Docket No. 50-289

# METROPOLITAN EDISON COMPANY

# THREE MILE ISLAND NUCLEAR STATION UNIT 1

# SPENT FUEL POOL MODIFICATION

# ENVIRONMENTAL IMPACT EVALUATION

January 1977

1408 035

7910100 463

TABLE OF CONTENTS





1408 036

## 1.0 INTRODUCTION

### 1.1 Purpose of Environmental Impact Evaluation

Subject to the approval of the Nuclear Regulatory Commission, Metropolitan Edison (Met-Ed) Company intends to increase the capacity of the "B" spent fuel storage pool at Three Mile Island (TMI) Nuclear Station Unit 1. Met-Ed is taking this action in order to assure the continued availability of electrical power to its service area and to the service areas of its sister companies - Jersey Central Power & Light Company and Pennsylvania Electric Company, co-owners of TMI-1. In view of the present uncertain future of the fuel reprocessing industry, which is extensively documented in both technical and popular literature, Met-Ed considers the only prudent course of action to be to increase its capacity to store spent fuel. This Environmental Impact Evaluation was prepared to evaluate the impact of the modification of the spent fuel racks to allow such an increase.

This Environmental Impact Evaluation describes the history and need for the proposed modifications. The proposed modification is described in Section 2.0. Section 3.0 evaluates the environmental effects of the normal operation of the modified facility while Section 4.0 addresses the environmental effects of accidents. Section 5.0 describes and evaluates the several alternative actions considered to alleviate the anticipated shortage of spent fuel storage capacity. A summary of the several alternative actions and cost-benefit analyses is presented in Section 6.0.

### 1.2 History and Need for the Proposed Modification

Three Mile Island Nuclear Station Unit 1 received its Operating License, DPR 50, in April 1974. At present there are 56 spent fuel assemblies stored in the "A" spent fuel pool. These assemblies were removed during the first refueling outage in March

1976. This number will rise to a total of 104 assemblies after the second refueling outage, scheduled to begin in March 1977. The prese t storage ca ity in the "A" pool is 256 assemblies or approximately 1-1 ... .

It is prudent en neering practice and the policy of Met-Ed to re erve stora space in the spent fuel pool to receive an entire reactor core should offloading of the core be necessary or desirable because of operational considerations. This, together with the fact tha spent fuel reprocessing facilities cannot assuredly be available to Met-Ed prior to the mid-1980s at the earliest leads to the conclusion that an increase in the spent fuel storage capability is necessary.

To accommodate both spent fuel discharges through the mid-1980s and the full core offload capability after the 1977 refueling, a modification is planned to increase the spent fuel storage capacity by installing new spent fuel racks in the "B" pool. These new racks will maximize the storage capability by decreasing the center-to-center spacing of the fuel racks while maintaining subcriticality under all conditions. The planned modification will result in a maximum storage capacity of 752 assemblies.

## 2.0 GENERAL DESCRIPTION

### 2.1 Present Design

Three Mile Island Nuclear Station Unit 1 is a 2535-MWt PWR (B&W) with a total of 177 fuel assemblies in the core. Its spent fuel storage complex consists of two Pools, "A" and "B", connected to each other by a canal and sliding gate, and a spent fuel pool cooling system. Water in the system contains approximately 1800 ppm boron. The cooling system includes two coolant pumps, two coolers, one borated water recirculation pump, and associated piping, valves, etc. The spent fuel cask loading pit is adjacent to Pool "B", and Pool "A" is connected to the reactor building fuel transfer canal by two fuel transfer tubes.

The major equipment components of the cooling system are located on the west side of the the Fuel Handling Building, a Class I structure hardened to withstand hypothetical aircraft impact as described in the TMI-1 FSAR. Part of the cooling system piping extends into the Reactor Building and into the Auxiliary Building. Both these structures are also Class I and hardened to withstand hypothetical aircraft impact.

