POLICY ISSUE
(Information)

February 6, 1987 SECY-87-34

FOR: The Commissioners

FROM: Victor Stello, Jr.
Executive Director for Operations

SUBJECT: TMI-2 CLEANUP - STAFF REVIEW OF STATUS AND SCHEDULE

PURPOSE: To provide the Commission with a periodic update on the status of major cleanup issues at Three Mile Island Unit 2 (TMI-2). A discussion of calendar year (CY) 1986 cleanup progress and the licensee's current schedule is also provided.

SUMMARY: Despite encountering a number of problems, significant progress in the cleanup has been made during the past year. Defueling efforts have resulted in removal of approximately 20 percent of the damaged core. Good progress has been made in building and equipment decontamination. The licensee expects to complete planned decontamination efforts during CY 1987 on schedule. Progress in defueling has, however, been slower than expected and the licensee's defueling schedule has slipped several times. The NRC staff's evaluation of defueling problems concluded that they are related to technical considerations and not to management commitment or funding difficulties. The staff further concluded that additional defueling delays are likely and could ultimately increase the total cost above the current estimate of $965 million and extend the scheduled endpoint (September 1988) of the cleanup.

In addition to defueling and decontaminating the facility, two other major cleanup issues are currently being addressed by the NRC staff. A draft environmental impact statement (EIS) on the issue of disposing 2 million gallons of accident-generated water was recently issued. Following consideration of comments on the draft, the staff will issue a final EIS and provide the Commission with a recommendation on the licensee's pending disposition proposal. Additionally, the staff has begun evaluating the licensee's recently submitted plan for completing active cleanup and placing the facility into indefinite storage pending either decommissioning or recommissioning. An EIS will be prepared to address this issue.

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DISCUSSION: Defueling and Related Activities

The principal focus of the cleanup effort during CY 1986 has been the removal of fuel and core structural debris from the reactor vessel (RV). Defueling activities were initiated in October 1985 and through December 1986 have resulted in the removal of approximately 61,000 pounds, or 20 percent, of the core debris from the RV. Enclosure 1 presents summary descriptions of both the TMI-2 defueling approach and known conditions within the RV. Since offsite shipments began in July, approximately 32,000 pounds of core debris has been transferred to the Department of Energy's Idaho National Engineering Laboratory (INEL) for examination and storage.

While removal of 20 percent of the damaged core debris represents a substantial achievement, defueling has not progressed as quickly as expected. Enclosure 2 summarizes defueling progress in terms of core debris mass removed per month during CY 1986. A number of factors have delayed this progress and, as discussed later, have prompted the licensee to slip the schedule for completing defueling. Early in CY 1986, difficulties with RV water clarity were encountered. The reduced clarity and resulting degradation in visibility were believed to be primarily caused by a nuisance bloom of microorganisms (i.e., algae and bacteria) discovered to be growing in the RV. In addition to directly affecting in-vessel visibility, these microorganisms were found to plug filters designed to maintain water clarity and minimize worker dose. Since workers rely on in-vessel video cameras for picking up core debris and for loading and handling defueling canisters, these problems have reduced the efficiency of defueling efforts.

Early in 1986, a dedicated effort, involving a number of experts in the fields of biology and water chemistry, was begun to identify long-term solutions. In mid-April, defueling activities were halted so that a number of techniques to control biological growth could be implemented. By mid-May, the licensee, utilizing high pressure water sprays to dislodge surface-adherent growth, and hydrogen peroxide and filters to kill and remove organic material, successfully reduced the population of these microorganisms in the RV. Periodic batch additions of hydrogen peroxide have been used to maintain this condition. Although the microorganisms had been successfully controlled, visibility problems within the RV persisted. Inorganic particles, primarily colloidal iron compounds, were also found to directly affect visibility and to plug the water cleanup filters. Almost any mechanical manipulation of the core debris has been shown to suspend this material and dramatically reduce visibility for operators. While a number of parallel efforts (e.g., coagulant

additions to facilitate filtration of inorganics and high technology imagery systems for operators) are being pursued, no technique has yet proved successful for dealing with this problem.

Defueling activities were re-initiated in late May 1986 following the initial efforts to improve visibility. As illustrated in Enclosure 2, however, relatively little progress in removing core debris was achieved between late May and late June, when defueling was again halted. During this period, the licensee's efforts were focused on testing the effectiveness of new tools, performing video inspections inside the vessel, carrying out equipment maintenance and rearranging core debris to support the planned acquisition of core samples. In July, a 2½-ton drilling rig was used to obtain stratified samples at 10 locations in the damaged core. Samples were obtained by drilling vertically through the core region using a 2½-inch diameter hollow drill bit. Two samples of material from the lower reactor vessel head were also obtained. The program, funded by the Department of Energy, was carried out to obtain information about both the accident progression and core conditions affecting future defueling. Analysis of these samples is underway at the Idaho National Engineering Laboratory in Scoville, Idaho.

