U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-341/94003(DRSS)

Docket No. 50-341 License No. NPF-43

Licensee: Detroit Edison Company
6400 North Dixie Highway
Newport, MI 48166

Facility Name: Fermi Nuclear Power Plant, Unit 2

Inspection At: Fermi Site, Newport, Michigan

Inspection Conducted: January 18 - March 18, 1994

Inspectors: N. Shah — 3/24/94 Date

S. K. Orth — 3/24/94 Date

M. A. Kunowski — 3/29/94 Date

Approved By: M A Kunowski for J. W. McCormick-Barger, Chief, Radiological Programs Section 1 — 3/29/94 Date

Inspection Summary

Inspection on January 18 - March 18, 1994 (Report No. 50-341/94003(DRSS))
Areas Inspected: Follow-up inspection of licensee water management activities following the December 25, 1993, turbine event documented in Inspection Report (IR) No. 50-341/93029(DRS). The inspection included a review of Radwaste Building basement (RWBB) recovery, reactor water chemistry, and the cleanup and discharge of the condensate storage tank (CST). The inspection covered the program for maintaining radiation exposures As Low As Reasonably Achievable (ALARA), contamination controls, management controls, and external and internal exposure per inspection procedures (IPs) 83750 and 84750.
Results: Overall, recovery actions were good (Section 6) with strong management involvement (Section 2). Control of condensate storage tank discharges was excellent; licensee analytical results and offsite dose projections were in good agreement with independent NRC analyses and calculations (Sections 7 and 8). Some weaknesses were noted regarding adherence to radiation protection instructions (Section 3) and identification

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of concerns to plant management (Section 4), but these were effectively addressed by the licensee. Radiological performance was good (sections 3-5) considering the extensive and abnormal scope of work. Prompt and effective corrective actions were taken, after an inspector identified a contract operator being inattentive to duty in the radiological restricted area (Section 3).

## DETAILS

1. Persons Contacted

*@R. McKeon, Plant Manager
*@P. Fessler, Technical Manager
*J. Pendergast, Compliance Engineer
*@J. Walker, Director Plant Engineering
*D. Pettinari, General Supervisor, Radwaste
*@R. R. Eberhardt, Assistant to Plant Manager
*@E. F. Kokosky, General Supervisor, Radiation Protection Operations
*L. Goodman, Director, Nuclear Quality Assurance
*@R. Delong, Superintendent Radiation Protection, Chemistry, Radwaste and Industrial Health
*@S. Bartman, General Supervisor, Chemistry
@R. A. Newkirk, Acting Director, Nuclear Licensing
*R. Baum, Supervisor, Radiological Engineering
*D. Craine, Radiological Engineer
*@W. Terrasi, Technical Specialist
*J. Bragg, Group Lead, Audits
*@B. Szkotnicki, Supervisor, Instruments and Surveillance
*J. H. Plona, Superintendent Plant Operations
*@J. Tibai, Principal Compliance Engineer
*R. L. Russell, Supervisor, Radiation Protection Training
*J. L. Crews, Consultant
*E. Nickolite, General Supervisor, Maintenance

*@K. Riemer, NRC Resident Inspector

*The above personnel were present at the exit meeting on January 28, 1994.

@The above personnel were present at the exit meeting on February 28, 1994.

The inspector also interviewed other licensee and contractor personnel.

2. Management Controls and Organization (IPs 83750 and 84750)

Following the influx of approximately 800,000 gallons of water to several plant areas during the December 25, 1993, turbine-generator event, the licensee formed a water management committee to address plant recovery actions. This committee included representatives from the engineering, maintenance, radwaste, chemistry, and radiation protection (RP) staffs and met daily to discuss progress and allocate needed resources. Committee resolutions were communicated to station management at daily outage meetings. The inspectors attended several of these meetings and noted good cooperation and communication among plant groups. An inspector also attended meetings of the onsite review organization (OSRO) which reviewed procedures and safety evaluations

(SEs) written for the various modifications needed for processing and transferring water. A conservative approach towards radiation protection and ALARA was noted.

Strong management support of ALARA was also indicated by the plant manager's decision to delay draining the floor drain collector tank (FDCT) contents (Sections 3 and 6a(2)). This decision provided RP additional time to implement job controls and to remove temporary demineralizers (Section 6b) from service. During division switching of the residual heat removal (RHR) system, crud, which had accumulated in the RHR piping, entered the shielded reactor water cleanup (RWCU) system rather than the temporary demineralization systems, which would have significantly increased dose rates in the Turbine Building (TB).

No violations or deviations were identified.

