-milliliter samples for tritium analysis will be distributed on a bi-monthly basis.

Each participating Agency laboratory is expected to carry out three independent determinations for each radionuclide included in a particular study and to report the results to EPA. Upon receipt of the reports of all participating laboratories, the data will be analyzed. The analysis includes a determination of the laboratory standard deviation, calculations of the normalized range, normalized deviation, sample standard deviation, grand average of all laboratories and warning and control limits.

A report will be distributed by EPA to participating laboratories containing results of each intercomparison study. EPA will immediately notify any participating Agency laboratory if it is determined that the laboratory cross check results exceed the quality assurance deviation level for any given type of analysis.

[illegible]

WASHINGTON

April 13, 1979

MEMORANDUM FOR THE HONORABLE JOSEPH CALIFANO
THE HONORABLE JAMES SCHLESINGER
THE HONORABLE DOUGLAS COSTLE

FROM: JACK WATSON

SUBJECT: Long-Term Environmental Radiation Monitoring at Three Mile Island

It is clear that several Federal agencies must continue to play a key role in assuring the citizens around the Three Mile Island site of their safety during the final stages of the plant's shutdown and initiation of cleanup. It is essential that the involved Federal agencies work closely together to provide the most credible environmental radiation monitoring data. Consequently, pursuant to the President's direction that I coordinate the assistance efforts of all Federal agencies for the Three Mile Island accident, I am hereby designating the Environmental Protection Agency as the lead agency for these monitoring efforts. In addition, I am asking each of the agencies named below to continue to meet the responsibilities indicated and to provide adequate resources for those tasks.

Environmental Protection Agency

As the lead agency, EPA should assume responsibility for coordinating the collection and documentation of the environmental radiation data obtained by all of the Federal agencies involved since the accident occurred on March 28, 1979. The EPA should continue to maintain an operations center staffed with radiation specialists in the vicinity of Three Mile Island to coordinate data collection and to inform the public, through the Nuclear Regulatory Commission, of off-site radiation levels. The information and data collected by EPA should be made available to the other participating agencies on a regular basis. The EPA should also continue to operate, at an adequate level, its environmental monitoring network for air and water-borne radioactivity. Finally, the EPA should prepare a report of such environmental radioactivity for the recently established Presidential Commission to investigate the accident.

Health, Education, and Welfare

The Food and Drug Administration should continue to conduct radioanalyses of milk and food in the vicinity of Three Mile Island at appropriate intervals. These, and all previous analyses, should be promptly submitted to the operations center. Other environmental data collected by FDA, such as dosimeter readings, should also be included in the combined Federal report.

The Center for Disease Control and the National Institute of Occupational Safety and Health should keep the EPA operations center informed of their activities, either at the reactor site or off-site. Any environmental data gathered by CDC or NIOSH should be submitted to the operations center for inclusion in the report.

Department of Energy

The Department of Energy should continue to sample and conduct radioanalyses of soil and vegetation in the vicinity of Three Mile Island at appropriate intervals. These, and all previous analyses, should be promptly submitted to the operations center. Other environmental data collected by DOE, or its contractors, such as radiation intensity measurements from helicopter flights and dosimeter readings, should also be included in the combined Federal report. The Department should also continue to provide meteorological support at the operations center, as needed.

The Environmental Protection Agency should make every effort to obtain all pertinent environmental radiation data from the Nuclear Regulatory Commission, the State of Pennsylvania, and the utility.

* * *

I am very pleased with the reports I have received of the excellent cooperation among the Federal agencies assisting in the Harrisburg area. I am confident that this spirit of cooperation will continue, and that all of the participants will maintain their vigilance until the risks of radiation releases are reduced to a minimum.

If you have any questions on these assignments, please call me or Gene Eidenberg (456-6537).

cc: Chairman Joseph Hendrie,
Nuclear Regulatory Commission

APPENDIX B

METROPOLITAN EDISON TMI LONG-TERM MONITORING PROGRAM

The Metropolitan Edison (Met-Ed) Monitoring Program, is a combination of the TMI-1 and TMI-2 Environmental Technical Specification required programs and increased monitoring activities which were initiated after March 28, 1979.

The monitoring program is subject to change based upon review of the results and requests for additional monitoring. In no instance will the program be reduced to less than that required by the Environmental Technical Specifications. All major reductions in scope or intensity will be discussed with the NRC and the Commonwealth of Pennsylvania prior to implementation.

All air, water, and milk sampling locations refer to a location code which denotes location as a function of azimuth and distance from the reactor. The location code is shown as Table 1.

Air Sampler Network

Location	Location Code
North Weather Station	1F2
Falmouth Substation	8C1
Observation Center	5A1
West Fairview	15G1
Drager Farm	7F1
Middletown	1C1
Goldsboro Air Station	12B1
North York Substation	9G1

Sampling Frequency - weekly

Analysis:

Air particulate - Gross Beta
Gamma Spec. - if Gross Beta exceeds alert level

Quarterly composite of air particulate - $^{89-90}Sr$, Gross Alpha, Gamma Spec.

Charcoal Cartridge - radioiodine

Milk Network

Location	Location Code
Alwine Farm (cow)	4B1
Becker Farm (cow)	7B3
Fishing Farm (cow)	14D1
Cellig Farm (cow)	2G1
Hardison Farm (goats)	1B1

Sampling Frequency - Biweekly

Analysis - radioiodine (chem. spe.)
gamma spec.

$^{89-90}Sr$ (quarterly composite)

Met-Ed Water Sampling Network

Location	Met-Ed Location Code	Sampling and Analysis Code
Steelton Water Works	15F1	2,4
Swatara Creek	1C3	2
001 Outfall TMI	10S1	1
½ Distance Between 001 Outfall and South End TMI	9A2	5
South End TMI	9B1	5
York Haven Generating Station	8C2	2,4
Brunner Island	8E	2,3,4
Chickies Creek	6G3	6
Columbia Water Plant	7G1	2,3,4
Wrightsville	7G2	3
York	9G2	3
Lancaster	7G3	3

SAMPLING AND ANALYSIS CODES

1. Daily composite analyzed for radioiodine (ion-exchange separation), gross beta, tritium, and gamma radioactivity scan).
2. Automatic compositor collects hourly samples of raw water. Composite samples collected biweekly. Total composite sample for month analyzed for tritium and gamma radioactivity (scan).

3. Automatic compositor collects hourly samples of finished water. Composite samples collected biweekly. Total composite sample for month analyzed for tritium, gamma radioactivity (scan) and gross beta radioactivity. Analyzed for ^{131}I if the gamma scan is positive.

4. Quarterly composite analyzed for ^{89}Sr and ^{90}Sr.

5. Weekly raw grab sample composited monthly and analyzed for tritium and gamma radioactivity (scan).

6. Raw grab samples taken if ^{131}I is found in water samples from Lancaster or Columbia when upriver samples are negative.

Additional Samples

Fish, aquatic plants, aquatic sediments are sampled periodically as well as miscellaneous food products as they become available.

TLD Network

Location	Met-Ed Location Code
North Weather Station	1S2
North Bridge	2S2
Top of Dike	4S2
Top of Dike	5S2
Falmouth-Collins Substation	8C1
South TMI	9S2
Mechanical Draft Cooling Tower	11S1
North Boat Dock	16S1
Shelly Island	14S2
Laurel Road	4A1
Observation Center	5A1
Kohr Island	16A1
S. End Shelly Island	10B1
Goldsboro Air Station	12B1
Middletown Substation	1C1
Drager Farm	2F1
Route 241	4G1
North York Substation	9G1
W. Fairview	15G1
Columbia	7G1

Changeout - monthly

TABLE B - 1

Distance & Azimuth Of Sampling Locations For The Three Mile Island Nuclear Station Offsite Emergency Radiological Environmental Monitoring Program

Location	Distance (miles)	Azimuth	Location	Distance (miles)	Azimuth
1S2	0.4	0°	1C1	2.6	0°
2S2	0.7	25°	1C3	2.3	350°
4S2	0.3	71°	8C1	2.3	159°
5S2	0.2	95°	8C2	2.3	165°
9S2	0.4	184°	14C1	2.7	285°
10S1	0.8	200°	14C3	2.7	285°
11S1	0.1	221°			
14S2	0.4	293°	14D1	3.5	294°
16S1	0.2	340°			
			4E1	4.4	75°
1A2	0.7	0°	8E1	4.1	160°
4A1	0.5	65°	8E1	4.1	160°
5A1	0.4	86°			
7A1	0.3	137°	7F1	9.0	132°
7A2	0.5	137°	15F1	8.7	308°
9A2*	0.5-1.0	185°-191°			
9A2	0.5	188°	2G1	10.5	32°
10A1	0.8	202°	4G1	10	68°
10A3*	0.2-1.0	191°-213°	5G1	10.6	97°
11A1	0.5	225°	5G2	10.6	97°
13A1*	0.7-1.0	258°-281°	6G1	10.5	120°
16A1	0.4	332°	7G1	15	124°
16A2*	0.2-1.0	326°-348°	7G2	15	128°
			7G3	15.1	124°
1B1	1.2	5°	9G1	13	183°
4B1	1.1	65°	9G2	15	184°
5B1	1.0	92°	15G1	15	308°
6B1	1.5	118°			
7B1	1.1	141°	Ind*	0.2-2.0	270°-90°
7B3	1.6	140°	Ctrl*	0.2-2.0	90°-270°
9B1*	1.0-2.0	172°-194°			
9B1	1.5	183°			
9B2*	1.0-2.0	185°-194°			
9B3*	1.0-2.0	185°-194°			
10B1	1.1	204°			
12B1	1.6	253°			
16B1*	1.0-2.0	326°-348°			
16B8*	1.0-2.0	326°-348°			

*Locations so noted are part of the fish sampling program and since electrofishing is the primary collection technique, that entire area is generally fished.

APPENDIX C

THREE MILE ISLAND
EPA LONG-TERM SURVEILLANCE STATIONS

Air Samplers and Gamma Rate Recorders

STATION	AZ	DIST.	ASSOCIATED TOWN
3	325	3.5	Middletown, PA -- Harrisburg International Airport
4	360	3.0	Middletown, PA -- Elwoods' Sunoco Station
5	040	2.6	Royaltown, PA -- Londonderry Township Building
9	100	3.0	Newville, PA -- Brooks Farm (Earl Nissley Residence)
11	130	2.9	Falmouth, PA -- Charles Brooks Residence
13	150	3.0	Falmouth, PA -- Dick Libhart Residence
*14	145	5.3	Bainbridge, PA -- Bainbridge Fire Company
*16	180	7.0	Manchester, PA -- Manchester Fire Department
17	180	3.0	York Haven, PA -- York Haven Fire Station
20	205	2.5	Woodside, PA -- Zane Reeser Residence
21	250	4.0	Newberrytown, PA -- Exxon Kwick Service Station
*23	265	2.9	Goldsboro, PA -- Muellar Residence
31	270	1.5	Goldsboro, PA -- Dusty Miller Residence
34	305	2.7	Plainfield, PA -- Polites Residence
35	068	3.5	Royaltown, PA -- George Hershberger Residence
36	095	0.5	TMI Observation Center
*37	025	0.7	North Gate, TMI
*38	175	0.8	South Gate, TMI

* Scheduled for deletion after January 1, 1981. Reasons for deletion are as follows:

1. 014 Bainbridge Station is over 5 miles from TMI and detection of releases would be very unlikely. Station 013 is located on the essentially same azimuth at 3 miles and provides adequate coverage in this direction.

APPENDIX C CONTINUED

016 Manchester Station is 7 miles from plant and detection of releases would be unlikely. This azimuth is adequately covered by the York Haven Station (017) which is only 3 miles from the plant.

023 Goldsboro - Muellar Residence - Stations 31 and 23 are essentially on the same azimuth from the plant with Station 21 at Newberrytown well located to back up Station 31. This is basically a duplication of coverage.

037-038 North and South Gate TMI. These stations are being removed because (1) adequate monitoring is provided in these areas by other stations, (2) they have been subject to more frequent malfunction than stations located further from heavy traffic, and (3) the stations are located where shipments of radwaste routinely pass very close to the monitors and may occasionally be nearby. This creates the potential for false alarms and unnecessary effort to confirm that no releases have occurred.

APPENDIX D

EPA TLD NETWORK

STATION	AZ	DIST.	ASSOCIATED TOWN
001	290	6.2	Fishing Creek, PA -- Robert Bean Gulf Station
002**	320	5.2	Highspire, PA -- Citizens Fire Co. #1
003	325	3.5	Middletown, PA -- Harrisburg International Airport
004	360	3.0	Middletown, PA -- Elwoods' Sunoco Station
005	040	2.6	Royaltown, PA -- Londonderry Township Building
009	100	3.0	Newville, PA -- Brooks Farm (Earl Nissley Residence)
010	095	6.8	Elizabethtown, PA -- K. Hoffer ARCO Service Station
011	130	2.9	Falmouth, PA -- Charles Brooks Residence
013	150	3.0	Falmouth, PA -- Dick Libhart Residence
014	145	5.3	Bainbridge, PA -- Bainbridge Fire Company
015**	155	6.6	Saginaw,PA -- United Methodist Church
016	180	7.0	Manchester, PA -- Manchester Fire Department
017	180	3.0	York Haven, PA -- York Haven Fire Station
019**	205	10.7	Strinestown, PA -- Brenner's Mobile Service Station
020	205	2.5	Pleasant Grove, PA -- Zane Reeser Residence
021	250	4.0	Newberrytown, PA -- Exxon Kwick Service Station
023*	265	2.9	Goldsboro, PA -- Muellar Residence
025**	360	7.0	Hummelstown, PA -- Keefer's Exxon Service Station
026**	025	10.0	Hershey, PA -- Good's ARCO Service Station
030**	180	13.0	York, PA -- York Fire Station, Springetts #16
031	270	1.5	Goldsboro, PA -- Dusty Miller Residence
034	305	2.7	Plainfield, PA -- Polites Residence
035	068	3.5	Londonderry Township, PA -- George Hershberger Residence

APPENDIX D CONTINUED

STATION	AZ	DIST.	ASSOCIATED TOWN
036	095	0.5	TMI Observation Center
037*	025	0.7	North Gate, TMI
038*	175	0.8	South Gate, TMI
039+	329	5.3	Lower Swatara, PA
040+	314	10.6	Steelton, PA
041+	305	10.7	New Cumberland, PA -- Capitol City Airport
042	174	4.9	Conewago Heights, PA
001HSGBKG	110	31.0	Lancaster, PA -- Visitors Information Center
002HSGBKG	055	25.0	Lebanon, PA -- John Deere Equipment Co.
003HSGBKG	275	31.0	Carlisle, PA -- Myers Exxon Garage
004HSGBKG+	180	25.0	Loganville, PA

Total stations = 34

+New Stations added
*Scheduled for deletion after January 1, 1980
**Reactivated stations

APPENDIX E

NRC ENVIRONMENTAL TLD LOCATIONS

NRC Station	Location	NRC Station	Location
1	95° 5.9 mi	33	310° 5.9 mi
2	101° 3.9 mi	34	267° 5.8 mi
3	108° 2.7 mi	35	299° 6.3 mi
4	163° 1.8 mi	36	267° 1.2 mi
5	161° 2.2 mi	37	256° 1.4 mi
6	150° 1.0 mi	38	225° 1.9 mi
7	136° 0.6 mi	39	200° 2.1 mi
8	83° 0.4 mi	40	204° 2.5 mi
9	60° 0.5 mi	41	253° 3.9 mi
10	1° 1.7 mi	42	259° 7.3 mi
11	25° 0.9 mi	43	268° 5.8 mi
12	46° 2.8 mi	44	263° 4.7 mi
13	19° 5.2 mi	45	175° 3.2 mi
14	358° 2.5 mi	46	172° 3.0 mi
15	357° 2.7 mi	47	177° 5.7 mi
16	0° 3.1 mi	48	182° 9.0 mi
17	351° 4.1 mi	49	210° 8.2 mi
18	349° 3.5 mi	50	214° 9.6 mi
19	343° 3.2 mi	51	185° 12.6 mi
20	318° 5.0 mi	52	133° 9.0 mi
21	348° 1.3 mi	53	145° 4.9 mi
22	17° 3.1 mi	54	144° 4.6 mi
23	64° 3.8 mi	55	206° 0.9 mi
24	44° 3.6 mi	56	230° 0.5 mi
25	47° 7.6 mi	57	293° 0.4 mi
26	0° 5.1 mi	58	335° 0.5 mi
27	6° 7.4 mi	59	317° 1.2 mi
28	0° 9.3 mi		
29	3° 12.6 mi		
30	312° 13.8 mi		
31	306° 9.6 mi		
32	297° 7.4 mi		

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APPENDIX F

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
THREE MILE ISLAND TLD LOCATIONS (Frequency - monthly)

Location	Azimuth and Distance from Reactor: Azimuth (Degrees)	Distance (Miles)
$TOMT_1$ Middletown, Met. Ed. Mill St. substation	358	2.6
$TOMT_2$ TMI Observation Building	90	0.5
$TOMT_3$ Laughlin residence, Elizabethtown, PA	86	6.6
$TOMT_4$ Squire residence, Bainbridge, PA	145	5.2
$TOMT_5$ York Haven, PA Hydroelectric Plant	166	2.9
$TOMT_6$ Newberrytown, PA Township Building	252	4.5
$TOMT_7$ Falmouth Substation, Falmouth, PA	161	2.3
$TOMT_{10}$ Goldsboro, PA Met. Ed. Monitoring Station	254	1.3
$TOMT_{11}$ Beaver residence, Redland Acres, Etters, PA	284	4.6
$TOMT_{12}$ Highspire, PA Turnpike Commission Building	321	5.4

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APPENDIX G

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF WATER QUALITY MANAGEMENT
PROGRAM FOR MONITORING WASTEWATER DISCHARGES
FROM THREE MILE ISLAND

OBJECTIVE

The monitoring program for discharges from Three Mile Island and for the Susquehanna River below Three Mile Island is designed for the following purposes: First, it serves as an early warning system to notify downstream water supplies and other water users should any high-level radioactive discharges occur. Second, it provides a historical account of the radiological quality of discharges from TMI and of the river to show what, if any, concentrations of radioactivity exist. Third, it serves as an independent back-up to the Metropolitan Edison (Met-Ed) monitoring program. Fourth, it should provide some degree of public confidence in any decisions that are made concerning any discharges.

EARLY WARNING SYSTEM

A continuous water system has been installed on the Radiological Outfall (001) at TMI and is cooperatively operated by DER/BQM and EPA. This system is comprised of a sodium iodide detector coupled to a single channel analyzer with rate meter and strip chart recorder output. The analyzer has a window width from approximately 300 kev to 700 kev and is capable of detecting concentrations of ^{131}I and/or ^{137}Cs of about 100 pCi/l in the counting chamber. An automatic telephone dialing system will activate paging units to alert DER Water Quality Management (WGM) and EPA personnel. The concentration level at which the paging unit is activated is variable and will be established based on the inventory of radionuclides in the contaminated water. (As of September 5, 1979 that level is set at approximately 1,000 pCi/l, based on ^{137}Cs as the limiting radionuclide.)

ALARM RESPONSE AND SAMPLING PLAN

Should the early warning system detect an unusual occurrence, a WQM staff member and EPA will be notified by an automatic telephone paging system. In such an event, the following procedures will be utilized:

1. The designated WQM staff member and the senior EPA representative will make telephone contact to activate the confirmation and notification procedures.

2. The EPA representative will notify the NRC and Metropolitan Edison and request examination of in-plant monitors (RML-7) for confirmation and appropriate action if necessary.

3. The EPA/WQM representative will proceed to TMI to collect a sample for laboratory analysis to confirm that the continuous sampler is operating and to examine the strip chart for evidence of high radioactivity. He will also contact NRC/Met Ed from the site to obtain the information from the in-plant monitors. The DER Bureau of Radiation Protection and other appropriate BWQM staff will be notified.

4. The water sample will be analyzed by gamma spectroscopy to a level less than one tenth of the maximum permissible concentration at the site boundary as given by 10CFR20.

5. The Bureau of Radiation Protection will evaluate the significance of the discharge based on all available data including analysis of the "grab" sample and, in consultation with the Bureau of Water Quality Management and EPA, determine whether downstream water users will be impacted.

6. The Bureau of Water Quality Management will notify the downstream water users that an unusual occurrence has happened, indicate to them the estimated impact of the discharge on their water supplies and, if appropriate, recommend closing the water intakes until the discharge passes. Further, the State of Maryland will be notified.

7. If an incident occurs, additional sampling on the river will be initiated to tract the distribution of the discharge of radioactivity. Samples should be collected by BWQM Regional Staff at the York Haven Hydroelectric Dam at Brunner Island and at the Route 30 Bridge. Grab samples will be collected every 6 hours and analyzed as rapidly as possible by the EPA's TMI Field Station Laboratory.

SAMPLING LOCATIONS

1. A compositing sampling device operates on the main outfall from Three Mile Island (Discharge No. 001). This samples the discharge every 20 minutes and composites it over a 24-hour period. The sample is taken to the EPA TMI Field Station Laboratory in Middletown and analyzed by "gamma scan" to a level of 10 picocuries/liter. The Bureau of Radiation Protection will then take the sample and analyze for gross alpha, gross beta and tritium to a sensitivity consistent with routing surveillance protocol.

2. A weekly grab sample will be collected by DER/WQM personnel at City Island, above Three Mile Island, for background data. This sample will be analyzed by gamma scan to a level of 10 picocuries per liter and for gross alpha, gross beta and tritium to a sensitivity consistent with routine surveillance protocol. It is recognized that upstream facilities may introduce radioactivity into the river.

3. The City of Lancaster's water intake on the Susquehanna River will be sampled every 2 hours and composited once a day. This sample will be taken by the City of Lancaster personnel and transported to the Bureau of Radiation Protection Laboratory for analysis. This sample will be analyzed in the same manner as the other river samples.

APPENDIX H

KEY STAFF AND OFFICES FOR LONG TERM MONITORING PROGRAM TMI

ORGANIZATION	TITLE	NAME	DUTY PHONE	NIGHT
EPA	Director TMI Field Station	William Kirk	FTS 590-3909	(717) 533-619[illegible]
	TMI Project Manager	H. Matthew Bills	FTS 426-4452	(301) 948-171[illegible]
	Region III - S&A Div.	Stanley L. Laskowski	FTS 597-9390	(215) 399-0[illegible]
	Office of Radiation Programs	Roger J. Mattson	FTS 557-8217	(301) 946-6756
USPHS	Headquarters Coordinator	John Villforth	FTS 443-4690	(301) 424-591[illegible]
	PHS Onsite Coordinator	Charles Cox	FTS 443-4960	(301) 299-917[illegible]
NRC	Sr. TMI Site Rep.	Lake H. Barrett	FTS 590-1121	(717) 944-7211
	Chief, Fuel Facility & Material Safety Branch	George H. Smith	FTS 488-1200	(215) 326-[illegible]485
	Chief, Site Operations	S. N. Fasano	FTS 590-1123	(717) 944-[illegible]
	Senior Radiation Specialist	M. M. Shanbaky	FTS 590-1160	(717) 367-8741
DOE	Chief, Environmental Protection Public Safety Branch	L. Joe Deal	FTS 233-4093	(301) 353-5555
	DOE Emergency Center		FTS 233-5555	(301) 353-5555
PENNSYLVANIA:				
DER	Director, Bureau of Radiation Protection	Thomas Gerusky	(717) 787-2480	(717) 763-9041
WQM	Director, Bureau of Water Quality Mgmt.	Lewis Bercheni	FTS 787-4317	(717) 432-5658
		Ken Walizer	FTS 787-8184	(717) 667-0031
		James Flesher	FTS 787-9665	(717) 921-8765
		Ernie Giovannitti	FTS 787-8184	(717) 258-3440
		Bill Middendorf	FTS 787-5027	(717) 697-0994
MARYLAND:				
DH&MH	Chief, Div. Radiation Control	Robert E. Corcoran	(301) 383-2744	(301) 823-8328
		Richard Brisson	(301) 383-2744	(301) 838-8359

APPENDIX H (Continued)

Pennsylvania Emergency Management Agency (PEMA)		FTS 783-8150	(717) 233-4028
Lancaster Water Co.	Mike Freedman	(717) 397-3501	
Wrightsville Water Co.	Jack Miller	(717) 561-1103	(717) 564-8220
Columbia Water Co.	Charles Gohn	(717) 684-2188	(717) 684-4862

THREE MILE ISLAND MAILING ADDRESSES

EPA
U. S. Environmental Protection Agency
P. O. Box 103

Middletown, PA 17057

PHS
U. S. Public Health Service
c/o EPA Field Station
P. O. Box 103
Middletown, PA 17057

NRC
U. S. Nuclear Regulatory Commission
Three Mile Island Site
P. O. Box 311
Middletown, PA 17057

APPENDIX N. OCCUPATIONAL RADIATION EXPOSURE DURING ONSITE WASTE HANDLING

N.1 INTRODUCTION

Handling of radioactive waste generated at TMI-2 involves the following major steps that will result in occupational radiation exposure to site personnel:

- Transfer of solid materials from source to packaging station
- Waste packaging
- Transfer of packaged waste to onsite staging/storage facilities
- Transfer of packaged waste from onsite storage facilities to truck loading area
- Truck and shipping cask loading
- Survey of trucks and shipping casks prior to transport

The occupational dose received during each of these major steps will depend on the radiation field in which the operations are performed, the crew size, and the time required to perform the operation. The bases used to estimate the occupational dose incident to each of the major steps described above for each of the major waste forms are discussed in this appendix. To prepare these estimates, the staff made the following basic assumptions:

1. Systems used to compct trash would be operated by a crew of two in a 2-mR/hr field.
2. Drums or LSA boxes with surface radiation levels below 200 mR/hr would be handled unshielded, with distance from the package being the primary basis for reduction of the radiation field.
3. Packages with surface radiation levels above 200 mR/hr would be handled either remotely or within a transfer shield. The average radiation field personnel would be exposed to during these handling operations would be 2 mR/hr.
4. Packaged waste stored onsite would be segregated by radiation level. Packages with surface radiation levels below 200 mR/hr would be stored in an area where removal will expose personnel to an average radiation field of 10 mR/hr. Packages with higher surface radiation levels would be removed from storage using remote handling techniques, and the average radiation field personnel would be exposed to is 2 mR/hr.
5. The loading of unshielded packages onto a transport vehicle for unshielded shipment would be performed in an average radiation field of 20 mR/hr.
6. For shielded cask shipments, the average radiation level at the surface of the shipping cask would be 50 mR/hr.
7. Preshipment surveys of closed vans used for unshielded shipments and of shipping casks would be performed in an average radiation field of 10 mR/hr.

These basic assumptions form the basis for occupational dose estimates presented below. Since the operations involved and the magnitude of the radiation fields will vary with waste form and package type, these estimates were prepared separately for each of the waste forms to be handled and shipped offsite.

N.2 SOLID MATERIALS

The solid-material waste that could be generated consists of trash, contaminated equipment, irradiated hardware, and filter cartridges. Once packaged, these solid materials can be divided into two categories according to surface radiation level--those below and those above 200 mR/hr. Each of these package categories is discussed below.

N.2.1 Packages with Surface Radiation Levels Below 200 mR/hr

The waste forms expected to fall in this category include trash, contaminated equipment, and some irradiated hardware. These materials would be packaged either in 55-gallon drums or LSA boxes (3' × 4' × 6.5) with a volume of 80 ft^3.

Details on crew size, work effort, radiation fields, and occupational dose for the steps involved in handling trash packaged in 55-gallon drums from its generation through loading on a truck for offsite shipment are given in Table N.1. As shown, the average occupational dose is 5 person-mrem per drum generated. Details of the steps involved in handling noncompactible trash, contaminated equipment, and other hardware packaged in LSA boxes from its generation through loading on a truck for offsite shipment are given in Table N.2. The average estimated occupational dose is 26 person-mrem per LSA box generated.

Table N.1. Occupational Exposure from Handling of Low-Activity Trash Drums

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Drums	Unit Occupational Dose (person-mrem/drum)
Pickup and transfer to packaging area	1	5	10	0.5[a]	1.7
Drum loading/compaction	2	6	2	1	0.4
Pickup at packaging area	2	5	20	4[b]	0.83
Transfer to storage area	1	5	20	4	0.42
Placement in storage area	1	3	10	4	0.13
Pickup at storage area	1	3	10	4	0.13
Transfer to loading area	1	5	20	4	0.42
Placement in loading area	1	3	20	4	0.25
Truck loading	2	5	20	4	0.83
Truck survey	1	15	10	90	0.03
Total					~ 5

[a]The volume of waste handled in this operation is equivalent to half the volume of one drum.

[b]After packaging, drums are transferred by forklift on four-drum pallets.

These unit occupational dose estimates are the basis for the estimates of occupational doses presented in Sections 5, 6, 7, and 8 for these waste forms for drums and LSA boxes.

N.2.2 Packages with Surface Radiation Levels Greater than 200 mR/hr

The waste forms expected to be in this category include spent filter cartridges, some contaminated equipment, irradiated hardware, and immobilized incinerator ash. These materials would be packaged in 55-gallon drums and in large cylindrical and rectangular metal containers. Details on the steps involved in handling a typical spent filter cartridge from its generation through survey of the shipping cask used for shipment are given in Table N.3. The average occupational dose is about 11 person-mrem per cartridge, or about 77 person-mrem per drum. This was used to estimate spent filter cartridge handling doses in Sections 5 and 8.

Occupational exposure data for the steps involved in handling relatively high-level contaminated equipment and irradiated hardware are given in Table N.4. It is based on packaging in containers of 70 ft^3 capacity compatible with shielded shipment, with sectioning and disassembly operations performed using remote techniques. The average estimated occupational dose per disposable container is 38 person-mrem. This value was used to estimate occupational doses in Sections 6 and 8.

Table N.2. Occupational Exposure from Handling of LSA Boxes

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Boxes	Unit Occupational Dose (person-mrem/box)
Pickup and transfer to packaging area	1	5	10	0.25[b]	3.3
Segregation	1	5	20	1	1.7
Sectioning/disassembly[a]	2	30	20	5	4
Box loading	2	15	20	1[c]	10
Transfer to storage area	1	5	20	1	1.7
Placement in storage area	1	3	10	1	0.5
Pickup at storage area	1	3	10	1	0.5
Transfer to loading area	1	5	20	1	1.7
Placement in loading area	1	3	20	1	1
Truck loading	1	5	20	1	1.7
Truck survey	1	15	10	9	0.28
Total					~ 26

[a]Based on sectioning/disassembly of 20 percent of waste received.

[b]Volume of waste handled in this operation equivalent to one-quarter the volume of one box.

[c]After packaging, boxes are handled by forklift.

Steps involved in handling incinerator ash from its generation as combustible trash through survey of the shipping cask used for drum shipment are presented in Table N.5. The average estimated occupational dose is 18 person-mrem per drum, the figure used in Sections 6 and 8 to estimate occupational exposure if trash is incinerated.

N.3 PROCESS SOLIDS

The process solids that could be generated consist of expended ion-exchange materials from the EPICOR II system, the zeolite/resin system, and the evaporator/resin system; accident sludges; and evaporator bottoms. These wastes will be packaged in drums or large containers with surface radiation levels in excess of 200 mR/hr and will be handled using remote techniques. The basis for estimating occupational exposure incident to waste handling for each of these waste forms is discussed below.

N.3.1 EPICOR II Resin Wastes

Estimates of the occupational exposure from the steps involved in handling resins generated by use of the EPICOR II system are given in Table N.6. The average occupational dose per resin liner is estimated as 18 person-mrem. The same values given in the table are applicable to handling of the 50-ft^3 resin liners that could be generated by the evaporator/resin system discussed in Section 7.3. These unit occupational dose estimates are the basis for waste-handling dose estimates for EPICOR II liners in Sections 5 and 7 and evaporator/resin system resin liners in Section 7.

Table N.3. Occupational Exposure from Handling of Spent Filter Cartridges

Handling Operation[a]	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Cartridges	Unit Occupational Dose (person-mrem/ cartridge)
Removal from housing	2	10	20	1	6.7
Placement in transfer shield	2	5	20	1	3.3
Transfer to packaging station	1	15	2	1	0.5
Packaging in drum	2	5	2	1	0.33
Transfer to high-activity storage	1	15	2	7[b]	0.07
Removal from high-activity storage	1	15	2	7	0.07
Placement in shipping cask	1	10	2	7	0.05
Shipping cask closure	1	15	50	49[c]	0.25
Truck survey	1	15	10	49	0.05
Total					~ 11

[a]All handling is performed remotely.

[b]Each 55-gallon drum contains seven cartridges.

[c]Each cask contains an average of seven drums.

Table N.4. Occupational Exposure from Handling of Irradiated Hardware and Contaminated Equipment

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Containers	Unit Occupational Dose (person-mrem/ container)
Pickup and transfer to packaging area	1	15	10	0.25	10
Segregation	1	10	10	1	1.7
Sectioning/disassembly	2	30	10	2[a]	5
Container loading	2	15	10	1	5
Transfer to storage area	1	10	2	1	0.33
Removal from storage area	1	5	2	1	0.17
Transfer to loading area	1	10	2	1	0.33
Placement in shipping cask	1	10	2	1	0.33
Shipping cask closure	1	15	50	1	13
Truck survey	1	15	10	1	2.5
Total					~ 38

[a]Assumes 50 percent will be remotely disassembled or sectioned.

Table N.5. Occupational Exposure from Handling of Immobilized Incinerator Ash

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Drums	Unit Occupational Dose (person-mrem/drum)
Pickup and transfer to packaging area	1	5	10	0.1[a]	8.3
Segregation	1	5	20	0.5	3.3
Incineration[b]	2	30	2	0.5	4
Immobilization and packaging	2	20	2	1	1.3
Transfer to storage area	1	5	2	1	0.17
Removal from storage area	1	5	2	1	0.17
Placement in shipping cask	1	10	2	1	0.33
Shipping cask closure	1	15	50	18[c]	0.69
Truck survey	1	15	10	18	0.14
Total					~ 18

[a]Each drum contains the equivalent of 175 ft^3 trash.

[b]Incinerator throughput of 350 ft^3 trash per hour.

[c]With drums at 2 R/hr, shipping cask capacity is 18 drums.

Table N.6. Occupational Exposure from Handling of EPICOR II Resin Liners

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Liners	Unit Occupational Dose (person-mrem/liner)
Transfer to truck transfer cask	2	10	2	1	0.67
Transport to storage area	1	10	2	1	0.33
Transfer to storage	2	10	2	1	0.67
Place in storage	1	10	2	1	0.33
Remove from storage	1	15	2	1	0.50
Load shipping cask	1	10	2	1	0.33
Cask closure	1	15	50	1	13
Survey truck	1	15	10	1	2.5
Total					~ 18

N.3.2 Zeolite/Resin System Wastes

Steps involved in handling zeolites, resins, and spent filter catridges from the zeolite/resin system are presented in Table N.7. As shown, the average occupational dose per 10-ft^3 liner is 13 person-mrem. The dose from the larger 6' × 6' liners would be similar. These unit occupational dose estimates are the basis for waste-handling doses estimated for zeolite/resin system liners in Sections 6, 7, and 8.

N.3.3 Evaporator Bottoms and Accident Sludge

Details of the steps involved in packaging and handling evaporator bottoms and accident sludge are presented in Table N.8. The estimated unit occupational dose for both waste forms in the immobilized condition is 5 person-mrem per drum. These unit occupational dose estimates were used as the basis for waste-handling dose estimates for accident sludges in Sections 5 and 6 and for evaporator bottoms in Sections 7 and 8.

N.3.4 Liquids

The liquids that could be generated consist of chemical decontamination solutions. Some drums of immobilized decontamination solutions will have surface radiation levels below 200 mR/hr and others will have surface radiation levels above 200 mR/hr. Occupational exposure information for the steps involved in handling the low-activity drums is given in Table N.9. The average estimated occupational dose is about 3 person-mrem per drum. Similar information is presented for the intermediate-level solutions in Table N.10. The average estimated occupational dose is also about 3 person-mrem per drum. These values were used to estimate occupational dose for packaged decontamination solutions in Sections 5, 6, and 8.

Table N.7. Occupational Exposure from Handling of Zeolite Resin System Liners

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Liners	Unit Occupational Dose (person-mrem/liner)
Transfer to storage (underwater)	2	15	2	1	1
Transfer from storage (underwater)	2	30	2	1	2
Load shipping cask	1	15	2	1	0.5
Cask closure	1	10	50	1	8.3
Survey truck	1	15	10	2[a]	1.3
Total					~ 13

[a]10-ft^3 liners are shipped two casks per truck.

Table N.8. Occupational Exposure from Handling Drums of Evaporator Bottoms and Accident Sludge

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Drums	Unit Occupational Dose (person-mrem/drum)
Transfer to storage	1	15	2	1	0.5
Removal from storage	1	15	2	1	0.5
Placement in shipping cask	1	10	2	1	0.33
Cask closure	1	15	50	5[a]	2.5
Truck survey	1	15	20	5	1
Total					~ 5

[a]Expected radiation levels will permit between four and seven drums per cask shipment.

Table N.9. Occupational Exposure from Handling Drums of Low-Activity Decontamination Solutions

Handling Operation	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Drums	Unit Occupational Dose (person-mrem/drum)
Pickup at packaging area	2	5	20	4[a]	0.83
Transfer to storage area	1	5	20	4	0.42
Placement in storage area	1	3	10	4	0.13
Pickup at storage area	1	3	10	4	0.13
Transfer to loading area	1	5	20	4	0.42
Placement in loading area	1	3	20	4	0.25
Truck loading	2	5	20	4	0.83
Truck survey	1	15	10	90	0.03
Total					~ 3

[a]After packaging, drums are handled on a four-drum pallet.

Table N.10. Occupational Exposure from Handling Drums of Intermediate-Level Decontamination Solutions

Handling Operation[a]	Crew Size	Time Required (minutes)	Radiation Field (mR/hr)	Number of Drums	Unit Occupational Dose (person-mrem/drum)
Transfer to high-activity storage	1	15	2	1	0.5
Removal from high-activity storage	1	15	2	1	0.5
Placement in shipping cask	1	10	2	1	0.33
Shipping cask closure	1	15	50	10[b]	1.3
Truck survey	1	15	10	10[b]	0.25
Total					~ 3

[a]All operations performed remotely.

[b]Average cask radiation level of < 20 R/hr shipped in a 14-drum cask, > 20 R/hr to 100 R/hr shipped in a seven-drum cask.

APPENDIX O. DECONTAMINATION STATUS OF AUXILIARY AND FUEL HANDLING BUILDINGS

The decontamination status of the Auxiliary and Fuel Handling Buildings (AFHB) as of September 1, 1980, is summarized in Tables O.1 through O.3 for three different elevations within the buildings. The floor plans of the Auxiliary and Fuel Handling Buildings for these same elevations are shown in Figures O.1 through O.3, and the area labels in the first column of the following tables are keyed to the labels in these figures.

LOCATION	AREA DESCRIPTION
A	Liquid Waste Transfer Pump Entrance Way
B1	Cleanup Demineralizer and Filter A
B2	Cleanup Demineralizer and Filter B
C	Liquid Waste Transfer Pumps
D	Evaporator Condensate Test Tanks
E1	Makeup Pumps Entrance Way
E2	Makeup Pump A
E3	Makeup Pump B
E4	Makeup Pump C
F1	Neutralizer Tanks
F2	Neutralizer Filters
F3	Neutralizer Pump Room
G	Reactor Coolant Waste Evaporator
H1	Reclaimed Boric Acid Tank
H2	Reclaimed Boric Acid Pump
J1	Spent Resin Tank A
J2	Spent Resin Tank B
J3	Spent Resin Pump Room
K	Oil Drum Storage
L1	Makeup Valve Rooms Entrance Way
L2	Makeup Valve Rooms Access Corridor
L3	East Valve Room
L4	West Valve Room
M1	Liquid Waste Disposal Valve Room
M2	Entry Way
N1, N2	Bleed Holdup Tanks
O1	Auxiliary Sump
O2	Auxiliary Sump Tank
O3	Auxiliary Sump Valve Room
P1	Decay Heat Vault A
P2	Decay Heat Vault B
Q1	Spray Vault A
Q2	Spray Vault B
R	Elevator Pit
S	Seal Injection Room

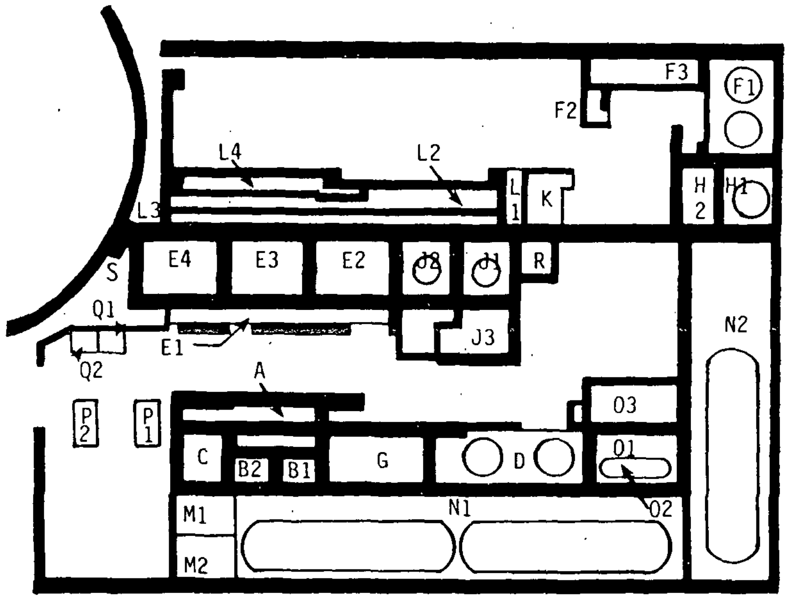

Figure O.1. Auxiliary and Fuel Handling Buildings, 281-Foot Elevation.

LOCATION	AREA DESCRIPTION
A	Intermediate Cooling Pumps/Seal Return Valve Room
B	Makeup Demineralizers
C	Gas Analyzer Room
D	Makeup Tank and Filters
E	Spent Fuel Cooler Area
F1	Spent Fuel Demineralizer
F2	Spent Fuel Filters
G1	Waste Gas Decay Tank
G2	Waste Gas Filter
G3	Waste Gas Decay Tank
G4	Waste Gas Valve Room
H	Deborating Demineralizers
K	Miscellaneous Waste Holdup Tank
M	Mezzanine Valve Room
N	Concentrated Waste Transfer Pump
O	Seal Return Coolers and Filter
P1	Makeup and Purification Valve Area Corridor
P2	Valve Room

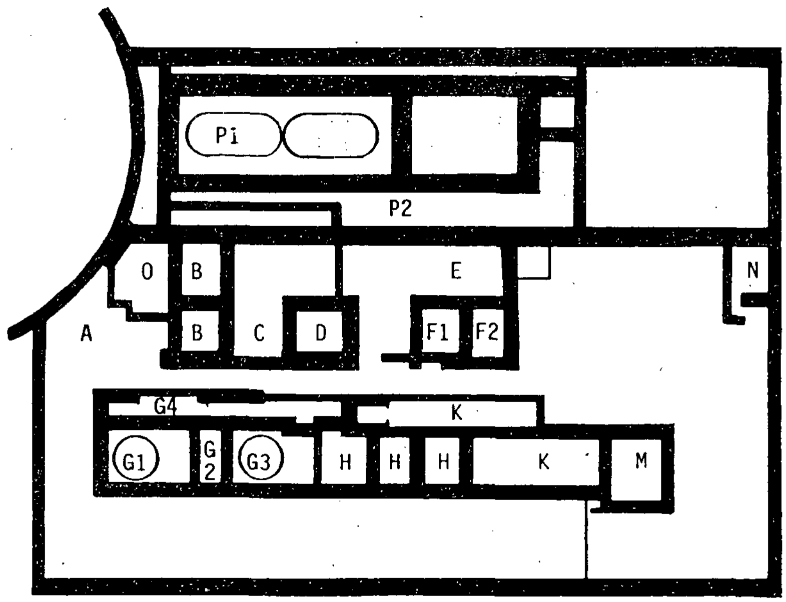

Figure 0.2. Auxiliary and Fuel Handling Buildings, 305-Foot Elevation.