In late July and early August, following sample acquisition activities, the licensee experimented with using the drilling system as a defueling tool. After replacing the hollow drill bit with a solid-face bit, 48 holes were drilled into the formerly molten "hard crust" region of the core. This was attempted in order to condition or break up this region of the core for further defueling efforts. The effort, however, proved only marginally successful. Drilling with the solid-faced bit was found to be severely hampered by loose core structural material, primarily stainless steel end fittings from the core's 177 fuel assemblies. Many of these end fittings were dispersed in the debris bed as a consequence of the accident. As a result of this difficulty, much of the period between mid-August and early October was spent on efforts to locate and remove all end fittings and to prepare for a full-scale drilling of the core's crust region. Efforts to improve visibility were also conducted during this period.

Full-scale drilling operations were carried out between late October and late November. A total of 409 holes were drilled into the crust region to condition this material for subsequent defueling. The entire cross sectional area of the core, except for a 2 foot ring at the periphery, was drilled to a depth between 1½ and 4 feet. Following the drilling,

however, reinitiated defueling has continued to be difficult. In addition to visibility problems, the licensee has found the drilled core debris to be relatively difficult to remove with available tooling. The reason for these problems remains uncertain, although several possibilities have been considered. Compaction of the high-density core material may be hindering tools (e.g., shovels and scoops) from penetrating the surface of the debris. It is also thought that several relatively large pieces of core material may have fallen from the undrilled 2-foot peripheral ring and are hindering access to the drilled material. While subsequent defueling progress has been made through the end of CY 1986, it has been slow. The licensee is, however, actively pursuing a number of parallel approaches for increasing defueling efficiency.

Decontamination and Dose Reduction

During CY 1986, the licensee has continued to make good progress in carrying out the decontamination of building and equipment surfaces within the facility. A number of techniques, including water flushing, scabbling (i.e., mechanical removal of surface-layer concrete), vacuuming and manual scrubbing, have been used to remove radioactive material dispersed by the accident.

Within the reactor building (RB), the licensee's decontamination efforts have been focused on maintaining low dose-rate areas for workers carrying out defueling. As a result of these efforts, average dose rates on the defueling platform and the 347' elevation of the RB have been maintained at approximately 10 and 40 mrem/hr, respectively. In addition, a number of robotic decontamination experiments have been conducted in the highly contaminated basement (i.e., 282' elevation) of the RB. Specially designed robots have been used to test the effectiveness of removing contamination with vacuums and high pressure sprays. The first large-scale decontamination effort in the basement is scheduled to begin early in 1987.

In the auxiliary and fuel handling buildings (AFHB), efforts have continued to decontaminate the approximately 460,000 square feet of surface area contaminated by the accident. Prior to CY 1986, approximately 44% of this total had been decontaminated. During CY 1986, another 22% was completed. The licensee expects to complete AFHB decontamination during CY 1987.

The radiation protection program has been effective in maintaining worker doses as low as reasonably achievable (ALARA). During CY 1986, there have been no individual exposures greater than regulatory limits, and the implementation of good radiation protection principles (e.g., training, job planning, shielding) has worked well in minimizing total dose received. The licensee continues to maintain an experienced and large radiological controls staff to deal with the unique radiological environment created by the accident.

Cleanup Schedules

The licensee's schedule for completing major cleanup milestones has continued to be a focus of attention for the agency, the TMI-2 Advisory Panel and members of the public. The schedule has required periodic revision for a number of reasons (e.g., equipment acquisition, technical difficulties with defueling and investigations resulting from worker allegations). The most recent schedule updates issued by the licensee are summarized in Table 1.

Table 1.
Summary of Licensee Schedular Updates

	Schedule Issued		
	August 1985	April 1986	October 1986
Cleanup Endpoint	9/88	9/88	9/88
Complete Defueling	6/87	9/87	12/87
Complete Decontamination of Buildings and Equipment	6/88*	3/88	12/87
Complete Fuel Shipments	4/88	6/88	9/88

*The August 1985 schedule, vis-à-vis the April and October schedules, included plans for a more aggressive decontamination of the highly contaminated basement level of the reactor building.