The cooling system is designed to maintain 135°F in the pools with a heat load based on decay heat from one-third of a fully irradiated core that has been cooled for 150 hours, the postulated normal time between shutdown and removal of fuel from the core. This can be accomplished with one pump and one cooler. After an entire core offload with an additional one-third of a core already in the pool from a refueling 100 days earlier, the pool can be maintained at 153°F by using both pumps and both coolers. The design capacity of the cooling system is $9.5 \times 10^6$ Btu/hr during a normal refueling and $28.0 \times 10^6$ Btu/hr during an Entire Core Offload condition. The worst case heat generation rate will cause the spent fuel pools to heat up at a rate of 5.2°F/hr should all cooling be lost. During this Entire Core Offload condition,

sufficient time would exist to activate the Reclaimed Water System as an additional water source or to restore service to one of the spent fuel pool cooling chains. A purification loop is provided within the Radioactive Liquid Waste Disposal system for removing fission products and other contaminants from the water. A small flow from the spent fuel cooling pumps is diverted to a radiation monitor. The spent fuel cooling system is designed so that a line rupture will not cause a serious lowering of pool water level.

The present TMI-1 fuel storage capacity consists of:

a. 253 Wet fuel locations in Pool "A"
b. 3 Wet failed fuel locations in Pool "A"
c. 63 Wet fuel locations in the Reactor Building Transfer Canal (rack temporarily removed but available for reinstallation)
d. 1 Wet failed fuel detection location in the Reactor Building Transfer Canal (temporarily removed but available for reinstallation)
e. 66 Dry new fuel locations in New Fuel Storage Pool
f. Pool "B" is now empty, but was originally designed for wet storage of 171 assemblies and 3 failed fuel assemblies.

The spent and new fuel assemblies are stored in racks in parallel rows having a center to center distance of 21.125" in both directions. Control rod assemblies requiring removal from the reactor are stored in the spent fuel assemblies.

At present, Pool "A" contains spent fuel stored in already existing racks. Pool "B", on the other hand, has never been used, contains neither water nor spent fuel racks, and is free of radioactive contaminants. The proposed modification, discussed in the next section, is for new spent fuel racks to be installed in Pool "B".

## 2.2 Proposed Modification

The proposed fuel rack modifications, which conform in all respects to Safety Guide 13 (USNRC RG 1.13), will involve installing high density storage racks in the empty "B" pool.