LOCATION	AREA DESCRIPTION
A	Concentrated Waste Tank
B	Mix Tank Area
C	FHB East Corridor

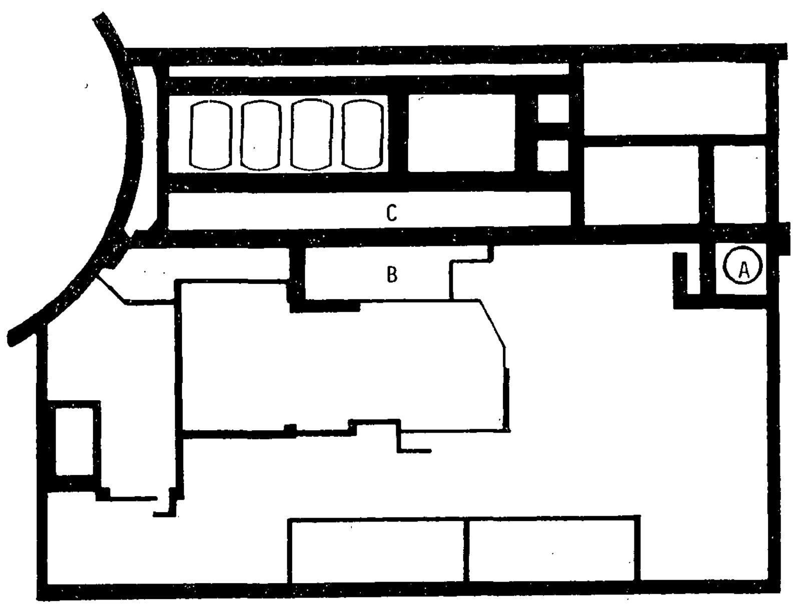

Figure 0.3. Auxiliary and Fuel Handling Buildings, 328-Foot Elevation.

Table 0.1. Decontamination Status for Elevation 281 as of September 1, 1980

			Initial Levels		Present Levels		
Location[a]	Area Description	Decontamination Efforts/Status	Surface Contamination[b]	Radiation Level[c]	Surface Contamination[b]	Radiation Level[c]	Remaining Efforts†
A	Liquid Waste Transfer Pump Entrance Way	Initial entry made with Scott Air Packs. Radiac wash, decontaminated to door.	>10^6			5,000	1
B1	Cleanup Demineralizer and Filter A	Decon complete except for demineralizer resin. First personnel entry with supplied air, respirators later. Hydrolaser used.		5,000	<1,000		2,4
B2	Cleanup demineralizer and Filter B	Decon will require disposal of spent resin in spent resin tank, transfer of cleanup demin. resin, change filter. No action taken yet.		10,000[d]		10,000[d]	2,3
C	Liquid Waste Transfer Pumps	Gross decontaminated for maintenance.	>10^6	<50,000			1,2
D	Evaporator Condensate Test Tanks	Floor drain removed, Radiac wash used. Decon complete except for filters and motors.	>10^6	<1,000			2,4
E1	Makeup Pumps Entrance Way	Entrance ways to all MP cubicles have been decontaminated but require additional work.		10,000	3,000		4
E2	Makeup Pump A	Respirators used. Gross decon completed; light decon need, except for strainer and rotor.	>10^6	10,000	<5,000		4
E3	Makeup Pump B	Gross decon complete.		>100,000	<25,000	<5,000	1,2

[a]See Figures 0.1 through 0.3.
[b]DPM/100 cm^2.
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts†
E4	Makeup Pump C	Respirators used, initial pass reduced smears to 5×10^5. Light decon required.	$>10^6$		<5,000		1,2
F1	Neutralizer Tanks	Water was cycled in and out of tanks reducing dose rate at door to 45 mR/hr.		150[d]	3,000		1,2
F2	Neutralizer Filters	Decontamination complete.		150	<1,000		6
F3	Neutralizer Pump Room	This room decontaminated several times, still requires additional effort. Piping needs flushing.	$>10^6$	100	<1,000	40	1,2
G	Reactor Coolant Waste Evaporator	Further light decon required.			<5,000		4
H1	Reclaimed Boric Acid Tank	Initial decontamination completed with supplied air. Subsequent passes reduced levels further. Maintenance in progress.	$>10^6$	<40	<5,000		1
H2	Reclaimed Boric Acid Pump	Same status as H1.	$>10^6$	50	<5,000		1
J1	Spent Resin Tank A	Seven decontamination passes reduced levels to about 2K DPM. Final decon to be completed prior to addition of cleanup resin.	$<10^6$	125	<1,000	<24	2
J2	Spent Resin Tank B	Six decontamination passes reduced levels to 2K DPM. Final decon to be completed prior to addition of cleanup resin.	$<10^6$	30	<1,000	<10	2

[a]See Figures 0.1 through 0.3.
[b]DPM/100 cm^2.
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table O.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts†
J3	Spent Resin Pump Room	Seven decontamination passes reduced levels to 1.5K DPM. This area used for Radiac wash drum storage--total decon required prior to transfer of cleanup resin.	$<10^6$	5	<1,000	3	6
K	Oil Drum Storage	Room is being used to store Radiac wash drums and floor drain strainers. Storage shelves and unidentified boxes located in room. Room scheduled for decon after drums transferred to solidification.		700	<1,000		6
L1	Makeup Valve Rooms Entrance Way	Area cleaned and decontaminated. Construction overhead, some final decon may be needed.			<2,000		4
L2	Makeup Valve Rooms Access Corridor	Hydrolaser has been used on floor with good results.		<2,000	<10,000	<200	1
L3	East Valve Room	Hydrolaser has been used on floor with good results.		<15,000		<200	1
L4	West Valve Room	Hydrolaser has been used on floor with good results.		<20,000		<200	1
M1	Liquid Waste Disposal Valve Room	High level decontamination has been done. Hydrolaser used.	$>10^6$	<250	<30,000		1
M2	Entry Way	Some decontamination completed.	$>10^6$	<100	<20,000		1

[a] See Figures O.1 through O.3.
[b] DPM/100 cm^2.
[c] mR/hr.
[d] At cubicle door.
[e] At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts†
N1, N2	Bleed Holdup Tanks	Gross decontamination complete. Maintenance required for final decontamination.	$>10^6$	>30,000	<50,000	<7,000	1
O1	Auxiliary Sump	Sump needs desludge, total clean and decon. Priorities being established on shielding, desludge, and decon. Hydrolaser used. Filters changed.	$>10^6$			5,000	1
O2	Auxiliary Sump Tank	Commenced tank desludge, continues when Aux. Sump Filters 3A & 3B are changed.		3,300		2,000	1,2
O3	Auxiliary Sump Valve Room	High-level decontamination performed with high pressure wash.	$>10^6$	1,200	<50,000	<1,000	1,2
P1	Decay Heat Vault A	High level decon done once. Further decon will proceed after mini-decay heat system is operable and the decay heat system can be flushed. Decay heat vaults are shielded.		<3,000[e]		<3[e]	1,2
P2	Decay Heat Vault B	Two decontamination passes. High radiation levels due to contained liquids. Further decon required after flushing. Decay heat vaults are shielded.		<3,000[e]		<3,000[e]	1,2
Q1	Spray Vault A	Two cleanup and decon passes completed. Further decon work needed.	$>10^6$	75,000	<400,000	<12,000	1

[a]See Figures 0.1 through 0.3.
[b]DPM/100 cm^2.
[c]mR/hr.
[d]At cubicle door.
[e]At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.1. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts†
Q2	Spray Vault B	No entry to date. High radiation area.		125,000[e]			3
R	Elevator Pit	Initial high-level decon complete. Waiting on resolution of untreated concrete contamination problem. Shielding installed.	$>10^6$				1
S	Seal Injection Valve Room	Hot-water flush and high-pressure wash complete. Contaminated concrete. System flushing & maintenance required.		<100,000		50,000	1,2,5
	General Area	Corridors, stairwells decontaminated. Effort continues daily to prevent recontamination.			<1,000		

[a]See Figures 0.1 through 0.3.

[b]DPM/100 cm^2.

[c]mR/hr.

[d]At cubicle door.

[e]At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.2. Decontamination Status for Elevation 305 as of September 1, 1980

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels: Surface Contamination[b]	Initial Levels: Radiation Level[c]	Present Levels: Surface Contamination[b]	Present Levels: Radiation Level[c]	Remaining Efforts†
A	Intermediate Cooling Pumps/ Seal Return Valve Room	High level decontamination done. Spill area and hot spots require further work. Filters changed.	>10^6	2,500	<5,000	<30	1
B	Makeup Demineralizers	No entry to date				5,000[d]	2,3
C	Gas Analyzer Room	High level decontamination complete. Filters changed.		<100,000	<5,000	<300	2,4
D	Makeup Tank and Filters	No entry to date.		10,000[d]		10,000[d]	2,3
E	Spent Fuel Cooler Area	Decontamination completed. Used for storage of Radiac wash drums. Construction area.		700	<1,000		4
F1	Spent Fuel Demineralizer	Decontaminated. Previous Radiac drum storage area. Filters need changeout.			<1,000		4
F2	Spent Fuel Filters	Decontaminated, filters changed.			<1,000		4
G1	Waste Gas Decay Tank	Floor decon complete, tank inspected.		10,000	<1,000	<4	4
G2	Waste Gas Filter	Decon complete, tank inspected.			<1,000		4
G3	Waste Gas Decay Tank	Decontamination of cubicle complete.		2,000	<1,000	<1	2

[a]See Figures 0.1 through 0.3.

[b]DPM/100 cm^2.

[c]mR/hr.

[d]At cubicle door.

[e]At entrance to vault.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.2. Continued

Location[a]	Area Description	Decontamination Efforts/Status	Initial Levels		Present Levels		Remaining Efforts†
			Surface Contamination[b]	Radiation Level[c]	Surface Contamination[b]	Radiation Level[c]	
G4	Waste Gas Valve Room	Decontamination complete. Construction underway.		600	<1,000		4
H	Deborating Demineralizers	Decontamination complete.			<1,000		6
K	Misc. Waste Holdup Tank	Decontamination will continue when tank flushed. Filters need to be changed.		3,000	<80,000		1,2
M	Mezzanine Valve Room	Floor decontaminated. High dose from sludge in MWHT.			<10,000	<15,000	1,2
N	Concentrated Waste Transfer Pump	Maintenance required to stop leak.			<10,000		4
O	Seal Return Coolers and Filter	No entry to date for decon.		3,000			2,3
P1	Makeup and Purification Valve Area Corridor	Floor decontaminated several times--more will be required.		150	<6,000		1
P2	Valve Room	No entry to date for decon.		200,000[d]		10,000[d]	3

[a]See Figures 0.1 through 0.3.

[b]DPM/100 cm^2.

[c]mR/hr.

[d]At cubicle door.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

Table 0.3. Decontamination Status for Elevation 328 as of September 1, 1980

			Initial Levels		Present Levels		
Location[a]	Area Description	Decontamination Efforts/Status	Surface Contamination[b]	Radiation Level[c]	Surface Contamination[b]	Radiation Level[c]	Remaining Efforts†
A	Concentrated Waste Tank	Decontamination complete.		3,000	<1,000		2
B	Mix Tank Area	Initial decon complete. Maintenance required on leaking components prior to final decon.			<10,000		1,2
C	FHB East Corridor	North section decontaminated, south section high dose rate from N_2 filters.	200,000		1,000		2,4

[a]See Figures 0.1 through 0.3.

[b]DPM/100 cm^2.

[c]mR/hr.

†Remaining Efforts:

1. Further decontamination required.
2. Transfer of fluids, changing filters, flushing lines, etc.
3. Complete decontamination required--not yet started.
4. Light decontamination required.
5. Debris removal.
6. Decontamination complete.

APPENDIX P. CHEMICAL SYSTEMS FOR DECONTAMINATION OF PRIMARY SYSTEM COMPONENTS

The staff assumes that 60 to 90 percent of the contamination remaining in the primary reactor coolant system after drain/flush operations will be present as activation and fission product plateout located in the corrosion product film. The remainder will be small amounts of particulate matter not removed by the drain/flush operations. Films on stainless steel and other high nickel alloys are not easily removed and require either corrosive treatments or some conditioning step to change the film characteristics. Films formed on surfaces of primary coolant systems of nuclear reactors have been investigated, and satisfactory procedures have been developed for removing these films and decontaminating the surfaces.[1]

Nuclear reactors can be decontaminated by use of relatively concentrated reagents (5 to 15 wt %) or dilute reagents (1000 wt ppm). Decontamination with both concentrated and dilute reagents has proven successful in lowering radiation levels. The dilute reagent decontamination process is designed for relatively frequent decontaminations but does not remove as much contamination as do the concentrated reagents.

All chemicals used for the TMI-2 reactor coolant system decontamination would be high-purity reagents (reagent grade) with very low concentrations of Cl^- and F^- (ions that can cause stress corrosion). The chemical reagents used in decontamination normally are obtained in concentrated form and require dilution with water. Large tanks with mixing capability are required to prepare the solutions. The TMI-2 reactor bleed tanks or the borated water storage tank could provide this capability.

P.1 OXALIC-CITRATE-PEROXIDE PROCESS

The solvents formulated to dissolve the films on stainless steel and high nickel alloys, described below, do not dissolve uranium oxide (UO_2) particulate matter. If significant amounts of UO_2 particulates remain following the flushing/draining operations, an oxalate-peroxide solvent application may be required to remove the particulates prior to application of one of the conventional decontamination processes. In general, oxalate-peroxide solutions for fission product decontamination from metal surfaces are superior to conventional decontamination solutions and have low corrosion rates on carbon steel (less than 0.00001 inch/hr). Of nearly a hundred formulations studied, the one having the best combination of long life, low corrosivity, high solvency for UO_2, decontamination power, safety, and ease of waste disposal was an aqueous solution of 0.4 molar (M) oxalic acid, 0.16 M ammonium citrate, and 0.34 M hydrogen peroxide adjusted to pH 4.0 with ammonium hydroxide.[1] This solvent is applied at 85 to 95°C for several hours.

P.2 OPG PROCESS

The chemical equation for the OPG (oxalic-peroxide-gluconic) solution is $Na_2C_2O_4$. It consists of 0.025 M $H_2C_2O_4$, 0.5 M H_2O_2, 0.013 M gluconic acid, and 0.045 M sodium gluconate at a pH of 4.5. It is relatively fast acting, one to four hours at the 80°C process temperature, and it is compatible with carbon steel, stainless steel, Inconel, Zn-2 and Al. Oxalic acid is well known for its efficacy in removing rust from iron and is so used in cleaning compounds for automobile cooling systems. Preparations containing oxalic acid have been studied for the defilming and decontamination of nuclear reactors along with the simultaneous dissolution of UO_2.[2] These studies have proven the solution's effectiveness in the processes by achieving decontamination factors as high as 1000 on stainless steel. The process has been effectively applied throughout the nuclear industry. The solution was used for fuel particulate dissolution during decontamination of the PRTR reactor.

Several system volumes (one to five) might be needed if fuel particulate dissolution is necessary in order to achieve the desired decontamination. The processing of the resulting contaminated solution would be similar to that described for the alkaline permanganate processes described below.

The advantages of this process are (1) it has been successfully used to dissolve UO_2 and decontaminate reactors, (2) it accomplishes both function's simultaneously and, (3) high decontamination factors are achieved. The disadvantages are (1) large quantities of chemical reagents would be required, (2) although the process is compatible with reactor materials, some corrosion does occur, and (3) additional chemical decontamination may be required after fuel particulate dissolution is complete.

P.3 CAN-DECON PROCESS

The CAN-DECON proprietary process* would involve the addition of dilute (0.1 wt %) chemical reagents to the liquid in the reactor coolant system. The solution of acidic reagents would attack a portion of the corrosion product layer and release particulates and dissolved material to the solvent. The particulate material would be removed by filtration. Cation resins would remove the corrosion products from the complex and regenerate the reagent--a process that would minimize the quantity of reagent required.

A commercially available reagent, Nutek L-106** (citric-oxalic-EDTA type) has been used in this process at the Douglas Point Reactor.[3] The solvent is recirculated at up to 150°C for several hours in a carbon steel system or for up to several days in a stainless steel system. Corrosion rates are 0.0001 inch/hr for carbon steel and less than 0.00003 inch/hr for stainless steel. The staff expects that there would be no deleterious aftereffects with the process and that decontamination factors of 6 to 8 would be achieved.[4]

The dilute chemical CAN-DECON decontamination technique would require little additional equipment beyond that needed for conventional decontamination processes using strong reagents. Since CAN-DECON is a one-step process, no draining or flushing of the system would be required during the decontamintion treatment. The treatment utilizes a cation resin to strip radionuclides from the process chemicals during the decontamination operation. This effectively regenerates the process solution. When the process was completed, the reagent and remaining dissolved corrosion products would be removed by mixed-bed resins or a cation bed and a mixed bed in series.

The advantages of this process are (1) it is a one-step process, (2) secondary waste streams are minimized, and (3) the process already has been used in reactor decontamination (Canadian reactors). Disadvantages are (1) modest decontamination factors, and (2) long reagent contact time.

P.4 ALKALINE PERMANGANATE-CITROX PROCESS

The alkaline permanganate (AP)-citric acid-oxalic acid (Citrox) process has been used successfully for the decontamination of stainless steel and Inconel parts of reactor systems.[3,5] For TMI, the procedure would consist of two steps: an AP pretreatment at 105°C for 4 hours, followed by rinses, then further cleaning by a solution of organic acids (citrox) at 80°C for 8 hours and more rinsing. Heat would be supplied by the pump heat or a heat exchanger. From 1 to 5 primary system volumes of radioactive waste could be created during this process.[6] More than 80 percent of this estimated process liquid volume (~400,000 gallons) could be expected to have low radioactivity levels in a recycle stream. This large volume/low radioactivity stream would represent the rinse liquids.

High decontamination factors (up to 1000) have been experienced with AP-citrox treatments. An average decontamination factor of 10 to 100 could be expected from treatment of the TMI-2 primary system by this method.

Evaporation and solidification methods would be used for final disposal of the chemical solutions. It might be necessary to treat the AP solution to reduce the permanganate prior to final treatment. The rinse water would be treated with ion-exchange resins prior to disposal.

Alkaline permanganate is 10 weight percent sodium hydroxide and 4 weight percent potassium permanganate; citrox is 0.2 M oxalic acid, 0.3 M citric acid, and 0.02 M corrosion inhibitors. About 80,000 kg (88 tons) of chemicals would be required for the chemical decontamination program. Corrosion rates for 304-stainless steel and Inconel-600 resulting from use of these reagents are very low (0.0000004 in/hr);[5] however, the presence of sulfate would accelerate the corrosion of

*London Nuclear services, Ltd., Niagara Falls, NY.

**Formulated and marketed by Nuclear Technology Corporation, Amston, CT.

Inconel-600 and care would have to be taken to exclude it from the system. Corrosion rates for carbon steel and 400 series stainless steel are 0.0001 to 0.0006 in/hr.[5] Each solution is applied at temperature for about 4 hours.

The advantages of this process are (1) it has been successfully used worldwide to decontaminate reactors, and (2) high decontamination factors could be expected. The disadvantages are (1) large quantities of chemical reagents would be required, (2) carbon steel and 400-series stainless steel would corrode slightly in these decontamination solutions, (3) the AP waste stream is a strong oxidant and might require additional treatment. (This is normally handled by mixing the waste AP with the waste acid stream to neutralized each stream).

P.5 ALKALINE PERMANGANATE-AMMONIUM CITRATE

Alkaline permanganate-ammonium citrate (APAC) would be a two-step process, nearly identical to the AP-citrox process. Ammonium citrate concentration would be 0.4 M. Ethylene-diamine-tetra-acetic acid (EDTA) complexing agent (0.01 M) would be added to the system to prevent redeposition of certain solubilized fission products.

The APAC treatment was used as part of a multistep process to decontaminate the Plutonium Research Test Reactor (see Section 1.5), a pressurized water reactor.[5] A modified APAC procedure has been used several times to decontaminate high-alloyed materials in the field.[6]

Corrosion, application temperatures, and application times are very similar to the AP-citrox process; however, decontamintion factors achieved with the APAC process are normally 2 to 10 times lower. The advantages and disadvantages of this system would be similar to the AP-citrox process.

P.6 DOW CHEMICAL NS-1

The Dow Chemical NS-1 process has been successfully tested and used in decontamination applications.[2] Present planning for the decontamination of Dresden 1 includes the use of this process.[7] The process is proprietary; therefore, detailed information on its composition and use is not available. It is, however, a concentrated process applied at ~250°F and 35 psi which results in high decontamination factors--10 to 100. Application time for this solvent is on the order of two to four days. Corrosion of Inconel and Type 304 stainless steel is 0.0000004 in/hr and of carbon steel is 0.0002 in/hr. Application of the chemical solution is followed by rising. Water contamination concentrations and processing methods for this application are expected by the staff to be similar to those described for the alkaline permanganate alternatives. About 70 percent of the water volume necessary could be expected to have low levels of radioactivity and represents the rinse liquids. This volume would be a recycle stream and as such would represent a sizable reduction in the overall liquid inventory required.

The advantages of this process are (1) it has been successfully used to decontaminate reactor components, and (2) waste volumes generated are less than with the two-step solvents. The disadvantages are (1) solvent contact times are long, and (2) corrosion is slightly higher than with the other processes.

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3. P.J. Pettit, et al., "Decontamination of the Douglas Point Reactor by the CAN-DECON Process," Materials Performance, pp 34-38, January 1980.

4. A.B. Meservey, "Peroxide-Inhibited Decontamination Solutions for Carbon Steel and Other Metals in the Gas-Cooled Reactor Program: Progress Report, November 1959 - July 1962," Oak Ridge National Laboratory, ORNL-3308, January 1963.

5. T.S. Drolet and W.B. Stewart, "Design Considerations for PHWR Decontamintion," Conference on Decontamination and Decommissioning of Nuclear Facilities, Sun Valley, ID, September 16-20, 1979.

6. W.K. Kratzer, "Decontamination of the Hanford N Reactor in Support of Continued Operation," UNC Nuclear Industries, Inc., UNI-SA-62, Richland, WA, August 1979.

7. D.E. Harmer and J.L. White, "Results to Date of the Dresden-1 Chemical Cleaning," Conference on Decontamination and Decommissioning of Nuclear Facilities, Sun Valley, ID, September 16-20, 1979.

APPENDIX Q. ONSITE STORAGE FACILITY

To date, two concrete storage modules have been completed and the base of a third has been constructed. The concrete waste storage facilities are modular structures with each module consisting of 60 storage cells. The modules are built on an as-needed basis and are located in the Unit 2 desilting basin. Sufficient space exists in the desilting basin to construct up to six modules. The module design resembles a rectangular-shaped concrete cube with dimensions of 57 ft wide by 91 ft long by 19 ft high. The module base is 3 ft thick, and walls are 4 ft thick for required shielding (i.e., less than 5 mR/hr from all surfaces). The storage facilities are located in the diked, protected area of the station and this, in addition to their elevation, protects the structures from the station's design basis flood.

The cells will prevent migration of radioactivity from the liners to the groundwater. The cells within each module consist of concrete shielded, galvanized, corrugated-steel cylinders with welded steel base plates. Each cell is 7 ft in diameter by 13 ft high. The top shielding for each is a 3-ft-thick rectangular concrete plug. The plugs are needed to provide shielding and prevent rain from leaking into the cells. The cell interior surfaces are painted with a coating that will facilitate decontamination.

The cell base plates are provided with a drain line leading to a sump to collect washdowns or liner drippage. The sump holds about 1000 gallons and is equipped with level indication that alarms on high level. All liquids collected in the sump are sampled and analyzed for radioactivity and processed as required (for example, through EPICOR I). Nonradioactive sump water is discharged to the station drainage system. The sump is designed to meet the seismic criteria of Regulatory Guide 1.143. The module is serviced by the same mobile crane used for the interim storage facility. The module is capable of housing one liner 6 ft in diameter by 6 ft high per cell, or two liners 4 ft in diameter by 4 ft high per cell. All liner transfers into or out of the cell are made with a 100-ton mobile crane. The module is designed to protect the stored liners from the freeze-thaw cycle, and the sump will be protected from freezing.

The concrete storage facility can be used for storage of other high-specific-activity wastes which would be handled in a manner similar to that described for the EPICOR II waste.

APPENDIX R. PROPOSED ADDITIONS TO TECHNICAL SPECIFICATIONS FOR TMI-2 CLEANUP PROGRAM*

R.1 PROGRAM DESIGN OBJECTIVES

R.1.1 Applicability

Applies to releases of radioactive effluents resulting from the cleanup and decontamination operation of Unit 2.

R.1.2 Objective

To ensure that the cleanup program is designed to meet the ALARA concepts of 10 CFR Parts 20 and 50 and that the program is designed to result in environmental impacts consistent with those evaluated in the final PEIS (1981) for Unit 2.

R.1.3 Specification

The releases of radioactive materials in gaseous and liquid effluents from TMI-2 during each calendar year shall be limited to the following criteria for offsite individuals:

(a) The dose or dose commitment from liquid effluents shall be less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

(b) The air dose due to noble gases in gaseous effluents shall be less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

(c) The dose from radionuclides (other than noble gases) in gaseous effluents shall be limited to less than or equal to 15 mrem to any organ.

R.1.4 Bases

This specification is provided to assure that the design objectives of Appendix I to 10 CFR Part 50 are not exceeded and to assure that actual environmental impacts are consistent with those assessed in the PEIS.

Requiring that the numerical design objectives of Appendix I to 10 CFR Part 50 are met will assure that the radiation dose received by the public during the cleanup operation is equivalent to or below that from a normal operating reactor. These doses are likely to have negligible health effects to individuals of the population. The background radiation in the area amounts to about 116 mrem per year, 36% of which comes from cosmic radiation, 39% from terrestrial radiation, and 24% from internal radiation (mainly K-40 deposited in the body). On the basis of comparison of the doses calculated here to those of natural background radiation, it is suggested that the health effects over the period from the onset of the accident through the completion of the cleanup operation are non-existent, especially in consideration of the fact that natural background radiation in the U.S. varies from one location to another within a range of about 70 to 310 mrem per year.

*This appendix describes technical specifications of general applicability throughout the cleanup program. Additional specific technical specifications may be necessary for particular cleanup activities and can only be developed in that context. Thus such additional technical specifications must await specific proposals for cleanup activities from the licensee.

R.2 RADIOLOGICAL REPORTING REQUIREMENTS

R.2.1 Applicability

Applies to radioactive effluents resulting from the cleanup and decontamination operation of Unit 2.

R.2.2 Objective

To provide the NRC with dose estimates which are based on actual releases.

R.2.3 Specification

(1) The following information shall be submitted to the Director of the Regional Office. This information shall be submitted on a calendar quarter basis (January-March, April-June, July-September, and October-December) and shall be submitted no later than 30 days following the end of each calendar quarter.

(a) Estimates of the amounts and types of radioactivity that were released to the environment during the quarter and during the calendar year. This shall include estimates of the total activity of each nuclide and the time rate of release of each nuclide.

(b) Estimates of populations and maximum individual doses which occurred during the calendar quarter and during the calendar year shall be provided. The estimates shall be based on actual hydrological and meteorological conditions which occurred during the releases. Calculational methods shall be those of U.S. NRC Regulatory Guides 1.109 (Revison 1, October 1977), 1.111 (Revision 1, July 1977), 1.112 (Revision 0-R, April 1976) and 1.113 (Revision 1, April 1977). These calculations shall be based on estimates of actual population distributions during the releases and shall take into consideration factors such as boating or fishing recreation.

R.2.4 Bases

The purpose of these specifications is to assure that the programs generally conform to their design objectives.

APPENDIX S. CALCULATIONS OF DISCHARGE OF PROCESSED ACCIDENT WATER TO THE ATMOSPHERE

S.1 INTRODUCTION

This appendix presents the methodology used to consider the natural evaporation alternative discussed in Section 7.2.3.4. Two different models were used. Model one, referred to as discrete evaporation, represents a worst case for offsite doses since it is based on maximum evaporation rates. Model two, referred to as no-wind evaporation, represents a worst case for worker exposure since it is based on static conditions above the evaporation pond. These two models bound the releases that could arise from implementing the natural evaporation alternative.

S.2 MODEL ONE - DISCRETE EVAPORATION

In this case, the average monthly pond surface temperature has been assumed to be equal to the average monthly air temperature (dry bulb). This is a conservative assumption with respect to dose rates because it yields conservatively high evaporation rates. It is also assumed that the air above the pond is continuously replaced due to wind, so that the HTO concentration in the air above the pond is essentially zero. This means no HTO molecules will condense from the air and reenter the pond as will some H_2O molecules. Thus, the net HTO evaporation rate, "per molecule", will be higher than the H_2O evaporation rate, "per molecule". The effect of the opposite of this assumption also will be considered.

The evaporation rate of HTO per unit area of the pond is given by[1]:

$$E_T = K\,((N_T/N_W)P_{To} - P_T)$$

Where:

E_T = evaporation rate of HTO (ft/day)

N_T/N_W = mole ratio of HTO to H_2O in the pond (dimensionless)

P_{To} = saturation vapor pressure of HTO at the temperature of pool surface (mm Hg)

P_T = actual vapor pressure of HTO in the bulk atmosphere above the pool surface (mm Hg)

K = a parameter that is constant for a given set of meteorological conditions (ft/day mm Hg).

The evaporation rate of H_2O per unit area of the pond is given by[1]:

$$E_W = K\ (P_{Wo} - P_W)$$

Where:

E_W = evaporation rate of H_2O (ft/day)

P_{Wo} = saturation vapor pressure of H_2O at the temperature of the pool surface (mm Hg)

P_W = actual vapor pressure of H_2O in the bulk atmosphere above the pool (mm Hg).

Therefore, $E_T/E_W = ((N_T/N_W)\ P_{To} - P_T)/(P_{Wo} - P_W)$.

When there is wind, the bulk atmosphere above the pool will continually be replaced by air containing no HTO vapor. Therefore, it was assumed that $P_T = 0$. It also can be assumed that $P_{To} = P_{Wo}$.

With these assumptions,

$$E_T/E_W = (N_T/N_W)/(1 - P_W/P_{Wo}).$$

In this analysis, it will be assumed that the bulk air temperature equals the pool surface temperature, which means that P_W/P_{Wo} = RH (relative humidity). This assumption is not valid in general during each hour of the day. Pool surface temperature would be expected to be less than air temperature during the daytime but greater at night. However, in this analysis, evaporation rates are computed as monthly averages, so the assumption is considered reasonable.

Therefore,

$$E_T = E_W\ (N_T/N_W)/(1 - RH),$$

or

$$E_T' = C \cdot E_W'/(1 - RH)$$

Where:

E_T' = evaporation rate of HTO (gal/month)

C = activity (pCi/gal)

E_W' = evaporation rate of H_2O (gal/month)

RH = Relative humidity

To incorporate the assumption of wind, E_W was estimated using the Penman equation[2]:

$$E_W = P_{Wo} (1 - RH) (0.5 - U_2/100)(1.138 \times 10^{-3})$$

where U_2 = wind speed (miles/day) at 2 meters above the surface of the pond. The total evaporation rate E_W can then be calculated using the assumed pond area of 60,000 ft^2.

The parameters substituted in the above equation except P_{Wo} were taken from Table S.1. The value for P_{Wo} was estimated from the monthly temperature and from Reference 4.

Initially a time frame of one month was assumed. This resulted in gross changes in concentrations. In order to "smooth out" these changes, the following assumptions and methodology were used: (1) all the water is presumed to be ponded on July 1; (2) the pond is allowed to evaporate for two weeks, i.e., losing HTO, which was followed by an influx of one-half the monthly precipitation; (3) from the evaporation loss and precipitation, a new concentration was calculated at the end of the two weeks and the process repeated for successive time periods.

The results of this approach are presented in Table S.2 for a three-month period. As shown, 80 percent of the initial HTO inventory is released. Figure S.1 presents these same results and also includes an extrapolation of the discrete model results. This extrapolation assumes a constant exponential slope ($e^{-1.04t}$)*, which means that the HTO concentration in the pond will be reduced by a factor of 10 about every 2.2 months. At this rate, the HTO concentration in the pond will approach the natural concentrations in the river (200 to 400 pCi/L) in about 1.3 years. Under natural conditions, concentrations will be reduced asymptotically.

To determine the effect of monthly climatology a similar analysis was conducted based on ponding the water in January. Figure S.2 shows the results of this case. As shown, it takes about 6 months to release 80 percent of the HTO and the extrapolated exponential slope ($e^{-0.88t}$) means it requires about 2.6 months to reduce pond HTO concentrations a factor 10. Under these conditions, HTO concentrations approaching those naturally occurring in the river are attained over about a 21-month period.

A reduction in the initial HTO concentration by filling the pond to 2.5 million gallons increases the time required to reach background concentrations. At an initial concentration of 0.3 μCi/mL and a pond volume of 2.5 million gallons, HTO concentrations in the 200 pCi/L to 400 pCi/L range are reached in 36 months with July ponding. January ponding would increase this to about 56 months.

S.3 MODEL TWO - NO-WIND EVAPORATION

This case is principally concerned with possible HTO concentration in the environs of the pond, which may be above MPC_a (MPC in air, 40-hour week) for workers. The assumptions used in the analysis were:

*The "slope" indicates that at two different times, t_1 and t_2,
$C_1/C_2 = \exp(-1.04(t_1-t_2))$

Table S.1. Mean Monthly Meteorological Data at Harrisburg Airport

Month	Dry-Bulb Temperature (°F)	Relative Humidity (%)	Wind Speed (mph)	Precipitation (inches/month)
Jan	30.1	67	8.4	2.57
Feb	32.3	67	9.2	2.42
Mar	41.0	65	9.7	3.22
Apr	52.8	60	9.3	2.98
May	63.1	63	7.8	3.76
Jun	72.0	67	6.9	3.11
Jul	76.1	68	6.3	3.70
Aug	73.9	72	6.0	3.22
Sep	67.0	71	6.2	2.66
Oct	55.8	67	6.6	2.57
Nov	43.8	67	7.9	3.19
Dec	32.6	66	8.1	3.07
Total				36.47

Source: "Local Climatological Data, 1977, Harrisburg, Pennsylvania," U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, U.S. Environmental Data Service.

Table S.2. HTO Releases to Air for July Ponding

Time Frame	Incremental Release (Ci)	Cumulative Release (Ci)	Pond Concentration (μCi/mL)	Pond HTO Inventory as Percent of Original[a]
Zero	0	0	0.50	100
July 1-15	730	730	0.39	75
July 15-31	570	1300	0.30	55
Aug 1-15	390	1690	0.23	42
Aug 15-30	310	2000	0.18	31
Sept 1-15	180	2180	0.15	25
Sept 15-30	140	2320	0.12	20

[a]2900 Ci of HTO in 1.54 million gallons.

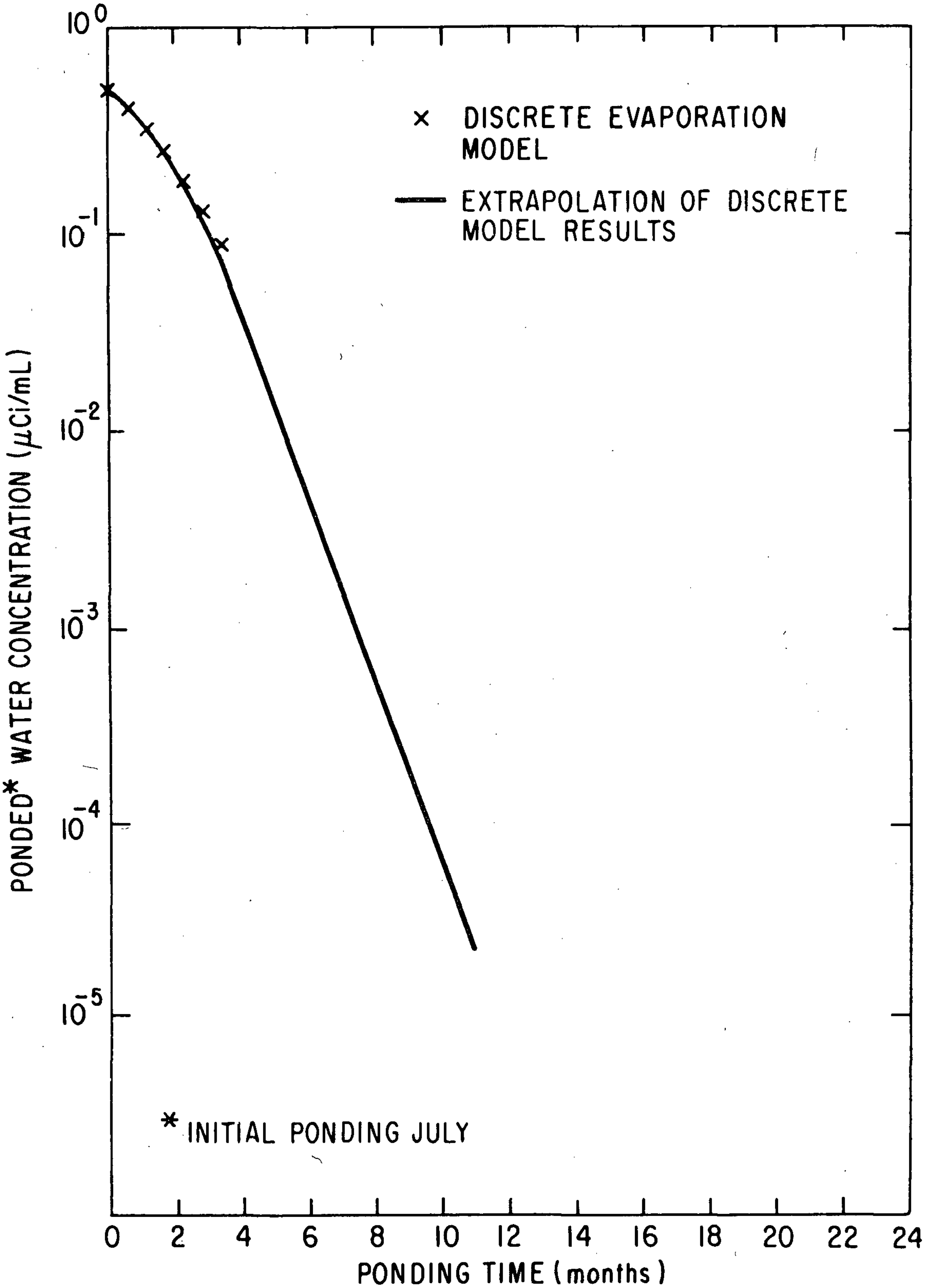

Figure S.1. HTO Concentration Versus Time for Water Ponded in July.

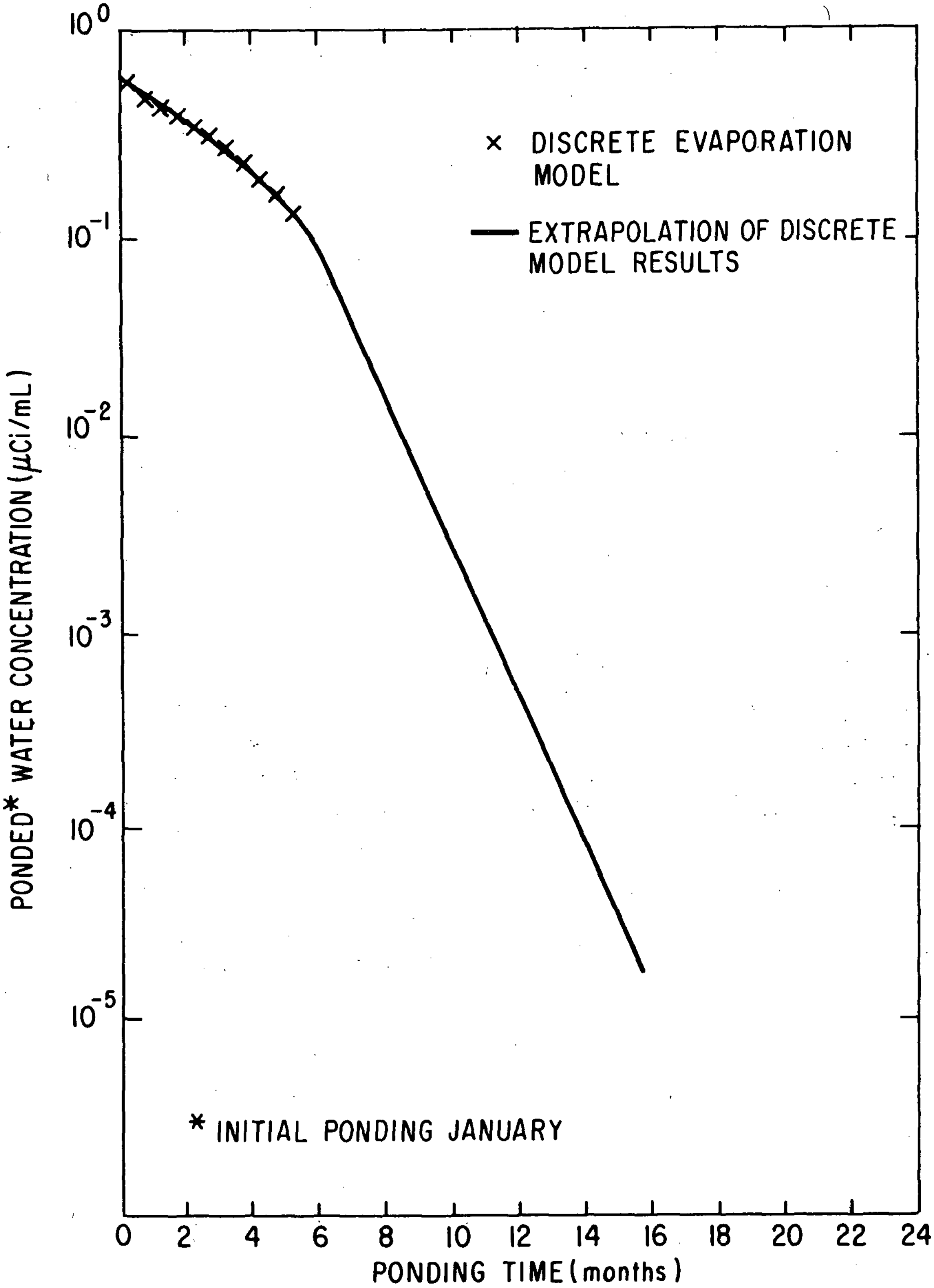

Figure S.2. HTO Concentration Versus Time for Water Ponded in January.