The projected September 1988 target for completing those cleanup activities required by licensee planning assumptions to place the facility into storage has not changed since issuance of the August 1985 schedule. The schedule for completing other intermediate cleanup milestones has been revised in the April and October 1986 issuances. The licensee's target for completing removal of the damaged core has been slipped due to the technical difficulties encountered over the past year as described previously. The schedule for completing decontamination of building and equipment surfaces has advanced six months. This is attributable to; 1) faster than anticipated progress in carrying out some decontamination activities, and 2) a reduction in the scope of decontamination activities in the highly contaminated basement of the RB. The licensee's current plan for limited decontamination of the basement prior to storage is based on their analysis that this approach will reduce overall worker dose. (A discussion of the licensee's plan for ceasing active cleanup and placing the facility into storage is presented later in this paper.) The changes in the projected schedule for completing shipment of the core debris to the INEL reflect a delay in initiation of shipments, as well as the previously discussed delay in completing defueling.

The licensee is currently considering the issuance of another schedule revision. It is likely that relatively recent difficulties in carrying out defueling will lead the licensee to slip the completion of this activity beyond the current December 1987 target.

Accident-Generated Water Disposal

As a result of discussions with the Commission on January 14, 1986, the licensee advanced their submission of a proposal for the disposition of accident-generated water (AGW) from early CY 1987 to July 31, 1986. That proposal requested Commission approval of a plan to evaporate approximately 2 million gallons of AGW at the TMI site over a 2½-year period. Residual solids from the evaporation process would be solidified and disposed of as low-level radioactive waste at the U.S. Ecology site near Richland, Washington. NRC staff actions related to the review of the licensee's proposal were summarized in a memorandum from the Executive Director for Operations to the Commission on September 26, 1986 (Enclosure 3). The staff has completed and issued (December 29, 1986) for comment a draft environmental impact statement (EIS) on this issue. The draft EIS assessed the environmental consequences of ten disposal alternatives, including the licensee's preferred method, and concluded that

no significant impact would result from implementation of any considered alternative. The public comment period on the draft EIS is scheduled to close on February 28, 1987. During the comment period, the staff will be meeting and discussing the draft EIS with the Commission's TMI-2 Advisory Panel and representatives of TMI Alert and the Susquehanna Valley Alliance.

Following consideration of comments on the draft and issuance of the final EIS, the staff will provide a recommendation on the licensee's specific proposal for Commission consideration. Commission approval of any disposal plan is required by the facility license. A formal license amendment, with opportunity for hearing requests, has also been determined to be required before any disposal method is implemented.

Cleanup Endpoint

On December 2, 1986, the licensee provided the first formal indication of its plan for completing active cleanup and placing the facility into what they have termed "Post-Defueling Monitored Storage" (PDMS). As discussed previously, the licensee's schedule for completing cleanup activities is September 1988. At that point, the PDMS plan assumes that the facility will have been defueled and decontaminated sufficiently to support safe monitored storage for an indefinite period of time. The licensee's plan makes no proposal on the ultimate disposition (i.e., decommission/recommission) of the facility. During the storage period, the licensee expects to retain an NRC Part 50 license, modified to reflect the plant's unique condition, and to evaluate factors affecting ultimate disposition.

The plan assumes that prior to entering PDMS, completed defueling and decontamination activities will preclude the possibility of nuclear criticality anywhere in the plant, eliminate the potential for significant release of radioactivity, and facilitate safe monitoring and maintenance programs by a limited number of workers. To assure these objectives are met, the plan further assumes that: 1) fuel and core material will have been shipped offsite, 2) any residual fuel left in the plant will have been quantified and shown to be less than that needed to sustain criticality, 3) all collected radioactive waste will have been packaged and shipped or safely stored pending shipment offsite, 4) water from all plant systems will have been removed, and 5) radiation levels will have been reduced to permit effective monitoring and maintenance. Following the storage period, some additional cleanup, particularly decontamination of the RB basement, would be required regardless of future efforts to either decommission or recommission the facility.

The NRC staff plans to fully evaluate the specifics of the licensee's proposal. An environmental impact statement will be prepared to supplement the 1981 Programmatic Environmental Impact Statement (NUREG-0683). Initiation of this effort is expected to begin following the licensee's submission of its PDMS environmental report in January 1987. Specific requests for changes to the license to reflect the PDMS period are not expected to be submitted until late CY 1987 or early CY 1988.

Cleanup Funding

The staff has reviewed the licensee funding plan for the remainder of the cleanup and has independently verified the individual sources of anticipated outside funding. Based on the licensee's currently estimated total cleanup cost of $965 million (M) and total expenditures of $728M through CY 1986, the projected cost to complete the cleanup through the licensee's September 1988 endpoint is $237M. Enclosure 4 provides, by source, funding amounts committed or reasonably assured through the end of cleanup. As a result of this review, the staff has determined that sufficient monies will be available to fund the cleanup effort at the projected rates through September 1988. It is the staff's understanding that the licensee no longer views securing of funds as a significant obstacle to accomplishing the cleanup. Any reasonable shortfall, due to the unavailability of outside funding or short-term delay in the current cleanup schedule, would likely be made up by the company. However, if there is a significant delay in the cleanup on the order of one or two years, then funding may become a factor in the completion of the effort.