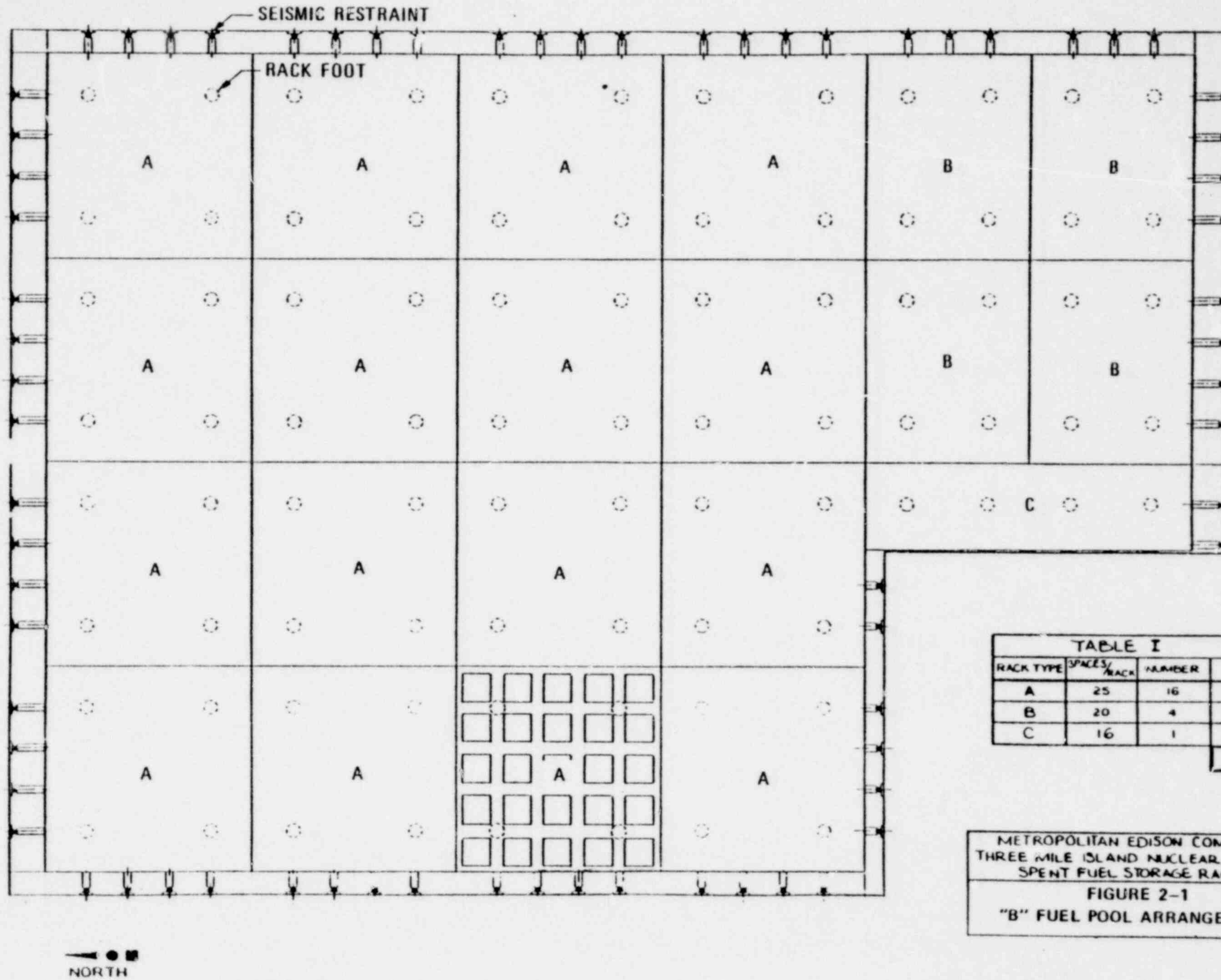
A rack assembly consists of a rectangular array of storage cells with a 13.625" center-to-center spacing. Each storage cell consists of a 9.12" I.D. square stainless steel cell having a wall thickness of 0.187". The array size of each rack was chosen to maximize use of pool space as shown in Figure 2-1. The expanded storage capacity of Pool "B" is 496 elements. The new racks contain no materials installed purely for neutron absorption capability. Reactivity calculations do consider the nuclear properties of the stainless steel cells and water but do not take credit for the 1800 ppm boron in the pool water.

The Spent Fuel Pool Cooling System will maintain the fuel pools at a maximum of 135°F during Normal Refueling with one pump and one cooler, and 147°F following an Entire Core Offload with two pumps and two coolers in operation.

As the installation will be made in a dry uncontaminated pool, no radiological problems are anticipated. The installation will not require movement of the new racks over the spent fuel in the "A" pool or over the new fuel storage area.

## 2.3 Schedule for Proposed Modification

The schedule for the proposed installation of spent fuel racks is presented in Table 2-1. In order to maintain an Entire Core Offload storage capability, the racks must be available following the 1977 refueling outage that is scheduled for completion in May 1977. In order for rack procurement and construction to begin in a timely manner, initial NRC review and comments will be necessary by March 11, 1977 with final approval by May 1, 1977.




| TABLE I | | | |
|---|---|---|---|
| RACK TYPE | SPACES/RACK | NUMBER | TOTAL |
| A | 25 | 16 | 400 |
| B | 20 | 4 | 80 |
| C | 16 | 1 | 16 |
| | | | 496 |

METROPOLITAN EDISON COMPANY
THREE MILE ISLAND NUCLEAR STATION
SPENT FUEL STORAGE RACKS

FIGURE 2-1
"B" FUEL POOL ARRANGEMENT

TABLE 2-1

SCHEDULE FOR PROPOSED MODIFICATION

| Item | Date |
| --- | --- |
| Submittal of Safety Analysis Report and Environmental Impact Evaluation | February 4, 1977 |
| Initial NRC Review and Comments | March 11, 1977 |
| Final NRC Approval | May 1, 1977 |
| Rack Installation | July-September 1977 |

## 3.0 ENVIRONMENTAL EFFECTS OF FACILITY OPERATION

This section details the changes in the environmental effects (heat, radiological, and chemical) due to expanding the "B" Pool fuel rack capacity over those previously evaluated in the TMI-1 FSAR. In addition, an evaluation of the resources committed during the construction of the fuel racks is provided.