3. <u>ALARA and External Exposure (IP 83750)</u>

The licensee was in the process of revising the original station's dose goal of 200 person-rem (2 person-Sieverts (Sv)) for 1994, to include expected dose from recovery actions. Total exposure from recovery activities, to date, was about 11 person-rem (0.11 person-Sv).

The inspectors observed the planning and execution of the evolutions described in Section 6. Overall, planning was conservative, and ALARA was appropriately considered. Good communication was noted during prejob briefings, and good attention to detail was noted while observing work activities. Management support of ALARA was evident during the draining of the FDCT and RHR division switching (Section 2). ALARA initiatives included the use of experienced personnel for oil skimming (Section 6a(1)), use of mockups in training, staging of temporary shielding and video equipment for demineralizer replacement (Section 6b), and continuous communications (Section 6a(2)) during the transfer of water to the condenser hotwell. During plant tours, the inspectors noted RP technicians performing appropriate surveys of temporary modifications to verify dose rates (Section 6b). Periodic updates were posted at the entrance to the radiological restricted area (RRA) to reflect changing plant conditions.

One weakness was identified concerning adherence to RP instructions during the draining of the FDCT (Section 6a(2)). Because expected exposure was low ($\leq$ 1 person-rem (10 person-mSv)), RP issued verbal instructions in lieu of a formal radiation work permit. These instructions included the donning of waterproof protective clothing and electronic dosimetry (ED) and continuous RP job coverage. Electronic dosimeters were also required around the tank outlet to monitor for potential crud bursts. These instructions were adhered to except for the placement of EDs at the tank outlet. Because of the additional job controls, the lack of the EDs was of minor safety significance. The workers were counseled by RP management on the importance of following RP instructions.

During a routine tour, the inspector identified a contract operator inattentive to duty at the temporary reactor water cleanup (RWCU) filtration system (Section 6b). The operator, who was responsible for monitoring system performance, indicated to the inspector that he had been sleeping. Station management immediately revoked the individual's access to the RRA, initiated a Deviation Event Report (DER), and subsequently, identified no fitness for duty concerns. No operational concerns were identified regarding the temporary RWCU system as a result of the inattentive operator. Corrective actions included increasing walkdowns by RP technicians and operators and increasing the frequency of relief periods for affected workers.

No violations or deviations were identified

4. Contamination Control (IP 83750)

To date, thirteen personnel contamination events (PCEs), associated with recovery activities, have occurred. The inspector noted good housekeeping and control of contaminated areas during plant tours.

Several good initiatives were taken to control the spread of contamination. For example, during Radwaste Building basement (RWBB) activities (Sections 6a(1) and 6a(2)) drip trays were placed under each pipe connection to collect any leakage, and RP technicians (RPTs) aided workers in donning and removing protective clothing. Also, RPTs and operators were observed walking down hoses to check for leaks, and dikes were built (Sections 6a(2) and 6c) to limit the spread of possibly contaminated water. Workers were also observed using good contamination control practices during the RWBB decontamination (Section 6a(3)).

After pumping RWBB water to the condenser (Section 6a(2)), a maintenance worker informed licensee management that a minor leak had occurred (about 50 gallons) from the hotwell to the water box. Although the leak apparently occurred while pumping, management was not informed until after pumping was completed. The licensee investigated the report but found no indications of leakage. Samples from the water box and the downstream circulating water discharge pond did not detect any radioactive contamination aside from natural background radioactivity. At one of the meetings (Section 9), an inspector emphasized the importance of identifying concerns to station management on a timely basis.

No violations or deviations were identified.

5. Internal Dosimetry (IP 83750)

No intakes of radioactive materials have occurred to date, primarily through the licensee's conservative planning. Continuous air monitors (CAMs) were used throughout the RWBB water transfer and decontamination activities (Section 6a) and for the CST work (Section 6c). Breathing zone air samples were also taken by workers in the RWBB area for comparison with CAM results and to aid in future work planning. The licensee took quick and appropriate response to suspected intakes. For example, during hydrostatic testing of the CST (Section 6c), an RPT received facial contamination from leaking water. Although the water contained very low levels of contamination, an immediate whole body count (WBC) was performed of the individual which verified that no intake had occurred.

No violations or deviations were identified.

6. Water Management Items (IP 84750)

As described in IR No. 50-341/93029(DRS), the turbine-generator failure resulted in degraded reactor water quality and the inflow of lake water (from the circulating water system) into the condenser hotwell and CST. The accident also resulted in about 800,000 gallons of lake quality water and 17,000 gallons of turbine lubricating oil entering the Turbine Building basement (TBB). About 600,000 gallons of this oil/water mixture drained to the RWBB until it was flooded to a depth of about six feet, rendering the plant's liquid radwaste processing equipment inoperable.