Conclusion

Despite encountering a number of problems, a significant amount of cleanup progress has been made during the past year. Efforts in defueling and decontaminating the facility have been extensive and have been carried out with a strong commitment to assuring safety. In the most recent Systematic Assessment of Licensee Performance (SALP) (period: 5/1/84 - 2/28/86), the NRC staff concluded that cleanup activities have been conducted "...in a safe and technically competent manner" and that the "...licensee's emphasis on safety has been demonstrated by a conservative approach, and a generally high degree of management involvement...". Overall licensee performance has continued to be strong during the remainder of the past year.

The pace of defueling has not proceeded as quickly as originally anticipated. A number of technical difficulties have resulted in defueling schedule extensions and, as noted previously, the licensee is currently considering further extension of the schedule based on recent defueling experience. The potential

for additional defueling delay is a concern since this could ultimately extend the time and cost required to complete the overall cleanup. The Commission has consistently held that the cleanup should be completed expeditiously in order to reduce risk to workers and the public. Delays in moving forward with cleanup have also been a continuing concern to some members of the public. Consistent with past Commission direction, the staff has reviewed the reasons for defueling delays and concludes that they are based on technical considerations associated with this unique activity and are not a result of a either a lack of management commitment or available funds. Additionally, cleanup delays have not occurred as a result of NRC staff regulatory activities. Consistent with the Commission's policy of supporting an expeditious cleanup, the agency's integrated licensing and inspection staff has been successful in keeping NRC activities off the cleanup's critical path. The staff has also continued to provide its assessment of cleanup progress and problems to the Commission's Advisory Panel and the public.

While the staff believes that some additional delay in completing defueling is likely, we have concluded that delays to date have not resulted in either significant safety consequences or in a significant increased potential for safety consequences. The reactor's fuel, for example, has continued to be maintained safely subcritical and is currently producing minimal decay heat. While removal of this material is essential to minimizing the facility's remaining risk, some additional delay is not expected to significantly increase this risk. It is also likely, in light of the licensee's relatively good financial health, that funding will be available for cleanup activities necessitated by some further extension of the schedule.

Consistent with past practice, the staff will keep the Commission informed on cleanup progress, including the licensee's ability to continue to provide adequate funding. If significant delays are anticipated and the staff determines that reasonable efforts are not being made by the licensee, we will recommend the Commission take appropriate action.

Victor Stello, Jr.
Executive Director
for Operations

Enclosures: See next page

Enclosures:
1. TMI-2 Defueling
2. Core Debris Removed During 1986
3. NRC Staff Actions Related to Disposition of TMI-2 Accident Generated Water, Memo from V. Stello to Commissioners, dtd. 9/26/86
4. TMI-2 Cleanup Spending and Sources of Funds

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ENCLOSURE 1

TMI-2 DEFUELING

The TMI-2 defueling effort is unique. The equipment and procedures being employed have been developed based upon limited information on the condition of degraded core. The principal defueling systems are summarized schematically in Figure 1. Workers conduct defueling activities while standing on a rotatable, shielded work platform directly above the water-filled RV. Using hydraulically operated tools and in-vessel video cameras, workers load core debris into special defueling canisters which are suspended from the underside of the work platform submersed within the RV. Filled canisters are transferred from the vessel via a specially designed fuel canister bridge to the flooded deep-end of the fuel transfer canal in the reactor building. Transfer to storage racks in the fuel handling building spent fuel pool is effected by a modified fuel transfer system and a second fuel canister bridge. The canisters are dry loaded into the shipping cask (7 per cask) via a shielded transfer cask which is manipulated by the existing fuel handling building crane. The loaded cask is placed on a railcar for shipment to the INEL.

The as-known condition of core debris within the reactor vessel is summarized in Figure 2.