- The atmosphere is static--no wind
- The proportion of HTO molecules to H_2O molecules is the same in the vapor and liquid state
- No allowance is made for possible dispersion in the local environs of the pond.

Two cases are considered--average monthly meteorological conditions and a realistic extreme. In either case the concentration of HTO above the pond can be calculated from:

HTO air = HTO water (d)(RH)

Where:

HTO air = concentration in air (μCi/mL)

HTO water = concentration in water (μCi/mL)

d = density of 100% saturated water vapor at temperature t (mL/g × 10^{-6}), Figure S.3, Reference 4

RH = relative humidity

S.3.1 Case 1--Average Monthly Meteorological Conditions

From the temperature values in Table S.1 and Figure S.3, the density of 100% saturated water vapor may be estimated (Table S.3). Substituting in the previous equation gives the HTO activity above the ponds. It should be noted that no allowance was made for possible dilution with precipitation, i.e., HTO water is constant over time and, thus, represents a worst case.

It is shown in Figure S.4 that without dilution, it is reasonable to expect that MPC_a will be exceeded during the summer months, under the previously stated assumptions. Using July as a base month, addition of 657,000 gallons of water would reduce the HTO concentration to 0.36 μCi/mL in the pond. This would ensure that MPC_a in the pond environs for this month would not be exceeded.

S.3.2 Case 2--Daily Realistic Extreme

Daily temperatures in the summer months may be expected to rise to 90°F with a relative humidity of 90 percent. Assuming this to be a realistic extreme leads to a possible concentration in the pond environs of 14.4 × 10^{-6} μCi/mL, or nearly three times MPC_a on site. In this case, the activity of the ponded water would have to be about 0.17 μCi/mL so as not to exceed MPC_a. This would be accomplished with the addition of some 3 × 10^6 gallons to dilute the water in the worst case.

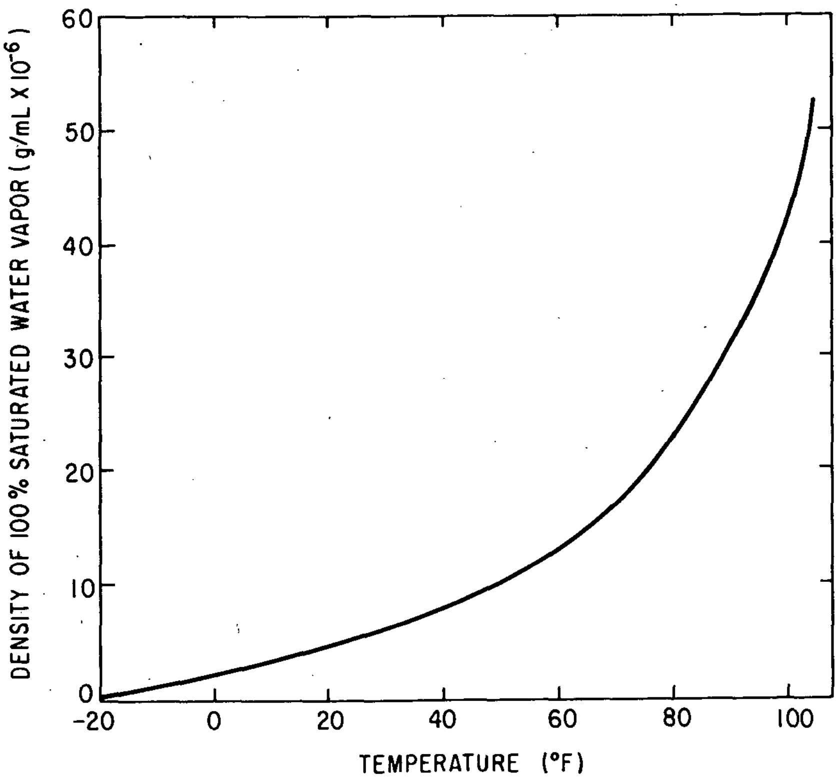

Figure S.3. Density of 100% Saturated Water Vapor versus Temperature. Source: C.J. Wiesner, "Hydrometeorology," chapman and Hall, Ltd., London, 1970.

Table S.3. Density of 100% Saturated Water Vapor, Relative Humidity, and HTO Air as a Function of Time[a]

Month	d (mL/g × 10^{-6})	RH (%)	HTO Air[b] (μCi/mL × 10^{-6})
Jan	5.9	67	2.0
Feb	6.0	67	2.0
Mar	8.0	65	2.6
Apr	10.8	60	3.2
May	14.0	63	4.4
Jun	17.0	67	5.7[c]
Jul	20.3	68	6.9[c]
Aug	18.0	72	6.5[c]
Sep	15.5	71	5.5[c]
Oct	12.0	67	4.0
Nov	8.3	67	2.8
Dec	6.3	66	2.1

[a]Assume HTO water constant at 0.50 μCi/mL.

[b]MPC_a is 5 × 10^{-6} μCi/mL.

[c]Exceeds MPC_a without dilution of pond water.

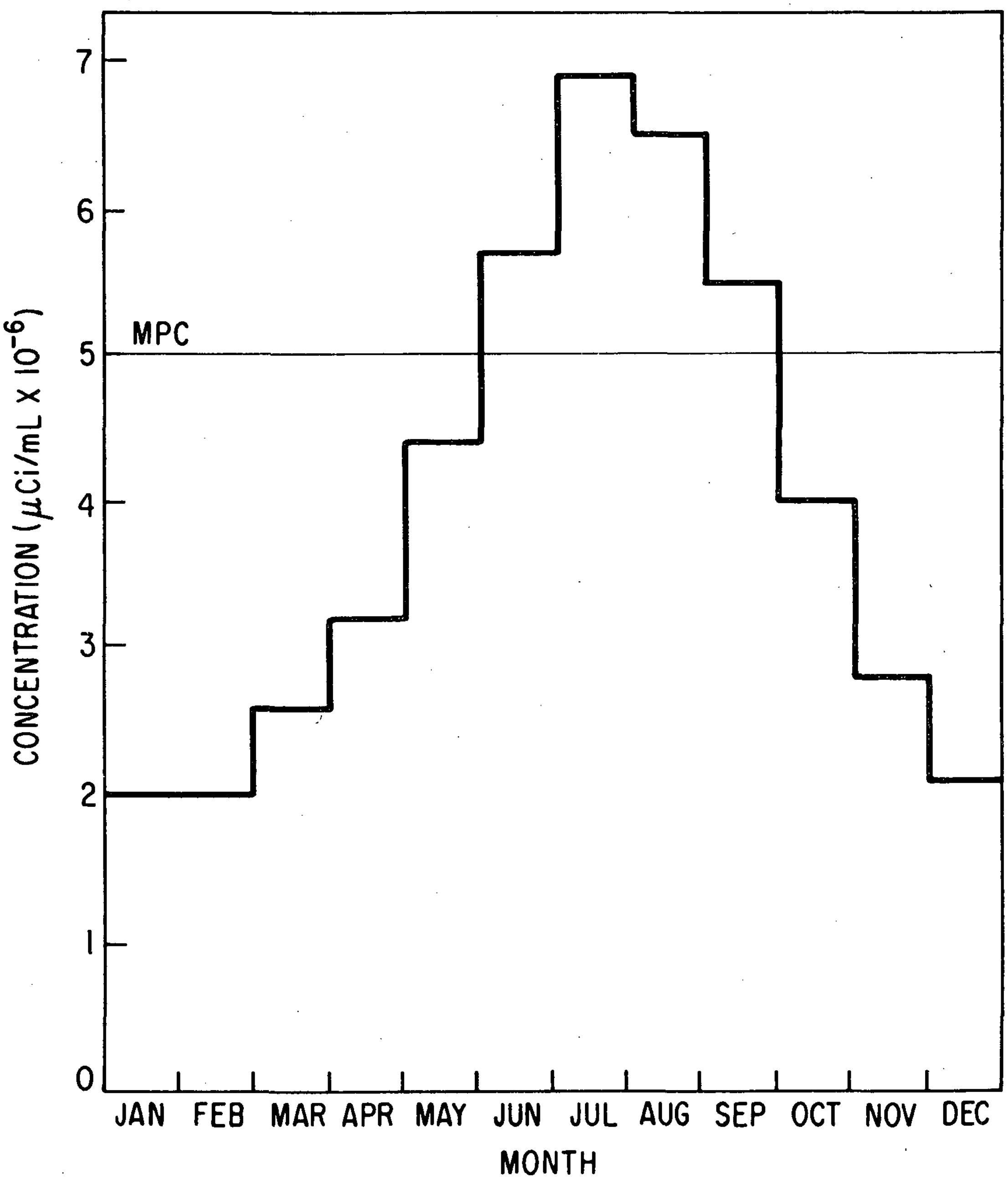

Figure S.4. Monthly HTO Concentrations above the Pond as Calculated Using Model Two.

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APPENDIX T. THE BEHAVIOR OF SORBABLE RADIONUCLIDES IN THE SUSQUEHANNA RIVER AND CHESAPEAKE BAY

T.1. BEHAVIOR OF RADIONUCLIDES IN SUSQUEHANNA RIVER

Radionuclides entering the Susquehanna River at TMI will move in the downstream direction with the river flow. Some radionuclides will remain in the dissolved state, while others will become concentrated in suspended and bottom sediments and aquatic organisms. Tritium discharged to the river will be in the form of tritiated water (HTO as compared to normal water, H_2O). The chemical and physical behavior of tritiated water is basically that of ordinary water with regard to mobility, interaction with suspended particles, and general dilution.

By contrast, the isotopes Cs-134 and Cs-137 have an appreciable tendency to be adsorbed onto suspended sediments and to concentrate in aquatic organisms. The isotopes Sr-89 and Sr-90 have a smaller tendency to be adsorbed onto sediments and will exist primarily in the dissolved state.

The fate of sorbable radionuclides such as cesium introduced into the Susquehanna River will depend on a number of physical and chemical factors. At steady state, the radionuclides will be partitioned between the suspended sediment and the water according to the relationship:

$$F_w = \frac{10^6}{10^6 + K_d C_{sed}} \qquad \text{(T1)}$$

where:

F_w is the fraction of the radionuclide remaining dissolved in the water,
K_d is the distribution coeffient between sediment and water, mL/g, and
C_{sed} is the concentration of suspended sediment, mg/L.

No direct measurements of K_d were available for Susquehanna River sediments, but estimates can be made based on measurements in other East Coast rivers and on the minerology of the Susquehanna River basin. One of the most useful studies of radionuclides in rivers was the Clinch River Study,[1] in which the migration of low-level radioactive waste seepage was extensively measured in a complicated river basin with multiple dams. It was found that the sorptive properties of the sediment were largely dominated by the clay fraction, and that illite, a micaceous clay mineral accounting for about 60 percent of the clay in the Clinch River, had the greatest affinity for cesium. An inventory of an approximately 21-mile reach of the Clinch River, from the point of release to the backwater area at Watts Bar Dam, indicated that about 21 percent of the cesium released over a 20-year period remained in the bottom sediments. Only about 0.2 percent of the released strontium remained on sediments, however, which demonstrates that strontium interaction with sediment is not strong. Measurements of K_d in the clay deposits along of the Clinch River ranged up to about 88,000 mL/g for cesium in a study by Carrigan et al.,[2] but other investigators have obtained much lower values in sediments of the Clinch River. Jenne and Wahlberg[3] report sediments of a tributary of the Clinch River showed a cesium K_d of between 650 and 1000 mL/g. Schell et al.[4] reported an average value of 1355 mL/g.

Extensive studies on the behavior of radionuclides in the Hudson River estuary indicate that up to 90 percent of the cesium near the Indian Point Nuclear Plant was in the form of suspended sediment during freshwater conditions. Measurements of cesium K_d of the suspended sediment indicate values of up to 3×10^5 mL/g. Once again, illite is the dominant clay mineral of the Hudson River. Simpson et al.[5] estimate that about 20 percent of the radiocesium entering the Hudson River accumulates in the bottom sediments (although a portion of that is removed by maintenance dredging).

Eaton et al.[6] state that illite is one of the dominant clay minerals of the Coastal Plain, and by inference, of the Susquehanna River. Moving sediments in the Susquehanna River are estimated to be 10 percent sand, 50 percent silt, and 40 percent clay.[7]

Suspended sediment loads in the Susquehanna River range from 5 to 1500 mg/L. Typical sediment loads downstream of Conowingo dam are 10 to 30 mg/L, with no obvious correlation to river flowrate for flows below 100,000 cfs.[7] Since it is estimated that, in years with no major floods, half to two-thirds of the sediment passing Harrisburg is trapped in the river above Conowingo Dam, average sediment loads near the TMI plant probably are in the range of 20 to 100 mg/L.

Equation (T1) has been evaluated in Figure T.1 for the range of K_d and sediment load values discussed above. It is clear that the fraction of sorbable radionuclides associated with sediments can vary over a wide range. An estimate of the importance of sediment to the transport of cesium in the river and bay will be discussed later.

Of the sorbed radionuclides attached to the sediment, part will be trapped behind the downstream dams and the rest will be transported into the Chesapeake Bay. The portion that becomes trapped behind the dams will depend on the flowrate of the river. As previously noted, in years where there are no major floods, between half and two-thirds of the sediment transported past Harrisburg does not pass Conowingo Dam, which is the last dam before the bay.[7] The phenomenon of sediment trapping by dams is a result of the reduced velocity and turbulance in the reservoirs behind the dams, which allows the particles to settle out of suspension. The phenomenon increases in effectiveness as the particle size increases. Most of the sorbed radioactivity will be associated with the very fine clay fraction of the suspended sediment. It is likely, therefore, that the sediment passing the dams will become enriched in the clay fraction which carries most of the sorbed radioactivity.

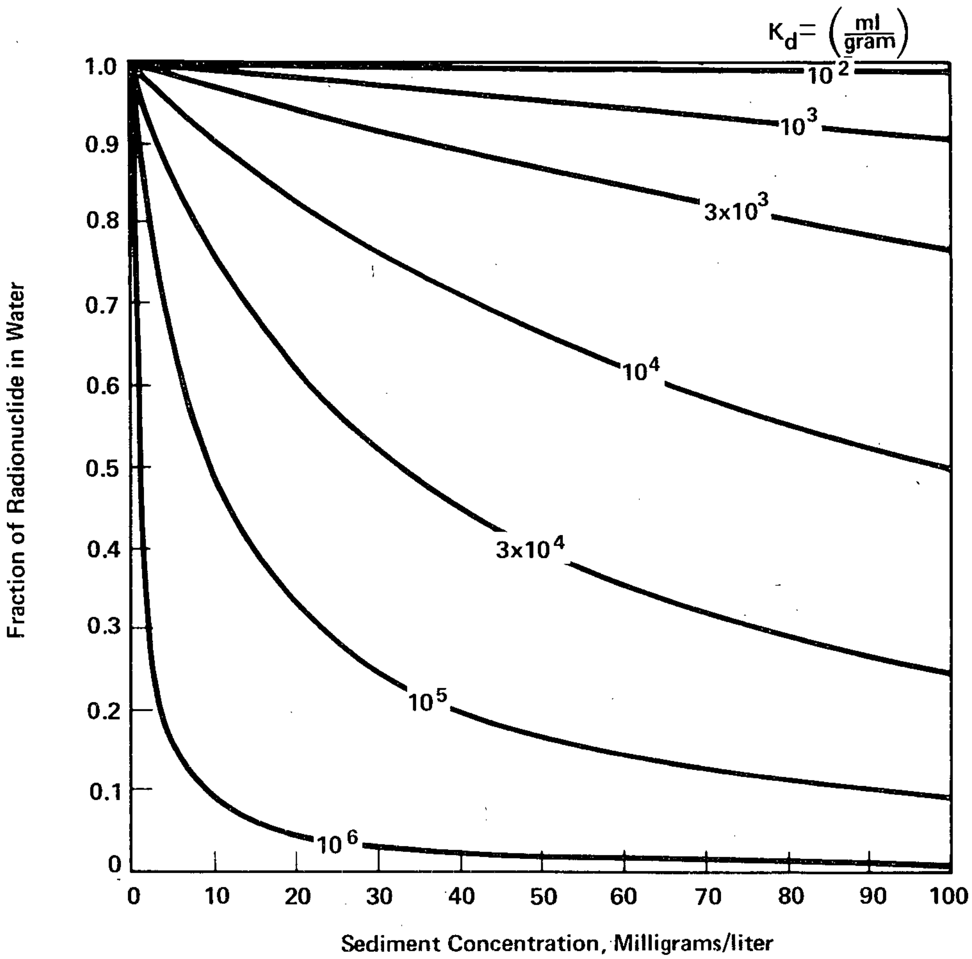

Figure T.1. Fraction of Radionuclide Remaining in Dissolved State.

Most sediment transport occurs episodically during flood events. During normal years, 50 to 60 percent of the sediment that does discharge at Conowingo Dam passes during the spring freshet* when flows are high due to snow melt. Between 1966 and 1976, the discharge of sediment from the Susquehanna River was about 50 million metric tons. Of this amount, about 30 million metric tons was due to Hurricane Agnes in June 1972, and 10 million metric tons was due to Hurricane Eloise in September 1975. It is estimated that the Agnes flood had a recurrence interval of greater than 1000 years, and the Eloise flood had an estimated recurrence interval of about 50 years.[8] For flows greater than 400,000 cubic feet per second, sediments that have deposited behind the dams are apparently eroded and transported into the northern Chesapeake Bay. A flood of this magnitude would have a recurrence interval of about six years.[7] Contaminated sediments therefore

*A "freshet" is a sudden rise in the level of a stream caused by heavy rains or the rapid melting of snow or ice.

would collect to a certain degree behind the Susquehanna dams, but would not reside there indefinitely since they would be flushed into the Chesapeake Bay during major floods. Although sediments contaminated with radioactivity would be resuspended during such floods, they would simultaneously be diluted by the large quantity of flowing water.

T.2 BEHAVIOR OF RADIONUCLIDES IN CHESAPEAKE BAY

Radionuclides discharged to the Susquehanna River at Three Mile Island will be carried in the downstream direction toward the Chesapeake Bay. The Chesapeake Bay (Figure T.2) is an estuary in which fresh water from the rivers and salt water from the ocean mix. Salinity varies from practically zero at the mouths of the rivers up to about 35 parts per thousand in the open ocean.

Substances that enter Chesapeake Bay mostly or entirely in the dissolved form eventually will be transported to the sea from the combined effects of advection by fresh water and dispersion caused by the astronomical tides and wind wave activity. The "flushing time", V/q, based on the known volume of the bay, V, and the average flowrates of the rivers, q, is about one year. The flushing time is indicative of the rate at which a dissolved pollutant would be purged from the bay; however, because of sediments, nonideal mixing, and entrapment in the complicated backwater areas, small traces of radioactive contamination probably would linger for several years.*

The bulk of the sediments passing into the Chesapeake Bay, probably more than 75 percent, will be deposited in the upper bay in the region known as the "turbidity maximum".[9] Eaton et al.[6] suggest that some Susquehanna River-derived sediment would be deposited as far as the mouth of the Potomac River. Direct measurements of radionuclides released from the Peach Bottom Nuclear Plant in Conowingo Pond suggest that sediment deposition of cesium is at the maximum at the mouth of the Susquehanna River, has decreased by two orders of magnitude by the Sassafras River, and is undetectable beyond.[10] The measurements may not have included the periods of major sediment transport during floods, however, which would both dilute and disperse contaminated sediment further into the bay to levels probably too low to detect.

Of the substances that are significantly adsorbed by sediment, cesium is the most radiologically important because of its long half-life, high dose and bioaccumulation factors, and abundance in nuclear waste. Cesium behaves as a monovalent cation and primarily undergoes ion exchange with sediments. There is strong evidence from other estuaries that cesium is at least partially desorbed from contaminated sediments in the presence of salt water because of the "common ion effect" and will reenter the water column. Cesium-134 and Cs-137 contamination on bottom sediments near the Indian Point Nuclear Plant on the Hudson River estuary disappeared at a rate corresponding to a half-life of about one year.[11] The major mechanism identified for the disappearance of cesium appears to be leaching by salt water intruding up the estuary during periods

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*There is no expectation that radionuclides released from the TMI cleanup would be detectable in the water, fish, or sediment beyond the site vicinity. Background levels of nuclear fallout, previous normal releases from TMI Units 1 and 2, and releases from the Peach Bottom Nuclear Plant would obscure the very small releases to be expected from TMI.

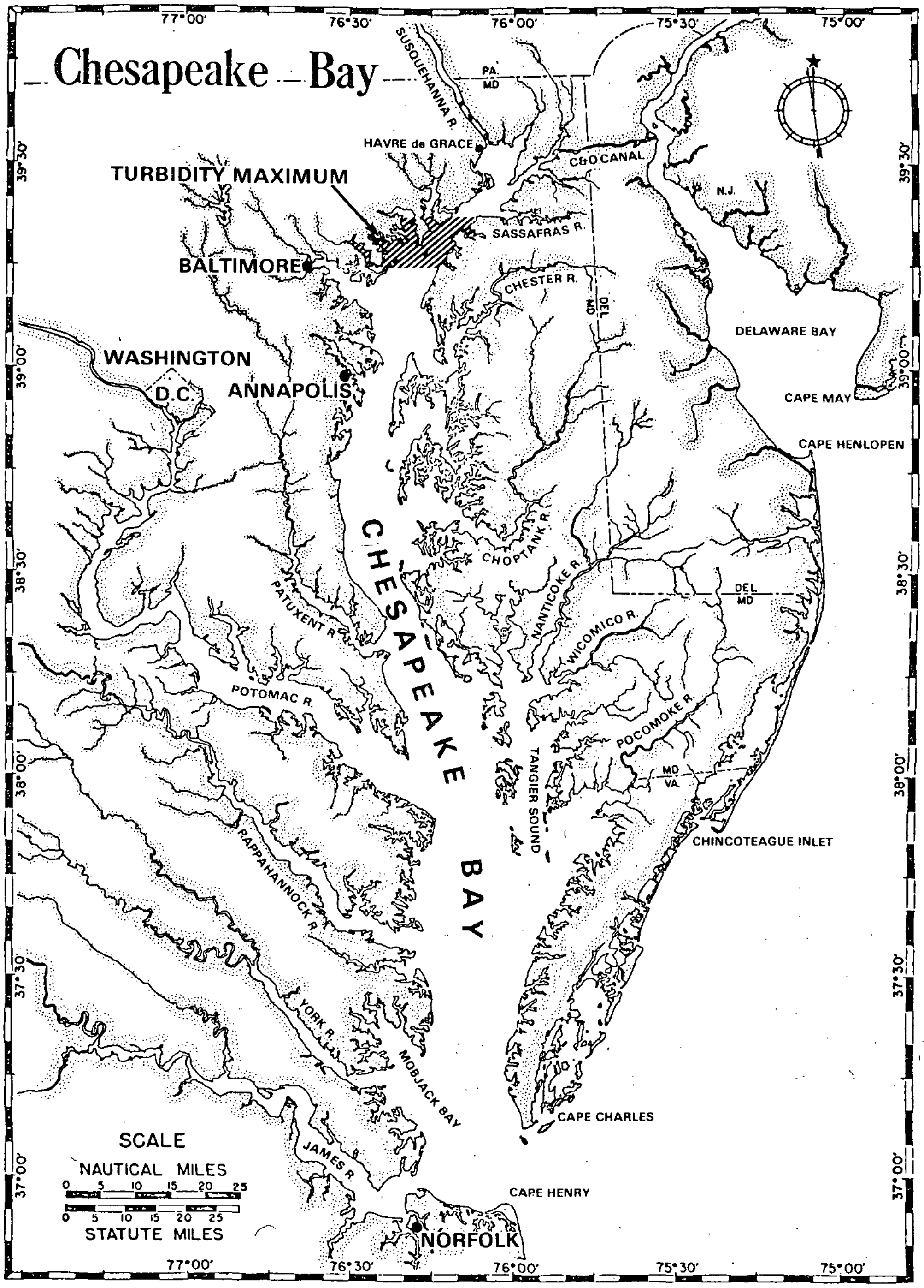

Figure T.2. Chesapeake Bay (from Reference 6).

of low flow. Similarlv, Patel et al.[12] observed that the apparent loss of Cs-137 in Bombay Harbor was consistent with an equivalent half-life of about two years. A certain portion of cesium that has been sorbed onto sediment probably will not be desorbed in the salt water. Some of the cesium will become practically irreversibly sorbed into the crystal lattice of certain clay minerals, such as illite, in fresh water and will not desorb to a great extent in the salt water.[13]

Cesium in dissolved form has a much smaller tendency to be sorbed by sediment once in salt water.[13] Therefore, cesium entering the brackish portion of the Chesapeake Bay in a dissolved state will largely remain dissolved.

The radionuclides Sr-89 and Sr-90 would have little tendency to be adsorbed by suspended sediments either in the freshwater or saltwater regions of the Susquehanna River and Chesapeake Bay and therefore would be transported predominantly in the dissolved phase.

T.3 ESTIMATES OF EXTENT OF CESIUM INTERACTION WITH SEDIMENT IN SUSQUEHANNA RIVER AND CHESAPEAKE BAY

Measurements by the State of Maryland,[10] indicate that the highest sediment concentrations of Cs-134 released from the Peach Bottom Nuclear Plant were 160 pCi/kg in Conowingo Pond and 640 pCi/kg at the mouth of the river. A very approximate and conservative estimate of the fraction of Cs-134 that has become associated with river sediments can be made by assuming that of the sediment discharge in the Susquehanna River passing Harrisburg during non-flood years, about half falls above Conowingo Pond and is contaminated to a level of 160 pCi/kg. The remainder is assumed to settle in the upper portion of Chesapeake Bay and is contaminated to a level of 640 pCi/kg. It is estimated that between the years 1966 and 1974, the annual average sediment load passing Harrisburg during years with no major floods was about 1.9 million metric tons.[7] Under the above assumptions, about 0.19 Ci of Cs-134 would be associated with the sediment. If it is conservatively assumed that all of the Cs-134 on the sediment came from the 1.62 Ci released at Peach Bottom during the second quarter of 1979, then less than 12 percent of the Cs-134 would be associated with sediment, and the remainder must have been carried away in the dissolved phase. The above calculation is conservative because (1) the concentrations of Cs-134 on sediments used were the highest point values reported for Conowingo Pond and the Chesapeake Bay and (2) the levels probably reflect previous inputs of Cs-134 from the Peach Bottom and the Three Mile Island Plants.

T.4 CONCLUSIONS

Some of the radionuclides, particularly cesium, released from the cleanup operations at TMI will become associated by the process of sorption with suspended river sediments. Contaminated sediments may accumulate to an extent in the reservoirs behind York Haven, Safe Harbor, Holtwood, and Conowingo Dams, but these sediments will be largely flushed during major floods. Much of the remaining sediment will be carried downstream and settle primarily in the upper Chesapeake Bay.

A portion of the cesium associated with the sediment will desorb in the presence of salt water and will reenter the water column. Measurements of the concentrations of Cs-134 on sediments of Conowingo Pond and the upper Chesapeake Bay indicated that probably less than 12 percent of the radiocesium released from TMI will ever become assocated with sediment. The relative importance of sediments to the radioecology of the Susquehanna River and Chesapeake Bay therefore will be minor.

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APPENDIX U. DECOMMISSIONING OF TMI-2

Decommissioning is defined as the preparation of a facility for retirement from active service and placement of the facility in such a condition that future risk from the facility to public safety is within acceptable bounds. The achievement of this rather broad goal, via three possible alternatives, is the subject of this appendix. Included are a review of appropriate technology, estimations of the radiation dose to workers and to the public, other potential environmental impacts, and estimations of the costs that would result from the decommissioning of TMI-2.

Much of the information presented here is based on earlier conceptual studies of decommissioning large light-water nuclear power reactors which had operated routinely throughout a normal operating lifetime,[1-3] adapted as appropriate to fit the atypical post-accident circumstances at TMI-2. Cost estimates are made in terms of mid-1980 dollars, with no predictions made of future interest or inflation rates.

U.1. POSTULATED FACILITY STATUS FOR DECOMMISSIONING

Under normal circumstances, decommissioning follows the orderly shutdown of a facility at the end of its planned operating life. The situation at TMI-2 is significantly different from normal, with the containment building and the auxiliary and fuel handling building severely contaminated, and much of the fuel core damaged. A major cleanup effort is currently underway. This cleanup effort is the principal subject of the programmatic environmental impact statement (PEIS) as related to decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at TMI-2, of which this decommissioning analysis is a small part. As discussed in Section 2.2.1, there is no significant difference in the initial cleanup activities (initial decontamination, reactor defueling, and RCS decontamination) whether it is planned to decommission or to restart the facility. Thus, the current planned cleanup efforts are carried to the point where either work to restore the plant to service could begin or decommissioning could begin. This is illustrated by the simplified decision-point diagram shown in Figure U.1. In terms of the schedule shown in Figure 1.4, active decommissioning efforts would begin at the conclusion of the fuel debris dissolution and the chemical decontamination of the reactor coolant system and associated systems. As a practical matter, the earlier cleanup efforts contribute to the total decommissioning effort, but for convenience in this analysis, decommissioning is necessarily treated separately from the initial cleanup. To obtain estimates of the total impact, the impacts from the initial cleanup should be added to the impacts from decommissioning.

The irradiated fuel elements and debris are assumed to be stored in the spent fuel pool in the auxiliary and fuel handling building (AFHB) at the start of decommissioning. Shipment of the irradiated fuel to an away-from-reactor fuel storage facility (AFR), reprocessing plant, or some other disposal facility is assumed to begin when decommissioning begins and to continue until all irradiated fuel has been removed from TMI-2. However, lack of a suitable facility to receive the fuel may result in its retention in the spent fuel pool in the AFHB for an extended period of time, in effect converting that portion of TMI-2 into an AFR.

For the decommissioning analyses, it is postulated that the washdown of the containment building and the installation of temporary shielding has resulted in general-area radiation dose rates on the operating floor (347-ft level) in the 5-10 mR/hr range, and on the lower levels of the containment building in the 30 mR/hr range. Building surfaces are assumed to have smearable contamination levels in the 3000-4000 dpm per 100 cm^2 range, exclusive of hot spots.

U.2 GENERIC DECOMMISSIONING CONSIDERATIONS

Regardless of the alternative chosen for the decommissioning of TMI-2, there are certain generic considerations involved. These generic decommissioning considerations include:

- Staff organization,
- Planning and preparation,

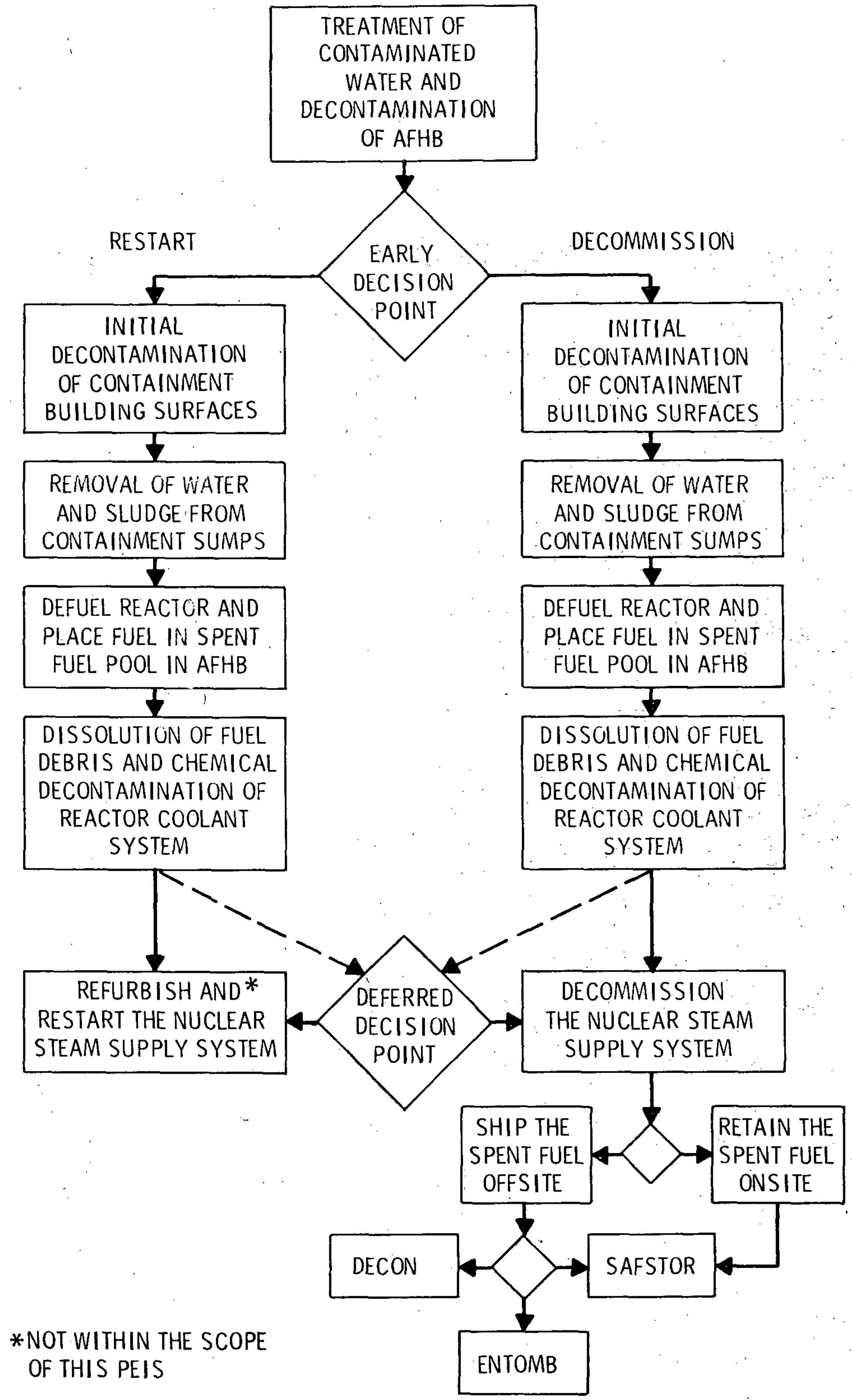


Figure U.1. Simplified Decision-Point Diagram.

- Equipment requirements,
- Decommissioning methods, and
- Additional requirements (e.g., quality assurance and environmental surveillance).

In addition, cost estimates for the decommissioning alternatives are developed based on unit cost factors common to all three decommissioning alternatives. This section provides a discussion of these considerations.

U.2.1 Decommissioning Staff Organization

A decommissioning organization is created within the utility at the start of planning and preparation. A cadre of experienced personnel already exists within onsite post-accident recovery teams. Staffing requirements are identified, and critical positions are filled with key engineering and operating personnel from these units. Additional training needs are identified and the personnel are trained as required to fulfill their roles in the organization.

The primary decommissioning activities are postulated to be performed on a two-shift, 5-day-week basis. However, selected support activities (i.e., system decontamination and draining, radwaste system operation) and security functions are carried out on three shifts, around-the-clock, 7 days per week. In addition, the main control room is manned full time for operation of essential systems and services.

Detailed knowledge of and familiarity with the facility being decommissioned increases the effectiveness of the decommissioning staff. This is particularly true for TMI-2 because of the special circumstances involved. Consequently, for TMI-2 decommissioning, positions are assumed to be filled, whenever possible, with personnel involved in the cleanup operations to provide continuity, capitalize on experience gained during cleanup, and minimize training requirements. Any additional training required to perform decommissioning tasks would be provided, with special emphasis given to the use of new and unique equipment and procedures.

Specialty contractors and consultants are postulated to be hired as needed to assist in areas outside the licensee's expertise or capability. The needs for such specialties are identified during the planning and preparation phase preceding the actual decommissioning, and contractual agreements are concluded as early as possible to ensure the uninterrupted completion of the decommissioning project. The specialty contractors anticipated to be required for the decommissioning alternatives considered are shown in Table U.1.

U.2.2 Planning and Preparation

In planning and preparing for decommissioning, data must be gathered and analyzed, detailed work plans and procedures must be developed, and regulatory requirements must be satisfied. These considerations are discussed in the following sections.

Table U.1. Specialty Contractors for Decommissioning

Specialty Contractor	Function	Decommissioning Alternative[a]		
		DECON	SAFSTOR	ENTOMB
Explosive specialists	Breaking up biological shield	X		
Hauling contractors	Transport of packaged radioactive materials to disposal site	X	X	X
Temporary radwaste handling & solidification support[b]	Radwaste handling and final cleanup after inplant radwaste systems are decontaminated and deactivated	X	X	X

[a] X denotes contractor applicable to decommissioning alternative.

[b] Assumed to be available onsite because of cleanup operations preceding decommissioning.

U.2.2.1 Data Gathering and Analysis

A large body of data is gathered and analyzed during the planning and preparation phase for decommissioning. These data help fulfill the regulatory requirements discussed in Section U.2.2.3, particularly the inventory of radioactive materials and the various safety analyses. In addition, they provide the bases for planning decommissioning tasks and selecting appropriate methods and equipment.

Included in this activity is a comprehensive survey of radiation dose rates and contamination levels within the facility. This survey, taken after chemical decontamination of the RCS, provides information for determining additional decontamination and temporary shielding requirements. It also provides data on radiation dose rates likely to be encountered during the various decommissioning tasks.

U.2.2.2 Development of Detailed Work Plans and Procedures

Detailed work plans and procedures are developed based on information gathered during data gathering and resultant analyses and provided to the NRC with the license amendment/decommissioning order request. These detailed plans and procedures contain all the information required to actually carry out the decommissioning tasks. They address the following items:

- Decommissioning methods,
- Schedules and sequences of events,
- Radioactive waste management,
- Contamination control,
- Radiological and industrial safety, and
- Equipment requirements.

Quality assurance (QA), security, and environmental constraints are also considered. The approved plans and procedures cover all aspects of the decommissioning project.

U.2.2.3 Regulatory Requirements

The licensee must comply with the applicable regulatory requirements and other constraints as discussed in Section 1.6. The current status of such requirements should be reviewed prior to the start of actual decommissioning operations. The major requirement is anticipated to be the necessary documentation (similar to that discussed in Appendix R) for any additional amendments to the facility nuclear license to prepare for the continuing care period.

In requesting amendments, the licensee must provide:

- A description of the current facility status,
- A current inventory of the onsite radioactive materials,
- A description of the proposed decommissioning activities, including sequence, schedule, and estimates of worker radiation exposure,
- A description of the proposed measures to minimize radioactive releases,
- Any additional changes to the technical specifications, and
- Safety analyses of both the proposed activities and the specification changes.

This information becomes the decommissioning plan.

In addition to the aforementioned documentation, the licensee must submit an environmental report as well as security and safeguards plans. Updated information concerning the financial qualification of the licensee may also be required. The following information would also be required:

- A description of the ultimate facility status,
- A description of future decommissioning activities, if any (including radioactive material disposal and site decontamination) and the associated environmental and safety precautions,
- Safety and environmental impact analyses of future decommissioning activities, if any, and any resultant releases, and
- Safety and environmental impact analyses of the plant in its ultimate status.

U.2.3 Equipment Requirements

Equipment requirements for decommissioning fall into two general categories:

- Inplant systems and services essential to the decommissioning effort, and
- Special tools and equipment required to carry out the decommissioning tasks.

The requirements in each of these categories are described below.

U.2.3.1 Essential Systems and Services

All or parts of certain facility systems and services must remain in place and in service until all radioactive material is either removed or secured in place, to prevent the release of significant quantities of radionuclides (or other hazardous materials) to the environment. Some systems and services are required for cleanup and disassembly activities. Other systems provide personnel health and safety protection. The essential systems and services are listed in Table U.2, together with the justification for retaining each.

Table U.2. Essential Systems and Services for Decommissioning

System or Service	Justification
Electrical Power	Operation of electrical equipment, including HVAC, lighting, and radiation monitoring
HVAC Systems	Ventilation and radioactive contamination confinement
Water Supply (service and domestic systems)	Decontamination, cleanup, fire protection, and potable water
Fire Protection System	Health and safety
Compressed Air Systems (control and service)	Operation of pneumatic controls and tools; personnel fresh air supply
Communications Systems	Facilitate and coordinate decommissioning activities
Radiation Monitoring Systems	Personnel safety considerations
Radwaste Systems	Treatment of radioactive liquids and solids
Spent Fuel Cooling and Cleanup System	Cleanup and cooling of water in spent fuel storage pool while spent fuel is there, and during defueling and reactor vessel/internals removal
Closed Cooling Water Systems	Secondary cooling of other systems
Chemical Feed System	Radwaste handling and water demineralization
Fuel Oil System	Auxiliary power
Security Systems	Public safety and plant protection considerations.

As areas within the facility are readied for demolition or secured for storage, the essential systems and services in these areas are deactivated and, if contaminated, removed as required. Continuous service to the remaining work areas is maintained as long as necessary.

For decommissioning by SAFSTOR or ENTOMB, certain systems and services are required during the continuing care period. These include:

- Electrical power,
- Radiation monitoring systems, and
- Security systems.

U.2.3.2 Special Tools and Equipment

Any special equipment required to complete the decommissioning project at TMI-2 is identified during planning and preparation. Designs and specifications are prepared for each item required. When the item is procured, it is inspected to verify that it meets specifications and complies with applicable QA and safety requirements. It is then tested to ensure that it performs as required. The testing also serves to train personnel in the use of the equipment and provide pertinent data on its operation.

The requirements for special tools and equipment needed to decommission TMI-2 by any of the three alternatives are shown in Table U.3, together with the functions of each item. Many of the tools and equipment needed for decommissioning are not part of the plant's normal operating complement. However, as noted in the table, many of the items are assumed to be available at TMI-2 as a result of the cleanup operations preceding decommissioning.

Table U.3. Special Tools and Equipment for Decommissioning

Item	Number Required for:			Major Function
	DECON	SAFSTOR	ENTOMB	
Underwater Manipulator[a]	1	0	0	Positioning and movement of underwater cutting devices
Underwater Plasma-Arc Torch[a]	2	0	1	Sectioning reactor vessel and internals, steam
Underwater Oxyacetylene Torch[a]	2	0	1	generators, tanks, and cutting piping, equipment,
Arc Saw	1	0	1	and structural members; welding
Portable Plasma-Arc Torch	4	2	4	
Portable Oxyacetylene Torch	2	2	2	
Guillotine Pipe Saw	10	2	10	Cutting piping
Power-Operated Reciprocating Hacksaw	10	2	10	Sectioning piping and equipment
Closed-Circuit, High-Resolution TV Systems[a]	2	2	2	Observation of remote or underwater operations
Underwater Lights and Periscopes[a]	AR[b]	AR	AR	Illuminating and observing underwater operations
Underwater Tools (e.g., Impact Wrenches, Bolt Cutters, Tongs)[a]	AR	AR	AR	Underwater disassembly, handling, and packaging operations
Submersible Pump with Disposable Filter[a]	5	2	5	Rapid cleanup and draining of pool water
High-Pressure Water Jet[a]	2	2	2	Surface decontamination
Scaffolding	AR	AR	AR	Safe access to heights
Safety Nets	AR	AR	AR	Protect personnel working on elevated equipment and structures
Shielded Vehicle with Manipulator Arms and Interchangeable Tools[a]	1	1	1	For remote operations in areas with high-radiation dose rates

Table U.3. (Continued)

Item	Number Required for: DECON	SAFSTOR	ENTOMB	Major Function
Mobile Chemical Decontamination Unit	5	5	5	Decontamination of liquid and solid radwaste equipment
Mobile Chemical Mixing and Heating Unit	4	4	4	Decontamination of drain systems
Power-Operated Mobile Manlift	9	3	9	Safe access to heights
10-Ton Mobile Hydraulic Crane	3	0	3	Removal and packaging of contaminated piping and equipment
10-Ton Forklift	6	1	6	Handling materials and loading trucks
Rigging Materials (e.g. Chokers, Grapples, Winches)	AR	AR	AR	Handling of piping and equipment
Concrete Drill with HEPA-Filtered Dust Collection System	4	1	4	Drilling holes in concrete for blasting or surface spalling
Concrete Surface Spaller	4	1	4	Removal of contaminated concrete surfaces
Front-End Loader (Light-Duty)	3	1	3	Cleanup and packaging tasks
Vacuum Cleaner (HEPA-Filtered)[a]	3	3	3	Cleanup tasks
Portable Ventilation Enclosure[a]	10	3	10	Contamination Control
Filtered-Exhaust Fan Unit	4	--	4	Contamination control
Supplied-Air Plastic Suit	250	100	250	Personnel respiratory and body-surface protection from radioactive contaminants
Polyurethane Foam Generator	2	2	2	Contamination control during HVAC work
Paint Sprayer[a]	0	4	0	Immobilization of contamination

[a]Assumed to be available onsite because of cleanup operations preceding decommissioning.

