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ENVIRONMENTAL ASSESSMENT

USE OF EPICOR-II

AT

THREE MILE ISLAND, UNIT 2

PREPARED BY

OFFICE OF NUCLEAR REACTOR REGULATION

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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.

The building also contains a stainless steel lined sump and is therefore watertight up to a height of 13.5 feet above the basement floor and would contain the release of water in the event of rupture of the tanks in the building, i.e., the chemical cleaning building contains two large water storage tanks, the chemical cleaning solution tank (CCST) with a capacity of 95,000 gallons and the rinse hold tank (RHT) with a capacity of 133,000 gallons.

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 for ultimate disposition. 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 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 tank to be processed. 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 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 280,000 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).

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 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. The chemical cleaning building is of watertight seismic Category 1 concrete construction to a height sufficient to contain the water in the large holdup tanks in the event of rupture of these tanks;

3. 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;

4. 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;

5. 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;

6. 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;

7. 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;

8. 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.

9. 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 TMI Unit 2 is through the TMI Unit 1 or 2 discharge lines. These discharge lines have radiation monitors which will alarm and automatically initiate closure of the discharge valves on a preset value.

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. Iodine fixing chemicals will be added to the sump to minimize iodine releases;

7. Iodine fixing chemical will also be added to the off-spec receiving/batch tank and to the clean water receiver tank.

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, Appendix I[13]). The bases used in this estimate are as follows:

1. Data obtained on nuclide activity levels in the reactor coolant and the reactor coolant bleed tanks;

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 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.

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. <u>Existing Radwaste Systems</u>

   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. <u>New EPICOR-II Radwaste System</u>

   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;

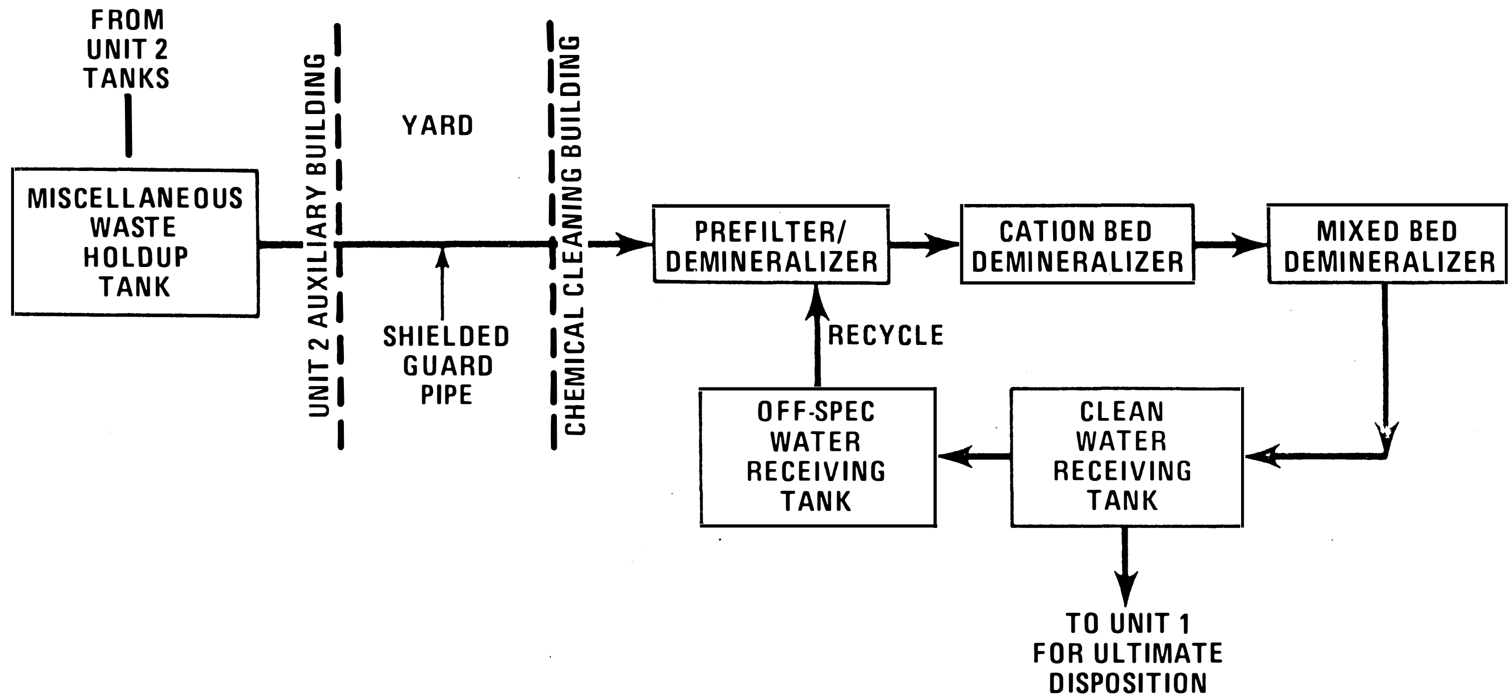
5. The occupational exposure due to system operation and handling and storage of solid waste corresponds to less than 1 percent of the normal annual average for a nuclear power plant;

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.

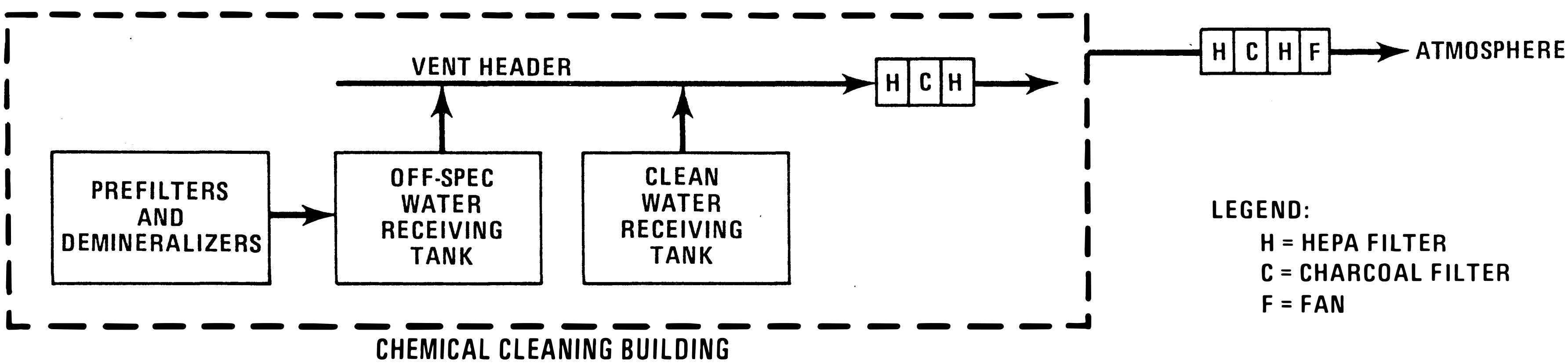
Based on our estimate of gaseous releases during operation of the EPICORE-II system, including a release due to an accidental spill, and our estimate of occupational dose and our estimate of direct radiation off-site, we conclude that the operation of this system does not constitute a significant environmental 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.



LIQUID WASTE FLOW PATHS



GASEOUS WASTE FLOW PATHS

Figure 1. Flow Schematic of EPICOR II Processing System

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

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."