TMI-2 DEFUELING PLAN

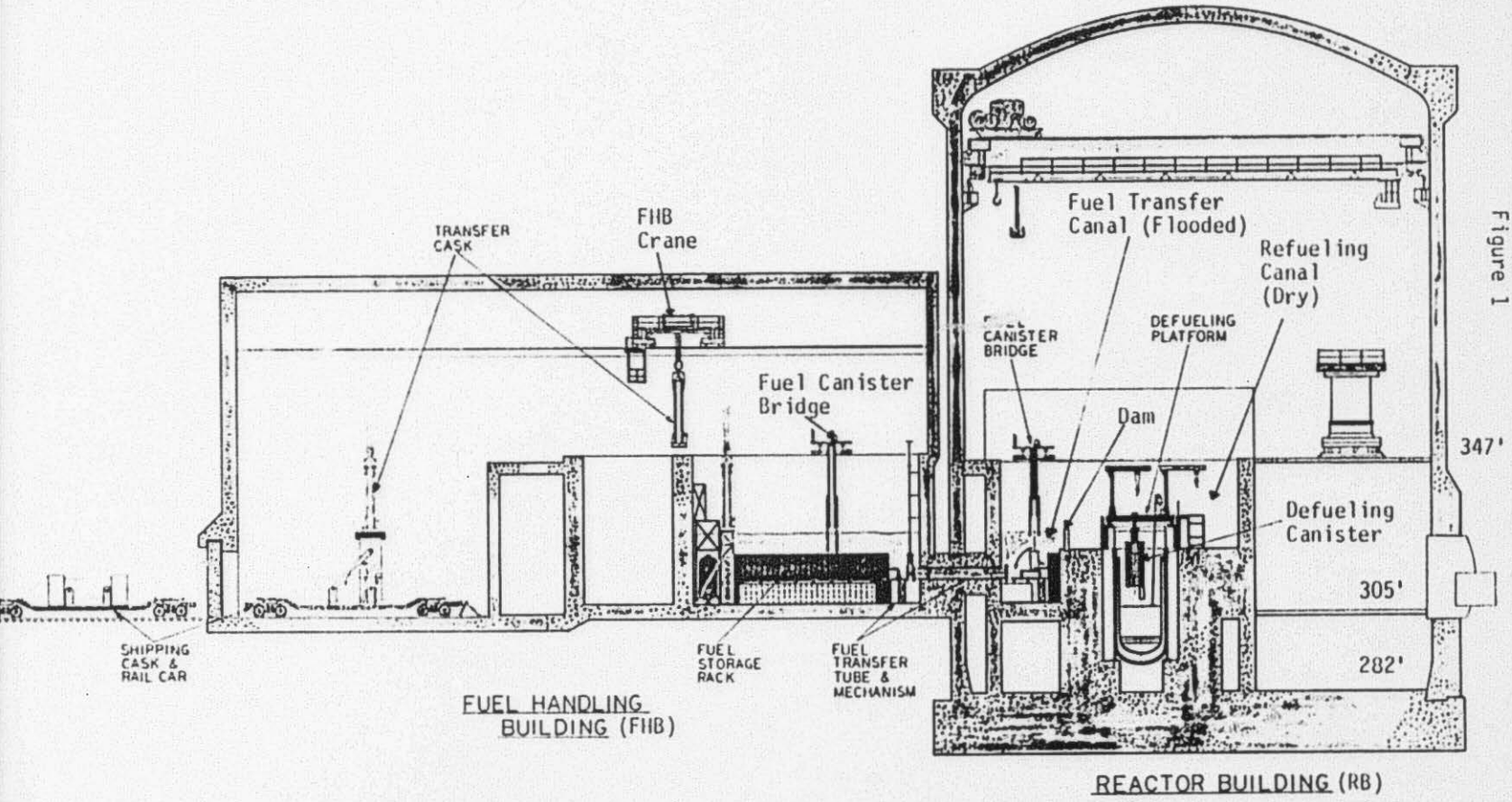