[b]AR - As Required.

U.2.4 Decommissioning Methods

The methods and associated equipment used to accomplish the various activities involved in decommissioning a nuclear facility such as TMI-2 fall into four major categories:

- Decontamination,
- Equipment disassembly,
- Radioactive waste packaging and shipping, and
- Contamination control.

Each of these methods is required, in varying degrees, in all of the decommissioning alternatives. These methods are discussed below.

U.2.4.1 Decontamination

Three basic methods can be used to remove radioactive materials from contaminated surfaces: (1) dissolution of the surface film containing the radionuclides, (2) physical cleaning of the surface, and (3) physical removal of the contaminated structural material. The first two methods are discussed at some length elsewhere in this PEIS (Chapters 5 and 6) and are not considered further here. Therefore, only physical removal of contaminated structural material (the third method) is described here. During facility decontamination, removal of both metal and concrete surfaces may be required. However, the techniques for metal-surface removal are the same as those for equipment disassembly, discussed in the next section. The present discussion is thus limited to concrete removal.

Some concrete in nuclear facilities such as TMI-2 is contaminated below the surface and cannot be decontaminated to release levels by physical surface cleaning alone. In addition, some of the concrete and structural steel in the biological shield surrounding the reactor vessel is activated as a result of neutron bombardment. In both instances, the structural materials must be physically removed and disposed of during decommissioning.

Several criteria must be considered when selecting a material-removal method for a particular location in the plant. The method chosen should minimize personnel radiation exposure and airborne contamination dispersion. In addition, the size and weight of removed materials must facilitate packaging and shipping for offsite disposal.

The major methods available for concrete removal are:

- Blasting,
- Core boring and hydraulic spalling,
- Flame cutting, and
- Thermic lance cutting.

Of particular interest are the blasting techniques for bulk removal of concrete and the spalling techniques for localized removal of concrete surfaces. Flame cutting and thermic lance cutting are both of less interest, primarily because of the copious quantities of toxic gases and/or smoke produced.

Bulk Concrete Removal

A very effective way to remove and segment the activated concrete in the biological shield is with explosives.[4] Because the shield's interior can be easily enclosed within ventilation-confinement envelopes, dust and airborne contamination can be effectively controlled. Placement of blasting mats over the affected region prevents flying debris from penetrating the confinement envelopes. Fog sprays of water, typically used from 1 minute before to about 15 minutes after blasting, help settle dust from blasting. Although blasting sequences are designed to minimize airpressure surges, the ventilation enclosures must be designed to withstand those pressure surges that do occur. Similarly, attention must be given to the building ventilation system to prevent surge damage to filters, with monitoring of the system to verify its continued integrity. After blasting, the area is inspected and surveyed to verify that all contamination is removed and that all explosives have detonated. The area may then be protected (by painting or by heavy fire-resistant plastic or canvas) to prevent recontamination during subsequent blasts. The procedure for explosive decontamination of concrete is described in Section F.1.3 of Reference 1 and in Section G.1.3 of Reference 3.

Concrete Surface Removal

A number of techniques can be used to remove contaminated concrete surfaces in nuclear facilities such as TMI2. A comparison of the major techniques is presented in Table U.4.[5]

Table U.4. Comparison of Major Concrete Surface Removal Techniques

Technique	Limitation	Type of Rubble Produced	Size of Air Filtration System Required	Relative Removal Speed
Sandblasting	Contamination embedded in pores not effectively removed	Small particles	Large	Slow
Jack hammer	Awkward to use on walls	Medium-size pieces and small particles	Medium	Medium Fast
Pneumatic or Hydraulic impactor	Limited to large accessible facilities	Medium-size pieces and small particles	Medium	Fast
Concrete spaller with air drill to make holes	Awkward to use on irregular surfaces or in cramped quarters	Medium-size pieces and small particles	Small	Medium Fast

Sandblasting, where the surface is mechanically eroded away, removes only a minimal surface thickness and produces large quantities of small, contaminated particles. Sandblasting primarily removes paint and a little of the concrete surface. It does not effectively remove contamination from the pores in the concrete or from expansion joints.[6] A large exhaust and air filtration system is needed with this method to control contaminated dust. This technique is relatively slow if the contamination penetrates beyond a thin surface layer (see Section 5.2.3.1).

Two surface removal methods used more extensively than the rest are jack hammers and impactors. Jack hammers, powered by compressed air, are readily available and are easily operated by one man. They are used to chip off the surface material deep enough to remove the contamination.[6] Because they are difficult to position on walls and ceilings, jack hammers are used primarily on floors. Impactors (or hoe rams), similar in operation to jack hammers but much larger, have been used successfully in several decontamination projects.[5,6] An impactor, powered either pneumatically or hydraulically, uses a pick chisel point that is driven into the concrete surface with high-energy impacts several times per second. A medium-size air filtration system is necessary to control the dust produced by both of these surface removal methods.

The last technique, use of a concrete spaller, permits localized concrete removal to depths of 2 to 3 inches with no explosions and very little dust. (The principal source of dust is the drilling of the hole into which the splitting tool is inserted.) A dust shield with a vacuum attachment minimizes the spread of contaminated dust and can be used to collect all but the largest pieces of rubble. The spaller is operated by inserting the expanding bit into a predrilled hole and activating the device hydraulically, causing the concrete surrounding the bit to be spalled off. The spaller is small, lightweight, and fully portable, and can be readily adapted to remote operation. For rapid removal of large surface areas, a number of the devices can be ganged together with a corresponding set of concrete drills and operated as a unit. Because the spacing between and the pattern of the holes are important parameters in the effectiveness of this technique, arrangement of the concrete drills and the splitting tools into a fixed-geometry array would ensure a relatively uniform removal pattern. Combining these ganged units with a vacuum transfer system for rubble removal would result in a fast and dust-free concrete removal method, one ideally suited to decommissioning facilities such as TMI-2. (See Section G.1.3.2 of Reference 3 for further discussion of concrete surface removal.)

U.2.4.2 Equipment Disassembly

Decommissioning of TMI-2 would require the disassembly and removal of the various contaminated equipment systems. The equipment must be segmented into pieces small enough to facilitate either onsite entombment or packaging for offsite shipment and disposal, depending on the decommissioning alternative selected.

Underwater Manipulator

The underwater sectioning of the neutron-activated reactor vessel and vessel internals requires a manipulator to handle the cutting equipment and other underwater tools involved. The equipment must be operable under 30 to 50 feet of water, in intense radiation fields. It is assumed that the existing fuel-handling bridge crane with its fuel-element handling boom can be adapted to this task, as postulated for the removal of the RPV head and internals and the core examination and defueling (Sections 6.2, 6.3 and 6.4). It is also assumed that, after modification for the cleanup tasks, no significant additional modification will be required to meet the needs for decommissioning.

Cutting Methods and Equipment

The principal equipment anticipated to be used for cutting activated and/or contaminated items are the oxyacetylene torch, the plasma-arc torch, and the arc saw. This equipment can be used either under water or in air. In addition, linear-shaped explosive charges may be used in special cutting applications. The oxyacetylene torch is a relatively common device and, therefore, is not discussed here; further information is available in Reference 7. The other items are described briefly below. (More detailed information is presented in Appendix E of Reference 1 and Appendix G of Reference 3.)

Plasma-arc cutting employs an extremely high-temperature, high-velocity, ionized-gas arc that melts and continuously removes metal in the work piece to produce a high-quality, saw-like cut. The process can be used to cut any metal. If inert gases are used, the cutting is dependent on thermal energy alone, but increased cutting speeds can be achieved using oxygen-bearing gases when cutting materials such as mild steel or cast iron, because the chemical energy resulting from reaction of the oxygen with the base material is added to the arc heat. The electrical circuit is similar to that used for tungsten-arc welding.

The plasma-arc cutting process can be used in air or under water. It is especially adaptable to automation and is thus useful when highly radioactive material is to be cut (e.g., the pressure vessels of the Elk River Reactor in Minnesota and the Sodium Reactor Experiment in California).[4,6] As it is not necessary to start the cut at the edge of the plate, the plasma-arc torch is particularly adaptable to cutting holes in large plates and vessels. It is also well adapted to gouging applications, including pad washing and scarfing. However, because of the short torch standoff distance, plasma-arc cutting is not suitable for some applications, particularly in tight spaces; air carbon-arc cutting can be used for such work. Plasma-arc cutting is preferred where it is possible.

The arc saw, a state-of-the-art metal-cutting device, is currently being developed for contaminated-equipment segmentation, with initial development and demonstration work already completed.[8] The device uses a charged, rotating blade to provide the cutting arc. The blade rotation helps to sweep removed materials from the kerf. Cutting can be accomplished remotely, either in air or under water, with automatic positioning and tracking of the saw blade during cutting operations. All equipment except the blade is commercially available, but modifications are necessary. Blades can be made in any well-equipped machine shop, and can be scaled to match the cutting requirements of the particular job.

A major advantage of the arc-saw over other saws is that if, because of position change or vibration, a portion of the work piece falls against or pinches the blade, the point of contact spark-erodes away because the "electrical leading edge" of the blade is transferred to the point of contact. This reduces the potential for binding of the blade. Consequently, the arc saw can cut through a variety of materials, shapes, and loose components that would be difficult to cut with conventional saws.

The use of self-contained, linear-shaped explosive charges is an economical and expedient method of reducing the size of equipment and piping to allow further processing or packaging for disposal. This method minimizes personnel radiation exposure and is particularly advantageous in areas with high-radiation levels. Linear-shaped charges have been used extensively in the last 15 to 25 years.[9,10] Recently, such methods have been used to segment and remove neutronactivated components and contaminated systems (e.g., fuel-pool liners and piping) that are not amenable to conventional removal techniques.[6,11]

A linear-shaped charge consists of an inverted-V-shaped tubular casing filled with an explosive. The principle behind use of the linear-shaped charge is that, as the detonation wave collapses the inverted V, the casing material becomes a jet of extremely hot metal particles traveling at very high velocity. These particles then tear through the material to be cut. The melting and subsequent fusing of the casing material with the base material being cut, together with the ragged edges of the finished cut, can make electropolishing of those edges very difficult.[12] Therefore, in-situ decontamination (either chemical or mechanical) prior to explosive cutting is recommended to minimize unnecessary waste of strategic materials. Clamp-on charges, available commercially, eliminate many problems in placement, handling, and detonating. The number of charges that can be detonated at one time is limited only by the blast effect on nearby equipment. Shock-wave and fragment damage can be reduced appreciably by placing blast curtains or other barriers in the vicinity of the detonation to disrupt the shock wave and intercept the fragments.

U.2.4.3 Radioactive Waste Packaging and Shipping

The decommissioning of TMI-2 by any of the three alternatives considered would produce significant quantities of radioactive wastes requiring proper packaging and shipping to an authorized disposal site. These radioactive wastes resulting from decommissioning can be classified as follows:

- Combustible or noncombustible,
- Activated or contaminated, and
- Wet or dry.

The bulk of the decommissioning wastes from TMI-2 would be dry, noncombustible, and either activated or contaminated. They include the activated reactor vessel and internals, the activated and contaminated concrete from the biological shield, contaminated concrete from walls and floors, and contaminated piping and equipment. The contact radiation dose rates from these materials vary from a few mrad/hr to thousands of R/hr. Different types of packaging and shielding are required, depending on the radiation levels involved.

Section 8 of this PEIS describes radioactive waste packaging and shipping for the TMI-2 cleanup operations preceding decommissioning. Most of the types of decommissioning wastes are thoroughly covered in Section 8 and, therefore, they are not discussed further here. The following discussion covers the remaining packaging and shipping requirements for decommissioning. The specific quantities of the various waste types produced for the three decommissioning alternatives are given later, in the sections of this appendix that detail the alternatives.

Disposable steel cask liners are used for packaging, shipping, and burying the bulk of the activated materials from the reactor vessel, the vessel internals, and the biological shield. Specially constructed steel boxes are used where size and radiation exposure considerations make packaging in cask liners unfeasible. In some cases, lead shielding must be added to the packages to reduce the surface dose rates of the containers to acceptable limits. In other cases, less-activated component pieces are used to surround the more-activated pieces to provide the required shielding without sacrificing part of the container volume.

Where external contamination levels allow, certain equipment items (e.g., heat exchangers and small tanks) will be packaged by capping the piping connections with welded metal covers and using the items' outer shells as the containers. Larger items, such as the steam generators, may be cut into sections, after which each section is capped and handled as its own container.

All disposal shipments are assumed to be made by exclusive-use trucks, in accordance with the regulations and considerations described in Section 9. A formal accident control and recovery plan is assumed to be developed prior to the first radioactive shipment of decommissioning waste. The plan is to provide for rapid and orderly utilization of utility, carrier, state, and municipal emergency personnel, as well as NRC radiological assistance teams, as required in the event that any transportation accident occurs. Procedures for control of contamination, radiation exposure, bodily injury, and property damage are included in the recovery plan. Also included are procedures for salvage and recovery of the radioactive shipment.

U.2.4.4 Contamination Control

Many decommissioning activities, particularly the cutting operations required for equipment disassembly, have the potential for generating significant amounts of airborne radioactive contamination. In addition, decommissioning involves operations in areas with smearable radioactive contamination; the movement of personnel, equipment, and materials in these areas can result in the further spread of radioactive contamination. To prevent significant radioactive releases to the environment and to minimize the personnel hazard and the potential for widespread contamination of work areas, contamination control is required.

Radioactive contamination control can be divided into three basic approaches:

- Local mitigation of contamination sources,
- Collection of contamination, and
- Isolation of contaminated areas.

These approaches are discussed below. (See Appendix G of Reference 3 for further information.)

Local Mitigation of Contaminated Sources

Mechanical or physical measures can be used to limit the spread of radioactive contamination. Two methods that have been successfully used are (1) water sprays to reduce airborne dust dispersion and (2) painting of contaminated surfaces to prevent smearing.

The wetting of dust with water or other liquids is one of the oldest methods of contamination control and can be very effective if properly used. Water sprays are widely used to control fugitive dust emissions from construction sites, and the spraying of water containing detergent (as a wetting agent) has been used in the nuclear industry to reduce dust concentrations in air.[13] Water sprays can be used in combination with other contamination control techniques, and are commonly used for dusty operations such as concrete removal.[6]

Strippable coatings can be used to seal porous surfaces (e.g., concrete) to prevent penetration of contamination. Paint can also be used to seal smearable contamination already present on surfaces to prevent subsequent contamination spread.[6] Painting is especially useful in high-traffic areas, where smearable contamination is likely to be picked up and spread around on shoe covers and equipment wheels. (See Section 5.1.3.1)

Collection of Contamination

Collection of radioactive contamination before it can be dispersed (preferably as it is generated) reduces the need for cleanup subsequent to decommissioning activities, particularly those activities that generate significant airborne contamination. Various collection methods can be used, with the use of vacuum collection and portable ventilation systems being the most common.

Contaminated materials can be collected as they are generated using vacuum systems. A dust shield with a vacuum attachment can be installed on the tool (e.g., concrete spaller or scrubber) being used.[5,6] As the contaminated dust is generated, it is drawn into the vacuum system and deposited in a collection drum. The outlet air is filtered (with roughing and HEPA filters) to prevent the collected contamination from being expelled. Various designs for vacuum collection systems are possible, depending on the required operating characteristics. A number of systems suitable for decommissioning work with little or no modification are available commercially.

Portable ventilation systems can be used to confine and collect airborne particulates generated during decommissioning operations.[6] General design information concerning such systems is discussed at length in Reference 14. Two portable ventilation systems, a work enclosure and a fume exhauster, are described here.

A portable ventilation enclosure is simply a portable "room" with a self-contained ventilation system that can provide ventilation control at various work locations during decommissioning. The enclosure unit may take whatever shape best performs the required function at a particular location. A simple, rectangular open-faced box will suffice for many applications. Roughing filters are installed at both the inlet and the outlet of the enclosure unit, and a flexible duct couples the enclosure to the cart-mounted ventilation system that consists of a large squirrel-cage blower drawing through a high-efficiency particulate air (HEPA) filter preceded by a glass-fiber roughing filter, all mounted on a wheeled cart. Radiation detection devices are used to monitor the buildup of radioactive material on the filters. A differential pressure gauge is installed across the HEPA filter to monitor the increasing pressure drop as particulates build up on the filter. Filters are changed when either the dose rate from the collected radioactive particles or the differential pressure across the HEPA filter reaches a predetermined level.

Another type of portable filtered ventilation system, a fume exhauster, has an electrostatic precipitator coupled with a roughing filter, HEPA filter, air-handling motor, squirrel-cage blower, and one or two free-standing intake ducts. The fume exhauster is used to collect radioactive and nonradioactive particulates at the point of generation. This high-volume ventilation system captures all types of particulate matter with efficiences of greater than 97% for the electrostatic unit and at least 99.95% for the HEPA filter. The advantages of this unit are its portability, ability to handle large volumes of particulate-laden air, and generation of relatively small amounts of solid wastes (HEPA filters). Buildup of radioactive materials on the precipitator and filters is monitored as described above. The electrostatic precipitator is flushed and the filters are changed when either the dose rate from collected radioactive particles or the differential pressure across the HEPA filter reaches a predetermined level.

Isolation of Contaminated Areas

One method of controlling contamination is the use of barriers to isolate contaminated areas from those with lesser or no contamination. Isolation is an important tool during continuing care as well as during active decommissioning.

One type of barrier commonly used in the nuclear industry to isolate contaminated areas is a "greenhouse." A greenhouse is constructed by covering a framework, usually steel scaffolding or fire-resistant wood frame, with fire-resistant plastic sheeting and sealing all joints. Overlapping flaps of plastic are generally used for the door. The greenhouse is connected either to the plant ventilation system or to a portable system to prevent outward leakage of contamination by drawing a slight vacuum on the greenhouse.[5] Greenhouses can be semi-permanent, portable struc-tures that can be moved from one location to another as needed, but are more often temporary confinement structures that are dismantled and discarded after each job. In many cases, construction of a complete greenhouse is unnecessary. A simple plastic curtain partitioning off one section of a room may be all that is required to isolate a contaminated area. The type and degree of isolation required depends on the equipment or structures involved, the associated level and mixture of radioactive contamination, and the decommissioning operation being performed.

Prior to the continuing care period for SAFSTOR or ENTOMB, portions of the facility containing significant amounts of radioactive contamination that are not removed during active decommissioning must be isolated from the remainder of the facility. Potential pathways for the migration of contamination from these areas are blocked by the installation of physical barriers. Besides acting as contamination control barriers, the barriers are designed to discourage unauthorized personnel entry into contaminated areas, so structurally substantial barriers are used. Piping, ventilation ductwork, equipment penetrations, and doors and hatches are sealed as necessary. Pressure-equalization lines are then installed between the isolated interior spaces and the outside environment to prevent pressure differentials (due to temperature or atmospheric pressure changes) from developing. The lines are equipped with replaceable HEPA filters to prevent contamination from being entrained in the air flow out of the buildings.

U.2.5 Additional Requirements

Most decommissioning requirements relate directly to the removal or stabilization of onsite radionuclides. However, there are additional requirements that serve to ensure the timely, effective, and safe completion of the work. The major additional requirements, which are discussed here, are quality assurance and environmental surveillance.

U.2.5.1 Quality Assurance

A complex project such as the TMI-2 decommissioning requires QA planning from the earliest stages. As each detailed decommissioning procedure is developed, the QA portions are included. Current regulations and guides that could apply to decommissioning are discussed in Section F.4 of Reference 1 and Chapter 5 of Reference 3.

U.2.5.2 Environmental Surveillance

Environmental surveillance is of concern during the decommissioning of any nuclear facility and particularly during the decommissioning of a facility such as TMI-2 where the decommissioning process may be complicated by unusual and unforeseen difficulties. The following objectives are relevent to the environmental surveillance for the decommissioning project:

- Detection of sudden changes and evaluation of long-term trends of (radionuclide) concentrations in the environment, with the intent of detecting failure to adequately control releases and then to initiate appropriate actions;

- Assessment of the actual or potential exposure of people to radioactive materials or radiation present in their environment, or estimation of the probable upper limits of such exposure;

- Determination of the fate of contaminants released to the environment, with the intent of detecting previously unconsidered mechanisms of exposure; and

- Demonstration of compliance with applicable regulations and legal requirements concerning releases to the environment.

The required levels of environmental surveillance for active decommissioning (the period of decommissioning activity immediately following the TMI-2 plant cleanup) would differ from those for the continuing care period (required for SAFSTOR and ENTOMB).

The environmental surveillance program for the active phase of TMI-2 decommissioning is expected to be a continuation of the program for the preceding cleanup period. This program is detailed in Appendix M and summarized in Chapter 11 of this statement. The program is subject to change based on review of the results obtained and any requests for additional monitoring. It is anticipated that the level of effort required will be reduced as the contaminated materials are removed from the site and the associated potential for radioactive release is reduced.

An abbreviated version of the environmental monitoring program for active decommissioning would be carried out during continuing care. Special surveillance requirements would be included for emergency situations involving radionuclide releases (e.g., fire or malicious acts) that would require prompt emergency actions to minimize public risk. Changes in background radiation levels, in environmental radiation accumulations (e.g., fallout from nuclear weapons testing), and especially in land usage and population distribution may, over a period of years, justify modifications to the continuing care surveillance program. The program is anticipated to be reviewed and revised as appropriate at the following times:

- After all fuel and source material have been removed from the plant,

- Approximately 10 years after decommissioning is completed, and

- After 10 half-lives of Co-60 decay (approximately 53 years), economic advantages of further decommissioning effort are ascertained by the owner, and environmental monitoring conceivably could be reduced or even eliminated.

As experience is gained and a data base is developed, modifications to the environmental program can be expected.

U.2.6 Unit Costs

The decommissioning cost information developed in this statement is based on unit cost data presented in Appendix I of Reference 1 and Appendix M of Reference 3. The cost data presented in the references are based on late-1977/early-1978 costs. For general cost items (e.g., labor, materials, and equipment), the base data have been adjusted by a factor of 1.17 to account for escalation to current (mid-1980) costs, based on the Handy-Whitman Index[15] and the Chemical Engineering Plant Cost Index.[16] Transportation costs for shipping radioactive wastes to a disposal site are increased on a per-mile basis in accordance with escalation in the published rates of a carrier licensed to transport radioactive materials.[17] Other adjustments are made as required to adjust for differences in assumptions between this statement and the reference studies (e.g., the shipping distance to a low-level waste disposal site is assumed to be about 2300 miles in this statement as opposed to 500 miles in the reference studies).

U.2.7 Activated Materials Inventory

The quantities of radionuclides present in the activated materials at TMI-2 are estimated by interpolation of the curves of radionuclide growth versus effective full-power years (EFPY) given in Figure C.1-4 of Reference 1 at the point of 0.26 EFPY (the accumulated exposure on TMI-2).

The interpolated fractions of activity relative to the activity after 30 EFPY are given in Table U.5 for the principal radionuclides present in the activated reactor vessel internals, together with the inferred specific activities and estimated surface dose rates. The values given in Table U.5 are for the most highly activated region of the vessel internals, at the core mid-plane.

Table U.5. Estimated Specific Activities and Surface Doses from Reactor Vessel Internals of TMI-2

Radionuclide	Fraction of Activity, Relative to 30 EFPY	Inferred Specific Activity (Ci/m^3)	Estimated Surface Dose Rate (Rad/hr)
Co-60	0.032	30,400	16,000
Fe-55	0.05	65,000	0.005
Ni-59	0.008	6	0.0007
Nb-94	0.008	0.04	0.016

In general, the levels of induced radioactivity in the structural materials of TMI-2 are in the range from 1 to 5% of the values that would be present after 30 EFPY. Since Co-60 is the dominant radioactive species produced, its fractional production factor in TMI-2 (0.032) can be applied with minimal error to the values presented in Appendix C of Reference 1 to obtain reasonable estimates of the quantities of activated materials present in TMI-2 at the time of the accident. Based on the quantities of radioactivity given in Table C.1-4 of Reference 1, the total activity in the reactor vessel internal components in TMI-2 at the time of the accident is estimated to be (4.82×10^6 Ci $\times$ 0.032), or 1.54×10^5 Ci. In the reactor pressure vessel, the total activity is estimated to be (1.92×10^4 Ci $\times$ 0.032), or 611 Ci. In the concrete biological shield, the total activity is estimated to be (2000 Ci $\times$ 0.032), or 64 Ci.

U.2.8 Contaminated Materials

The principal radionuclides present on external surfaces in TMI-2 are Cs-137 and Sr-90. The radiation fields from radionuclides deposited on the interior surfaces of the RCS and associated piping and equipment may also be dominated by Cs-137, although significant quantities of Co-60 are probably present also. Since Cs-137 is the principal radionuclide contributing to the radiation fields within the plant, the decrease in radiation dose rates with time will be controlled largely by the half-life of Cs-137 (~30 years).

This condition is different from the reference decommissioning studies[1-3] where Co-60 is the dominant radionuclide, controlled by its 5.7-yr half-life, and extensive surface contamination is not a major problem. Thus, deferring decommissioning action at TMI is less effective in reducing radiation dose than would be the case at the reference reactors. The longer half-life of Cs-137 also lengthens the time that an entombment structure would have to retain its integrity, more than 300 years, until the contamination has decayed to unrestricted release levels.

U.3 IMMEDIATE DISMANTLEMENT (DECON)

DECON is the removal from the site of all materials having radioactivity levels greater than permitted for unrestricted use of the property. Thus, all radioactively contaminated equipment, tanks, pumps and piping; the reactor vessel and internals; and activated and contaminated concrete must be removed, packaged, and shipped to an authorized radioactive waste disposal site. Radiation surveys of the decontaminated facility and site must show that residual levels of radioactivity do not exceed those given in Table 1 of Regulatory Guide 1.86, which appears as Table 1.1 in this report, in order for the nuclear license to be terminated. As a result, large expenditures of personnel radiation exposure, disposal site space, and money are made in exchange for the fairly prompt release of the facility and the site for other uses.

An additional factor favoring the DECON alternative is that a knowledgable work force is available (from the facility operations staff) to perform the decommissioning work. The elimination of continuing security, maintenance and surveillance requirements for the unit are not very significant benefits for TMI-2 because these services are readily provided by the other unit on the site (TMI-1). Decommissioning via DECON would preclude storage of the irradiated fuel in the AFHB beyond the length of time required to ship the fuel to an offsite facility since, by definition, all radioactive materials must be removed. The continued use by TMI-1 is postulated for such facilities as the chemical cleaning building (EPICOR-II), EPICOR-I, the radiochemistry hot lab, and the solid radwaste staging modules. The resin solidification and mid-high level radwaste staging facility (if built) is also postulated to remain in place for service with Unit 1.

U.3.1 Decommissioning Activities for DECON

Once the irradiated fuel has been placed in the spent fuel pool in the AFHB, the fuel debris has been dissolved and removed, and the reactor coolant system and associated fluid handling systems have been chemically decontaminated, disassembly, disposal, and further decontamination can proceed promptly. Work begins in the reactor containment building, proceeds through the AFHB, and concludes with the service and control buildings. The turbine building and other onsite structures (except for the EPICOR-II building and any other as-yet constructed waste treatment buildings) are assumed to be uncontaminated.

The estimated duration of each event during DECON is shown in Figure U.2. The disassembly and decontamination of the facility is estimated to require nearly four years.

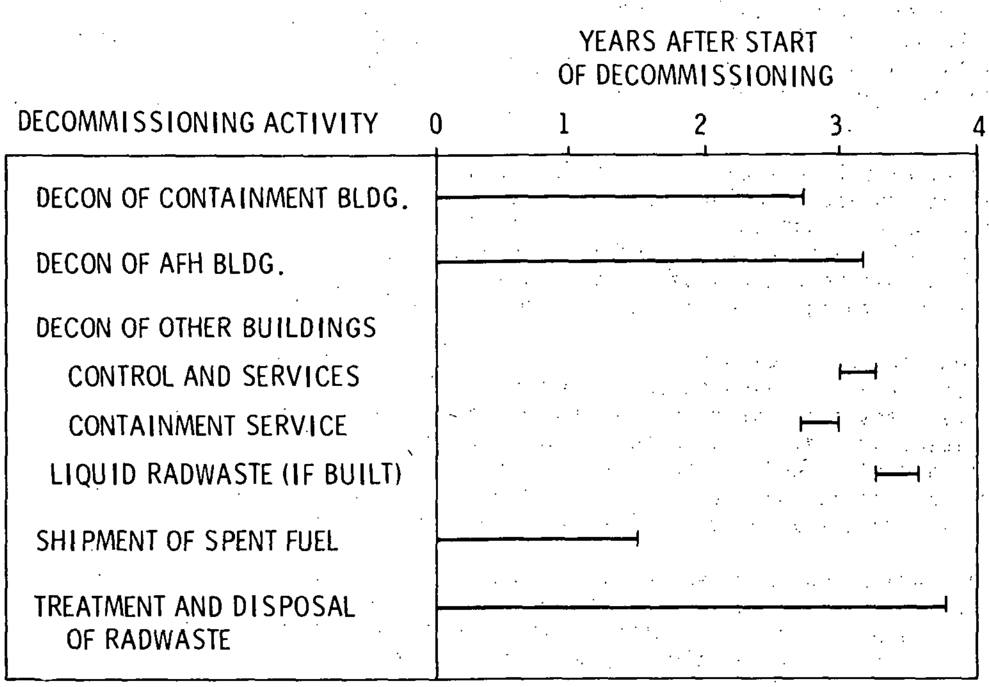
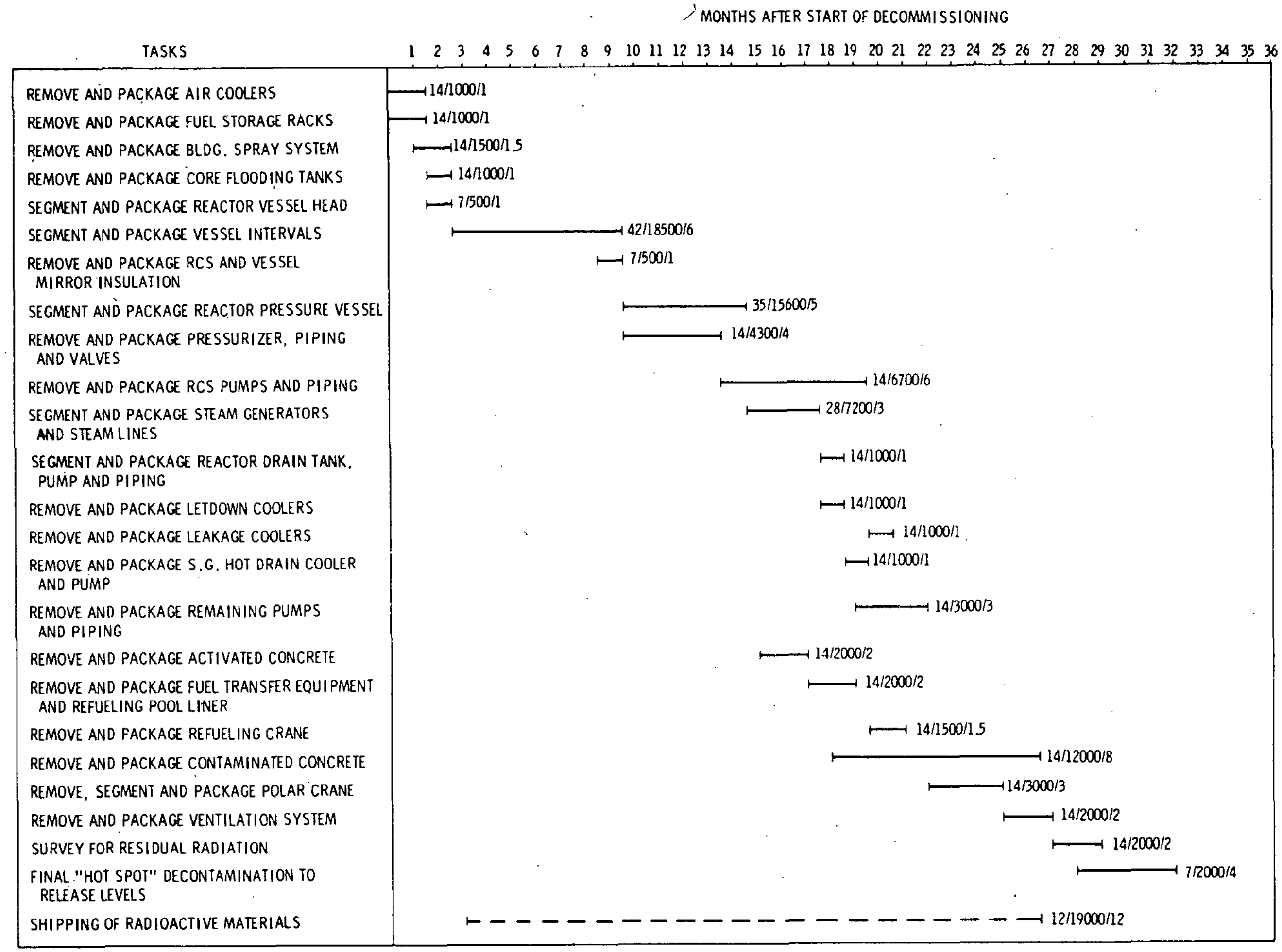


Figure U.2. Duration of DECON Activities.

U.3.1.1 Containment Building

The postulated sequence and schedule for major tasks for disassembly and decontamination of the containment building is shown in Figure U.3, together with postulated crew sizes and estimated exposure hours. The associated worker radiation doses are given in Section U.3.4.



LEGEND:

DIRECT STAFF PER DAY/EXPOSURE HOURS/CALENDAR MONTHS

├──┤ CONTINUOUS OPERATIONS OVER THE TIME SPAN SHOWN

├ ─ ┤ INTERMITTENT OPERATIONS OVER THE TIME SPAN SHOWN

TOTALS:		
	PERSON-MONTHS	1,188
	PERSON-HOURS	226,160
	EXPOSURE-HOURS	110,300

THIS SCHEDULE COULD BE SIGNIFICANTLY INFLUENCED BY MANY FACTORS THAT ARE NOT PRECISELY KNOWN AT THIS TIME. THESE INCLUDE, BUT ARE NOT LIMITED TO, THE EXACT RADIOLOGICAL CONDITIONS ENCOUNTERED UPON COMPLETION OF INITIAL DECONTAMINATION EFFORTS, FINANCIAL LIMITATIONS, REGULATORY ACTIVITIES, CRAFT LABOR AND MATERIAL AVAILABILITY, AND AVAILABILITY OF OFFSITE OR ONSITE RADWASTE DISPOSAL CAPABILITY ON A TIMELY BASIS.

Figure U.3. Postulated Sequence and Schedule of Tasks for DECON of the Containment Building.

Disassembly begins with the removal and packaging of the containment air coolers (if not previously removed), the fuel storage racks, the containment spray system, and the core flooding tanks, thus freeing most of the 305-ft level for use as a packaging and storage area for packaged materials pending shipment offsite. The fuel transfer canal is now available for segmentation and temporary storage of the activated portions of the reactor vessel internals and for temporary storage of activated segments of the reactor pressure vessel while the vessel is being sectioned.

Removal of the decontaminated structures is not required to terminate the nuclear license and thus is not considered in this analysis. The disposition of the released structures is at the owner's option.

The estimates of direct labor hours, waste volumes, and costs are derived largely by comparison with the results of previous conceptual decommissioning studies,[1,3] adjusted for the sizes and masses of equipment, levels of contamination or activation in the materials, distance to the disposal site, and escalations in costs from the time of the reference studies to mid-1980.

It is assumed that the reactor vessel head, the upper plenum assembly, and the core support structure are successfully removed intact during defueling and cleanup and are reinstalled for the chemical decontamination of the reactor coolant system, in which the RCS pumps are used for recirculation of the decontamination solution and final flushing. The head is removed and sectioned for packaging. The upper plenum assembly and the core support structures are removed and sectioned and stored temporarily under water in the fuel transfer canal. The water level in the canal is lowered to about the 322-ft level to remove the seal plate and the mirror insulation surrounding the vessel. The water level in the vessel is lowered to just below the planned level for cutting. The vessel is cut into segments that are temporarily stored in the fuel transfer canal prior to packaging. As the reactor vessel is drained and cut, the remainder of the RCS is drained for sectioning. Removal and packaging of the pressurizer and piping is followed by sectioning and removal of the RCS pumps and piping. Sectioning of the steam generators and removal of the steam export lines and valves is followed by removal and packaging of the letdown coolers, the steam generator hot-drain cooler, the leakage coolers, the reactor drain tank, the oil-shielded drain tanks, the incore instrumentation drives, and assorted pumps and equipment on the 282-ft level.

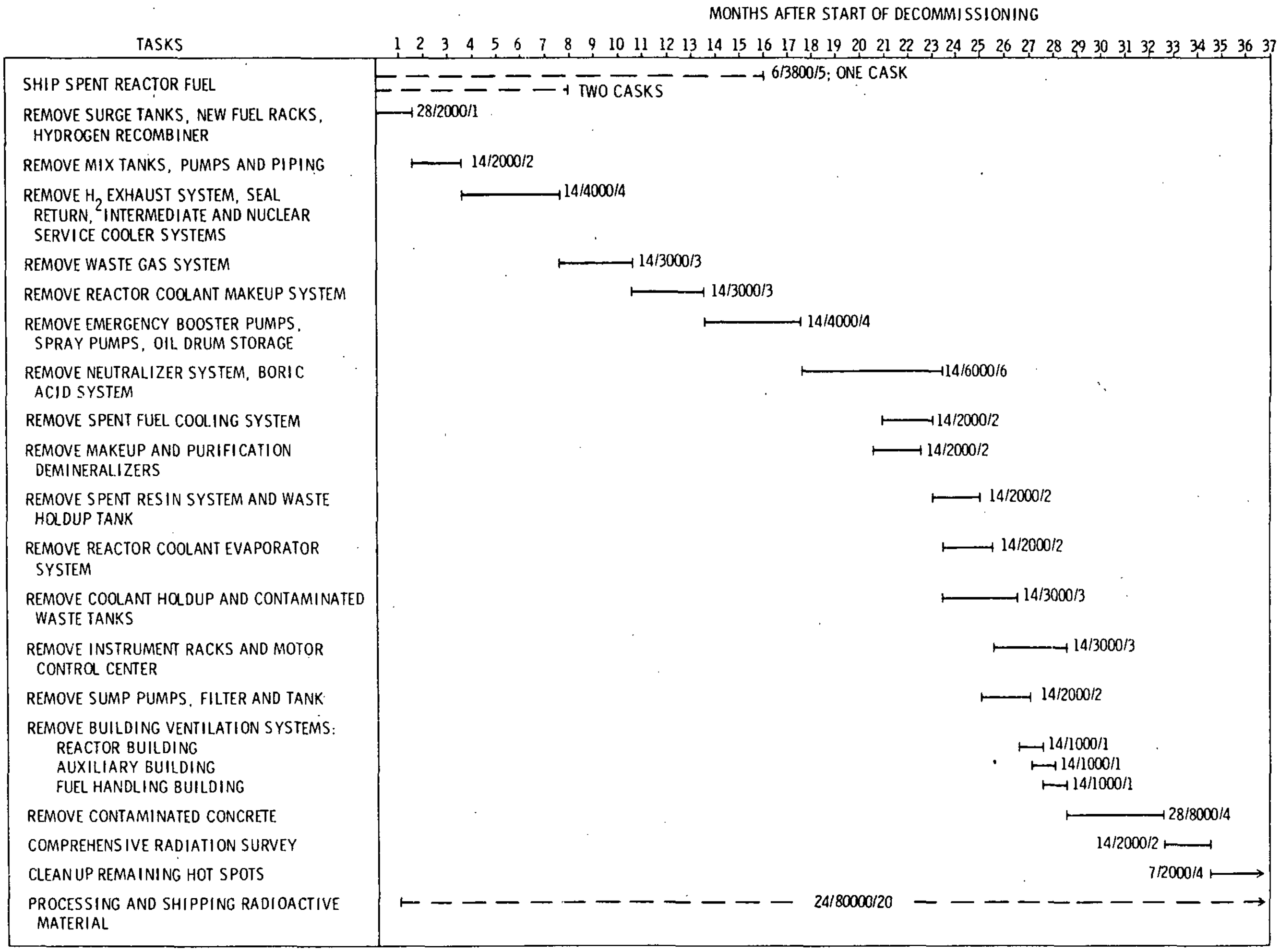
Removal of some of these items will require removal of sections of the shield walls surrounding them. The lower sections of the vertical tendons are most likely contaminated and will have to be removed for disposal. Those portions of the concrete biological shield in the vicinity of the fuel core that have been activated by neutron bombardment are removed and packaged. The refueling bridge crane, the fuel transfer equipment, and the liner of the fuel transfer canal are removed and packaged. The outer 2 to 3 inches of concrete is removed from concrete surfaces that were subjected to standing contaminated water, principally the concrete floor of the 282-ft level and the first 9-10 feet of wall surfaces rising from the 282-ft level and the surfaces of the tendon gallery. Other concrete surfaces are removed as dictated by radiation survey data. The polar crane is either decontaminated to release levels or is dismantled and packaged. Removal and packaging of the remaining ventilation equipment precedes the radiation survey to determine the releasability of the containment building. Any areas found to have radioactivity levels exceeding those levels set for release are cleaned or removed. At this point the containment building is available for non-nuclear use or demolition, at the owner's option.

Disassembly, decontamination, and disposal of the radioactive materials from the containment building are estimated to require about 226,000 direct labor hours, including 110,000 hours of work in radiation zones. Transport workers and workers at the waste disposal site are not included in these estimates.

U.3.1.2 Auxiliary and Fuel Handling Building

With the reactor core stored in the spent fuel pool, the first activity to get underway in the AFHB is the shipment of the spent fuel to a storage facility, a reprocessing plant, or a disposal facility offsite. Assuming an IF-300 cask (capacity 7 elements) is used, with an 18-day round-trip cycle, 26 round trips by rail will be required to remove the 177 fuel elements, or about 16 months elapsed time. Availability of another spent fuel shipping cask of similar capacity would reduce the fuel shipment period to about 8 months. Additional shipments may be required to remove packaged fuel debris.