### 3.1 Heat Dissipation Effects

This section evaluates the changes in thermal effects due to the proposed increased spent fuel storage capacity. Spent fuel assemblies will be added to the fuel pools periodically and it is not anticipated that any will be shipped offsite in the foreseeable future.

Heat generation rates were calculated using the computer code ORIGEN developed at Oak Ridge National Laboratory. ORIGEN is a point depletion code that solves the equations of radioactive buildup and decay for large numbers of isotopes with arbitrary coupling. This state-of-the-art method of calculation is based on finite fuel irradiation periods rather than infinite periods as originally used.

The first of two cases that were analyzed involved the Normal Refueling condition. The heat load was based on the following assumptions:

1. 56 fuel assemblies present in the pool after the 1976 refueling

2. 518 additional assemblies accumulated in successive refuelings through the 1986 refueling

The heat load for this first case is $9.7 \times 10^6$ Btu/hr. This heat load is $0.2 \times 10^6$ Btu/hr greater than the heat load previously evaluated in the TMI-1 FSAR.

The second case involved an Entire Core Offload condition. The heat load was based on the following assumptions:

1. 56 fuel assemblies present in the pool after the 1976 refueling.

2. 518 assemblies accumulated in successive refuelings through the 1986 refueling

3. 177 assemblies (one full core) offloaded during the 1987 refueling

The heat load for this second case is $25.7 \times 10^6$ Btu/hr, a decrease of $2.3 \times 10^6$ Btu/hr in the full core offload heat generation previously evaluated in the TMI-1 FSAR.

The heat loads estimated by the ORIGEN model corresponding to the normal refueling and entire core offload conditions result in spent fuel pool temperatures that are essentially unchanged from those originally presented in the TMI-1 FSAR. Thus, there is no effect beyond that previously evaluated and reported.

## 3.2 Radiological Effects

This section describes the changes in the radiological effects from the proposed modification of the spent fuel pool over those previously evaluated in the TMI-1 FSAR.

The increase in fuel storage resulting from this fuel rack modification will have negligible effect on the radiation effects in the Fuel Handling Building. A QAD computer code was utilized to analyze radiological consequences. As discussed in Sections

11.3.1 and 11.3.2.6 of the TMI-1 FSAR, the normal fuel handling building dose rates were originally shown to be less than 1.5 mR/hr, with certain refueling manipulations causing short-term levels in excess of 1.5 mR/hr. During these conditions, the radiation levels will be closely monitored to establish the allowable exposure times for unit personnel in order not to exceed the integrated doses specified in 10 CFR 20. Analysis indicates that dose levels will be essentially unchanged as a result of this fuel rack modification.

Section 11.3.2.6 of the TMI-1 FSAR also states that the dose rate at the pool surface is 15 mR/hr during fuel transfer operations with a minimum water depth of seven (7) feet between a fuel assembly and the pool surface. A QAD computer calculation indicates that the dose rate at the water surface will remain approximately 15 mR/hr. The dose rate contribution attributed to the increased fuel storage is negligible.

The "B" fuel pool modification will have an insignificant impact on the TMI-1 Fuel Handling Building radiological effects previously evaluated in the TMI-1 FSAR.

### 3.3 Chemical Discharges

The TMI-1 spent fuel pool water is purified by the Radioactive Liquid Waste Disposal (RLWD) System. The primary purification medium is two (2) precoat filters. In addition, mixed-bed demineralizers and evaporators are available if necessary. It is projected that the solid waste generated because of the spent fuel pool modification will be insignificant. Experience to date shows that the fuel pool introduces a negligible amount of waste to the RLWD System. No appreciable increase will occur as more fuel is stored in the pools.

The TMI-1 "A" spent fuel pool has stored spent fuel since March 1976. Since then, the RLWD System has purified pool water only

once. During the February-April 1976 refueling outage, pool water was circulated through the RLWD System for 73 hours while a full core was in temporary storage. The precoated filter for this operation was also used to purify the Borated Water Storage Tank for 48 hours prior to being recoated. It is therefore impossible to determine the amount of contaminants introduced by the fuel pool. However, because the discharged powdered resin of a precoat filter undergoes extensive concentrating steps prior to reaching a solid waste condition, it is further impossible to predict the amount of waste generated from the contents of one precoat filter. It is accurate to say, however, that the amount of generated waste from storing fuel since March 1976 is negligible. Projecting over the next ten years indicates that the spent fuel pools at TMI-1 will generate little waste. Since the discharged precoat filter resin and any radioactive waste is packaged and shipped to an approved burial site, this modification will result in no chemical discharge.