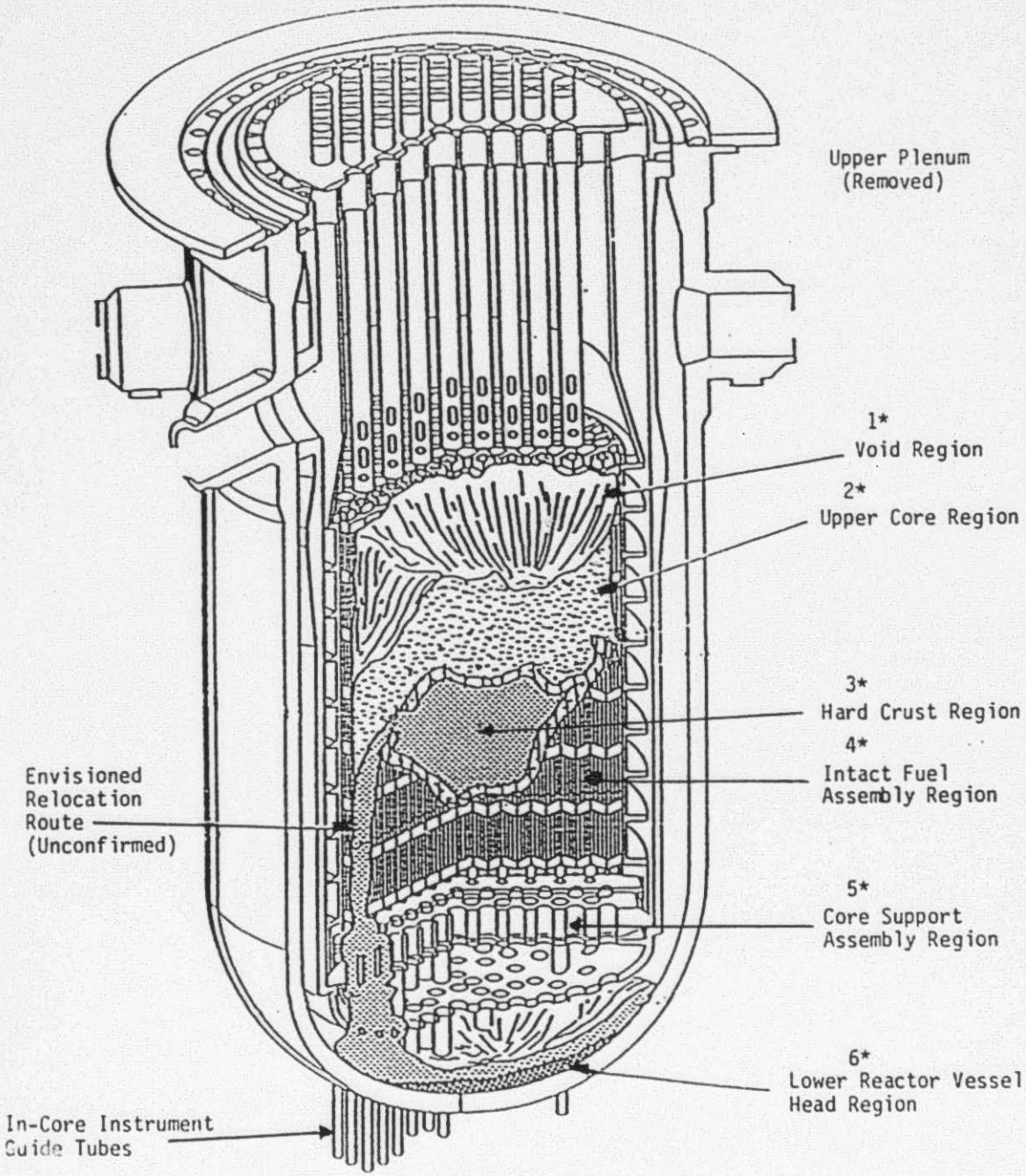