The postulated sequence and schedule of tasks for disassembly and decontamination of the AFHB is shown in Figure U.4. The general plan of attack is to start on the upper levels, removing systems no longer needed, and proceed toward the lower levels. The spent fuel pool cleanup system will remain in service until shipment of spent fuel is completed.



LEGEND:

DIRECT STAFF PER DAY/EXPOSURE HOURS/ CALENDAR MONTHS

⊢—⊣ CONTINUOUS OPERATIONS OVER THE TIME SPAN SHOWN

⊢ – – ⊣ INTERMITTENT OPERATIONS OVER THE TIME SPAN SHOWN

THIS SCHEDULE COULD BE SIGNIFICANTLY INFLUENCED BY MANY FACTORS THAT ARE NOT PRECISELY KNOWN AT THIS TIME. THESE INCLUDE, BUT ARE NOT LIMITED TO, THE EXACT RADIOLOGICAL CONDITIONS ENCOUNTERED UPON COMPLETION OF INITIAL DECONTAMINATION EFFORTS, FINANCIAL LIMITATIONS, REGULATORY ACTIVITIES, CRAFT LABOR AND MATERIAL AVAILABILITY, AND AVAILABILITY OF OFFSITE OR ONSITE RADWASTE DISPOSAL CAPABILITY ON A TIMELY BASIS.

TOTALS:		
	PERSON-MONTHS	1,436
	PERSON-HOURS	252,820
	EXPOSURE-HOURS	138,800

Figure U.4. Postulated Sequence and Schedule of Tasks for DECON of the AFH Building.

The waste handling and treatment system will remain in service until all other radioactive fluid handling systems are removed. The outer 2 to 3 inches of concrete is removed from concrete surfaces that were subjected to contaminated water spills. Removal and packaging of the building ventilation equipment is the final action preceding the radiation survey to determine the releasability of the AFH building. Any areas found to have radioactivity levels exceeding those levels set for release are cleaned or removed. At this point the AFH building is available for non-nuclear use or demolition, at the owner's option. Disassembly, decontamination, and disposal of the radioactive materials from the AFH building is estimated to require about 252,800 direct labor hours, including about 138,800 hours of work in radiation zones. Transport workers and workers at the waste disposal site are not included in these estimates.

U.3.1.3 Other Buildings

Other buildings associated with TMI-2 that contain quantities of radioactivity are the control and service building, the containment service building, and the liquid radwaste processing building (if built). It is postulated that the chemical cleaning building (EPICOR-II), EPICOR-I, the radioachemistry hot lab, the resin solidification and mid-high level radwaste staging facility (if built), and the solid radwaste staging modules will remain onsite and be servicable for use with TMI-1.

Control and Service Building

Radioactively contaminated equipment in this building is limited to the contaminated drain system and the isolation valve tanks and pumps on the 280-ft level, the monitoring and soiled laundry areas on the 305-ft level, and the decontamination filter assembly on the 351-ft level. Since all systems and services are controlled from this building, it will be the last to be decontaminated.

Containment Service Building

This structure is basically an extension of the containment building, enclosing the equipment hatch and providing a staging area for shipping packaged material from the containment building. It is postulated that decontamination efforts in this building are limited to surface cleaning, since most of the materials are already packaged before removal from containment.

Liquid Radwaste Processing Building

This structure does not presently exist and its contents can only be postulated. Likely systems include a radwaste evaporator and a liquid waste solidification system. Removal of these systems is delayed until decontamination of the containment and AFH buildings is complete.

Summary of Other Buildings

Disassembly, decontamination, and disposal of radioactive materials from the other buildings are estimated to require about 22,000 direct labor hours, including about 18,000 hours in radiation zones.

U.3.2 Waste Volumes from DECON

The volumes of activated or contaminated material postulated to be packaged for disposal during DECON of TMI-2 are estimated by comparing sizes and masses of the TMI-2 materials with similar materials analyzed in a previous study.[1,2] Using the methods described in Reference 2, scaling factors are constructed based on the ratio of the mass of the TMI-2 component to the mass of the reference component. These mass ratios, or scaling factors, are applied to the volumes and costs estimated in Reference 1 to obtain estimates for TMI-2. Where mass ratios could not be readily constructed, an overall scaling factor based on energy output, as derived in Reference 2, is employed (0.84). The resultant waste volumes are summarized in Table U.6.

The volume of contaminated concrete is postulated to be 20% greater than given in Reference 1, reflecting the large areas of TMI-2 that were subjected to standing contaminated water for extended periods of time. The other values generally reflect the physical size or configuration of TMI-2 compared with the Reference plant.

Table U.6. Estimated Volumes of Radioactive Waste Arising from DECON of TMI-2

Components	Scaling Factor	Estimated Burial Volume (ft^3)	Truck Shipments
Reactor vessel w/head and internals	0.94	15,600	156
RCS pumps, piping and pressurizer	0.83	9,100	22
Steam generators	0.83	17,700	26
Activated concrete	1.0	25,000	49
Contaminated concrete	1.2	455,000	889
Contaminated equipment	0.84	127,000	34
Miscellaneous radwastes	1.0	22,000	180
Totals		671,000	1,356

[a]Values rounded to three significant figures.

U.3.3 Effluents and Releases to the Environment

The atmospheric release of radionuclides is assumed to be the only source of radiation to the public from routine decommissioning operations. All liquid radioactive wastes generated during decommissioning operations are assumed to be sent to the plant liquid waste storage system or to other tanks designated for temporary storage of these solutions. The wastes are then assumed to be processed through the waste concentration and solidification system, and the decontaminated water released to the environment. All systems designed to control the release of hazardous material to the environment or to noncontaminated portions of the facility are assumed to be in operation during the decontamination activities and subsequent waste processing.

The primary sources of radioactive effluents from routine decommissioning operations are the release of contaminated liquid aerosols during decontamination, the release of contaminated vaporized metal during equipment removal, and the release of contaminated concrete dust during decontamination or removal of concrete structures.

An analysis of the generation of airborne radioactivity during DECON operations at a large PWR is given in Appendix J of Reference 1, with the results of that analysis summarized in Table U.7. The values given in Table U.7 have been adjusted downward from those developed in Reference 1 to reflect the smaller amount of activated corrosion product deposited on piping interiors (∿ 4 percent of the amount postulated in Reference 1), the smaller amount of activation in the concrete bioshield (∿ 5 percent of the amount postulated in Reference 1), and adjusted upward to reflect the assumption of a less effective HEPA filter system than was postulated in Reference 1. The releases postulated here do not include releases from possible accidents involving transport of spent reactor fuel from the site to a disposal facility.

From Reference 1, the compositions of the reference radionuclide inventories considered in the analysis are presented in Tables U.8, .9, .10, and .11.

Table U.7. Postulated Releases of Airborne Radioactivity to the Environment During DECON Operations

DECON Operation	Reference Radionuclide Inventory	Airborne Releases (μCi)
Segmenting contaminated equipment	4	6
Activated concrete removal	3	0.2
Contaminated concrete removal	5	0.0016
Water-jet cleaning	5	9.8

Table U.8. Reference Radionuclide Inventory 2, Carbon Steel Activation Products - Lower Vessel

	Fractional Radioactivity Normalized to Reactor Shutdown at Decay Times of:				
Radionuclide	Shutdown	10 Years	30 Years	50 Years	100 Years
Mn-54	5.3×10^{-2}	1.6×10^{-5}	-[a]	-	-
Fe-55	8.2×10^{-1}	6.3×10^{-2}	3.7×10^{-4}	2.1×10^{-6}	-
Fe-59	3.1×10^{-2}	-	-	-	-
Co-58	7.5×10^{-3}	-	-	-	-
Co-60	8.5×10^{-2}	2.3×10^{-2}	1.6×10^{-3}	1.2×10^{-4}	1.6×10^{-7}
Ni-59	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}	3.6×10^{-5}
Ni-63	4.3×10^{-3}	4.0×10^{-3}	3.5×10^{-3}	3.0×10^{-3}	2.1×10^{-3}
Mo-93	1.5×10^{-6}	1.5×10^{-6}	1.5×10^{-6}	1.5×10^{-6}	1.5×10^{-6}
Totals	1.0	9.0×10^{-2}	5.5×10^{-3}	3.2×10^{-3}	2.1×10^{-3}

[a] A dash indicates values less than 1×10^{-10}.

Table U.9. Reference Radionuclide Inventory 3, Concrete Activation Products - Biological Shield[a]

Radionuclide	Fractional Radioactivity Normalized to Reactor Shutdown at Decay Times of: Shutdown	10 Years	30 Years	50 Years	100 Years
Ar-39	1.14×10^{-3}	1.11×10^{-3}	1.05×10^{-3}	1.00×10^{-3}	8.78×10^{-4}
Ca-41	2.01×10^{-4}	2.01×10^{-4}	2.01×10^{-4}	2.01×10^{-4}	2.01×10^{-4}
Ca-45	1.05×10^{-1}	2.30×10^{-8}	-[b]	-	-
Mn-54	4.83×10^{-3}	1.05×10^{-6}	-	-	-
Fe-55	8.65×10^{-1}	6.64×10^{-2}	3.91×10^{-4}	2.30×10^{-6}	-
Co-60	1.92×10^{-2}	5.15×10^{-3}	3.71×10^{-4}	2.67×10^{-5}	3.73×10^{-8}
Ni-59	3.42×10^{-5}	3.42×10^{-5}	3.42×10^{-5}	3.42×10^{-5}	3.42×10^{-5}
Ni-63	4.02×10^{-3}	3.75×10^{-3}	3.27×10^{-3}	2.84×10^{-3}	2.01×10^{-3}
Total	1.0	7.70×10^{-2}	5.32×10^{-3}	4.10×10^{-3}	3.12×10^{-3}

[a]The radionuclides listed include only those whose half-life and/or initial concentration result in a significant contribution after one year's decay and/or one hundred year's decay.

[b]A dash indicates values less than 1×10^{-10}.

Table U.10. Reference Radionuclide Inventory 4, Neutron-Activated Corrosion Products Deposited on Piping Internal Surfaces

Radionuclide	Fractional Radioactivity Normalized to Reactor Shutdown at Decay Times of: Shutdown	10 Years	30 Years	50 Years	100 Years
Cr-51	2.4×10^{-2}	-[a]	-	-	-
Mn-54	3.6×10^{-2}	1.1×10^{-5}	-	-	-
Fe-59	8.2×10^{-3}	-	-	-	-
Co-58	4.6×10^{-1}	-	-	-	-
Co-60	3.2×10^{-1}	8.6×10^{-2}	6.2×10^{-3}	4.4×10^{-4}	6.0×10^{-7}
Zr-95	5.6×10^{-2}	-	-	-	-
Nb-95	5.6×10^{-2}	-	-	-	-
Ru-103	2.6×10^{-2}	-	-	-	-
Cs-137	1.2×10^{-3}	9.5×10^{-4}	6.0×10^{-4}	3.8×10^{-4}	1.2×10^{-4}
Ce-141	6.6×10^{-2}	-	-	-	-
Totals	1.0	8.7×10^{-2}	6.8×10^{-3}	8.2×10^{-4}	1.2×10^{-4}

[a]A dash indicates values less than 1 x 10-10.

NOTE: The activities are based on actual data from the Turkey Point Reactors extrapolated to 7 years of commercial operation.

Table U.11. Reference Radionuclide Inventory 5, Radioactive Surface Contamination in the Reference PWR

Radionuclide	Fractional Radioactivity Normalized to Reactor Shutdown at Decay Times of:				
	Shutdown	10 Years	30 Years	50 Years	100 Years
Mn-54	1.4×10^{-3}	4.2×10^{-7}	-[a]	-	-
Fe-55	2.2×10^{-2}	1.7×10^{-3}	9.9×10^{-6}	5.7×10^{-8}	-
Fe-59	8.7×10^{-4}	-	-	-	-
Co-58	7.5×10^{-3}	-	-	-	-
Co-60	7.5×10^{-2}	2.0×10^{-2}	1.4×10^{-3}	1.0×10^{-4}	1.4×10^{-7}
Sr-89	1.2×10^{-3}	-	-	-	-
Sr-90	6.9×10^{-4}	5.4×10^{-4}	3.4×10^{-4}	2.1×10^{-4}	6.3×10^{-5}
Y-90	6.9×10^{-4}	5.4×10^{-4}	3.4×10^{-4}	2.1×10^{-4}	6.3 x 10-5
Zr-95	2.5×10^{-4}	-	-	-	-
Nb-95	2.5×10^{-4}	-	-	-	-
Te-129m	3.1×10^{-4}	-	-	-	-
I-131	1.4×10^{-2}	-	-	-	-
Cs-134	1.2×10^{-1}	4.1×10^{-3}	4.8×10^{-6}	5.4×10^{-9}	-
Cs-136	1.1×10^{-3}	-	-	-	-
Cs-137	7.5×10^{-1}	5.9×10^{-1}	3.7×10^{-1}	2.4×10^{-1}	7.4×10^{-2}
Totals	1.0	6.2×10^{-1}	3.7×10^{-1}	2.4×10^{-1}	7.4×10^{-2}

[a] A dash indicates values less than 1×10^{-10}.

U.3.4 Environmental Impacts

The environmental impacts associated with the decontamination and disassembly of a nuclear power reactor are contained in three general categories: (1) the radiation dose to the workers involved in the disassembly, packaging, and transport of the radioactive materials from the site to a disposal facility; (2) the radiation dose to the public resulting from releases of radioactivity from the site during decommissioning operations and from radiation emanating from shipments of radioactive waste while in transit on public highways or railways; and (3) the commitment of space in a low-level radioactive waste burial ground for the disposal of the radioactive materials from the plant. The impacts associated with each of these categories are discussed in the following sections.

U.3.4.1 Estimated Occupational Radiation doses from DECON Activities

The radiation dose accumulated by the workers performing DECON activities is estimated by multiplying the average local radiation dose rate for a given task times the number of worker exposure hours estimated for that task, and summing over all tasks. The average local dose rates for general areas in the containment building and the AFH building are given in Table U.12. Also given are cumulative exposure hours for persons working in those general areas (taken from Figures U.3 and U.4), the computed cumulative dose to the workers accomplishing tasks in those areas, and the total radiation dose received by workers while performing DECON activities. These radiation doses include only the doses resulting from external exposure and do not include any potential doses that might result from inhalation or ingestion of radioactive material during the decommissioning operations.

The estimated dose received by the transportation workers during the transport of packaged radioactive wastes, based on an assumed realistic dose rate for each shipment as given in Section 9.5.1.1 (56 mrem/trip/driver), is given in Table U.13. The estimated dose received by railway workers during the transport of the spent reactor fuel, based on information developed in Section 11.4.1 of Reference 1, is also given in Table U.13.

Table U.12. Estimated Cumulative Radiation Doses Received by Workers During DECON Operations

DECON Operation Area	Average Local Dose Rate (mrem/hr)	Worker Exposure Hours in the Area	Cumulative Radiation Dose (person-rem)
Containment Building			
347-ft level	~5	47,600	240
305-ft level	5-10	25,000	125
282-ft level	30	37,700	1,130
AFH Building			
All levels	2	138,800	278
Other Buildings			
All levels	2	18,000	35
Total[a]			1,810

[a]Total rounded to three significant figures.

Table U.13. Estimated Cumulative Radiation Doses Received by Transport Workers During DECON Operations

Worker Type	Dose/Shipment (mrem/driver)	Number of Shipments	Cumulative Radiation Dose (person-rem)
Truck Drivers	56	1,400	156.8[a]
Train Crew	120	26	6.2[a]
Total			163

[a]Assumes two drivers/truck, two brakemen/train.

U.3.4.2 Offsite Doses from DECON Activities

The dose estimates presented here for DECON activities are based on the source terms of Table U.7 and on the assumption that decommissioning activities take place 10 years after the TMI-2 accident. The calculational models used to make these estimates and the interpretation of their results are described in Appendix W. The significance of these doses and their human health and environmental consequences are discussed in Section 10.3. The dose estimates to the maximum-exposed individual are listed in Table U.14. The 50-mile total body population dose received by the human population during this DECON operation is estimated to be 6×10^{-5} person-rems.

The estimated radiation dose to the public resulting from transport of radioactive materials offsite is presented in Table U.15 for both truck and rail transport.

Table U.14. Estimated Doses to the Maximum-Exposed Individual from Normal Decommissioning Activities (DECON)

Location	Pathway	Dose (mrem)[a]		
		Total-Body	Bone	Liver
Nearest garden[b]	Inhalation	1.4×10^{-7}	3.1×10^{-7}	2.6×10^{-7}
	Ground Shine	7.2×10^{-7}	7.2×10^{-7}	7.2×10^{-7}
	Vegetable Use	3.2×10^{-6}	1.4×10^{-5}	1.3×10^{-5}
	Total	4.1×10^{-6}	1.5×10^{-5}	1.4×10^{-5}
Nearest milk goat	Inhalation	1.2×10^{-7}	1.7×10^{-7}	1.7×10^{-7}
	Ground Shine	6.9×10^{-7}	6.9×10^{-7}	6.9×10^{-7}
	Goat Milk Use	8.4×10^{-6}	6.5×10^{-5}	7.6×10^{-5}
	Total	9.2×10^{-6}	6.6×10^{-5}	7.7×10^{-5}
Nearest cow and garden	Inhalation	1.5×10^{-7}	2.0×10^{-7}	2.1×10^{-7}
	Ground Shine	1.1×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
	Vegetable Use	4.6×10^{-6}	2.0×10^{-5}	1.9×10^{-5}
	Cow Milk Use	3.1×10^{-6}	2.4×10^{-5}	2.8×10^{-5}
	Total	9.0×10^{-6}	4.5×10^{-5}	4.8×10^{-5}

[a]Doses were calculated for total-body, GI-tract, bone, liver, kidney, thyroid, lung and skin. The maximum three organ doses are listed in this table. Doses were calculated for four age groups: adults, teenagers, children, and infants. The highest dose estimates for each age group are listed. The dose estimates for the total-body pathway are for adults. The dose estimates for the bone and liver pathways for the nearest garden and nearest cow and garden locations are for children, and for the nearest goat location are for infants.

[b]The basis for selecting the special locations is described in Appendix W. The actual locations are: Nearest garden = 1.05 mile east-northeast, nearest milk goat = 1.02 mile north, and nearest cow and garden = 1.05 mile east.

Table U.15. Estimated Cumulative Radiation Dose Received by the Public During Transport of Radioactive Wastes from DECON

Type of Shipment	Number of Shipments	Dose/Shipment (person-rem)	Public Radiation Dose (person-rem)
Radioactive material (truck)	1,400	0.053[a]	74.2
Spent reactor fuel (rail)	26	0.0293[b]	0.76
Total			75

[a]Based on data given in Section 9.5.1.2.

[b]Based on data given in 11.4.1 of Reference 1.

U.3.4.3 Other Environmental Effects

Other impacts on the environment surrounding the TMI station resulting from DECON of Unit 2 will be similar to those discussed in Section 10.6, but of lesser magnitude because there will be fewer workers involved in DECON and because gross contamination cleanup efforts will have been completed before the start of decommissioning.

It is anticipated that decommissioning of Unit 2 would reduce the level of anxiety and psychological stress among local residents.

Completion of decommissioning will reduce the number of persons employed at the TMI site, thus reducing the local payroll, at least temporarily.

U.3.5 Estimated Costs for DECON

The principal cost items in DECON are labor, waste disposal, spent fuel disposal, and energy. Other costs include special equipment, specialty contractors, licensing and insurance, and miscellaneous supplies. The bases for the costs presented here are given in Appendix G and Section 10 of Reference 1, and are adjusted for escalation between early-1978 and mid-1980, as discussed in Section U.2.5. The costs are summarized in Table U.16, with the estimates of the principal cost items developed in the following sections.

U.3.5.1 Decommissioning Labor Costs

The basic decommissioning crew is postulated to consist of seven members: a crew leader, a utility operator, two laborers, two craftsmen, and a health physics technician. The average salary cost per hour per crew member (developed from data given in Table I.1-1 of Reference 1, escalated by 17%) is $15.12. From Table 10.1-2 of Reference 1, the ratio of crew labor cost to total decommissioning labor cost is 2.24. The direct decommissioning crew labor hours for the principal buildings and activities are given in Table U.17, summarized from Section U.3.1.

U.3.5.2 Radioactive Waste Disposal Costs

The radioactive materials requiring disposal during DECON of TMI-2 consist of three main categories: neutron-activated, surface-contaminated, and miscellaneous radwaste such as filters, ion exchange resins, solidified radioactive fluids, and combustible wastes. Estimates of the cost of disposing of these materials are summarized in Table U.18, and packaging and shipping information for each type of material is discussed briefly in the following sections.

Table U.16. Summary of Estimated DECON Costs

Category	Cost in Millions of Mid-1980 Dollars
Decommissioning labor	
Direct	7.196
Support	8.923
Radwaste disposal	13.791
Spent fuel shipment	2.496
Energy	4.620
Other costs	
Supplies	1.820
Equipment	0.960
Contractors	0.640
Nuclear insurance	0.940
Licensing fees	0.060
Subtotal	41.446
25% contingency	10.361
Total[a]	51.8

[a]Total rounded to three significant figures.

Table U.17. Estimated Labor Costs for DECON

Activity	Direct Crew Hours	Labor Costs in Millions of Dollars	
		Direct Crew	Total
Containment building	200,816	3.037	6.803
AFH building	135,520	2.050	4.592
Other building	22,176	0.335	0.750
Radwaste processing and shipping	112,020	1.694	3.795
Spent fuel shipping	5,280	0.080	0.179
Total	475,812	7.196	16.119

Table U.18. Estimated Costs for Disposal of Radioactive Wastes from DECON

Radioactive Material	Number of Shipments	Container Cost[a]	Cask Rental[b]	Transport Costs[c]	Handling Charges[d]	Burial Volume (ft^3)	Burial Charges[a]	Total Cost
Neutron-activated steels	156	124,800	280,000	88,920	32,136	15,600	248,040	774,696
Neutron-activated concrete	49	92,120	-	181,300	-	25,000	217,500	490,920
Contaminated equipment	82	154,160	-	303,400	39,850	154,000	1,339,800	1,837,210
Contaminated concrete	889	1,670,850	-	3,289,300	-	455,000	3,958,500	8,918,650
Miscellaneous radwastes	180	151,800	324,000	1,026,000	54,600	22,000	212,872	1,769,272
Total	1,356	2,193,730	604,800	4,888,920	126,586	671,600	5,976,712	13,790,748

[a]Assumes cask liner cost of $800, LSA Box cost of $470, special container cost of $6000/box.

[b]Assumes a rental fee of $300/day and a 6-day cycle for each shipment.

[c]Assumes a transport cost of $5700/round trip, $3700/one-way.

[d]Assumed to average $350/cask liner, overweight objects @ $87.50 + (0.02/lb >10,000 lb).

[e]Assumes burial charges of $8.70/$ft^3$, liner and curie surcharges as given in current NECO price list.

Neutron-Activated Material

Because of the rather short exposure history of the TMI-2 reactor vessel and its internals, the levels of neutron-induced radioactivity in structural components are low compared with the levels expected to be found in a reactor that has operated for 30-40 years. As a result, it is anticipated that the activated materials could be shipped in unshielded cask liners within shielded shipping casks. Based on the information developed in Section U.3.2, it is estimated that 156 single cask shipments of activated materials will be required. The neutron-activated concrete from the biological shield will require 49 truck shipments in unshielded LSA boxes.

Contaminated Equipment

The contaminated equipment, pumps, piping, heat exchangers, etc., are packaged in unshielded LSA boxes. From Table U.6, 82 truck shipments will be required.

Contaminated Concrete

The contaminated concrete removed from building surfaces during physical decontamination is packaged in 3556 unshielded LSA boxes and will require 889 truck shipments.

Miscellaneous Radwaste

The filters, ion exchange resins, solidified radioactive fluids, and combustible wastes resulting from DECON are packaged in a variety of containers. Based on information presented in Table G.4-6 of Reference 1 and on cask-liner-costs of $800 each and 55-gal-drum costs of $20 each, the container costs will be $151,800. Cask rentals will total $324,000, and 180 truck shipments will be required.

U.3.5.3 Spent Fuel Disposal Costs

Assuming that the 177 fuel bundles are shipped in a large rail cask (IF-300) that can carry seven bundles per shipment, 26 shipments are required. The spent-fuel-receiving facility is assumed to be located 1500 miles from TMI-2, and an 18-day round-trip cycle is maintained.

The transportation costs are assumed to be $33,000 per trip. A cask rental of $3500/day is assumed. Thus, the cost for removing the spent fuel from the TMI-2 facility is ($3500/day) (18 days/trip) + $33,000/trip = $96,000/trip, for a total of $2.5 million for 26 trips. No charges are included for handling and eventual disposal of the fuel at the final destination.

U.3.5.4 Energy Costs

Energy usage during decommissioning is comprised of electrical and fossil energy, in roughly equal amounts. The cost of energy is estimated in References 1 and 3 to be about $3.5 million in 1978 dollars. Assuming an escalation factor of 32%, the energy costs are estimated to be $4.6 million.

U.3.5.5 Other Costs

Other cost items include miscellaneous supplies, special equipment, specialty contractors, nuclear insurance, and licensing fees. It is assumed that the cost of these items as presented in Reference 1, when escalated by 17%, are appropriate for the TMI-2 analysis. Based on Table 10.1-1 of Reference 1 and Table 10.1-1 of Reference 3, these items are estimated to be $1.82, $0.96, $0.64, $0.94, and $0.06 million, respectively.

U.4 SAFE STORAGE FOLLOWED BY DEFERRED DECONTAMINATION (SAFSTOR)

This section contains the details of SAFSTOR for TMI-2. Information is included on those activities required to place (preparations for safe storage) and maintain (safe storage) the radioactive facility in such condition that the risk to safety is within acceptable bounds under the conditions of the NRC license. Since materials having radioactivity levels above unrestricted levels are still onsite, the nuclear license remains in force throughout the SAFSTOR period. SAFSTOR is completed by subsequently decontaminating the facility to levels that permit release of the facility for unrestricted use (deferred decontamination), thus permitting termination of the nuclear license.

SAFSTOR satisfies the requirements for the protection of the public while minimizing, in various degrees, the initial commitments of time, money, occupational radiation exposure, and regulated waste disposal site space. Since TMI-2 is on a multiple-reactor site, SAFSTOR is assumed to minimize the combined impacts of preparations, continuing care, and deferred decontamination. This advantage is offset somewhat by the need to maintain the nuclear license and by the associated restrictions placed on the use of the property. The SAFSTOR alternative requires continuing physical security and surveillance of structural integrity sufficient to ensure public protection.

The information presented in this section includes:

- Considerations for SAFSTOR,
- Methods, equipment, and other information,
- Decommissioning activities,
- SAFSTOR schedules and manpower estimates,
- Estimated external occupational radiation doses for SAFSTOR
- Estimated costs for SAFSTOR, and
- Deferred decontamination.

U.4.1 Considerations for SAFSTOR

Initially, the reactor defueling and chemical decontamination of the RCS are assumed to be completed, as shown in Figure S-1 of the summary. At this point, 4-1/2 to 5 years of cleanup activities have been carried out before SAFSTOR activities are begun.

The planning and preparation phase is carried out simultaneously with the last months of mandatory cleanup activities. Without detailed study of the time required, it is postulated that the planning and preparation phase spans about 18 months for SAFSTOR. SAFSTOR activities are assumed to start immediately after a comprehensive radiation survey is updated.

Planning and preparation includes the following considerations:

- Staff selection and training,
- Regulatory requirements,
- Data gathering and analysis,
- Development of detailed work plans and procedures,
- Design, procurement, and testing of special equipment,
- Selection of specialty contractors, and
- Removal of unneeded spent fuel storage racks (optional).

These considerations are discussed generically in Section U.2.

U.4.2 Methods, Equipment, and Other Information

Decommissioning methods, special tools and equipment, and essential systems and services used to prepare TMI-2 for SAFSTOR are discussed in this section. These methods and considerations, in order of their presentation in the following sections, are:

- Decontamination, deactivation, and sealing methods,
- Spray painting,
- Transfer of contaminated equipment and materials,
- Decontamination and isolation procedures,
- Special tools and equipment, and
- Essential systems and services.

U.4.2.1 Decontamination, Deactivation, and Sealing Methods

The decontamination methods that have been used in the decontamination of the AFHB also are used for SAFSTOR. The methods are discussed in detail in Section 5.1.2 and 5.2.2 and are not repeated here. Selected decontamination tasks may proceed concurrently. The primary concern is to ensure that no recontamination of clean areas occurs and that air leaving a given area flows through a filter system or, in the case of liquid effluents, through the existing contaminated waste systems.

The particular method used to decontaminate, deactivate, and seal each system or piece of equipment is identified during the planning phase. In general, all systems not necessary to prevent the spread of contamination are deactivated. Additional considerations are discussed in Section 5.1.3 and 5.2.3.

For SAFSTOR, portions of the facility that contain significant amounts of radioactivity are isolated by tamperproof barriers. Indirect access routes, however unlikely, are determined from as-built drawings and sealed. Such routes may include, but are not limited to, access through large vessels, tanks, or large-diameter pipes. Barriers are constructed by welding or bolting and sealing steel plates to block potential pathways of unauthorized entry or contamination migration. Polysulfide rubber is used extensively as a sealant because it is durable and flexible. In the HVAC systems servicing these isolated areas, vents with HEPA filters are installed to allow for changes in air pressure and temperature; however, the systems themselves are deactivated.

Contaminated drains are decontaminated and building sumps are decontaminated and secured. In some cases, after the sump pumps are decontaminated and/or removed, steel plates are welded in place to cover the sump area.

U.4.2.2 Spray Painting

After the loose, readily removable contamination is removed by the physical cleaning methods described in Section 5.1.3, and 5.2.3, the rooms or areas and their associated equipment are thoroughly spray painted before isolation or removal procedures begin. Whenever possible, all contaminated surfaces, both inside and outside, are coated to prevent the entrainment of radioactivity in the air during the active decommissioning tasks or during subsequent surveillance and maintenance activities.

In general, if the contamination on a surface cannot be removed by wiping or washing using standard decontamination solutions, it is painted to fix the contamination in place. An example is a concrete surface that has been penetrated by contaminated liquids. While the surface might be cleaned initially, the subsurface contamination can migrate to the surface and be dispersed by air movement and/or foot traffic. On protected, interior surfaces with essentially no traffic or adverse environment, the paint coatings can be expected to last almost indefinitely. Part of the surveillance program is to monitor painted areas for deterioration of the coatings and to recoat them as necessary.

U.4.2.3 Transfer of Contaminated Equipment and Materials

Unsalvageable, contaminated equipment and other miscellaneous noncombustible items may be transferred to other secured, onsite retrievable storage areas, as described in Chapter 8. Likewise, wastes consisting of trash, expended EPICOR II resins, and chemical decontamination solutions will be handled using the methods described in Section 8 and Appendix H.

It is anticipated that before transferring small equipment items, the items are carefully spray painted to immobilize any contamination. Freshly exposed surfaces are immediately painted to prevent dispersal of contamination. The disconnected items are carefully bagged and transferred to a retrievable storage area. The equipment and ductwork remaining in the work area is physically decontaminated as described in Section 5.2 and spray painted as previously described.

U.4.2.4 Decontamination and Isolation Procedure

The 13-point procedure given below is postulated to be used to prepare the contaminated areas for SAFSTOR:

1. Conduct initial radiation survey.
2. Vacuum interior surface areas.
3. Deactivate nonessential systems and equipment.
4. Clean building interior surface areas and exposed surfaces of equipment and piping.
5. Clean remaining hot spots.
6. Apply protective paint.
7. Transfer, as feasible, contaminated equipment and materials.
8. Decontaminate and seal vent systems.
9. Install HEPA-filtered vents.
10. Deactivate remaining nonessential systems and equipment.
11. Install intrusion, fire, and radiation detection systems as necessary and provide for onsite readout and servicing.
12. Conduct final radiation survey.
13. Secure the structure.

U.4.2.5 Special Tools and Equipment

Fewer special tools and equipment are required for the preparations for SAFSTOR than for DECON. No decontamination of highly activated material or equipment is necessary, thus eliminating the need for and expense of special remote handling equipment.

A list of special tools and equipment postulated for use in preparations for SAFSTOR, together with their functions, is given in Section U.2.2.

U.4.2.6 Essential Systems and Services

During preparations for SAFSTOR, certain facility systems and services must remain in place and in service for contamination control, for industrial or personnel safety, and to aid in the completion of decommissioning tasks. These systems and services are the same as those described in Section U.2.2 and are not repeated here.

As areas within the facility are secured for continuing care, the essential systems and services in these areas are deactivated as described previously. Continuous service to the remaining work areas is maintained as required.

After placing the facility in SAFSTOR, certain systems and services are required during the continuing care period. These systems and services are listed in Table U.19, together with the justification for retaining each. The equipment in these systems is inspected and renovated to ensure adequate reliability before the surveillance and maintenance period begins. In addition, it is assumed for this analysis that for as long as fuel is stored at TMI-2 the intrusion alarm systems within the facility and on the perimeter fence are modified as necessary to provide surveillance capability by the existing onsite security force.

Table U.19. Systems and Services Required During the Continuing Care Period

Systems and Services	Justification
Electrical power	Operations of electrical equipment, including lighting, surveillance monitoring, and radiation monitoring systems and alarms
Fire protection system	Health and safety
In-Plant communications system (telephone)	Personnel safety considerations
Security systems	Public safety and plant protection considerations, including fuel storage (a recognized optional consideration)

U.4.3 Decommissioning Activities

The postulated facility status for the start of all of the decommissioning alternatives used for this analysis is described in Section U.1 and is not repeated here. The decommissioning activities for SAFSTOR start with the shipment of the irradiated fuel assemblies and recovered spent fuel pieces to a disposal facility. The fuel shipments continue relatively unabated until all irradiated fuel is removed from TMI-2. The schedule for the fuel shipments, including manpower, estimated occupational doses, and associated costs, are the same as those described in Section U.3 for DECON.

At the start of SAFSTOR decommissioning activities for TMI-2, prodigious amounts of various types and sizes of shielding materials, special tools, equipment, instruments, in-place staging, and other beneficial but currently undefined hardware will be in-place and/or onsite and ready to use for active decommissioning. Undoubtedly, this material will aid in the decommissioning effort. On the other hand, all material that was previously used must be assumed to be contaminated to varying degrees as a result of the post-accident recovery and cleanup efforts for which it was originally purchased. Therefore, whether any such material is reused for SAFSTOR activities (an advantage and cost savings) or is simply in the way (a costly disadvantage), it must eventually either be decontaminated, disposed of as radwaste, or reused elsewhere. The potential volume of this onerous material is currently unknown and therefore is not addressed in this analysis.

A comprehensive radiation mapping of the reactor containment building and the AFHB is completed. The objective of this mapping (both the initial effort and those of an ongoing nature that occur throughout the preparations for continuing care) is to: (1) acquire and update technical data needed to plan for additional decontamination, (2) assess the current condition of the buildings and equipment, and (3) provide necessary maintenance for equipment needed during the preparations for continuing care to prevent radioactive releases or to implement decontamination activities. The technical data needed include current radiological surveys, isotopic analyses, and radiological mapping to identify hot spots and assess decontamination requirements and likely locations for additional shielding/radiation barriers. The mapping and assessment is postulated to consist of entries of relatively long duration during which detailed surveys of radiation fields, including ductwork and other equipment, are made. The TMI-2 site and pre-accident support facilities are given a comprehensive radiation survey and are assumed in this analysis to be released for unrestricted use without further effort.

The duration of events during SAFSTOR preparations for continuing care is shown in Figure U.5. The decontamination and preparations for continuing care of TMI-2 is estimated to require about 30 months.

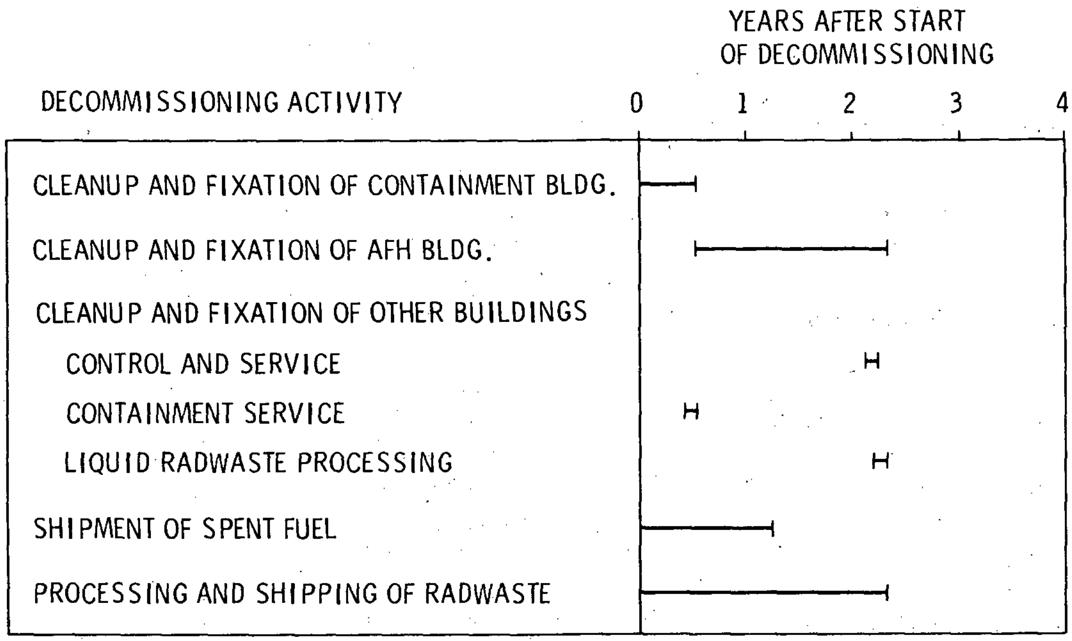


Figure U.5. Duration of Activities Preparing for Safe Storage.

A brief discussion of the postulated preparations for SAFSTOR of the TMI-2 unit is presented in the following sections.

U.4.3.1 Containment Building

Post-accident recovery and cleanup activities are assumed to have left the containment building in a radiological condition such that additional decontamination is required (see Section U.1 for details). As mentioned earlier, the chemical decontamination of the RCS and intertied systems is assumed to be completed following the defueling and disabling of the reactor. Radiation and contamination levels allow for controlled but continuous access of decommissioning workers into the containment building. Large amounts of the shielding materials used for the massive post-accident cleanup effort are assumed to either be in place or readily available to use for decommissioning activities in the containment building and elsewhere. Other materials and equipment in this category also may prove useful to the overall decommissioning effort (see Section 6.1.5).

Decommissioning parameters (e.g., volumes of waste, occupational dose, and total costs) are directly impacted by the radiological condition of the buildings at TMI-2 at the start of the preparations for continuing care. What these conditions will be is unknown; however, in Section U.1, the postulated facility status is discussed. In addition, several assumptions are considered as necessary preconditions to clarify this SAFSTOR decommissioning analysis for the reactor containment building. These assumptions are given in the following paragraphs.

For the fuel transfer canal (FTC) the following assumptions apply:

1. Ultimate disposition of tritiated water has not currently been decided.
2. The FTC is decontaminated with water jets as it is drained; water is processed before being returned to storage after defueling operations; additional decontamination (including hot spots) is followed by painting.
3. Decontamination of fuel storage racks is reasonably effective; therefore the racks are painted and left in storage during continuing care.

For general decontamination efforts in the reactor containment building, the following assumptions are made:

1. Essential building systems and services have been restored, renovated, and left in-place after the post-accident recovery cleanup effort.
2. The upper boundary radiological condition for the general decontamination activity is estimated to require a 60:40% mixture of water-jet and hands-on work, respectively, for all surfaces requiring additional decontamination before being painted.
3. The decontamination efforts described in the above assumption are assumed to be used on one-third of the total inside surface area of the building, including equipment therein. (It should be recognized that the same surfaces in all cases will not necessarily require both methods of decontamination.)
4. Waste solution generation rates are based on:
   - Water-jet methods at about 6 gpm; 2-person crews; and a cleaning rate of about 500 ft^2/hr/crew.
   - Hands-on methods at about 25 gph; 4-person crews; and a cleaning rate of about 165 ft^2/hr/crew.
5. Two 4-person crews/shift, using a man-lift, are required for painting. The painting rate per crew is estimated to be about 2500 ft^2/hr. Since it is assumed that all building internal surfaces have been decontaminated at least once by this time, all building surface are painted, thus immobilizing any remaining contamination.
6. A minimum of 56,000 gallons of contaminated water from semi-remote decontamination and about 6,800 gallons of decontamination liquids are estimated to require processing.
7. Of the four alternatives for equipment decontamination, only in-place decontamination and certain disposal activities are considered necessary during the preparations for continuing care.
8. The sump water processing system is assumed to have been removed.
9. Processed accident-generated water (i.e., all radionuclides removed except tritium) is used for all water-jet washing activities so that the total inventory of contaminated water is not increased.
10. Hot spots that were shielded earlier will either be decontaminated or the shielding left in place, depending on surveillance, maintenance, and survey worker's needs during continuing care (an ALARA consideration).

Finally, the RPV shielding blocks are assumed to be placed above the reactor in their normal position for the continuing care period.

The estimate of the work required to prepare the reactor containment building for continuing care is based on the analysis of necessary decommissioning activities, including the assumptions just given, previous studies,[1-3] and engineering judgement. In general, the work involves additional semi-remote and hands-on decontamination activities of the type previously described in Chapter 5. As a result of predefueling decontamination work, it is anticipated that the levels of radiation/contamination at the start of the preparations for continuing care will be the same as those postulated in Section U.1.

The sequence and schedule of events for preparing the reactor containment building for the continuing care period is given in Figure U.6.

U.4.3.2 Auxiliary and Fuel Handling Building

Once the comprehensive radiation mapping of the AFHB (see Section U.4.3) has been completed the next activity to get underway is the shipment of the spent fuel and recovered spent fuel pieces to a storage facility, a reprocessing facility, or a disposal facility offsite. Assuming an IF-300 cask (capacity seven elements) is used, with an 18-day round-trip cycle, 26 trips will be required to remove the 177 fuel elements, or about 16 months elapsed time. Availability of another spent fuel shipping cask of similar capacity would reduce the fuel shipment period to about 8 months.