## 3.4 Resources Committed

Construction of the high density spent fuel storage racks for the storage of 496 fuel assemblies will involve the commitment of 350,000 lb of stainless steel. The annual U.S. consumption is $2.82 \times 10^{11}$ lb. As may be seen, only a small fraction of this resource will be used. No other material resource is committed in significant amounts.

## 3.5 Summary of Environmental Effects

The conclusion to be drawn from the above analyses is that increasing the spent fuel pool storage capacity as proposed will have a negligible increased effect on the environment over that previously evaluated.

## 4.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

This section discusses the changes in environmental effects of postulated accidents that involve the handling of spent fuel in the spent fuel pool. These accidents were previously analyzed in the Environmental Report and the Final Environmental Statement (FES).

### 4.1 Fuel Assembly Drop in Fuel Storage Pool

This accident was analyzed by the AEC (NRC) in the Final Environmental Statement, Three Mile Island Nuclear Station Units 1 & 2, Docket Numbers 50-289 and 50-230, December, 1972, Table 20, Section VI. The FES states that the accident would result in a site boundary dose of 1.0% of 10 CFR 20 limits and a 50-mile radius population dose of 1.30 man-rem. After examining the assumptions currently being used to calculate this accident as given in Appendix 5, USNRC RG 4.2 (Rev. 1, Proposed Annex to Appendix D 10 CFR 50), it is concluded that nothing in the proposed modification would cause a change in the stated results.

### 4.2 Heavy Object Drop Onto Fuel Rack

The FES states that the doses resulting from this accident are estimated to be 3.8% of the 10 CFR 20 limits at the site boundary and 5.3 man-rem to the population within a 50-mile radius. The proposed modification would not change the Appendix 5, USNRC RG 4.2 (Rev. 1, Proposed Annex to Appendix D 10 CFR 50) assumptions and values used in calculating the resulting dose and the stated results are therefore still valid.

### 4.3 Fuel Cask Drop

This accident was analyzed by the NRC in the Final Supplement to the Final Environmental Statement, Three Mile Island Nuclear Station Unit 2, Dec. 1976 (NUREG-0112), Table 7.2. This report

supplements the Station Final Environmental Statement referenced above. NUREG-0112 states that the doses resulting from this accident are estimated to be 21% of 10CFR20 limits at the site boundary and 33 man-rem to the population within a 50-mile radius. The proposed modification will not change the assumptions and values used in calculating the resulting doses, therefore, the doses are still valid.

## 4.4 Summary of Environmental Effects of Accidents

The environmental effects of accidents, as a result of the proposed modification of the spent fuel racks, were described in the three preceding sections. The effects of any of the accidents result in no increase in the environmental impact previously evaluated.

## 5.0 ALTERNATIVE ACTIONS

This section discusses the alternative actions to the planned modification that were considered by Met-Ed for relief from the shortage of spent fuel storage at TMI-1. Each alternative was evaluated on a cost-benefit basis and compared with the proposed method of storage increase and the consequences of reactor shutdown.

The total cost of the spent fuel storage rack modification is approximately $1,850 per storage location in 1976 dollars. This estimate includes capital costs, engineering, construction, installation, contingencies and other peripheral costs. The benefit is the capacity to store additional spent fuel assemblies and to maintain a full core offload capability through the mid-1980s.

The summary of actions considered is presented in Section 6 and tabulated in Table 6-1.

### 5.1 Storage at an Independent Commercial Facility

The cost of storage in a commercial storage facility has been investigated. It is estimated that it would cost $9,000 to $22,500 per storage location to ship and store fuel at an independent commercial facility. This estimate was computed in terms of today's dollars with no escalation.

### 5.2 Storage at an Independent Metropolitan Edison Co. Facility

The economic feasibility of constructing a spent fuel storage facility has been analyzed in terms of today's dollars. A pool with 200-550 MTU capacity would cost $14 - 23 million resulting in a cost per storage location of $19,000 to $30,000.