Figure 1

Figure 2

As-Known Condition of Core Debris
Within the TMI-2 Reactor Vessel



* Figure 2 Key next page

Figure 2 Key

1. Void Region - encompasses about one-third of total core volume and extends out to partially damaged peripheral fuel assemblies.

2. Upper Core Region - consists of loose rubble (e.g. end fittings, fuel rod segments, etc.) and 20 damaged but standing peripheral fuel assemblies. Contains 24 - 27% of total core debris. Most debris defueling to-date has been removed from this region.

3. Hard Crust Region - consists of resolidified core material and contains 22 - 33% of total core debris.

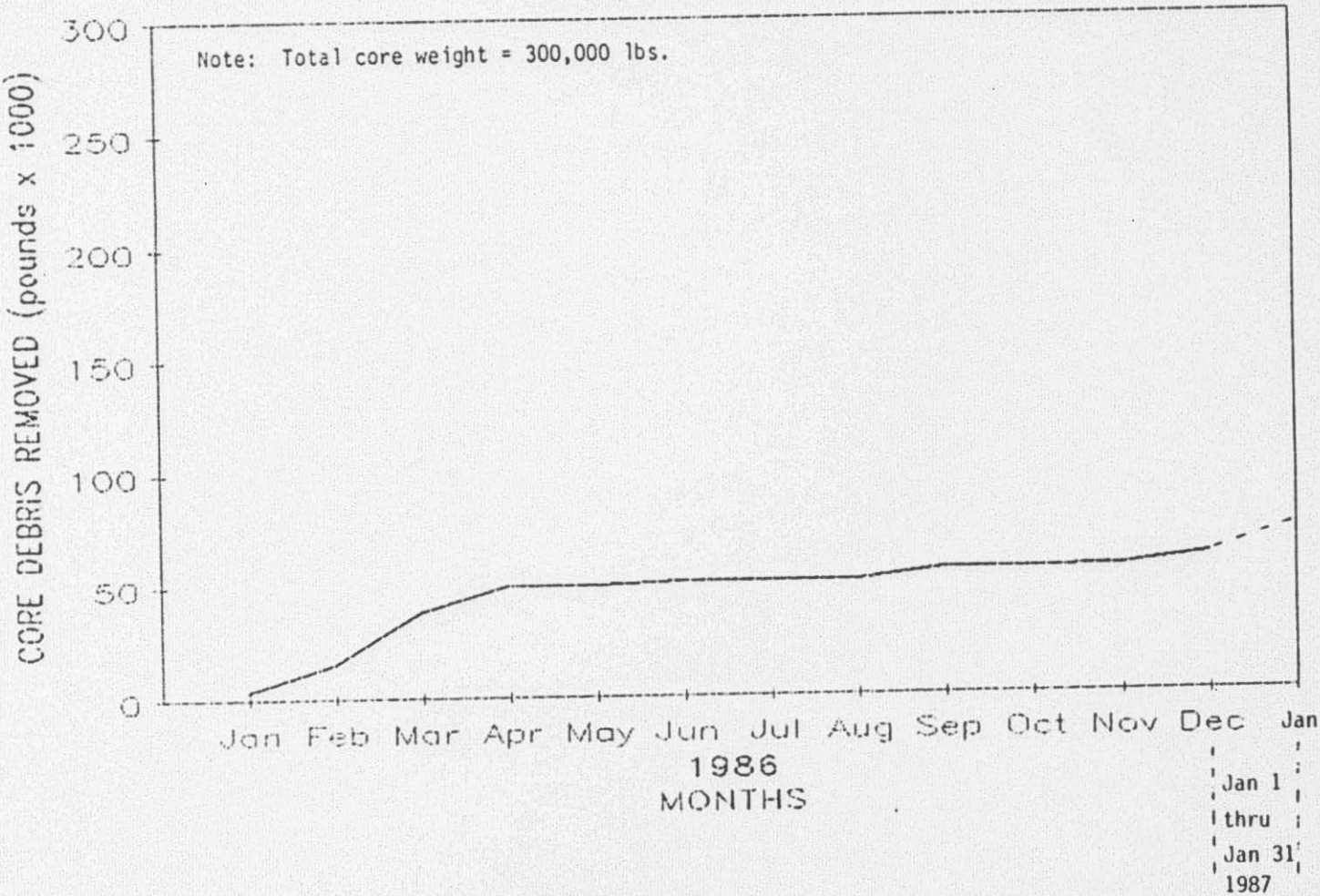
4. Intact Fuel Assembly Region - consists of geometrically intact partial fuel assemblies and contains 20 - 31% of total core debris.

5. Core Support Assembly Region - contains loose previously molten material estimated at 1.7 - 2.7% of the total core debris.

6. Lower Reactor Vessel Head Region - consists of previously molten core material and contains 11 - 18% of the total core debris.

ENCLOSURE 2

CORE DEBRIS REMOVED DURING 1986



ENCLOSURE 3

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

SEP 2 6 1986

MEMORANDUM FOR: Chairman Zech
Commissioner Roberts
Commissioner Asselstine
Commissioner Bernthal
Commissioner Carr

FROM: Victor Stello, Jr.
Executive Director
for Operations

SUBJECT: NRC STAFF ACTIONS RELATED TO DISPOSITION OF TMI-2 ACCIDENT GENERATED WATER

The licensee has recently submitted a proposed plan for the disposition of approximately 2.1 million gallons of water contaminated as a result of the March 1979 accident at Three Mile Island Unit 2 (TMI-2). The Commission, in an April 27, 1981 Policy Statement accompanying the issuance of the Final Programmatic Environmental Impact Statement (PEIS) on the TMI-2 cleanup, directed that any proposal for disposing of this water be referred to the Commission for approval. The purpose of this memorandum is to inform the Commission of the staff's plans for evaluating the licensee's proposal.

Background

As a result of the 1979 accident, about 2.1 million gallons of radioactively contaminated water are projected to be accumulated at the TMI-2 site by September 1988, the scheduled endpoint of the current cleanup program. The water, referred to here and in the TMI-2 Technical Specifications as Accident Generated Water (AGW), contains tritium, relatively small amounts of strontium-90, cesium-137 and trace amounts of other radionuclides. The AGW consists of water contaminated directly by the accident (approximately 1.3 million gallons) and additional water from system inleakage which has become comingled with the original accident contaminated water. Since the accident, this water has been processed through specially designed demineralizer systems

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to reduce its radioactivity content, and has been stored in the plant and utilized in carrying out various cleanup activities (e.g., decontamination flushes). Processing of the AGW continues on an as-needed basis. Following its final processing, prior to disposition, the AGW is projected to contain a total of 1020 curies of tritium, 0.9 curies of strontium-90 and 0.29 curies of cesium-137.