The postulated sequence and schedule of tasks for the preparations for continuing care of the AFHB is shown in Figure U.7. For the start of decommissioning activities in the AFHB, it is

MONTHS AFTER START OF DECOMMISSIONING

TASK	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
PREDECOMMISSIONING FACILITY RADIATION MAPPING	6/550/1
DECONTAMINATION[a]	
347-ft LEVEL	16/410/0.6
305-ft LEVEL	16/290/0.3
OSTG CUBICLES AND EQUIPMENT	16/330/0.3
RPV HEAD AND CAVITY	16/170/0.1
282-ft LEVEL	16/680/0.6
305-ft LEVEL ENCROACHMENT AREA	18/640/0.3
CHEMICALLY DECONTAMINATE DRAIN SYSTEMS	10/550/1 (intermittent)
PAINTING (ALL REQUIRED SURFACES)	16/2300/1.1 (intermittent)
PROCESSING AND SHIPPING OF RADWASTE:	
• PROCESS DECONTAMINATION WATER-JET WATER (~56,000 GALLONS)	16/1056/0.5
• PROCESS HANDS-ON CHEMICAL DECONTAMINATION SOLUTIONS (~6,800 GALLONS)	16/1875/1.2
• PROCESS SOLID, DRY TRASH (~150 COMPACTED DRUMS)	2/210/0.6 (intermittent)
• PROCESS DRAIN DECON FLUIDS (~7,900 GALLONS)	16/3240/1.5
ISOLATE AND SEAL EQUIPMENT AND AREAS AND INSTALL HEPA-FILTERED VENTS	12/1580/1
DEACTIVATE UNNECESSARY UTILITIES	8/530/0.5
INSTALL INTRUSION, RADIATION MONITORING, AND FIRE ALARM SYSTEMS	5/660/1
FINAL RADIATION SURVEY	4/350/1

[a]DECONTAMINATION INCLUDES: (1) SEMI-REMOTE DECONTAMINATION, (2) HANDS-ON DECONTAMINATION, AND (3) REMOVAL OF POST-ACCIDENT RECOVERY MATERIALS AND EQUIPMENT LEFT IN PLACE TO AID THE PREPARATIONS FOR CONTINUING CARE.

THIS SCHEDULE COULD BE SIGNIFICANTLY INFLUENCED BY MANY FACTORS THAT ARE NOT PRECISELY KNOWN AT THIS TIME. THESE INCLUDE, BUT ARE NOT LIMITED TO, THE EXACT RADIOLOGICAL CONDITIONS ENCOUNTERED UPON COMPLETION OF INITIAL DECONTAMINATION EFFORTS, FINANCIAL LIMITATIONS, REGULATORY ACTIVITIES, CRAFT LABOR AND MATERIAL AVAILABILITY, AND AVAILABILITY OF OFFSITE OR ONSITE RADWASTE DISPOSAL CAPABILITY ON A TIMELY BASIS.

LEGEND:

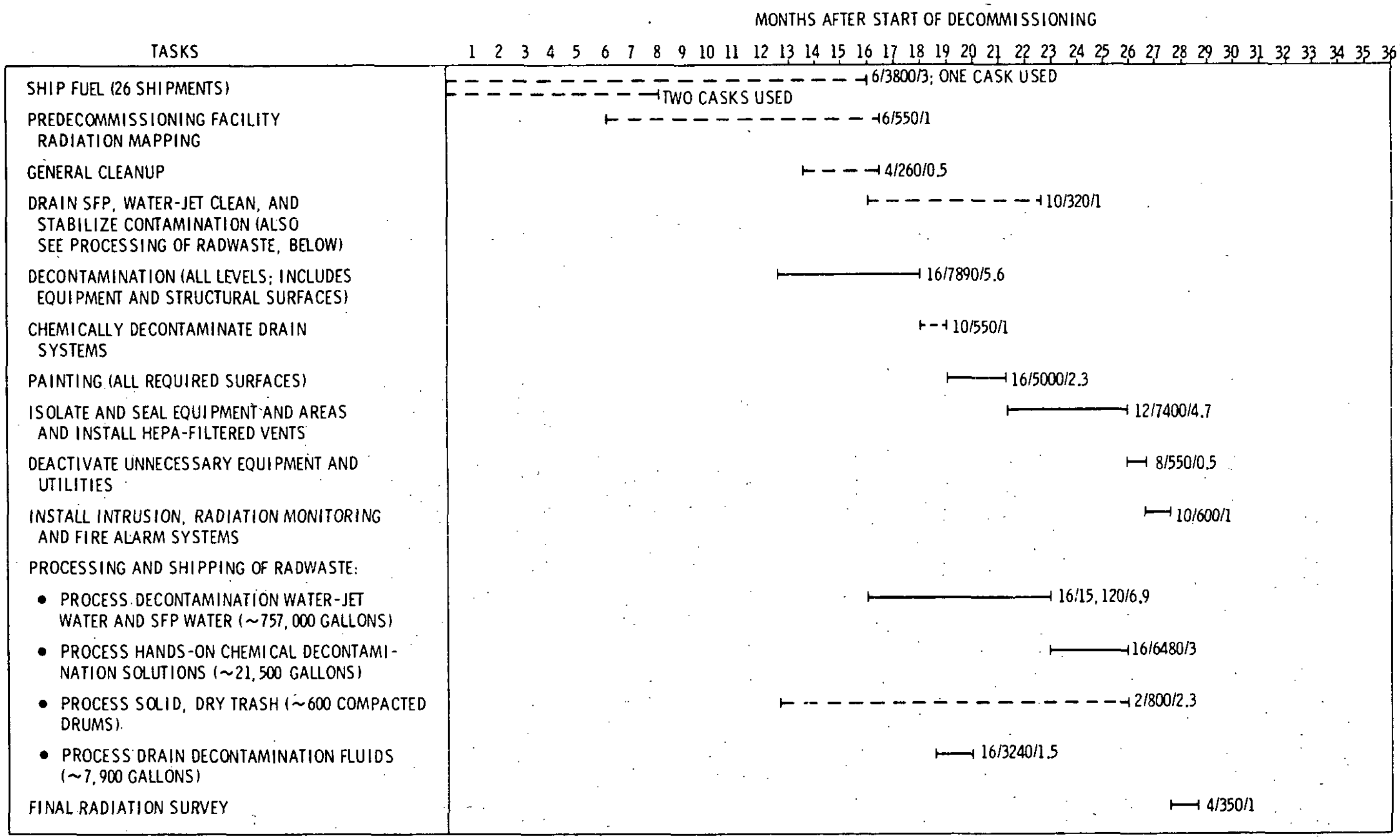
DIRECT STAFF PER DAY/EXPOSURE HOURS/CALENDAR MONTHS

├──┤ CONTINUOUS OPERATIONS OVER THE TIME SPAN SHOWN

├- - -┤ INTERMITTENT OPERATIONS OVER THE TIME SPAN SHOWN

TOTALS: PERSON-MONTHS 149
PERSON-HOURS 25,838
EXPOSURE-HOURS 15,421

Figure U.6. Postulated Sequence and Schedule of Tasks for SAFSTOR of the Reactor Containment Building.



THIS SCHEDULE COULD BE SIGNIFICANTLY INFLUENCED BY MANY FACTORS THAT ARE NOT PRECISELY KNOWN AT THIS TIME. THESE INCLUDE, BUT ARE NOT LIMITED TO, THE EXACT RADIOLOGICAL CONDITIONS ENCOUNTERED UPON COMPLETION OF INITIAL DECONTAMINATION EFFORTS, FINANCIAL LIMITATIONS, REGULATORY ACTIVITIES, CRAFT LABOR AND MATERIAL AVAILABILITY, AND AVAILABILITY OF OFFSITE OR ONSITE RADWASTE DISPOSAL CAPABILITY ON A TIMELY BASIS.

LEGEND:

DIRECT STAFF PER DAY/EXPOSURE HOURS/CALENDAR MONTHS

├──┤ CONTINUOUS OPERATIONS OVER THE TIME SPAN SHOWN

├ ─ ─ ┤ INTERMITTENT OPERATIONS OVER THE TIME SPAN SHOWN

TOTALS: PERSON-MONTHS 446
PERSON-HOURS 78,462
EXPOSURE-HOURS 53,910

Figure U.7. Postulated Sequence and Schedule of Tasks for SAFSTOR of the AFH Building.

assumed that all radioactive liquids in tanks and systems that are unneeded for subsequent decommissioning activities have been drained and processed. This assumption appears to be reasonable based on decontamination efforts to date and on the status of those still to be completed (see Section 5.1 and Appendix O).

In general, decontamination activities start on the upper levels and proceed toward the lower levels. The spent fuel pool cleanup system will remain in service until shipment of spent fuel is completed.

Since considerable post-accident decontamination work, both initial and follow-on, will have been done prior to the start of decommissioning, it is assumed that the radiological conditions in the AFHB are somewhat improved over those described in Section U.1 for the reactor containment building. In practical terms, this means that similar contamination activities (semi-remote and hands-on) will be necessary to prepare the AFHB for continuing care, but to a lesser degree than in the containment building, because of the generally lower overall average radiation/ contamination levels. However, since it is necessary to decontaminate and/or immobilize a greater total surface area in the AFHB than in the reactor containment building, the result will be a net increase in occupational hours consumed and volumes of wastes produced.

U.4.3.3 Other Buildings

The other buildings associated with TMI-2 that contain any quantities of radioactivity are the control and service building, the containment service building, and the liquid radwaste processing building (if built). It is postulated that the chemical cleaning building (EPICOR II), EPICOR-I, the radiochemistry hot lab, the resin solidification and mid-high level radwaste staging facility (if built), and the solid radwaste staging modules will remain onsite and servicable for use with TMI-1.

Control and Service Building

Radioactively contaminated equipment in this building is limited to the contaminated drain system and the isolation valve tanks and pumps on the 280-ft level, the monitoring and soiled laundry areas on the 305-ft level, and the decontamination filter assembly on the 351-ft level. Since all systems and services are controlled from this building, it will be the last to be decontaminated.

Containment Service Building

This structure is basically an extension of the containment building, enclosing the equipment hatch and providing a staging area for shipping of packaged material from the containment building. It is postulated that the decontamination effort in this building is limited to surface cleaning, since the materials are mostly already packaged before removal from containment.

Liquid Radwaste Processing Building

This structure does not presently exist and its contents can only be postulated. Likely systems include a radwaste evaporator and a liquid waste solidification system. Decontamination and deactivation of these systems is delayed until decontamination of the reactor containment and AFH buildings is complete.

U.4.4 Waste Volumes from SAFSTOR

Preparing TMI-2 for safe storage will produce radioactive wastes from four different sources:

1. Water-jet cleaning liquid from the reactor containment building and water-jet cleaning liquid, plus SFP draining liquid, from the AFH building,
2. Hands-on chemical decontamination solutions from all sources,
3. Dry, solid waste from all sources, and
4. Chemical decontamination solutions from contaminated drains.

A summary of the estimated radioactive waste volumes from all four sources is given in Table U.20, along with estimated numbers and types of containers postulated used for disposal and/or storage and their estimated burial volumes.

Table U.20. Estimated Volumes of Radioactive Waste from Preparing TMI-2 for Safe Storage

Location[a]	Source	End Product Waste Form	Waste Processing Method	Amount & Units	Estimated Number and Type of Disposable Waste Containers: 55-gal drum at 7.5 ft^3/each	Estimated Number and Type of Disposable Waste Containers: 50-ft^3 Liner	Estimated Burial Volume (ft^3)
RCB	Water-jet decontamination	Resin	EPICOR-II	56,000 gal	-[c]	10	500
		Filter			1	-	7.5
	Hands-on decontamination	Concreted	Solidification	6,800 gal	217	-	1,627.5
	Drains DECON solution	Concreted	Solidification	7,925 gal	182	-	1,365
	Dry, solid waste	Compacted[d] material	Compaction	726 drums[d]	145	-	1,087.5
AFHB	Water-jet decontamination	Resin	EPICOR-II	757,000 gal[e]	-	135	6,750
		Filter			6		45
	Hands-on decontamination	Concreted	Solidification	21,500 gal	677	-	5,077.5
	Drains DECON solution	Concreted	Solidification	7,925 gal	182	-	1,365
	Dry, solid waste	Compacted[d] material	Compaction	2,970 drums[d]	594	-	4,455
Total					2,004	145	22,280

[a] RCB is the reactor containment building; AFHB is the auxiliary and fuel handling building.

[b] The number of significant figures shown is for computational convenience and does not imply precision of that degree.

[c] Dash (-) means not applicable.

[d] Compacted at a 5:1 ratio.

[e] It is postulated that the SFP is water-jet cleaned step-wise as it is being drained; 700,000 gallons of this amount represents the SFP inventory, with the remaining 57,000 gallons being generated from all AFHB water-jet cleaning activities.

U.4.5 Effluents and Releases to the Environment

Under normal storage, transportation, and disposal conditions, no routine effluents or releases from the waste packages or transport vehicles are expected. "Normal" transport is the situation when transport occurs without unusual delay, loss or damage to the package, or an accident involving the transporting vehicle.

The various types of packages that may be used to ship the TMI wastes are designed to prevent any releases during storage, handling, transportation, or disposal operations if their integrity is maintained. Thus, no impact on the environment from this source will occur.

The atmospheric release of radionuclides is assumed to be the only source of radiation to the public from routine decommissioning operations. All liquid radioactive wastes generated during decommissioning operations are assumed to be sent to the plant liquid waste storage system or to other tanks that are designated for temporary storage of these solutions. The wastes are then assumed to be processed through the waste concentration and solidification system. All systems designed to control the release of hazardous material to the environment or to noncontaminated portions of the facility are assumed to be in operation during the decontamination activities and subsequent waste processing.

The primary source of radioactive effluents from routine decommissioning operations while preparing the plant for safe storage is contaminated liquid aerosols that result from the various decontamination activities.

An analysis of the generation of airborne radioactivity during decommissioning operations at a large PWR is given in Appendix J of Reference 1, with the results of that analysis summarized in Table U.7. Only one of the DECON operations listed in Table U.7 is of significance during the preparations for safe storage: water-jet cleaning, with a postulated release of about 10 μCi. The release involves the radionuclide mixture defined as Reference Radionuclide Inventory No. 5, as listed in Table U.11. The releases postulated in Table U.7 do not include releases from possible accidents involving transport of spent reactor fuel from the site to a disposal facility.

U.4.6 Environmental Impacts

The environmental impacts associated with the decontamination and minor disassembly operations performed while preparing TMI-2 for safe storage are contained in three general categories: (1) the radiation dose to the workers involved in the disassembly, packaging, and transport of the radioactive materials from the site to a disposal facility; (2) the radiation dose to the public resulting from releases of radioactivity from the site during decommissioning operations and from radiation emanating from shipments of radioactive waste while in transit on public highways or railways; and (3) the commitment of space in a low-level radioactive waste burial ground for the disposal of the radioactive materials from the plant. The impacts associated with each of these categories are discussed in the following sections.

U.4.6.1 Estimated Occupational Radiation Dose from SAFSTOR Activities

The radiation dose accumulated by the workers performing SAFSTOR activities is estimated by multiplying the average local radiation dose rate for a given task times the number of worker exposure hours estimated for that task, and summing over all tasks. The average local dose rates for general areas in the reactor containment building, the AFH building, and other buildings are given in Table U.21. Also given are cumulative exposure hours for persons working in those general areas, taken from Figures U.6 and U.7, the computed cumulative dose to the workers accomplishing tasks in those areas, and the total radiation dose received by workers while performing SAFSTOR operations.

The estimated dose received by the transportation workers during the transport of packaged radioactive wastes, based on an assumed realistic dose rate for each shipment as given in Section 9.5.1.1 (56 millirem/trip/driver), is given in Table U.22. The estimated dose received by railway workers during the transport of the spent reactor fuel, based on information developed in Section 11.4.1 of Reference 1, is also given in Table U.22.

Table U.21. Estimated Cumulative Radiation Doses Received by Workers During SAFSTOR Operations

Location and Task	Average Local Dose Rate (rem/hr)	Estimated Worker Exposure Hours	Cumulative Radiation Dose (person-rem)[a]
Reactor Containment Building			
Predecommissioning facility radiation mapping	0.017	550	9.35
Decontamination:			
347-ft level	0.005	410	2.05
305-ft level	0.010	290	2.9
OSTG cubicles and equipment	0.030	330	9.9
RPV head and cavity	0.030	170	5.1
282-ft level	0.030	680	20.4
305-ft level encroachment area	0.003	640	1.92
Chemically decontaminate drain systems	0.001	550	0.55
Painting (all required surfaces)	0.006	2,300	13.8
Processing of radwaste:			
Process Decontamination Water-jet water (~56,000 gallons)	0.002	1,056	2.11
Process hands-on chemical decontamination solutions (~6,800 gallons)	<0.001	1,875	0.65
Process solid, dry trash (~150 compacted drums)	0.003	210	0.63
Process drain decon fluids (~7,900 gallons)	<0.001	3,240	0.6
Isolate and seal equipment and areas and install HEPA-filtered vents	0.005	1,580	7.9
Deactivate unnecessary utilities	0.003	530	1.59
Install intrusion, radiation monitoring and fire alarm systems	0.002	660	1.32
Final radiation survey	0.003	350	1.05
Auxiliary and Fuel Handling Building			
Ship fuel (26 shipments)	0.003	3,800	11.4
Predecommissioning facility radiation mapping	0.005	550	2.75
General cleanup	0.004	260	1.04
Drain SFP, water-jet clean, and stabilize contamination (also see processing of radwaste, below)	0.004	1,320	5.28
Decontamination (all levels; includes equipment and structural surfaces)	0.002	7,890	15.78
Chemically decontaminate drain systems	0.001	550	0.55
Painting (all required surfaces)	0.002	5,000	10
Isolate and seal equipment and areas and install HEPA-filtered vents	0.005	7,400	37
Deactivate unnecessary equipment and utilities	0.001	550	0.55

Table U.21. (Continued)

Location and Task	Average Local Dose Rate (rem/hr)	Estimated Worker Exposure Hours	Cumulative Radiation Dose (person-rem)[a]
Install intrusion, radiation monitoring and fire alarm systems	0.001	600	0.6
Processing of radwaste:			
Process decontamination water-jet Water and SFP water (~757,000 gallons)	0.002	15,120	30.24
Process hands-on chemical decontamination solutions (~21,500 gallons)	<0.001	6,480	2
Process solid, dry trash (~600 compacted drums)	0.003	800	2.4
Process drain DECON fluids (~7,900 gallons)	~0.001	3,240	0.6
Final radiation survey	0.002	350	0.7
Other Buildings			
All levels	0.003	5,000	15
Total			218[b]

[a]The number of figures shown is for computational accuracy and does not imply precision to that many significant figures.

[b]Rounded to the nearest person-rem.

Table U.22. Estimated Cumulative Radiation Doses Received by Transport Workers During SAFSTOR Operations

Worker Type	Dose/Shipment (millirem/driver)	Number of Shipments	Cumulative Radiation Dose (person-rem)
Truck drivers	56	114	12.8[a]
Train crew	120	26	6.2[a]
Total			19

[a]Assumes two drivers/truck, two brakemen/train.

U.4.6.2 Offsite Doses from SAFSTOR Activities

The dose estimates presented here for the SAFSTOR decommissioning operations are based on the source terms described in Section U.4.5 and on the assumption that decommissioning activities take place 10 years after the TMI-2 accident (11.4 micro-curies of reference inventory 5). The calculational models used to make these estimates and the interpretation of their results are described in Appendix W. The significance of these doses and their human health and environmental consequences are discussed in Section 10.3. The dose estimates to the maximum-exposed individual are listed in Table U.23. The 50-mile total body population dose received by the human population during these activities is estimated to be 7×10^{-5} persons-rems.

Table U.23. Estimated Doses to the Maximum-Exposed Individual from Normal Decommissioning Activities (SAFSTOR)

Location	Pathway	Dose (mrem)[a]		
		Total-Body	Bone	Liver
Nearest garden[b]	Inhalation	1.6×10^{-7}	3.6×10^{-7}	3.0×10^{-7}
	Ground Shine	6.4×10^{-7}	6.4×10^{-7}	6.4×10^{-7}
	Vegetable Use	3.6×10^{-6}	1.6×10^{-5}	1.5×10^{-5}
	Total	4.4×10^{-6}	1.7×10^{-5}	1.6×10^{-5}
Nearest milk goat	Inhalation	1.4×10^{-7}	1.9×10^{-7}	2.0×10^{-7}
	Ground Shine	6.1×10^{-7}	6.1×10^{-7}	6.1×10^{-7}
	Goat Milk Use	9.7×10^{-6}	7.5×10^{-5}	8.8×10^{-5}
	Total	1.0×10^{-5}	7.6×10^{-5}	8.9×10^{-5}
Nearest cow and garden	Inhalation	1.7×10^{-7}	3.9×10^{-7}	3.3×10^{-7}
	Ground Shine	9.4×10^{-7}	9.4×10^{-7}	9.4×10^{-7}
	Vegetable Use	5.3×10^{-6}	2.4×10^{-5}	2.2×10^{-5}
	Cow Milk Use	3.6×10^{-6}	1.8×10^{-5}	1.7×10^{-5}
	Total	1.0×10^{-5}	4.3×10^{-5}	4.0×10^{-5}

[a] Doses were calculated for Total-body, GI-tract, bone, liver, kidney, thyroid, lung and skin. The maximum three organ doses are listed in this table. Doses were calculated for four age groups: adults, teenagers, children, and infants. The highest dose estimates for each age group are listed. The dose estimates for the total-body pathway are for adults. The dose estimates for the bone and liver pathways for the nearest garden and nearest cow and garden locations are for children, and for the nearest goat location are for infants.

[b] The basis for selecting the special locations is described in Appendix W. The actual locations were: nearest garden = 1.05 mile east-north-east, nearest milk goat = 1.02 mile north, and nearest cow and garden = 1.05 mile east.

The estimated radiation dose to the public resulting from transport of radioactive materials offsite is presented in Table U.24 for both truck and rail transport.

Table U.24. Estimated Radiation Dose Received by the Public During Transport of Radioactive Waste from SAFSTOR Operations

Type of Shipment	Number of Shipments	Dose/Shipment (person-rem)	Public Radiation Dose (person-rem)
Radioactive material (truck)	114	0.053[a]	6.04
Spent reactor fuel (rail)	26	0.0293[b]	0.76
Total			6.8

[a]Based on data given in Section 9.5.1.2.

[b]Based on data given in Section 11.4.1 of Reference 1.

U.4.6.3 Other Environmental Effects

Other impacts on the environment surrounding the TMI station resulting from SAFSTOR of Unit 2 will be similar to those discussed in Section 10.6, but of lesser magnitude because there will be fewer workers involved in SAFSTOR and because gross contamination cleanup efforts will have been completed before the start of decommissioning.

Continued storage of the bulk of the radioactive materials onsite during SAFSTOR might tend to continue the existing levels of anxiety in the local community, even though the readily dispersible materials have been solidified and packaged. Not shipping these materials to a disposal site would tend to reduce the anxiety levels among the populace along the transport routes until deferred decontamination takes place.

The number of persons employed at the TMI site will be reduced when Unit 2 has been placed in safe storage, thus reducing the local payroll.

U.4.7 Estimated Costs for SAFSTOR

The principal cost items for SAFSTOR are labor, waste disposal, spent fuel disposal, and energy. Other costs include special equipment, specialty contractors, licensing and insurance, and miscellaneous supplies. The bases for the costs presented here are given in Appendix H and Section 10 of Reference 1, and are adjusted for escalation between early-1978 and mid-1980, as discussed in Section U.3.5. The costs are summarized in Table U.25, with the estimates of the principal cost items developed in the following sections.

U.4.7.1 Decommissioning Labor Costs

The basic decommissioning crew is postulated to consist of seven members: a crew leader, a utility operator, two laborers, two craftsmen, and a health physics technician. The average salary cost per hour per crew member developed from data given in Table I.1-1 of Reference 1. escalated by 17%, is $15.12. From Table 10.2-2 of Reference 1, the ratio of crew labor cost to total decommissioning labor cost is 2.63. The direct decommissioning crew labor hours for the principal buildings and activities are given in Table U.26, summarized from Section U.4.3.

U.4.7.2 Radioactive Waste Disposal Costs

The radioactive materials requiring disposal during SAFSTOR of TMI-2 consist of the sources and end product waste forms given in Table U.20; these are:

- Resins and filters from water-jet decontamination,
- Hands-on and drains decontamination solutions, and
- Dry, solid waste.

Estimates of the costs of disposing of these materials are summarized in Table U.27.

Table U.25. Summary of Estimated Costs for SAFSTOR

Category	Cost in Millions of Mid-1980 Dollars
Decommissioning labor	
Direct	1.887
Support	3.044
Radwaste disposal	1.214
Spent fuel shipment	2.496
Energy	2.64
Other costs:	
Supplies	1.044
Equipment	0.088
Contractors	0.123
Nuclear insurance	0.344
Licensing fees	0.045
Subtotal	12.925
25% contingency	3.231
Total[a]	16.2

[a]Total rounded to three significant figures.

Table U.26. Estimated Labor Costs for SAFSTOR

Activity	Direct Crew Hours	Labor Cost in Million of Dollars	
		Direct Crew	Total
Containment building	16,616	0.251	0.660
AFH building	45,550	0.689	1.812
Other buildings	15,206	0.230	0.605
Radwaste processing and shipping	42,134	0.637	1.675
Spent fuel shipping[a]	5,280	0.080	0.179
Total	124,786	1.887	4.931

[a]Based on Table U.17.

Table U.27. Estimated Costs for Disposal of Radioactive Wastes from SAFSTOR

Radioactive Material	Number of Disposable Containers[a]	Solidification Costs ($)[b]	Container Costs ($)[c]	Estimated Number Requiring Shielding	Cask Rental Costs ($)[d]	Number of Shipments Shielded/ Unshielded[e,f]	Transportation Costs ($)[g]	Handling Costs ($)[h]	Burial Volumes (ft^3)	Burial Costs ($)[i]	Total Disposal Costs ($)
Dry, solid wastes	739	0	14,780	224	28,800	16/6	125,400	11,200	5,550	49,570	229,750
Decontamination solutions	1,258	15,590	25,160	0	0	0/18	102,600	0	9,435	82,090	225,440
Water-jet and SFP liquids											
Filters	7	0	140	7	1,800	1/0	5,700	350	53	500	8,490
Resin	145	10,270	72,500	145	131,400	73/0	416,100	50,750	7,250	68,880	749,900
Total[j]	2,149	25,860	112,580	376	162,000	90/24	649,800	62,300	22,288	201,040	1,213,580

[a] Based on Table U.20.

[b] Assumes solidification costs of $1.77/ft^3$ and based on the internal volumes of the specific container that is used.

[c] Assumes 55-gal steel drum cost of $20 each and 50-$ft^3$ steel cask liner of $500 each.

[d] Assumes rental fee of $300/day, a 6-day cycle for each shipment, a maximum of seven drums per cask, and one 50-ft^3 container per cask.

[e] Assumes two casks per shipment.

[f] Average load is about 88 unshielded drums for dry, solid wastes. An average laod for concrete drums is about 73 unshielded drums, based on weight considerations.

[g] Assumes a transport cost of $5700/round trip, $3700/one-way.

[h] Assumed to average $350/cask liner, overweight objects $@87.50 + (0.02/lb >10,000 lb).

[i] Assumes burial charges of $8.70/ft^3$, liner and curie surcharges as given in current NECO price list; surface dose rates assumed to be 0.21 to 1.00 R/hr for those drums requiring shielding during shipment, <0.2 R/hr for all others; rounded to next highest $10.

[j] The number of figures shown is for computational accuracy and does not imply precision to that many significant figures.

U.4.7.3 Spent Fuel Disposal Costs

Assuming that 177 fuel bundles are shipped in a large rail cask (IF-300) that can carry seven bundles per shipment, 26 shipments are required. The spent fuel receiving facility is assumed to be located 1,500 miles from TMI-2, and an 18-day round-trip cycle is maintained.

The transportation costs are assumed to be $33,000 per trip. A cask rental of $3500/day is assumed. Thus, the cost for removing the spent fuel from the TMI-2 facility is ($3500/day) (18 days/trip) + $33,000/trip = $96,000/trip, for a total of $2.5 million for 26 trips. No charges are included for handling and eventual disposal of the fuel at the final destination.

U.4.7.4 Energy Costs

Energy usage during decommissioning is comprised of electrical and fossil energy, in roughly equal amounts. The cost of energy is estimated in References 1 and 3 to be about $2 million in 1978 dollars. Assuming an escalation factor of 32%, the energy costs are estimated to be $2.64 million.

U.4.7.5 Other Costs

Other cost items include miscellaneous supplies, special equipment, specialty contractors, nuclear insurance, and licensing fees. It is assumed that the cost of these items as presented in Reference 1, when escalated by 17%, are appropriate for the TMI-2 analysis. Based on Table 10.2-1 of Reference 1 and Table 10.2-1 of Reference 3, these items are estimated to be $1.044, $0.088, $0.123, $0.344 and $0.045 million, respectively.

U.4.8 Deferred Decontamination

As mentioned elsewhere in this statement, it is preferable to restrict decommissioning alternatives to those that do not imply use of the TMI-2 site for storage of radioactive materials beyond the normal operating lifetime of the other nuclear power reactor present on the site, which is approximately 30 years. To terminate the nuclear license after a safe storage period of about 30 years would probably require the dismantling of all originally contaminated systems to demonstrate their releasability. Therefore, it is assumed that essentially the same operations and waste volumes as described for DECON in Section U.3 could be expected, but with less total occupational radiation dose because of decay of the radioactive contaminants.

The types and quantities of manpower used for surveillance and maintenance and the radiation doses present in the plant will determine the cumulative occupational radiation exposure during the continuing care period. Based on Table H.4-4 of Reference 1, an occupational radiation dose in the range of 10 to 14 person-rem would be accumulated during the first 30 years of continuing care. Less than 4 person-rem total radiation dose would be accumulated during the subsequent 70 years. Because a larger fraction of the total radioactivity present in TMI-2 is Cs-137 than was the case in the reference study, the cumulative dose may be somewhat larger than given in Reference 1.

Based on the detailed cost estimates developed in Appendix H of Reference 1, and escalated by 17% for inflation, annual continuing care costs of about $60,000 are estimated for TMI-2, excluding the environmental monitoring program described elsewhere in this PEIS.

The same basic activities that are performed during DECON are also performed during deferred decontamination.

The cost of deferred decontamination of TMI-2 after the plant has been placed in safe storage and maintained for some period of continuing care can be estimated using the cost results reported in the reference studies.[1,3] These results are summarized in Table U.28.

Table U.28. Comparison of DECON and Deferred Decontamination Costs from Reference Decommissioning Studies

Decommissioning Activity	PWR Study Cost ($ millions)	PWR Study % of DECON Cost	BWR Study Cost ($ millions)	BWR Study % of DECON Cost
DECON	34.1[a,b]	100	43.6[d]	100
Deferred decontamination after 10-30 years	29.0[a,c]	85	35.5[e]	81
Deferred decontamination after 50-100 years	22.5[b,c]	66	26.4[e]	61

[a]From Table 10.1-1 of Reference 1.

[b]Cost for facility demolition is deleted, $6.41 million + 25% contingency = $8.01 million.

[c]From Table 10.4-1 of Reference 1.

[d]From Table 10.1-1 of Reference 3.

[e]From Table 10.4-2 of Reference 3.

The percentages of DECON cost for deferred decontamination after 10 to 30 years and after 50 to 100 years, from the reference studies, are averaged and used to estimate the cost of deferred decontamination for TMI-2, based on the DECON cost estimated in Section U.3.5 of this statement. These estimated costs for deferred decontamination of TMI-2 are given in Table U.29.

Radiation doses and radionuclide releases during decommissioning are related to the radionuclide inventory in the facility at the time the decommissioning activities take place. The doses and releases from deferred decontamination would be less than those for DECON (estimated previously in Section U.3.4 of this statement) because: (1) the radionuclide inventory in the facility would be reduced by the decontamination efforts associated with the preparations for continuing care and (2) the radionuclide inventory would decline during continuing care according to the decay characteristics of the inventory. Since the radioactivity of the dominant Cs-137 will have only decayed to one-half its initial value after 30 years of safe storage, the utilization of personnel unfamiliar with the facility and the refurbishment of systems and services needed for the final decontamination will result in radiation doses to the workers only slightly less than were estimated for DECON. Some reductions in radiation could be expected after 100 years of safe storage, since the Cs-137 radioactivity would have decayed to about one-tenth of its initial value. It is assumed that applicable shielding and contamination control is used during deferred decontamination in the same manner as during DECON. No quantitative estimates are made here for the doses and releases from deferred decontamination. However, based on the results of previous studies[1,3] it is anticipated that the doses and releases resulting from all phases of SAFSTOR (preparations for SAFSTOR, continuing care, and deferred decontamination would not exceed those resulting from DECON alone.

Table U.29. Comparison of DECON and Deferred Decontamination Costs for TMI-2

Decommissioning Activity	% of DECON Cost[a]	Cost in Millions of Mid-1980 Dollars
DECON	100	52.8
Deferred decontamination after 10-30 years	83	43.8
Deferred decontamination after 50-100 years	63	33.3

[a]Averaged from values in Table U.28.

U.5 ENTOMBMENT (ENTOMB)

ENTOMB means to encase and maintain property in a strong and structurally long-lived material (e.g., concrete) to assure retention until radioactivity decays to an unrestricted level.[18] For this analysis, it is assumed that entombment takes place within that portion of the containment building below the floor at the 305-ft level and within the cavities enclosed by the D-ring and biological shield structure. These areas are already reasonably well enclosed within structurally strong concrete walls and/or floors, and can be completely enclosed with nominal effort. Access to the containment building via the airlocks located on the 305-ft level must be maintained to permit bringing in radioactive materials for placement and, ultimately, structural materials for the entombment barriers. The remainder of the facility is decontaminated to levels permitting unrestricted use of the space, with all radioactive materials removed and either placed within the entombment structure or shipped offsite for disposal. A reinforced-concrete entombment barrier is then poured at the 305-ft floor level of the containment building and at the tops of the shielded cavities in the D-ring structure.

All penetrations through the containment wall into the entombment structure area are capped and filled with concrete. The containment-building airlocks are used to move contaminated materials from other buildings into the containment building for placement in the entombment structure. When the entombment is completed, the larger airlock is sealed, and the smaller airlock is securely locked and fitted with an intrusion-alarm device. (The smaller airlock remains operable to allow entry into the containment building for inspection purposes during the continuing care of the entombed plant.) The upper portion of the containment building serves as a secondary barrier over the top of the entombment structure.

If the radioactivity entombed at the site includes significant levels of long-lived neutron activation products (e.g., Ni-59 with an 80,000-year half-life and Nb-994 with a 20,000-year half-life) as are present in the reactor vessel and internals, the required retention period may be exceedingly long (i.e., tens of thousands of years or more), depending on the acceptable release limits for residual radioactivity. This implies that the entombment structure must remain inviolable for extensive periods of time. There is currently no reasonable assurance of such long-term integrity for man-made structures of this kind. In addition, ENTOMB will likely require continuation of the utility's nuclear license (and the associated financial and surveillance commitments) in perpetuity, unless either the long-lived radioactivity is removed initially or the entombment structure is reopened (at some later time) and the materials stored inside are disposed of offsite. The latter case involves an additional decommissioning step, deferred decontamination, that is complicated by the necessity to break into and remove radioactive materials from a structure designed to retain its integrity under any but the most severe conditions.

In effect, ENTOMB creates a permanent onsite waste repository unless either deferred decontamination ultimately takes place or all long-lived radionuclides are initially removed, in which case ENTOMB still represents long-term onsite storage of significant quantities of radioactive materials (long-term meaning beyond the normal operating lifetime of a power reactor, which is about 30 years).

As discussed previously in this statement, alternatives that involve permanent waste disposal onsite at TMI appear to be neither technically feasible nor compatible with current national policies and regulatory guidelines for radioactive waste disposal. It is unlikely that TMI could be qualified for permanent disposal of either high-level or low-level wastes because of such factors as nearby population densities and hydrology. (See Chapter 3 of this statement for further details on these factors.)

It is the staff's position that TMI should not become a permanent waste repository site. Hence, alternatives involving temporary onsite waste storage that would greatly increase the effort required for subsequent removal and offsite storage are regarded by the staff as unacceptable.

Based on the aforementioned considerations and constraints, ENTOMB appears to be an unacceptable alternative for the decommissioning of TMI-2. It should also be noted that the costs for ENTOMB, including the required expenditures for continuing care and deferred decontamination, are similar to those for DECON. Overall (including continuing care and deferred decontamination), ENTOMB is a more difficult and time-consuming alternative. It thus appears that ENTOMB, as compared to

DECON and SAFSTOR, is the decommissioning alternative of last resort for TMI-2 and would be acceptable only if severe constraints were placed on the other two alternatives.

The estimates of labor hours, waste volumes, and costs for ENTOMB are derived largely from those for DECON because many of the activities required for the two alternatives are the same, particularly those activities outside of the entombment structure area. Estimates for activities unique to ENTOMB are derived largely by comparison with the results of previous conceptual decommissioning studies,[1,2] adjusted as required for specific plant parameters and for cost escalation from the reference studies' base costs.

U.5.1 Decommissioning Activities for ENTOMB

As stated previously in Section U.3.1, it is assumed that by the time the irradiated fuel has been placed in the spent fuel pool in the AFHB and the reactor coolant system and associated fluid handling systems have been chemically decontaminated, the necessary regulatory approvals will have been received so decommissioning can proceed promptly. Work begins in the reactor containment building, proceeds through the AFHB, and concludes with the service and control buildings.

The overall time schedule of ENTOMB activities is shown in Figure U.8 and is very similar to that shown previously for DECON. The duration of activities in the containment building is extended somewhat to allow adequate time to move contaminated materials from the AFHB into the entombment area. The duration of radwaste shipping activities remains the same, although less material is shipped offsite during ENTOMB than during DECON. The overall duration of ENTOMB for TMI-2 is estimated to be nearly four years.

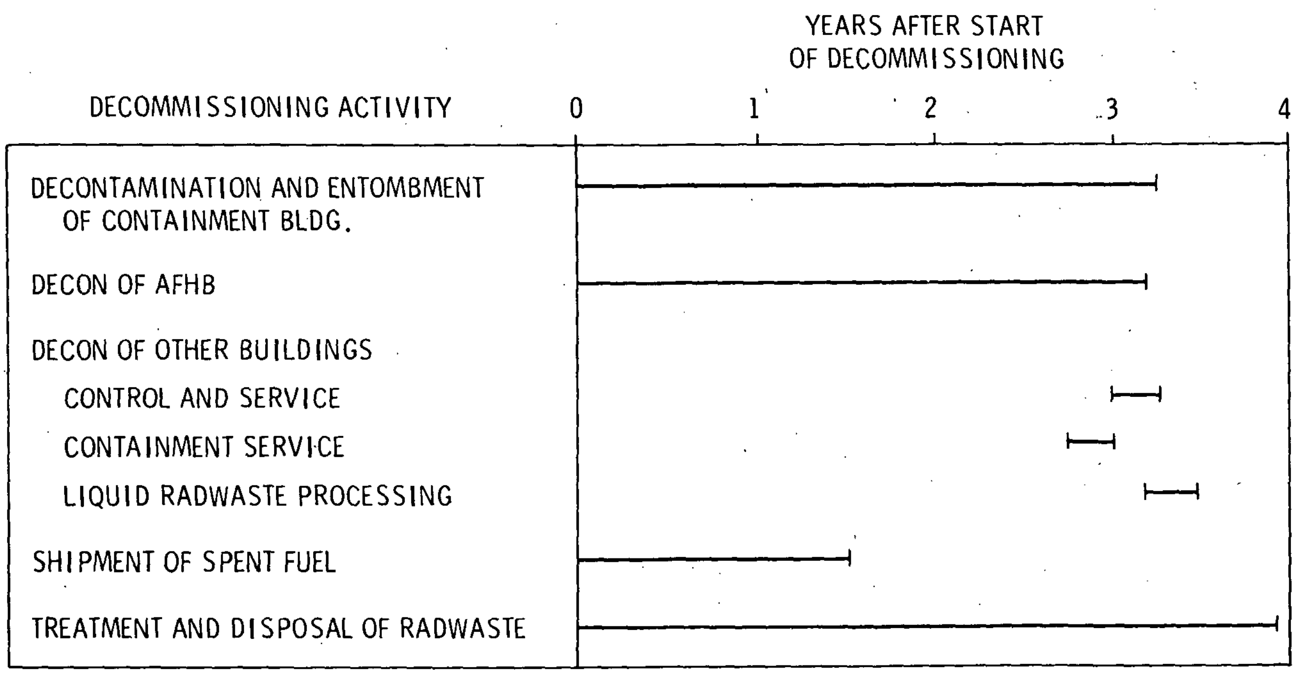


Figure U.8. Duration of ENTOMB Activities.

The major differences between activities for ENTOMB and those for DECON are in the containment building. Activities in other portions of the plant are essentially the same for both alternatives.

U.5.1.1 Containment Building

ENTOMB requires removal of all radioactive materials outside of the postulated entombment structure. Therefore, ENTOMB activities in the containment building outside of the entombment structure area are the same as the corresponding DECON activities (described previously in Section U.3.1.1) except that only some of the resulting radioactive wastes require packaging for offsite shipment and the remaining wastes are placed inside the entombment structure. DECON activities inside the entombment structure area are deleted and replaced by unique ENTOMB activities. Piping that penetrates the postulated entombment structure is cut off at all points of penetration and the openings are sealed with welded steel plates. In addition, other piping and equipment that may impede the movement of radioactive materials into the entombment structure is removed and placed in a more convenient location in the structure. Additional hatchways are cut through the floor at the 305-ft level to facilitate the movement of materials into the area. After the entombment structure is filled with radioactive materials, all penetrations through the structure (e.g., piping penetrations, hatchways, and stairwells) are sealed with cast-in-place reinforced concrete. The tops of the cavities in the D-ring shield structure are also sealed. After completion of the entombment structure, appropriate security and surveillance systems are installed in the decontaminated upper portion of the containment building, and all utilities not required during continuing care are disconnected. Then, the larger air-lock is sealed and the smaller one is fitted with an intrusion alarm and locked. Continuing care of the entombment structure commences at this point.

Total person-hours and exposure hours associated with ENTOMB activities are postulated to be the same as for DECON (226,160 and 110,300, respectively).

U.5.1.2 Auxiliary and Fuel Handling Building

ENTOMB activities in the AFHB are essentially the same as those for DECON (Section U.3.1.2). The major difference is that only some of the radioactive material removed is packaged and shipped offsite for disposal; the remainder is moved to the containment building for placement in the entombment structure. Total person-hours and exposure hours are postulated to be the same as for DECON.

U.5.1.3 Other Buildings

ENTOMB activities in the other TMI-2 buildings are postulated to be the same as those for DECON, as described in Section U.3.1.3. Total person-hours and exposure hours are assumed to be the same as for DECON.

U.5.2 <u>Waste Volumes from ENTOMB</u>

The volumes of radioactive material originating outside the postulated entombment structure and requiring either placement in the entombment structure or shipment offsite for disposal are estimated from those shown previously for DECON in Table U.6. The first four items for DECON (reactor vessel with head and internals, RCS equipment, steam generators, and activated concrete) originate inside the entombment boundary and do not apply here. Contaminated equipment (not including the steam generators and the RCS pumps, piping, and pressurizer) and miscellaneous radwastes are assumed to be essentially the same for both alternatives. The percentage of contaminated concrete from DECON originating outside of the entombment boundary, derived from Tables G.4-4 and G.4-5 of Reference 1, is estimated to be $\sim$89%. The resulting volumes of radioactive material generated during ENTOMB are summarized in Table U.30.