## 5.3 Storage at a Reprocessing Facility

Spent fuel storage at reprocessing facilities is presently available to some utilities, but it is not now available to Met-Ed. It is inconceivable that such storage will become available in the next ten (10) years. Additional storage capacity for TMI-1 fuel must be gained in 1977 to maintain the ability to off-load an entire core. Since it is not available and does not offer a solution to the TMI-1 storage capacity problem in a realistic time frame, it is not a viable alternative.

## 5.4 Storage at Other Nuclear Plant Facilities

General Public Utilities, owner of Metropolitan Edison Company, is presently completing construction of Three Mile Island (TMI-2) Unit 2. The TMI-2 spent fuel pools are located in the same fuel handling building with the TMI-1 pools, thereby eliminating the burdensome requirement of overland shipment. If TMI-1 fuel were transferred to TMI-2, TMI-2 would not have sufficient storage capacity to offload a full core commencing in 1980, its projected third year of commercial operation. Therefore, transfer of fuel to TMI-2 provides short term storage relief, but compounds the overall problem since 1980 would find two operating units without full core offload capability.

Consideration was given to possible fuel storage at Jersey Central's Oyster Creek (BWR) Nuclear Generating Station. Jersey Central is a subsidiary of the General Public Utilities Corporation. Jersey Central is presently awaiting authorization from the NRC to expand its fuel pool storage capacity. Authorization will extend storage of Oyster Creek fuel assemblies until 1983 while retaining the capability of removing an entire core from the vessel. In order to receive fuel from TMI-1, PWR racks would have to be installed since BWR racks cannot store PWR fuel.

Reducing Oyster Creek BWR storage capacity in order to receive TMI-1 fuel assemblies would restrict Oyster Creek's fuel storage capacity.

Again, such transfer would provide short-term storage relief for TMI-1 but would compound the overall General Public Utilities Corporation fuel storage problem.

According to a survey conducted and documented by ERDA,[1] as many as 46 percent of the operating nuclear power plants will lose the ability to refuel during the period 1975-1984 should there not be any additional spent fuel storage pool expansions or commitments to utilize off-site storage facilities. Thus Metropolitan Edison Company and General Public Utilities cannot assuredly rely on any other facility to provide additional storage capability except on a short-term emergency basis.

In summary, storing TMI-1 spent fuel at other nuclear plant facilities is not a viable alternative.

## 5.5 Reactor Shutdown

If no action is taken to provide additional spent fuel storage capacity, TMI-1 would have to be shut down to stop the generation of spent fuel. Replacement cost of energy and capacity would be approximately $159 million per year. Considering a fuel discharge of 52 assemblies per year, the cost per fuel assembly is $3.1 million.

---

[1] LWR Spent Fuel Disposition Capabilities, 1975-1984, ERDA-25, March 1975.

## 6.0 SUMMARY OF COST-BENEFIT ANALYSES

Table 6-1 summarizes the costs and benefits of various fuel storage alternatives. The benefit to be derived from three (3) viable alternatives is continued operation of TMI-1 and its production of electrical energy. Storage at a reprocessing facility is not available and storage at other nuclear plant facilities is not viable since it only provides short-term storage relief and later compounds storage problems. Reactor shutdown and subsequent storage of fuel in the reactor vessel has no benefit since it results in the cessation of electrical energy production.

From examination of Table 6-1, it can be seen that the most cost-effective alternative is the proposed modication to the "B" pool storage racks.

TABLE 6-1

SUMMARY OF COST-BENEFITS

| Alternative | Cost per Assembly | Benefit |
|---|---|---|
| Pool expansion | $1,850 | Continued operation and energy generation |
| Storage at independent commercial facility | $9,000-$22,500 | Continued operation and energy generation |
| Storage at independent Metropolitan Edison Facility | $19,000-$30,000 | Continued operation and energy generation |
| Storage at a reprocessing facility | — | None. This alternative is not available |
| Storage at other nuclear plant facilities | — | None. This alternative is not viable |
| Reactor shutdown | $3.1 million | None. No production of electrical energy |

1408 054