There continues to be a great deal of public interest in the ultimate disposition of this water. The interest has focused primarily on concern that TMI-2 AGW might be discharged into the Susquehanna River. Individually, the City of Lancaster, PA and the Susquehanna Valley Alliance, in May 1979, filed a suit against the NRC and the licensee to prevent TMI-2 liquid discharges. In settling these suits, the NRC agreed to evaluate environmental impacts prior to approval of any river discharge and to keep the parties informed of any NRC actions related to potential approval of river discharge.

In the March 1981 PEIS on the TMI-2 cleanup, the staff addressed, based on available information, the disposition of the AGW. As noted earlier, the Commission, at that time, directed the staff to refer any future proposal for water disposition to the Commission for approval. As a result, the TMI-2 Technical Specifications, revised after the accident to reflect the unique status of the facility, prohibit the licensee from discharging AGW until NRC approval is obtained.

Discussion

The licensee, by letter dated July 31, 1986, has proposed a plan to evaporate by forced heating the AGW at the TMI site over a period of about two and one-half years. Under this plan, the residual solids (i.e., bottoms) resulting from the evaporation process would be solidified with cement and disposed of as low-level radioactive waste at the U.S. Ecology site in Washington State. In order to implement this plan, the licensee, in addition to NRC approval, will require approval from the Department of Energy for additional low-level waste volume allocation to permit disposal of the solidified evaporator bottoms (range: 27,000 - 46,000 cubic feet). The licensee estimates that its standard allocation, as established by the Low-Level Radioactive Waste Amendments Act of 1985, is not sufficient to permit disposal of these bottoms. A request for additional allocation has recently been sent by the licensee to the Secretary of Energy.

In making its proposal, the licensee has provided an evaluation, including an assessment of environmental impacts, of three disposition alternatives: 1) forced evaporation with off-site disposal of evaporator bottoms, 2) solidification and on-site disposal, and 3) controlled discharge to the Susquehanna River. Due to the relatively low concentrations of radioactive material and other contaminants (i.e., sodium hydroxide and boric acid), the licensee concluded that all three options are environmentally safe and could be implemented within

applicable federal and state requirements. The licensee's preference for implementing the evaporation alternative, as stated in their submittal, is based primarily their recognition that the river discharge option is perceived as unacceptable by the general public.

The NRC staff plans to independently evaluate the licensee's proposal and to provide the Commission with a recommendation. To facilitate this, and recognizing the strong public interest in disposition of this water, the staff plans to supplement the information contained in the March 1981 PEIS. The supplement will evaluate this issue based on current information and will include a discussion of water disposition alternatives and associated impacts. The supplement will be published and made available for comment by interested members of the public and appropriate federal and state agencies. The staff will also brief and solicit comments from the Commission's TMI-2 Advisory Panel in a public meeting. The staff views this approach as consistent with the Commission's sensitivity to previously expressed concerns regarding water disposition. It should serve to provide for full consideration of interested parties and a complete record for Commission disposition of this issue. It should be noted that because of the current prohibition on the discharge of AGW set forth in the Technical Specifications, a license amendment may be necessary.

The final supplement will form the basis of the staff's recommendation on the licensee's proposal to the Commission. A draft supplement is expected to be publicly available in December 1986. The final supplement and a staff recommendation is expected in May 1987. The licensee hopes to begin disposal during the summer of 1987.

The staff will inform the Commission of any significant deviations from this schedule.

Original signed by
Victor Stello

Victor Stello, Jr.
Executive Director
for Operations

cc: OGC
SECY

See previous concurrences.*

TMI-2PD/DPLB*	OGC*	DRL	ONRR	ONRR	EDO
WTravers/MMasnik/RHall	LChandler	FJMiraglia	RVollmer	HRDenton	VStello
9/11/86	9/17/86	9/19/86	9/23/86	9/23/86	9/26/86

ENCLOSURE 4

TMI-2 CLEANUP SPENDING AND SOURCES OF FUNDS
($ Millions)

	Actual Through CY 1986	Projected for CY 1987 and Beyond	Total
Spending	$728	$237	$965
Sources of Funds			
- GPU Customers	$165	$ 84	$249
- NJ & PA State Appropriations	26	15	41
- Insurance	306	-	306
- U.S. Department of Energy*	69	10	79
- Industry (EEI & EPRI)	46	107	153
- Japanese Consortium	9	9	18
- GPU Internally-Generated Funds	107	12	119
	$728	$237	$965