Only part of the radioactive waste arising from ENTOMB can be placed in the entombment structure; the rest requires packaging and shipment offsite for disposal. Based on information presented in Reference 19, the free volume available for entombment in the D-ring shield structure is estimated to be 172,480 ft^3. Additional entombment volume estimated to be available below the 305-ft level floor is 124,720 ft^3. Thus, the total volume available for entombment of radioactive materials at TMI-2 is about 297,200 ft^3. Because of the variety of shapes and sizes of both the volume available within the entombment structure and the contaminated materials to be stored there, as well as the difficulty in placing materials in some portions of the structure, a volume utilization efficiency of 50% is assumed. Therefore, up to 148,600 ft^3 of the radioactive waste originating outside the entombment structure can be placed inside, reducing the volume that requires packaging

Table U.30. Estimated Volumes of Radioactive Waste Arising from ENTOMB of TMI-2

Component	Fraction of Volume for DECON	Estimated Burial Volume (ft^3)
Contaminated concrete	0.89	393,700
Contaminated equipment	1.00	127,200
Miscellaneous radwaste	1.00	22,000
Total		542,900

for offsite shipment and disposal to 394,300 ft^3. This apportionment of the wastes resulting from ENTOMB of TMI-2 is summarized in Table U.31.

It should be noted that not all of the waste originating outside the entombment boundary is readily amenable to placement in the entombment structure. Large equipment items present particular problems in this regard. Thus, care must be taken in apportioning the particular items to maximize worker efficiency and minimize radiation doses associated with equipment disassembly and handling.

U.5.3 Effluents and Releases to the Environment

During ENTOMB, as during DECON (Section U.3.3), the atmospheric release of radionuclides is assumed to be the only source of radiation to the public from routine decommissioning operations. (Effluents and releases from waste transportation activities are discussed separately in Chapter 9 of this statement.) All liquid radioactive wastes generated during decommissioning are assumed to be sent to the plant liquid waste storage system or to other tanks designated for temporary storage of these solutions. The wastes are then assumed to be processed through the waste concentration and solidification system. All systems designed to control the release of hazardous material to the environment or to noncontaminated portions of the facility are assumed to be operating during the decontamination activities and subsequent waste processing, to minimize the potential impacts of these activities.

The primary sources of radioactive effluents from routine decommissioning operations are the release of contaminated liquid aerosols during decontamination, the release of contaminated vaporized metal during equipment removal, and the release of contaminated concrete dust during decontamination or removal of concrete structures.

Based on an analysis of the generation of airborne radioactivity during DECON operations at a large PWR, given in Appendix J of Reference 1, a summary of the results of such an analysis for ENTOMB is presented in Table U.32. The releases postulated here do not include releases from possible accidents involving transport of spent reactor fuel from the site to a disposal facility. From Table U.6, the total contaminated equipment removed during DECON (including the RCS equipment and the steam generators) is 154,000 ft^3 while, from Table U.30, the total removed for ENTOMB is 127,200 ft^3. The releases for segmenting contaminated equipment during ENTOMB are thus $\sim$83% of those given in the reference for DECON. The releases during removal of contaminated concrete in the reference study are based on 6912 ft^3 of concrete removed (see Table G.4-4 of Reference 1), as compared to an estimated 393,700 ft^3 postulated to be removed for ENTOMB of TMI-2 (see Table U.30). Thus, the release reported in the reference is adjusted by a factor of $\sim$57 to account for the differing volumes of concrete considered. The rest of the releases reported in Table U.32 are drawn directly from the reference because the operations considered are the same for either DECON or ENTOMB. The compositions of the reference inventories of radionuclides considered in the analysis were presented previously in Tables U.8 through U.11.

Table U.31. Apportionment of Radioactive Waste Arising from ENTOMB of TMI-2

Component	Estimated Burial Volume (ft^3)
Total waste originating outside entombment boundary	542,900[a]
Waste entombed onsite	148,600
Waste packaged and shipped offsite for disposal	394,300

[a]From Table U.30.

Table U.32. Postulated Releases of Airborne Radioactivity to the Environment During ENTOMB Operations

ENTOMB Operation	Reference Radionuclide Inventory[a]	Airborne Release (μCi)
Segmenting contaminated equipment	4	5
Contaminated concrete removal	5	0.0014
Water-jet cleaning	5	9.8

[a]The reference radionuclide inventories are presented in Section U.3.3.

U.5.4 Environmental Impacts

The environmental impacts associated with ENTOMB of a nuclear power reactor are contained in three general categories: the radiation dose to the workers involved, the radiation dose to the public, and the commitment of disposal space in a low-level waste burial ground. The impacts associated with ENTOMB for each of these categories are discussed in the following sections.

U.5.4.1 Estimated Occupational Radiation Doses from ENTOMB Activities

The radiation dose accumulated by the workers performing ENTOMB activities is estimated by multiplying the average local radiation dose rate for a given plant area times the number of worker exposure hours estimated for that area, and summing over the entire project. The average local dose rates for general areas in the containment building and the AFH building are given in Table U.33. Also given in the table are cumulative exposure hours for persons working in those general areas, taken from Section U.5.1, the computed cumulative dose to the workers accomplishing tasks in those areas, and the estimated total radiation dose received by workers while performing ENTOMB activities. Worker exposure hours in the various areas outside the containment building are assumed to be the same for ENTOMB as for DECON. For the containment building, it is assumed that only half as much exposure time is required at the 282-ft level for ENTOMB as compared with DECON, with proportionally more time at the 305-ft level to make up the difference.

The estimated dose received by the transportation workers during the transport of packaged radioactive wastes, based on an assumed realistic dose rate for each shipment as given in Section 9.5.1.1 (56 millirem/trip/driver), is given in Table U.34. The estimated dose received by railway workers during the transport of the spent reactor fuel, as derived in Section U.3.4.1 for DECON, is also given in the table.

U.5.4.2 Offsite Doses from ENTOMB Activities

The dose estimates presented here for ENTOMB decommissioning operations are based on the source terms described in Section U.5.4, Table U.32, and on the assumption that the decommissioning activities take place 10 years after the TMI-2 accident. The calculational models used to make these estimates and the interpretation of their results are described in Appendix W. The significance of these doses and their human health and environmental consequences are discussed in Section 10.3. The estimated doses to the maximum exposed individual are listed in Table U.35. The 50-mile total body population dose received by the human population during these activities is estimated to be 6×10^{-5} person-rems.

The estimated radiation dose to the public resulting from transport of radioactive material offsite is presented in Table U.36 for both truck and rail transport.

U.5.4.3 Other Environmental Effects

Other impacts on the environment surrounding TMI resulting from ENTOMB of Unit 2 will be similar to those discussed in Section 10.6, but of lesser magnitude because there will be fewer workers involved in ENTOMB and because gross contamination cleanup efforts will have been completed before the start of decommissioning.

It is anticipated that the decommissioning of Unit 2 would reduce the level of anxiety and psychological stress among local residents.

Completion of decommissioning will reduce the number of persons employed at the TMI site, thus reducing the local payroll, at least temporarily.

U.5.5 Estimated Costs for ENTOMB

The principal cost items for ENTOMB are labor, waste disposal, spent fuel disposal, and energy. Other costs include special equipment, speciality contractors, licensing and insurance, and miscellaneous supplies. The costs presented here are based largely on those for DECON, presented previously in Section U.3.5. Additional information used to estimated costs is drawn from Section 4 of Reference 2. The costs for ENTOMB are summarized in Table U.37, with discussions of the principal cost items presented in the following sections.

Table U.33. Estimated Cumulative Radiation Doses Received by Workers During ENTOMB Operations

Operation Area	Average Local Dose Rate (mrem/hr)	Worker Exposure Hours in the Area	Cumulative Radiation Dose (person-rem)
Containment Building			
347-ft level	~5	47,600	240
305-ft level	5-10	43,900	220
282-ft level	30	18,800	564
AFH Building			
All levels	2	106,800	213
Other Buildings			
All levels	2	18,000	35
Total			1,272

Table U.34. Estimated Cumulative Radiation Doses Received by Transport Workers During ENTOMB Operations

Worker Type	Dose/Shipment (mrem/driver)	Number of Shipments	Cumulative Radiation Dose (person-rem)
Truck drivers	56	755	84.6[a]
Train crew	120	26	6.2[a]
Total			91

[a]Assumes two drivers/truck, two brakemen/train.

Table U.35. Dose Estimates to the Maximum-Exposed Individual from Normal Decommissioning Activities (ENTOMB)

Location	Pathway	Dose (mrem)[a]		
		Total-Body	Bone	Liver
Nearest garden[b]	Inhalation	1.4×10^{-7}	3.1×10^{-7}	2.6×10^{-7}
	Ground Shine	6.9×10^{-7}	6.9×10^{-7}	6.9×10^{-7}
	Vegetable Use	3.2×10^{-6}	1.4×10^{-5}	1.3×10^{-5}
	Total	4.3×10^{-6}	1.5×10^{-5}	1.4×10^{-5}
Nearest milk goat	Inhalation	1.2×10^{-7}	1.7×10^{-7}	1.7×10^{-7}
	Ground Shine	6.6×10^{-7}	6.6×10^{-7}	6.6×10^{-7}
	Goat Milk Use	8.4×10^{-6}	6.5×10^{-5}	7.6×10^{-5}
	Total	9.2×10^{-6}	6.6×10^{-5}	7.7×10^{-5}
Nearest cow and garden	Inhalation	1.5×10^{-7}	3.4×10^{-7}	2.9×10^{-7}
	Ground Shine	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}
	Vegetable Use	4.6×10^{-6}	2.0×10^{-5}	1.9×10^{-5}
	Cow Milk Use	3.1×10^{-6}	2.4×10^{-5}	2.8×10^{-5}
	Total	8.9×10^{-6}	4.5×10^{-5}	4.8×10^{-5}

[a]Doses were calculated for Total-body, GI-tract, bone, liver, kidney, thyroid, lung and skin. The maximum three organ doses are listed in this table. Doses were calculated for four age groups: adults, teenagers, children, and infants. The highest dose estimates for each age group are listed. The dose estimates for the total-body pathway are for adults. The dose estimates for the bone and liver pathways for the nearest garden and nearest cow and garden locations are for children, and for the nearest goat location are for infants.

[b]The basis for selecting the special locations is described in Appendix W. The actual locations are: nearest garden = 1.05 mile east-north-east, nearest milk goat = 1.02 mile north, and nearest cow and garden = 1.05 mile east.

Table U.36. Estimated Cumulative Radiation Dose Received by the Public During Transport of Wastes from ENTOMB

Type of Shipment	Number of Shipments	Dose/Shipment (person-rem)	Cumulative Public Radiation Dose (person-rem)
Radioactive material (truck)	755	0.053[a]	40.0
Spent reactor fuel (rail)	26	0.0293[b]	0.76
Total			41

[a]Based on data given in Section 9.5.1.2.

[b]Based on data given in Section 11.4.1 of Reference 1.

Table U.37. Summary of Estimated Costs for ENTOMB

Category	Cost in millions of Mid-1980 Dollars
Decommissioning labor	
Direct	7.196
Support	8.923
Radwaste disposal	8.503
Spent fuel shipment	2.496
Energy	4.620
Other costs	
Supplies	1.820
Equipment	0.960
Contractors	0.510
Nuclear insurance	0.940
Licensing fees	0.050
Subtotal	36.018
25% contingency	9.004
Total	45.020
Annual continuing care costs	0.040

U.5.5.1 Decommissioning Labor Costs

Labor cost estimates for ENTOMB are developed based on the person-hour totals presented in Section U.5.1 and the labor cost assumptions used in Section U.3.5.1 for DECON. The direct decommissioning crew hours and the resulting labor costs are summarized in Table U.38.

U.5.5.2 Radioactive Waste Disposal Costs

The radioactive materials requiring offsite disposal during ENTOMB of TMI-2 consist of surface-contaminated equipment and concrete and miscellaneous radwaste (e.g., filters, ion exchange resins, solidified radioactive fluids, and combustible wastes). Estimates of the costs for disposing of these materials are summarized in Table U.39, based on the disposal cost estimates and assumptions given for DECON in Section U.3.5.2 and on the waste volumes from ENTOMB given previously in Section U.5.2. All of the miscellaneous radwastes are assumed to be shipped offsite. In addition, ~71% of the contaminated equipment and concrete generated outside the entombment structure is assumed to be shipped offsite, for a total of 394,300 ft^3 of waste disposed of offsite (see Table U.31).

U.5.5.3 Spent Fuel Disposal Costs

Spent fuel disposal costs are the same for ENTOMB as for DECON. The total cost for spent fuel disposal is $2.5 million, as derived previously in Section U.3.5.3.

U.5.5.4 Energy Costs

Energy costs for ENTOMB are assumed to be the same as those for DECON, or $4.62 million, as derived previously in Section U.3.5.4.

Table U.38. Estimated Labor Costs for ENTOMB

Activity	Direct Crew Hours	Labor Cost in Millions of Dollars: Direct Crew	Total
Containment building	200,816	3.036	6.803
All others	274,996	4.160	9.318
Total	475,812	7.196	16.119

Table U.39. Estimated Costs for Offsite Disposal of Radioactive Wastes from ENTOMB

Radioactive Material	Number of Shipments	Container Cost[a]	Cask Rental[b]	Transport Costs[c]	Handling Charges[d]	Burial: Volume (ft^3)	Burial: Charges[e]	Total Cost
Contaminated equipment	25	334,170	-	92,500	-	90,900	790,830	1,217,500
Contaminated concrete	550	1,033,530	-	2,035,000	-	281,400	2,448,180	5,516,710
Miscellaneous radwastes	180	151,800	324,000	1,026,000	54,600	22,000	212,872	1,769,272
Total	755	1,419,400	324,000	3,153,500	54,600	394,300	3,451,882	8,503,482

[a] Assumes cask liner cost of $800, LSA box cost of $470, special container cost of $6000/box.

[b] Assumes rental fee of $300/day and a 6-day cycle for each shipment.

[c] Assumes a transport cost of $5700/round trip, $3700/one-way.

[d] Assumed to average $350/cask liner, overweight objects @ $87.50 + (0.02/lb >10,000 lb).

[e] Assumes burial charges of $8.70/$ft^3$, liner and curie surcharges as given in current NECO price list.

U.5.5.5 Other Costs

Other cost items include miscellaneous supplies, special equipment, specialty contractors, nuclear insurance, and licensing fees. It is assumed for ENTOMB, as it was in Section U.3.5.5 for DECON, that the costs of these items as presented in Reference 2, when escalated by 17%, are appropriate for the TMI-2 analysis. Based on Table 4.5-1 of Reference 2 and Table 10.3-1 of Reference 3, these items are estimated to be $1.82, $0.96, $0.51, $0.94, and $0.05 million, respectively.

Continuing care, involving surveillance and maintenance of the entombment structure, is estimated to cost about $40,000 annually (see p. 4-10 of Reference 2 and p. 10-15 of Reference 3). Thus, for example, a continuing care period of 100 years would add about $4 million to the cost of TMI-2 ENTOMB.

U.5.6 Deferred Decontamination

As discussed previously in Section U.5, deferred decontamination must follow ENTOMB if it becomes desirable to terminate the nuclear license of the facility. This deferred decontamination following ENTOMB, though not analyzed here in detail, is anticipated to be an extensive project. Although there is less radioactive material to remove from the plant (because of some offsite disposal during the initial phase of ENTOMB) and this remaining radioactive material is consolidated in a relatively small portion of the facility, the operation is complicated by the necessity to break into the entombment structure (designed to retain its integrity under any but the most severe conditions) and remove the more-or-less randomly placed radioactive materials stored inside. Therefore, the costs for deferred decontamination following ENTOMB are anticipated to be similar to those for deferred decontamination for SAFSTOR (see p. 2-14 of Reference 3), given previously in Section U.4.8.

The radiation doses and radioactive releases associated with deferred decontamination are expected to decrease with the entombment time in accordance with the radioactive decay of the entombed materials. However, it should be noted that (1) the doses and releases associated with segmenting and removing the neutron-activated materials, avoided during the initial phase of ENTOMB, would certainly be encountered during deferred decontamination and (2) these doses and releases will not decline significantly after about the first 100 years of entombment because of the long half-lives associated with the remaining activation products (see Figure 7.4-1 of Reference 1). Thus, the overall total doses and releases for ENTOMB and deferred decontamination are anticipated to be only a little less than those for DECON alone. Furthermore, any savings in doses and releases resulting from ENTOMB could be more reasonably achieved by SAFSTOR, particularly because SAFSTOR involves simpler, less time-consuming procedures and lower overall costs than ENTOMB.

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APPENDIX V. ASSESSMENT OF GROUNDWATER LIQUID PATHWAY FROM LEAKAGE OF CONTAINMENT WATER AT THREE MILE ISLAND, UNIT 2

The staff has conservatively estimated the concentrations of radioactivity that would occur in the Susquehanna River from the leakage of radioactive water in the reactor building.

The Unit 2 reactor building has approximately 700,000 gallons of radioactively contaminated water on the basement floor (reactor building sump water). Major quantities of tritium (0.95 μCi/mL), Cs-137 (163 μCi/mL), Cs-134 (24 μCi/mL) and Sr-90 (2.61 μCi/mL) are dissolved in this water. The postulated accident is a breach of containment that allows part of this contaminated water to escape to the ground.

The reactor building water level was 290 ft MSL in April 1980, as shown in Figure V.1. The corresponding groundwater level was 285 ft MSL. Under these circumstances, the maximum water loss would be less than two-thirds of the 700,000 gallons. The water table fluctuates under the influence of river stage and rainfall, however. For the purposes of this computation, the staff assumed that 470,000 gallons of the water was lost to the groundwater.

V.1 RELEASE MECHANISM

There is no realistic mechanism that would result in release of large quantities of the radioactive water to the environment. For the purposes of this study, it was arbitrarily and conservatively assumed for the transport of Sr-90 and Cs-137 that water released from the reactor building by a non-mechanistic crack failure would seep into the ground over an area equal to that of the entire reactor building floor. The range of permeability values for the surficial soils was 10^{-2} to 10^{-3} cm/s.[1] On the basis of these conservative assumptions, the staff estimated that it would take from 0.25 to 2.5 days for all the 470,000 gallons of water to seep away. A more realistic seepage rate would be much smaller than this and would be limited by the size of the crack in the containment. The natural water table has a measured slope in the direction of the river of about 0.006.[1] The staff estimated that the travel time under normally occurring water table conditions would range from 350 days to 7060 days. The true groundwater travel time is almost certainly longer than the minimum, however, for the following reasons:

1. The actual gradient is probably smaller than that reported during construction of the site because much of the natural land surface is now covered with impermeable concrete and is also well drained; and

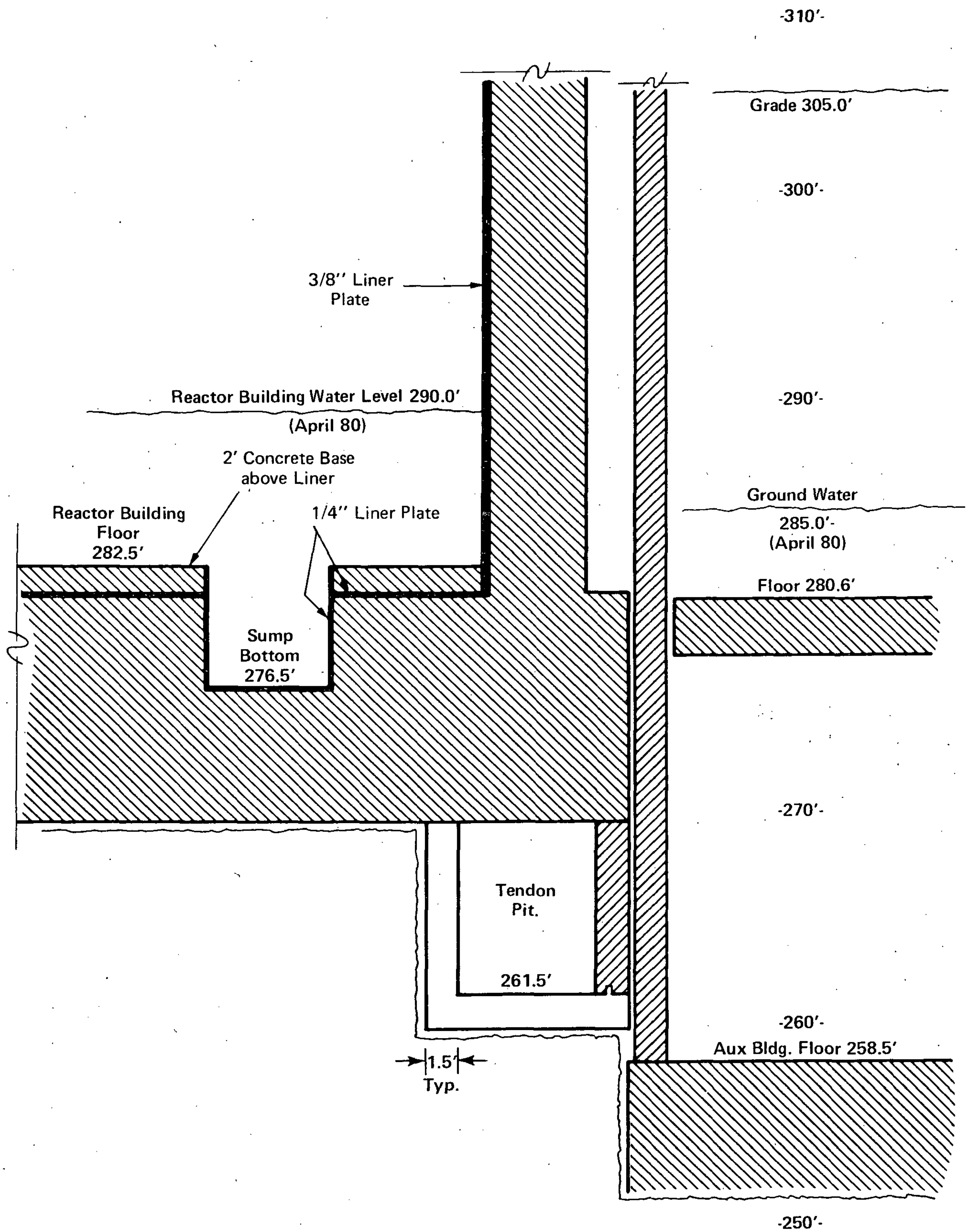

Figure V.1. Reactor Building.

2. A travel time of 350 days would require a recharge to the water table of about 50 percent of all rain falling onto the land. Typical groundwater recharge would be only a few percent of the rainfall after evapotranspiration and runoff in a well-graded area.

The released contaminated water would recharge the water table, creating a local groundwater "mound" which would perturb normal flow. The effect of the 470,000-gallon volume of contaminated water on the water table would be substantial, but of short duration. It is possible to demonstrate by way of an example that the perturbation of flow in the water table can be neglected for the most important radionuclides, Sr-90 and Cs-137, which have large liquid pathway dose factors and relatively long half-lives.

Because of sorption of radionuclides on the soil, transport of sorbed radionuclides from the reactor containment to the river would take a minimum of tens of years. In a ten-year period, the quantity of groundwater flowing directly under the reactor building under the assumptions used to calculated 350-day groundwater time would be approximately 1.5×10^7 gallons, as compared to the 0.47×10^6 gallons in the reactor building. The water in the reactor building could, therefore, provide only a few percent, at most, of the water necessary to transport sorbed radionuclides to the river. Radionuclides that are not sorbed, notably tritium, would be significantly affected by the perturbation in groundwater flow, however.

Transport in the groundwater would take place through the unconsolidated material and weathered bedrock underlying the site. The unconsolidated material is sand, silt, and gravel. The bedrock is red siltstone. Although there is evidence of some fracturing of the bedrock under the site, it is virtually impossible to contaminate groundwater units other than the water table since they are under artesian pressure. Leakage from the artesian aquifer would be in the outward direction only.[2]

There were apparently no chemical analyses performed on these materials that would indicate to what extent the radionuclides in the contaminated water would be retarded. Literature values of retardation are not reliable for realistic assessments, and for lack of field data, conservative values have been chosen. Field and laboratory data have been compiled for sorption on a number of soils and rocks.[3] The lowest sorption coefficient, K_d, for unconsolidated material reported is 1.4 mL/g for strontium and 22 mL/g for cesium in quartz sand. Values for siltstone and alluvial materials such as that at the TMI site would be expected to be higher, but the above low values are chosen for conservatism.

The retardation coefficient, which is related to K_d, is the ratio of the speed at which the groundwater moves relative to the speed of the sorbed substance, and is always greater than or equal to 1:

$$R_d = 1 + \frac{\rho K_d}{n} ,$$

where ρ is the density (g/mL) of the medium and n is the total porosity. If a typical density of 2.0 g/mL and a total porosity of 0.15 are chosen, R_d is 24 for strontium and 294 for cesium.

V.2 TRANSPORT MODEL FOR SORBED RADIONUCLIDES

A simple transport model is proposed to calculate the flux of sorbed radioactivity to the river. Consider the conservative situation wherein the 470,000 gallons of reactor building sump water seeps into the water table over an area the size of the floor of the building. If the seepage occurred quickly compared to the movement of the natural water, then the concentration profile in the water table would resemble the rectangular pulse shown in Figure V.2(a).* As the contamination was eluted by the flowing groundwater, the front and back end of the square pulse would become rounded by diffusion and dispersion as shown in parts (b) and (c) of Figure 2. Dispersion in the unconsolidated alluvial deposits may be too small to diminish the concentration in the center of the pulse significantly (the bases for this conclusion are given in Sec. V.5 of this appendix). It is, therefore, conservatively assumed that the concentration in the center of the pulse remains the same as when it was first released except that it is reduced to account for radioactive decay.

The pulse flows into the Susquehanna River at a rate determined by the groundwater flow rate, the retardation coefficient, and the decay coefficient:

$$\text{Flux} = \frac{Mu}{\ell R_d} \exp\left(-\frac{\lambda x R_d}{u}\right) \text{ curies/day}$$

where

- M = the source term of the radionuclide, curies (2/3 of contaminated water)
- ℓ = the length of the pulse, ft
- u = the groundwater velocity, ft/day
- R_d = the retardation coefficient
- λ = the decay coefficient, $\text{day}^{-1} = \frac{0.693}{\text{half-life in days}}$
- x = the distance from the leading edge of the pulse to the river.

*For computational expediency, it is assumed in the model that the leaked reactor building sump water enters groundwater instantaneously. The resulting concentrations in the Susquehanna River would not be highly sensitive to the rate of leakage if interdiction by removal of the source term is not taken into account.

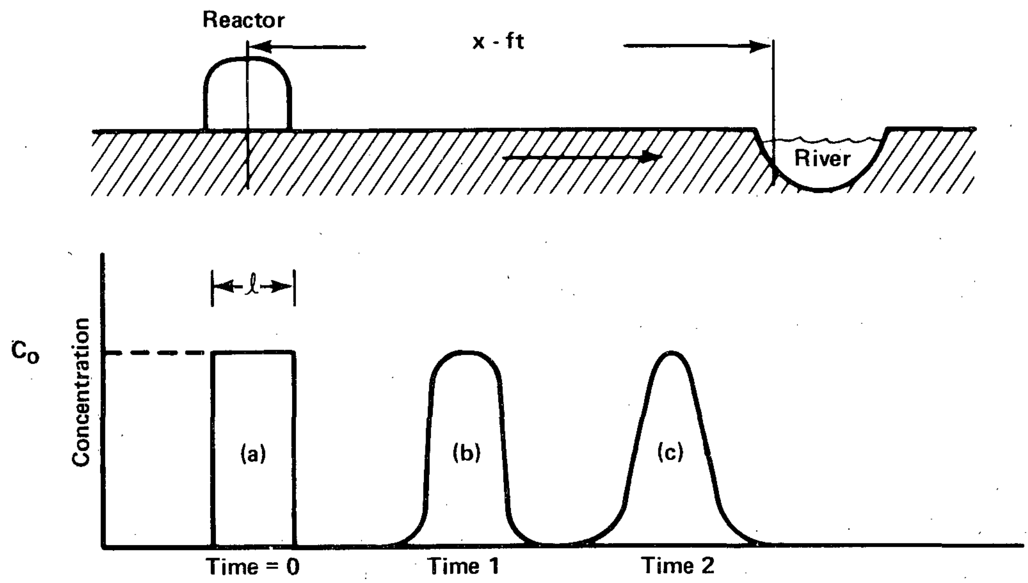

Figure V.2. Elution of Radionuclides.

For the present example, the parameters chosen are given below:

Parameter	Sr-90	Cs-137
M, curies	4610	2.88×10^5
R_d	24	294
$t_{1/2}$, years	29	30.1
ℓ, feet	150	150
u, ft/day	1.7	1.7
x, ft	600	600

The maximum fluxes of Sr-90 and Cs-137 calculated are 1.25 and 0.016 Ci/day, respectively. The leading edge of the pulse would reach the river in 23 years for Sr-90 and 284 years for Cs-137. By the time the radionuclides reach the river, radioactive decay will have reduced the Sr-90 to 2660 Ci and the Cs-137 to 416 Ci.

V.3 TRANSPORT OF TRITIUM

Unlike the Sr-90 and Cs-137, the flux of tritium into the Susquehanna River would depend to a degree on the flow induced in the groundwater by the large volume of the spill. The flux of tritium is estimated by assuming that the dissolved radioactivity is released to the water table from an instantaneous point source. The circle of contaminated water displaces fresh water in the water table with no mixing. The contaminated water then moves with the ambient velocity of the groundwater towards the Susquehanna River, carrying with it the dissolved tritium, but leaving sorbed nuclides behind. Details of this model are given in Section V.6 of this appendix.

The maximum flux of tritium is estimated to be 1.9×10^{-4} Ci/s into the Susquehanna River.

V.4 SURFACE WATER DILUTION

The release of Sr-90 and Cs-137 to the Susquehanna River would continue over a long period if left unchecked. Since doses are usually calculated over a period of at least one year, the logical choice of a stream flow would be the reciprocal mean flow of 12,600 cubic feet per second (the derivation of this value is discussed in Sec. 3.4.1). All downstream drinking water users on the Susquehanna River are located far enough downstream that total mixing of the effluent across the channel would be expected. Travel time to downstream users would be negligible compared to that of the groundwater pathway. The peak radionuclide concentrations in the Susquehanna River based on the annual average flow would be 4.05×10^{-8} μCi/mL for Sr-90, 5.1×10^{-10} μCi/mL for Cs-137, and 5.2×10^{-7} μCi/mL for tritium. Furthermore, the peaks of these three radionuclides would occur at different times because of sorption. Maximum permissible concentrations (MPC) for unrestricted drinking water from 10 CFR Part 20 are 3×10^{-7} μCi/mL for Sr-90, 2×10^{-5} μCi/mL for Cs-137 and 3×10^{-3} μCi/mL for tritium. The calculated river concentrations are thus orders of magnitude below MPC.

After the initial delay, Sr-90 and Cs-137 would continue to be released over periods of about 8.5 and 140 years, respectively, although at a reduced rate once the peak concentration has subsided. The maximum average concentration over a one-year period for the purpose of computing an annual dose commitment would be close to the peak concentrations for these two nuclides. All of the tritium would be released over a 130-day period (after a delay of 350 days), so the annual average concentration should be based on the quantity released. In this case, about 2300 Ci would be released to the river. The annual average concentration of tritium in drinking water would be about 1.3×10^{-7} μCi/mL.

Minor amounts of Cs-137 would be expected to become attached (sorbed) to suspended and bottom sediments, especially behind the dams on the river. This would partially cleanse the water column of Cs-137, while increasing the exposure to bottom dwelling organisms and aquatic life feeding on them. These phenomena would be expected to have only a minor effect on dose and are neglected in the present analysis.

As described in Appendix E, all species of fish in York Haven Pond exhibit movement upstream, downstream, and across the channel, so they would be exposed to an average concentration rather than the concentration at a single point in the channel. Staff practice for calculating the highest fish exposure is to use the average concentration within 1/4 mile of the point of release.

In this case, the 1/4-mile average would be the concentration in the middle channel of the Susquehanna River since the effluent first flows into this channel. The flow in the middle channel is estimated to be about 25 percent of the total river flow. The concentrations for annual dose commitments for fish consumption are, therefore, four times greater than those used for the drinking water, namely 1.6×10^{-7} µCi/mL for Sr-90, 2.1×10^{-9} µCi/mL for Cs-137, and 7.5×10^{-7} µCi/mL for tritium.

V.5 DISPERSION FROM AN AREA SOURCE

The concentration in an aquifer downgradient of an instantaneous nondecaying source strength of 1 curie has been shown to be:

$$C_i = \frac{1}{n_e R_d} X(x,t)\ Y(y,t)\ Z(z,t)\ (\mathrm{Ci/ft^3})$$

where n_e is the effective porosity, and X, Y, and Z are the Green's functions in the x, y, and z directions, respectively.[4] The Green's functions describe the spreading in their respective coordinate directions and are independent of each other.

The X Green's function describes spreading in the x direction, which in this case is the direction of flow for the groundwater. For an area source of length ℓ in the direction of flow as shown in Figure V.2:

$$X = \frac{1}{2\ell} \left\{ \mathrm{erf} \frac{(x + \frac{\ell}{2}) - \frac{ut}{R_d}}{\sqrt{4D_x t/R_d}} - \mathrm{erf} \frac{(x - \frac{\ell}{2}) - \frac{ut}{R_d}}{\sqrt{4D_x t/R_d}} \right\} \quad \text{(V1)}$$

where
- x is the distance from the center of the source, ft
- ℓ is the length of the source, ft
- u is the groundwater velocity, ft/day
- t is time, days
- D_x is the dispersion coefficient, ft²/day
- R_d is the retardation coefficient
- erf is the error function.

As the center of the pulse reaches the river in Figure V.2:

$$t = \frac{xR_d}{u} \quad \text{(V2)}$$

Equation (V1) reduces to:

$$X = \frac{1}{\ell} \text{ erf (arg)} \tag{V3}$$

where $\text{arg} = \dfrac{\ell/2}{\sqrt{4D_x x/u}}$

If we postulate that longitudinal dispersion is unimportant in diminishing the concentration of the pulse, then the functional dependence of X on D_x and t is zero or small. Such a condition is met by:

erf (arg) close to 1.0.

As a criterion for specifying that dispersion has less than a 5 percent effect on the concentration at the center of the pulse we may state:

erf (arg) $\geq$ 0.95.

The error function is a monotonically increasing function that approaches unity. For arg = 1.38, erf (arg) = 0.95, or within 5 percent of unity. Therefore:

$$\text{arg} = \frac{\ell/2}{\sqrt{4D_x\ x/u}} \geq 1.38 \tag{V4}$$

The dispersion coefficient is related to velocity in the x direction:

$$D_x = \alpha u\ , \tag{V5}$$

where D is the dispersivity, ft.

Therefore equation (V4) reduces to:

$$\frac{\ell/2}{\sqrt{4\ \alpha x}} \geq 1.38$$

$$\text{or } \frac{\ell^2}{\alpha x} \geq 30.5 \tag{V6}$$

A typical dispersivity in unconsolidated sand would be α = 0.3 ft.[5] For the TMI case ℓ = 150 ft., x = 600 ft. Therefore, $\frac{\ell^2}{\alpha x}$ = 125, which is greater than 30.5. Even if α = 1.0 feet, $\frac{\ell^2}{\alpha x}$ = 37.5. We must, therefore conclude that longitudinal dispersion could have less than a 5 percent effect on diminishing the maximum groundwater concentration at the TMI site.

V.6 FLUX OF TRITIUM FROM INITIAL SPILL*

The volume of water that leaks into the water table will alter the water level and induce flow of its own. This flow will carry dissolved radionuclides, especially those such as tritium which are not easily sorbed.

In an isotropic, homogeneous aquifer of infinite lateral extent and of constant thickness, the horizontal flow of groundwater can be estimated by the partial differential equation:[6]

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = \frac{1}{\beta}\frac{\partial h}{\partial t} \qquad \text{(V7)}$$

where h is the piezometric level, ft,
β is the transmissivity = ft^2/day,
n_e is the effective porosity,
k is the permeability, ft/day,
h is the thickness of the aquifer, ft,
t is time, days,
and x and y are the coordinates, ft.

A conservative model of this induced flow assumes that the water is instantaneously injected at a point into a continuous, isotropic medium of infinite extent as shown in Figure V.3. By analogy to the transport of the heat from a line source in an infinite cylinder[7] the water surface elevation h can be predicted as a function of time:

$$h = \frac{Q}{n_e 4\pi\beta t} \exp\left(-\frac{r^2}{4\beta t}\right) \qquad \text{(V8)}$$

where Q is the quantity of water injected, ft^3,
r is the radial distance of a given point from the point $(x_o + ut, y_o)$, moving with the pore velocity u, where (x_o, y_o) is the point of groundwater release,
and the other terms are as previously defined.

This equation is correct only for confined aquifers where the thickness of the saturated layer does not vary. In the present situation, the aquifer is unconfined, so is also the piezometric level. Some error will be introduced, especially for short times and distances close to the point of release.

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*This analysis was performed for 100% of the reactor building sump water volume escaping. The flux of tritium would be approximately two-thirds of the value presented here.

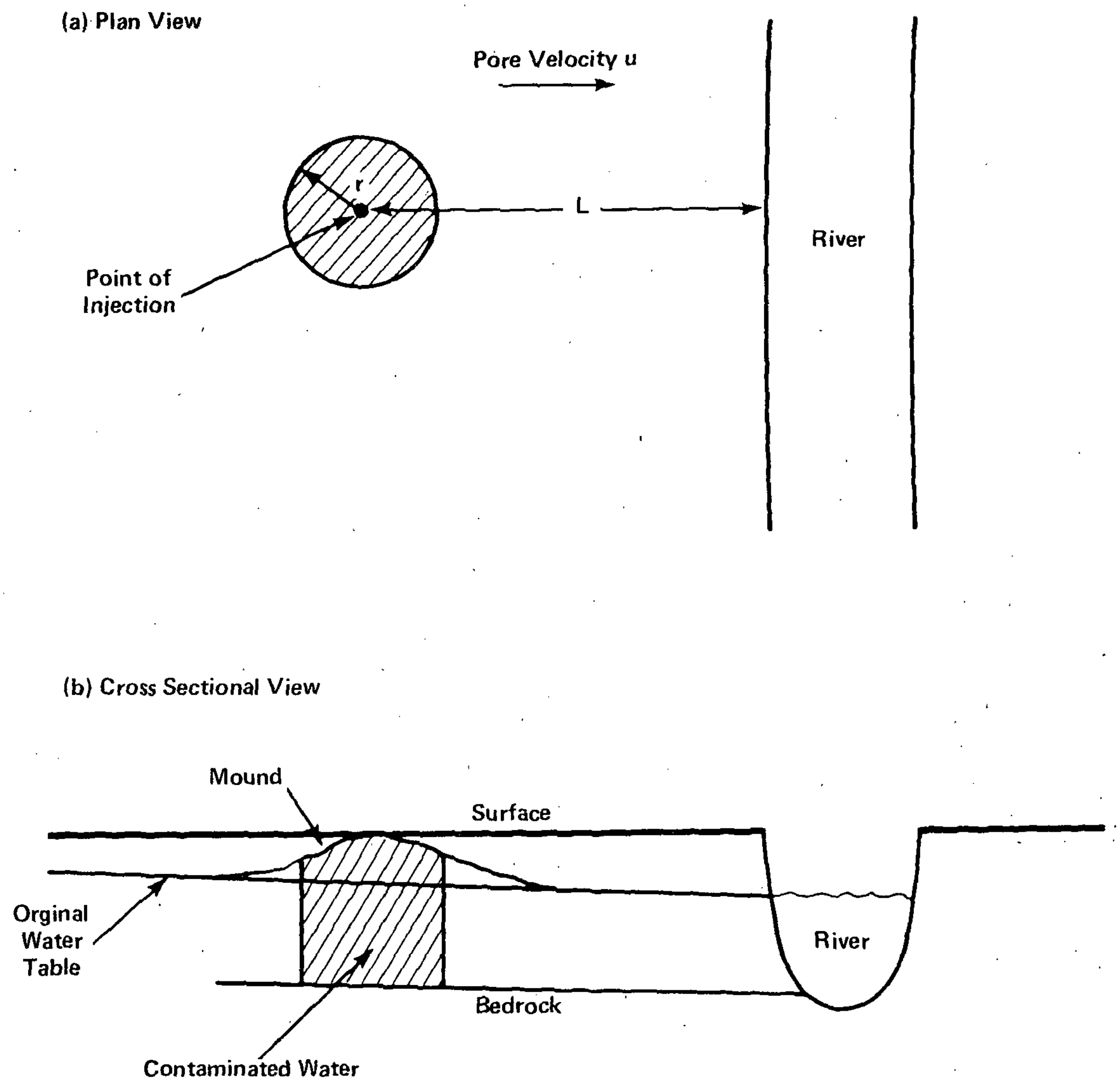

Figure V.3. Spread of Contaminated Water from Large Volume Releases.

In the reference plane of the center of the spreading mound, which is moving with the ambient groundwater pore velocity u, the flow is away from the center at radial velocity U_r:

$$U_r = -\frac{\partial h}{\partial r}\, k/n_e = \frac{Qkr}{8\pi n_e^2 \beta^2 t^2} \exp\left(-r^2/4\beta t\right) \qquad \text{(V9)}$$

If the conservative assumption is made that contaminated water will exactly displace fresh water in the aquifer, the radius of the circle of contaminated water will grow at the radial velocity U_r:

$$r = \int_o^t U_r dt = \int_o^t \frac{Qkr}{8\pi n_e^2 \beta^2 t^2} \exp\left(-r^2/4\beta t\right) dt \qquad \text{(V10)}$$

Equation (V10) is solved by numerical integration. Integration is facilitated by a change of variables:

$$t = \frac{1}{z^2} \qquad \text{(V11)}$$

Which yields the equation

$$r = \int_{\frac{1}{z^2}}^{\infty} \frac{Qkrz}{4\pi n_e^2 \beta^2} \exp(-r^2 z^2/4\beta)\, dz \qquad \text{(V12)}$$

The integration takes place in the reverse direction, since at $z = 0$, $t = \infty$. The initial condition for $z = 0$ for the radius is the maximum

$$r\,(t = \infty) = \sqrt{\frac{Q}{\pi n_e H}} \qquad \text{(V13)}$$

For the present case, the parameters for Equation (V13) are:

$Q = 93583\ ft^3$*

$k = 28$ ft/day

$H = 25$ ft

$n_e = 0.1$

$\beta = kH/n_e = 7000.$

The radius of the circle for the present case as a function of time is shown in Figure V.4.

The expanding circle travels with the ambient pore velocity. The flux of contaminant (curies/ft^3) into an intersecting river can be approximated by the integral

$$\text{Flux} = 2 \int_{o}^{Y} (H + h)\, u n_e\, C e^{-\lambda t} dy, \text{ curies/day} \qquad \text{(V14)}$$

where

λ is the decay coefficient $= \frac{\ln 2}{\text{half-life}}$,

$Y^2 = r^2 - L^2$

*It is now assumed that only 2/3 or about 62,400 cubic feet (470,000 gallons) will escape.

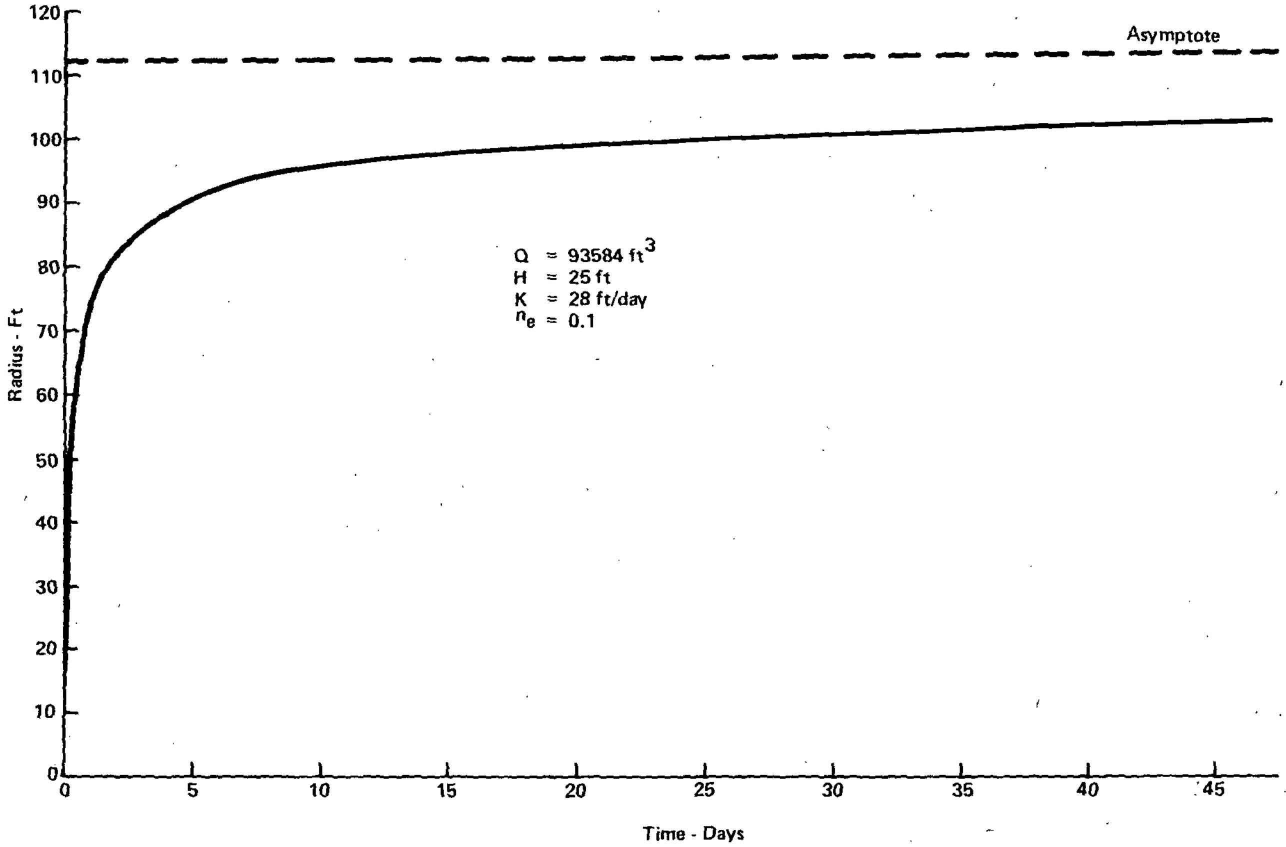

Figure V.4. Radius of Contaminant Circle vs Time.

$L = x_0 - ut$,

h is defined by Equation (V.8), and

C = activity concentration, Ci/mL.

This integral may be evaluated analytically:

$$\text{Flux} = e^{-\lambda t}\, u\, n_e\, C \left\{ 2HY + \frac{1}{2n_e \sqrt{\pi\beta t}} \exp\left(- \frac{\ell^2}{4\beta t} \right) \text{erf}\left(\frac{Y}{4\beta t} \right) \right\} \qquad \text{(V15)}$$

For the present case, C = 0.95 µCi/mL and half-life = 12.33 years. The flux calculated from Equation (V15) is shown in Figure V.5. Since the travel time for the contaminated water will be

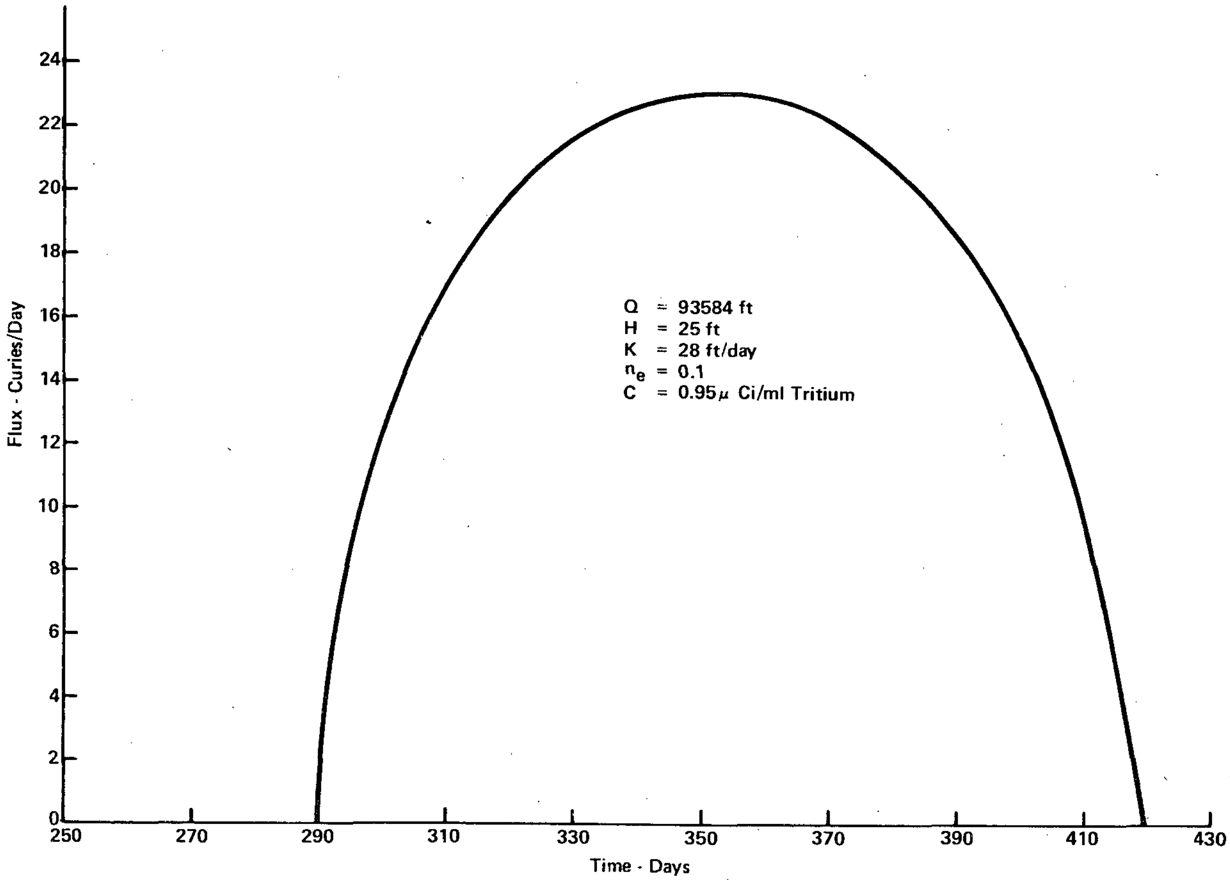

Figure V.5. Flux of Tritium into River.

hundreds of days in this case, it is safe to say that the circle of contamination has nearly reached maximum radius at the river. The appropriate maximum flux is therefore

$$\text{Flux (max)} = 2Hr(\text{max})\ u\ n_e\ C\ \exp\ (-\lambda\ t_{max}) \quad \text{(V16)}$$

where

$$t_{max} = \frac{x}{u}.$$

For the present case,

$x = 600$ ft

$u = 1.7$ ft/day

$C = 0.95$ µCi/mL.

The maximum flux of tritium is therefore

$$\text{Flux (max)} = 2.8 \times 10^{-4}\ \text{Ci/s},^*$$

which is in close agreement with the more precise Equation (V15).

References--Appendix V

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*For 2/3 of the volume escaping, the flux would be approximately 1.87×10^{-4} Ci/s.

APPENDIX W. CALCULATION MODELS AND PARAMETERS USED IN ESTIMATING DOSES, AND INTERPRETATION OF MODEL RESULTS

W.1 ATMOSPHERIC RELEASES

The calculational methods used to estimate doses from atmospheric releases due to routine decontamination or accidental atmospheric releases are those described in Regulatory Guide 1.109. The computer code which the NRC staff uses which contains these methods is designated GASPAR and its use is described in the "User's Guide to GASPAR Code," NRC report NUREG-0597. Regulatory Guide 1.109 models are appropriate for short-term releases with certain minor adjustments in application and parameter values, even though the models were originally developed for normally operating reactors (long-term releases). These adjustments and the parametric values used in the code are described below.

It was assumed the period of time over which an individual consumes contaminated food was one year and that the releases occurred uniformly over this period of a year. This modeling approach is realistic for the normal decontamination program because most of the releases will be made over fairly long time periods (3 months to over 1 year), hence, the assumption of uniform annual release rate is reasonable.

It is useful to apply the uniform annual release rate assumption to short-term releases, as well as long-term releases, and the principal difference is in how the results are interpreted. The short-term accidental release requires special interpretation for two reasons. In the first place, it is impossible to predict meteorological conditions at the time of an accident, and second, it is impossible to predict the season during which an accident may occur. As a result it is also impossible to predict vegetable garden production, or cow pasture use (average annual rates of vegetable production and cow pasture use were assumed). For normal releases, the correct interpretation of the results is that they describe the expected maximum doses that actually will occur offsite. These represent maximum values because locations are also chosen that will result in highest doses. On the other hand, for the short-term release, (1) the wind could be in some other direction where the doses would likely be smaller, (2) whatever the direction of the wind, the actual atmospheric dispersion could be very different from the average value in that direction, and/or (3) there may or may not be cows on pasture or garden production, depending on season and wind direction. The most important uncertainty in the accident calculation is the inability to predict the actual meteorological conditions and, thus, dispersion during an accident. For this reason, the hourly atmospheric dispersion parameter values for the location resulting in highest doses are used. This means the results for accidents should be interpreted as worst location expected values, rather than worst location actual values. The uncertainty in the values that could occur is discussed below. Table W.1 lists the tables of Regulatory Guide 1.109 where model input parameters and problem specific parameters which were used in the calculations can be found.

The atmospheric dispersion parameters that were used are described below and were selected to assure that calculated doses overestimate potential actual ones. The value used for the nearest residence and garden calculation was not selected on the basis of the actual nearest residence/garden but was selected on the basis of the actual residence/garden where the annual meteorological relative deposition rate was highest. The values selected for goat milk and cow milk consumption were also selected on the basis of the highest meteorological relative deposition rate.* The meteorological parameters used for normal releases represent annual average long-term conditions whereas the meteorological parameters used for accidental releases represent short-term conditions.

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*Locations of gardens, cows, and goats were taken from the Three Mile Island Nuclear Station Radiological Environmental Monitoring Program Annual Report for 1979.

Table W.1. Table Numbers of Regulatory Guide 1.109 where Input Parameters Can Be Found, and Problem-Specific Parameters Used in the PEIS

Parameter	Table Numbers
Usage factors for maximum exposed individual	E-5
External dose factors	E-6
Dose conversion factors	E-7 through E-14
Other parameters	E-15
Problem- and Site-Specific Parameters:	Value
Period of long-term buildup	1.0 year
Fraction of year vegetables taken from garden	0.5
Fraction of year cows on pasture	0.5
Fraction of year beef on pasture	1.0
Fraction of year goats on pasture	1.0

For population dose estimates, the population projected for the year 2010 was used. It was conservatively assumed that all milk, meat, and vegetables consumed by this population was produced within the 50-mile radius. Production rates were assumed to be uniform within the 50-mile radius, and consumption rates were those of Table E-4 of Regulatory Guide 1.109.

The availability of an onsite meteorological measurement program provides a real time source of information to assess the consequence of radioactive gaseous releases due to TMI-2 cleanup activities. Two approaches for evaluating release dispersion were taken. The first represents a continuous release from the plant, which, although it may be less than 1 year's duration, can be identified by the annual long-term average relative concentration that affects the surroundings. The second represents a short duration release evaluation which may be used to represent an accident such as a fire or filter failure, both of which are of short duration.

Both the long-term (continuous release) and the short-term release assessment models determine the relative concentration of radioactive gaseous effluents (χ/Q) as a function of distance from the release point, based on atmospheric stability, wind speed, and wind direction. The meteorological models incorporate the release height and building wake influence in a manner that maximizes the χ/Q at ground level and thus the possible dose for a receptor at the point of interest. The long-term analysis method is described in Regulatory Guide 1.111 and the short-term method is described in Regulatory Guide 1.145.

The accuracy of atmospheric transport models used here have been reviewed recently in two publications of the Oak Ridge National Laboratory.[1,2] In general, the accuracy of the models is a function of sampling time, terrain and vegetation, or a unique meteorological environment such as a valley wind or a sea breeze. The uncertainty in determining the maximum concentration of radioactivity in a plume at short downwind distances within 10 km for a ground-level release in generally uniform terrain with steady winds is estimated to be ± 20 percent. The range of the ratio of the predicted to observed concentration for specific locations within 10 km was 0.1 to 10.0, with the Gaussian plume model used for estimating downwind air concentrations of radionuclides.

In complex wooded terrain conditions, such as around TMI, the Gaussian model for short-term releases overestimates the concentrations under poor diffusion conditions of stable atmosphere and low wind speeds when compared to actual measurements. The amount of overestimation may range from 50-500 times the value observed. Annual average release evaluations have been shown generally to be within a factor of two to four for regional distances (out to about 100 km) depending on the terrain conditions.

The relative concentrations given in Tables W.2 through W.6 below reflect the analysis for times that the wind blew towards the point of interest and are based on onsite data collected in the period 1971 through 1975.

Table W.2 lists the special locations for which maximum individual dose calculations are made. Atmospheric dispersion parameters for normal releases and for accident release are listed in the table.

Table W.2. Locations for Maximum Exposed Individual Dose Calculation and Atmospheric Dispersion Parameters

	Dispersion Parameters			
Location	χ/Q (s/m^3)	χ/Q (decayed) (s/m^3)	χ/Q (decayed-depleted) (s/m^3)	D/Q (m-2)
Routine Releases				
Nearest garden (ENE, 1.05 mile)	1.93×10^{-6}	1.88×10^{-6}	1.67×10^{-6}	3.22×10^{-9}
Nearest milk goat (N, 1.02 mile)	1.74×10^{-6}	1.71×10^{-6}	1.51×10^{-6}	3.10×10^{-9}
Nearest garden and milk cow (E, 1.05 mile)	2.13×10^{-6}	2.08×10^{-6}	1.84×10^{-6}	4.74×10^{-9}
Accident Releases				
Nearest garden (ENE, 1.05 mile)	2.9×10^{-5}	-	-	1.9×10^{-7}
Nearest milk goat (N, 1.02 mile)	2.9×10^{-5}	-	-	1.9×10^{-7}
Nearest garden and milk cow (E, 1.05 mile)	2.0×10^{-5}	-	-	1.9×10^{-7}

The method used for determining the accident relative deposition rate assumed, at the time of the release, 100% of the effluent went to the receptor location during the entire release. The deposition analysis uses a method described in Regulatory Guide 1.111. No decay values for the accident χ/Q are provided since effluent moving at 0.5 meters per second (1.1 mph) would take less than 1 hour to reach the nearest locations and little decay would have taken place.

Tables W.3 through W.6 list the atmospheric dispersion parameters for each sector element used to make the population dose calculations for normal atmospheric releases. Population dose calculations are not made for accidental atmospheric releases.

W.2 RELEASES TO THE RIVER

The calculational methods used to estimate doses from routine decontamination liquid releases or accidental liquid releases are those described in Regulatory Guide 1.109. The computer code which the NRC staff uses that contains these methods is designated LADTAP and its use is described in the "User's Manual for LADTAP-II," NRC report NUREG/CR-1276. Regulatory Guide 1.109 models are appropriate for short-term releases with certain minor adjustments in application and parameter values, even though the models were originally developed for normal operating reactors (long-term releases). These adjustments and the parameter values used in the code are described below.

Table W.3. χ/Q (s/m^3) Values Used in Population Dose Estimates (no decay - no depletion)

Direction from Site	Segment Boundaries (in miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.840E-06[a]	1.037E-06	4.987E-07	3.116E-07	2.200E-07	1.116E-07	4.395E-08	2.209E-08	1.419E-08	1.022E-08
SSW	1.879E-06	6.848E-07	3.267E-07	2.030E-07	1.428E-07	7.199E-08	2.807E-08	1.401E-08	8.953E-09	6.430E-09
SW	2.279E-06	8.278E-07	3.974E-07	2.481E-07	1.752E-07	8.888E-08	3.499E-08	1.760E-08	1.131E-08	8.153E-09
WSW	2.999E-06	1.081E-06	5.189E-07	3.242E-07	2.290E-07	1.164E-07	4.594E-08	2.316E-08	1.491E-08	1.076E-08
W	3.931E-06	1.434E-06	6.866E-07	4.275E-07	3.012E-07	1.523E-07	5.961E-08	2.985E-08	1.912E-08	1.376E-08
WNW	3.721E-06	1.344E-06	6.482E-07	4.065E-07	2.879E-07	1.470E-07	5.842E-08	2.961E-08	1.912E-08	1.383E-08
NW	3.549E-06	1.291E-06	6.259E-07	3.934E-07	2.791E-07	1.427E-07	5.687E-08	2.886E-08	1.864E-08	1.349E-08
NNW	2.697E-06	9.797E-07	4.763E-07	2.999E-07	2.131E-07	1.093E-07	4.371E-08	2.226E-08	1.441E-08	1.044E-08
N	2.858E-06	1.037E-06	5.030E-07	3.164E-07	2.246E-07	1.150E-07	4.591E-08	2.335E-08	1.510E-08	1.094E-08
NNE	3.116E-06	1.133E-06	5.510E-07	3.471E-07	2.467E-07	1.266E-07	5.068E-08	2.582E-08	1.672E-08	1.212E-08
NE	3.182E-06	1.154E-06	5.554E-07	3.476E-07	2.458E-07	1.251E-07	4.951E-08	2.501E-08	1.612E-08	1.164E-08
ENE	3.264E-06	1.197E-06	5.781E-07	3.602E-07	2.561E-07	1.304E-07	5.157E-08	2.601E-08	1.673E-08	1.207E-08
E	3.612E-06	1.313E-06	6.279E-07	3.909E-07	2.755E-07	1.393E-07	5.459E-08	2.736E-08	1.754E-08	1.262E-08
ESE	3.462E-06	1.246E-06	5.965E-07	3.721E-07	2.626E-07	1.332E-07	5.250E-08	2.646E-08	1.703E-08	1.229E-08
SE	3.622E-06	1.306E-06	6.215E-07	3.858E-07	2.712E-07	1.367E-07	5.328E-08	2.661E-08	1.703E-08	1.224E-08
SSE	3.996E-06	1.451E-06	6.942E-07	4.323E-07	3.046E-07	1.541E-07	6.043E-08	3.031E-08	1.944E-08	1.400E-08

[a] 2.840E-06 = 2.840×10^{-6}.

Table W.4. χ/Q (s/m^3) Values Used in Population Dose Estimates (2.26-day decay - no depletion)

Direction from Site	Segment Boundaries (in miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.793E-06[a]	1.002E-06	4.707E-07	2.873E-07	1.984E-07	9.504E-08	3.279E-08	1.412E-08	8.001E-09	5.172E-09
SSW	1.846E-06	6.609E-07	3.077E-07	1.867E-07	1.284E-07	6.110E-08	2.088E-08	8.922E-09	5.027E-09	3.235E-09
SW	2.245E-06	8.027E-07	3.771E-07	2.305E-07	1.594E-07	7.667E-08	2.667E-08	1.156E-08	6.657E-09	4.244E-09
WSW	2.961E-06	1.054E-06	4.968E-07	3.051E-07	2.119E-07	1.030E-07	3.663E-08	1.626E-08	9.364E-09	6.110E-09
W	3.884E-06	1.399E-06	6.586E-07	4.033E-07	2.796E-07	1.355E-07	4.807E-08	2.135E-08	1.234E-08	8.081E-09
WNW	3.684E-06	1.317E-06	6.264E-07	3.874E-07	2.707E-07	1.332E-07	4.851E-08	2.198E-08	1.281E-08	8.417E-09
NW	3.500E-06	1.256E-06	5.972E-07	3.682E-07	2.564E-07	1.249E-07	4.440E-08	1.962E-08	1.127E-08	7.338E-09
NNW	2.664E-06	9.558E-06	4.566E-07	2.827E-07	1.975E-07	9.690E-08	3.491E-08	1.562E-08	9.023E-09	5.891E-09
N	2.823E-06	1.012E-06	4.819E-07	2.977E-07	2.076E-07	1.015E-07	3.632E-08	1.615E-08	9.313E-09	6.081E-09
NNE	3.064E-06	1.095E-06	5.199E-07	3.200E-07	2.223E-07	1.075E.07	3.759E-08	1.636E-08	9.325E-09	6.060E-09
NE	3.138E-06	1.122E-06	5.295E-07	3.251E.07	2.257E-07	1.095E.07	3.878E-08	1.714E-08	9.858E-09	6.432E-09
ENE	3.208E-06	1.156E-06	5.449E-07	3.333E-07	2.305E-07	1.108E-07	3.843E-08	1.666E-08	9.500E-09	6.180E-09
E	3.561E-06	1.276E-06	5.980E-07	3.652E-07	2.525E-07	1.217E-07	4.265E-08	1.875E-08	1.079E-08	7.069E-09
ESE	3.413E.06	1.211E-06	5.680E-07	3.472E-07	2.402E-07	1.156E-07	4.038E-08	1.766E-08	1.014E-08	6.637E-09
SE	3.576E-06	1.273E-06	5.946E-07	3.626E-07	2.505E-07	1.207E-07	4.240E-08	1.873E-08	1.083E-08	7.127E-09
SSE	3.939E-06	1.410E-06	6.608E-07	4.035E-07	2.790E-07	1.344E-07	4.708E-08	2.066E-08	1.186E-08	7.750E-09

[a] 2.793E-06 = 2.793×10^{-6}.

Table W.5. χ/Q (s/m^3) Values Used in Population Dose Estimates (8-day decay with plume depletion)

Direction from Site	Segment Boundaries (in miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.531E-06[a]	8.759E-07	3.981E-07	2.377E-07	1.615E-07	7.553E-08	2.514E-08	1.049E-08	5.788E-09	3.656E-09
SSW	1.674E-06	5.784E-07	2.606E-07	1.547E-07	1.047E-07	4.867E-08	1.605E-08	6.650E-09	3.657E-09	2.304E-09
SW	2.032E-06	7.001E-07	3.177E-07	1.897E-07	1.289E-07	6.038E-08	2.017E-08	8.453E-09	4.684E-09	2.968E-09
WSW	2.676E-06	9.160E-07	4.159E-07	2.488E-07	1.694E-07	7.969E-08	2.690E-08	1.143E-08	6.405E-09	4.099E-09
W	3.508E-06	1.215E-06	5.507E-07	3.284E-07	2.230E-07	1.045E-07	3.503E-08	1.481E-08	8.284E-09	5.296E-09
WNW	3.323E-06	1.140E-06	5.210E-07	3.132E-07	2.140E-07	1.014E-07	3.471E-08	1.495E-08	8.473E-09	5.470E-09
NW	3.166E-06	1.093E-06	5.012E-07	3.015E-07	2.060E-07	9.737E-08	3.304E-08	1.405E-08	7.862E-09	5.021E-09
NNW	2.405E-06	8.299E-07	3.819E-07	2.303E-07	1.577E-07	7.486E-08	2.561E-08	1.099E-08	6.193E-09	3.977E-09
N	2.551E-06	8.787E-07	4.033E-07	2.428E-07	1.660E-07	7.865E-08	2.679E-08	1.144E-08	6.420E-09	4.109E-00
NNE	2.778E-06	9.571E-07	4.397E-07	2.648E-07	1.810E-07	8.552E-08	2.891E-08	1.220E-08	6.775E-09	4.296E-09
NE	2.839E-06	9.765E-07	4.446E-07	2.663E-07	1.814E-07	8.536E-08	2.880E-08	1.221E-08	6.830E-09	4.363E-09
ENE	2.909E-06	1.011E-06	4.612E-07	2.760E-07	1.878E-07	8.812E-08	2.946E-08	1.233E-08	6.823E-09	4.318E-09
E	3.221E-06	1.111E-06	5.025E-07	2.994E-07	2.031E-07	9.498E-08	3.169E-08	1.331E-08	7.396E-09	4.702E-09
ESE	3.088E-06	1.055E-06	4.773E-07	2.848E-07	1.935E-07	9.062E-08	3.028E-08	1.271E-08	7.045E-09	4.465E-09
SE	3.232E-06	1.107E-06	4.980E-07	2.959E-07	2.005E-07	9.349E-08	3.113E-08	1.307E-08	7.276E-09	4.634E-09
SSE	3.564E-06	1.228E-06	5.555E-07	3.310E-07	2.246E-07	1.050E-07	3.507E-08	1.474E-08	8.195E-09	5.213E-09

[a] 2.531E-06 = 2.531×10^{-6}.

Table W.6. D/Q ($1/m^2$) Values Used in Population Dose Estimates

Direction from Site	Segment Boundaries (in miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.720E-09[a]	1.458E-09	5.803E-10	3.171E-10	2.016E-10	8.658E-11	2.685E-11	1.064E-11	5.682E-12	3.517E-12
SSW	2.723E-09	8.413E-10	3.348E-10	1.829E-10	1.163E-10	4.994E-11	1.549E-11	6.138E-12	3.278E-12	2.029E-12
SW	3.654E-09	1.129E-09	4.492E-10	2.455E-10	1.560E-10	6.702E-11	2.078E-11	8.237E-12	4.399E-12	2.723E-12
WSW	5.251E-09	1.622E-09	6.456E-10	3.528E-10	2.242E-10	9.631E-11	2.987E-11	1.184E-11	6.321E-12	3.912E-12
W	8.044E-09	2.485E-09	9.890E-10	5.404E-10	3.435E-10	1.475E-10	4.575E-11	1.813E-11	9.683E-12	5.994E-12
WNW	7.223E-09	2.232E-09	8.880E-10	4.853E-10	3.084E-10	1.325E-10	4.108E-11	1.628E-11	8.695E-12	5.382E-12
NW	5.862E-09	1.811E-09	7.206E-10	3.938E-10	2.503E-10	1.075E-10	3.334E-11	1.321E-11	7.056E-12	4.367E-12
NNW	4.630E-09	1.431E-09	5.693E-10	3.111E-10	1.977E-10	8.492E-11	2.633E-11	1.044E-11	5.574E-12	3.450E-12
N	5.431E-09	1.678E-09	6.677E-10	3.649E-10	2.319E-10	9.961E-11	3.089E-11	1.224E-11	6.538E-12	4.047E-12
NNE	5.712E-09	1.765E-09	7.022E-10	3.837E-10	2.439E-10	1.048E-10	3.248E-11	1.287E-11	6.875E-12	4.256E-12
NE	5.722E-09	1.768E-09	7.034E-10	3.844E-10	2.443E-10	1.049E-10	3.254E-11	1.290E-11	6.887E-12	4.263E-12
ENE	5.927E-09	1.831E-09	7.286E-10	3.982E-10	2.531E-10	1.087E-10	3.371E-11	1.336E-11	7.134E-12	4.416E-12
E	8.725E-09	2.696E-09	1.073E-09	5.862E-10	3.726E-10	1.600E-10	4.962E-11	1.967E-11	1.050E-11	6.501E-12
ESE	9.701E-09	2.997E-09	1.193E-10	6.517E-10	4.142E-10	1.779E-10	5.517E-11	2.187E-11	1.168E-11	7.228E-12
SE	1.206E-08	3.726E-09	1.483E-09	8.101E-10	5.149E-10	2.212E-10	6.858E-11	2.718E-11	1.452E-11	8.985E-12
SSE	9.071E-09	2.802E-09	1.115E-09	6.094E-10	3.873E-10	1.664E-10	5.159E-11	2.045E-11	1.092E-11	6.758E-12

[a] 4.720E-09 = 4.720×10^{-9}.

The same assumptions were made for the liquid releases as were made for the gaseous releases described above regarding consumption rates during releases of radioactivity. Thus, the calculations result in estimates of the average expected value, rather than the actual value, particularly for very short-term releases.

Table W.1 lists the tables of Regulatory Guide 1.109 where model input parameters can be found. Other model parameters which are particularly relevant to liquid pathways are listed in Table W.7.

Table W.7. Parameters Used in Maximum Individual Dose Calculations and Dose to Biota Calculation for Liquid Pathways

Parameter	Value
Adult fish consumption	21 kg/yr
Adult water consumption	730 kg/yr
River flow at fish location for doses to humans	3150 ft^3/s
River flow at nearest water intake for dose to humans	12,600 ft^3/s
River flow for dose to fishes in river	12,600 ft^3/s

The river flow used for the computation of maximum individual doses from fish consumption is based on the average flow in the center channel of the river where the releases are made. 100% mixing is assumed, not because 100% is expected to occur, but because as described in Appendix E, Section E.1, all species of fish in the area exhibit considerable movement, especially over the time required to bioaccumulate radionuclides (several days). The river flow used for the computation of the maximum individual dose from water consumption is based on the average flow in the entire river. 100% mixing is expected by the time the effluent reaches the first downstream drinking water intake because it is 16 miles downriver from the discharge point.

For population dose calculations, it was assumed that 2.2 million people live in the 50-mile radius around Three Mile Island and they get all their drinking water from the nearest downstream municipal water intake. This assumption is very conservative, since the actual population drawing water from nearby downstream locations would not be expected to approach this figure for many years. The dose from sport fish consumption was based on the number of fishing licenses issued in the four counties downstream of TMI. Approximately 50,000 are issued per year. To estimate the fish consumption population dose it was assumed that each angler caught ten pounds of fish per year of which three pounds consisted of edible fish flesh (see page 6, Appendix III of the TMI Environmental Report, 1971). It was assumed that the downstream shoreline, swimming and boating use was 83,000 hours per year, 120,000 hours per year, and 520,000 hours per year, respectively. Population dose estimates from all pathways were based on an assumed river flow of 12,600 ft^3/s and uniform release of radionuclides over a period of one year.

References

1. F.O. Hoffman, et al., "The Evaluation of Models Used for the Environmental Assessment of Radionuclide Releases," Workshop Proceedings, Oak Ridge National Laboratory, ORNL Conf.-770901, Oak Ridge, TN, April 1978.

2. C.A. Little, and C.W. Miller, "The Uncertainty Associated with Selected Environmental Transport Models," Oak Ridge National Laboratory, ORNL-5528, Oak Ridge, TN, November 1979.

APPENDIX X. CONTRIBUTORS TO THE PEIS

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 Argonne National Laboratory and other consultants indicated below. The individuals who were major contributors are listed below with their affiliations and functions or expertise:

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APPENDIX Y. SCHEDULED MEETINGS FOR DISCUSSION OF TMI-2 CLEANUP DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (1980)

September 3	Public Meeting - State Education Dept., Forum Auditorium (Harrisburg, Pa.)
September 5	Susquehanna River Basin (Harrisburg, Pa.)
September 16	Meeting with local labor unions
September 17	Meeting with Dauphin County Commissioners Public Meeting with TMI Alert
September 18	Meeting with York County Commissioners Public Meeting with Against Nuclear Group Residents of York (ANGRY) (York, Pa.)
September 19	Meeting with local members of clergy (Middletown, Pa.)
September 22	NRC representative appeared on call-in, Radio Station WAHT, Fred Williams Show Meeting with West Shore local elected officials in Camp Hill, Pa.
September 23	Meeting with East Shore local elected officials (Middletown, Pa.)
September 25	Meeting with local labor unions in York area
September 27	Meeting with American Association of University Women, Reading, Pa.
September 29	Meeting with Pa. Grange Association
September 30	Meeting with Friends and Family of TMI *Public Meeting in Annapolis, Md.
October 2	Area Chambers of Commerce (Harrisburg, Pa.) Meeting with Rotary in Middletown, Pa.
October 6	*Public Meeting - Lancaster, Pa.
October 7	Meeting with the Pa. Farmers Association in Camp Hill
October 8	*Public Meeting with Newberry Township Steering Committee
October 20	*Public Meeting with People Against Nuclear Energy (PANE), Middletown, Pa.
October 23	*Meeting with Pa. Medical Society
October 29	*Public Meeting - Havre de Grace, Md.
October 31	Meeting with Lebanon Valley Chamber of Commerce
November 6	Meeting with Middletown Rotary Club
November 10	*Public Meeting - State Education Dept., Forum Auditorium (Harrisburg, Pa.)
November 12	*Public Meeting of NRC TMI Advisory Panel
November 13	Meeting of Lancaster Jaycee's
November 17	*Public Meeting - Baltimore
November 19	*Public Meeting - Middletown, Pa.

*Verbatim Transcripts Prepared.

APPENDIX Z. HEALTH EFFECTS ESTIMATORS

In estimating the number of health effects resulting from both offsite and occupational radiation exposures during the cleanup, the NRC staff used best estimate somatic (cancer) and genetic risk estimators based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Science's Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR).[1] Although a detailed discussion of the literature available on this subject is outside the scope of this document, this appendix includes: (1) information that details the bases for health effect estimators used by the NRC staff, and (2) perspective on the uncertainty associated with estimating radiation-induced health effects.

The base data used for the fatal cancer risk estimators (expressed as deaths per million person-rem) used by the NRC staff can be found in Section 9.3.2, "Upper Bound for Latent Cancer Fatalities," in the NRC staff's "Reactor Safety Study, WASH-1400, October 1975.[2] Specifically, the data on "Upper Bound Risk Coefficients for Latent Cancer Fatalities," Table VI 9-2, for specific age groups were used. Tables Z.1 through Z.8 contain, for different cancer types, the age, specific data and calculations which, when summed in Table Z.9, yield the cancer risk estimators used by the NRC staff (131 and 135) deaths per million person-rem for workers and individual members of the public, respectively). The WASH-1400 (October 1975) coefficients are based on BEIR, 1972, and on new data made available since the issuance of BEIR, 1972. Table Z.10 is presented to provide perspective on the uncertainty involved in making estimates of radiation-induced health effects. The basis for each of these estimates can be found in greater detail in the listed references.

The NRC staff's genetic risk estimator (260 genetic effects per million total-body person-rem in the future generations of the exposed population) was derived from the 1972 BEIR report.[1] Specifically, this value can be calculated by summing the geometric means of the distributions given in Table 4, Chapter V, of that report. The geometric mean is an appropriate technique for obtaining a representative value for the 1972 BEIR report's range of 60 to 1500 genetic effects per million person-rem. The 1980 BEIR report listed a range of 60 to 1100 genetic effects in offspring per million person-rem.[3]

In summary, several points should be emphasized. The values utilized by the NRC staff for estimating potential health effects associated with the decontamination of TMI-2 are based on widely accepted scientific information. Even if upper range BEIR, 1980, risk estimators were used to characterize potential health effects from the cleanup, those health effects would remain small compared to natural incidence.

References

1. "The Effects on Populations of Exposure to Low-Levels of Ionizing Radiation," National Academy of Science, Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), November 1972.

2. "Reactor Safety Study," U.S. Nuclear Regulatory Commission, WASH-1400, October 1975.

3. "The Effects on Populations of Exposure to Low-Levels of Ionizing Radiation," National Academy of Science, Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), 1980.

4. "Sources and Effects of Ionizing Radiation," United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 1977 Report to the General Assembly, New York, NY, 1977.

Table Z.1. Calculation of Expected Leukemia Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	0	10	15	1.65
0-0.99	0.014	71.3	2	25	2	0.70
1-10	0.146	69.4	2	25	2	7.3
11-20	0.196	60.6	2	25	1	4.9
21-30	0.164	51.3	2	25	1	4.10
31-40	0.118	42.0	2	25	1	2.95
41-50	0.109	32.6	2	25	1	2.75
51-60	0.104	24.5	2	22.5	1	2.34
61-70	0.080	17.1	2	15.1	1	1.21
71-80	0.044	11.1	2	9.1	1	0.40
80+	0.020	6.5	2	4.5	1	0.09
						28.4 (23.2)[b]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.2. Calculation of Expected Lung Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	-	-	-	-
1-10	0.146	69.4	-	-	-	-
11-20	0.196	60.6	15	30	1.3	7.64
21-30	0.164	51.3	15	30	1.3	6.40
31-40	0.118	42.0	15	27	1.3	4.14
41-50	0.109	32.6	15	17.6	1.3	2.49
51-60	0.104	24.5	15	9.5	1.3	1.28
61-70	0.080	17.1	15	2.1	1.3	0.22
71-80	0.044	11.1	15	0	1.3	0
80+	0.020	6.5	15	0	1.3	0
						22.2 (25.3)[b]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.3. Calculation of Expected Stomach Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	-	-	-	-
1-10	0.146	69.4	-	-	-	-
11-20	0.196	60.6	15	30	0.6	3.53
21-30	0.164	51.3	15	30	0.6	2.95
31-40	0.118	42.0	15	27	0.6	1.91
41-50	0.109	32.6	15	17.6	0.6	1.15
51-60	0.104	24.5	15	9.5	0.6	0.59
61-70	0.080	17.1	15	2.1	0.6	0.10
71-80	0.044	11.1	15	0	0.6	0
80+	0.020	6.5	15	0	0.6	0
						10.2 (11.7)

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.4. Calculation of Expected Pancreas and Alimentary Canal Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	-	-	-	-
1-10	0.146	69.4	-	-	-	-
11-20	0.196	60.6	15	30	0.2	1.18
21-30	0.164	51.3	15	30	0.2	0.98
31-40	0.118	42.0	15	27	0.2	0.64
41-50	0.109	32.6	15	17.6	0.2	0.38
51-60	0.104	24.5	15	9.5	0.2	0.20
61-70	0.080	17.1	15	2.1	0.2	0.03
71-80	0.044	11.1	15	0	0.2	0
80+	0.020	6.5	15	0	0.2	0
						3.4 (3.9)

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.5. Calculation of Expected Breast Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor[b] (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	-	-	-	-
1-10	0.146	69.4	-	-	-	-
11-20	0.196	60.6	15	30	1.5	8.82
21-30	0.164	51.3	15	30	1.5	7.38
31-40	0.118	42.0	15	27	1.5	4.78
41-50	0.109	32.6	15	17.6	1.5	2.88
51-60	0.104	24.5	15	9.5	1.5	1.48
61-70	0.080	17.1	15	2.1	1.5	0.25
71-80	0.044	11.1	15	0	1.5	0
80+	0.020	6.5	15	0	1.5	0
						25.6 (29.2)[c]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Assumes 50 percent mortality.

[c]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.6. Calculation of Expected Bone Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	10	30	0.4	0.17
1-10	0.146	69.4	10	30	0.4	1.75
11-20	0.196	60.6	10	30	0.4	2.35
21-30	0.164	51.3	10	30	0.2	0.98
31-40	0.118	42.0	10	30	0.2	0.71
41-50	0.109	32.6	10	22.6	0.2	0.49
51-60	0.104	24.5	10	14.5	0.2	0.30
61-70	0.080	17.1	10	7.1	0.2	0.11
71-80	0.044	11.1	10	1.1	0.2	0.01
80+	0.020	6.5	10	0	0.2	0
						6.9 (4.5)[b]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.7. Calculation of Expected Thyroid Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor[b] (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	-	-	-	-
0-0.99	0.014	71.3	10	30	4.3 × 1.0	0.181
1-10	0.146	69.4	10	30	4.3 × 1.9	3.58
11-20	0.196	60.6	10	30	4.3 × 1.6	4.05
21-30	0.164	51.3	10	30	4.3 × 1	2.12
31-40	0.118	42.0	10	30	4.3 × 1	1.53
41-50	0.109	32.6	10	22.6	4.3 × 1	1.06
51-60	0.104	24.5	10	14.5	4.3 × 1	0.648
61-70	0.080	17.1	10	7.1	4.3 × 1	0.244
71-80	0.044	11.1	10	1.1	4.3 × 1	0.021
80+	0.020	6.5	10	0	4.3 × 1	0
						12.4 (9.7)[c]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Assumes 10 percent mortality.

[c]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.8. Calculation of All Other Expected Cancer Deaths for External Exposure

Age Cohort (years)	(A) Fraction of Population	(B) Life Expectancy (years)	(C) Latent Period[a] (years)	(D) Years at Risk	(E) Risk Factor (10^6/rem/year)	(F) Expected Deaths (F=A×D×E)
In utero	0.011	71.0	0	10	15	1.65
0-0.99	0.014	71.3	15	30	0.6	0.25
1-10	0.146	69.4	15	30	0.6	2.63
11-20	0.196	60.6	15	30	1	5.88
21-30	0.164	51.3	15	30	1	4.92
31-40	0.118	42.0	15	27	1	3.19
41-50	0.109	32.6	15	17.6	1	1.92
51-60	0.104	24.5	15	9.5	1	0.99
61-70	0.080	17.1	15	2.1	1	0.17
71-80	0.044	11.1	15	0	1	0
80+	0.020	6.5	15	0	1	0
						21.6 (19.5)[b]

[a]The latent period is that period of time between radiation exposure and the manifestation of a cancer.

[b]Values in parentheses represent risk estimates for occupational workers (ages 20-70). The risk estimator (see Table Z.9) for workers includes consideration of the workers' age grouping (estimated between 20 and 70 years). The offsite population estimator is based on the 1970 U.S. population age group distribution.

Table Z.9. Maximum Expected Latent Cancer Deaths Per Million Person-rem

Type of Cancer	Expected Deaths/10^6 Person-Rem: General Public	Occupational
Leukemia	28.4	23.2
Lung	22.2	25.3
Stomach	10.2	11.7
Alimentary canal	3.4	3.9
Pancreas	3.4	3.9
Breast[a]	25.6	29.2
Bone	6.9	4.5
Thyroid[b]	13.4	9.7
All others	21.6	19.5
	135	131

[a]Assumes 50 percent mortality/case.

[b]Assumes 10 percent mortality/case; all other types assume 100 percent mortality.

Table Z.10. 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]	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 the linear and pure quadrate effects models also fit observed data nearly as well. Projected health effects from those models would range from about 10 to 500 deaths per million person-rem. An update of BEIR, 1972 (Ref. 3).

[c]Values obtained from Table V-4, BEIR, 1980, are an update of values obtainable in Tables 3-3 and 3-4 of BEIR, 1972. Range attributable to differences between absolute and relative projection models (Ref. 1).

[d]Range of estimates for low-dose, low-LET radiation (Ref. 4).

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16. ABSTRACT (200 words or less)

A Final Programmatic Environmental Impact Statement (PEIS) related to the decontamination and disposal of radioactive wastes resulting from the March 28, 1979, accident at Three Mile Island Nuclear Station, Unit 2 (Docket No. 50-320) has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission in response to a directive issued by the Commission on November 21, 1979. This statement is an overall study of the activities necessary for decontamination of the facility, defueling, and disposition of the radioactive wastes. The available alternatives considered ranged from implementation of full cleanup to no action other than continuing to maintain the reactor in a safe shutdown condition. Also included are comments of governmental agencies, other organizations, and the general public on the Draft PEIS on this project, and staff responses to these comments.

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