Several temporary modifications were initiated to clean the reactor and CST water and restore the RWBB and TBB. Each of the modifications was reviewed by the NRC prior to implementation and are either discussed below or in IR No. 50-341/93029(DRS).

a. **Recovery of the RWBB and TBB:**

The recovery process constituted three stages: (1) oil removal; (2) transfer of water to the condenser hotwell; and (3) decontamination. Each of these stages is described below.

1. Oil Removal

Oil from the RWBB was removed via surface skimming under the supervision of an experienced contractor. The skimmed oil was stored in liners in the Onsite Storage Facility (OSSF). Because of the larger surface area in the TBB, surface skimming was not deemed practical. Instead, the TBB water was pumped through a filter to the condenser hotwell until oil was observed on the filter. The pumping was then stopped, and the remaining oil/water mixture was pumped into liners.

About 15,000 gallons of oil was removed and transferred to the OSSF. Because the OSSF SE only allowed for storage of about 7,000 gallons of oil, the oil was shipped to an offsite contractor for incineration. Each of these shipments was about 2,400 gallons and contained between 5E-4 to 1E-3 microcuries (μCi) (1.8E-2 to 3.7E-2 kiloBecquerels (kBq)) per milliliter (ml). An inspector reviewed the licensee's analyses for several shipments of contaminated oil and verified that the isotopic levels did not exceed the incinerator's limits.

The SE concerning oil removal used the methodology for postulated RWBB accidental releases contained in the updated final safety analysis report (UFSAR) (see IR No. 50-341/93029 (DRS)) to demonstrate that an accidental release to the lake would be below relevant NRC criteria. A routine quality assurance (QA) surveillance identified that activity contained in a planned oil shipment (1.04E-3 uCi (3.8E-2 kBq) per ml) exceeded the basis evaluated in the SE (4.3E-4 uCi (1.6E-2 kBq) per ml). As a corrective action, the licensee delayed the shipment and revised the SE to include a bounding calculation (about three times expected activity) to demonstrate compliance with NRC requirements. The inspector reviewed the QA finding and the corrective actions. No problems were identified.

2. <u>Transfer of water to the condenser hotwell</u>

Because of the large volume of water that resulted from the turbine-generator failure, the licensee chose to temporarily store it in the condenser hotwell. Hoses were routed from a hydraulically driven sump pump located in either the RWBB or TBB, through the TB, and into the condenser bay. The SE for the transfer was discussed in IR No. 50-341/93029(DRS).

During pumping, operations and RP personnel periodically checked hoses for leaks and performed dose rate measurements. Additionally, workers were stationed at the hotwell, pump, and condenser bay to monitor flow rate and detect possible leakage; these personnel maintained radio contact with the system engineer responsible for the activity.

About 600,000 gallons of water (average activity 5E-4 uCi (1.8E-2 kBq) per ml) were transferred from the RWBB into the hotwell. After pumping, about 14,000 gallons of water remained on the floor of the RWBB. An additional 12,000 gallons was drained to the floor from the FDCT (Section 3), raising the total volume to 26,000 gallons. The drainage of the FDCT was necessary to accommodate routine inflow (1000 gallons/day) from the reactor building floor drains. The 26,000 gallons was then pumped to a diked area in the TBB from where it and 279,000 gallons of water already in the TBB were pumped to the condenser hotwell.

3. <u>Decontamination of RWBB and TBB</u>

After pumping, contamination levels ranged from 3,000 - 500,000 disintegrations per minute (dpm) per 100 $cm^2$ (with occasional contact dose readings between 15 - 30 millirem (150 - 300 microSv) per hour) in the RWBB, and about 80,000 dpm/100 $cm^2$ in the TBB. Following hydrolazing and mopping, these levels were reduced to 500 - 18,000 dpm/100 $cm^2$ and 500 - 5000 dpm/100 $cm^2$, in the RWBB and TBB, respectively. About 2.1 person-rem (21 person-mSv) was accrued from RWBB and TBB decontamination activities. During plant tours, the inspectors noted significant progress towards recovery of flooded areas. Further decontamination progress will be reviewed in subsequent inspections.

b. **Performance of temporary RWCU system**

After the accident, reactor water conductivity increased to 185 microSiemens (uS)/cm, chloride concentration increased to 10,000 parts per billion (ppb), and pH increased to about 10, exceeding the Technical Specification shutdown limits of 10 uS/cm, 500 ppb, and 8.5, respectively. Because the RWCU system was unable to remove this level of contamination, temporary demineralizers were installed. These systems performed well, and current conductivity, chloride and pH levels were 9.0 uS/cm, 15.1 ppb, and 8.5, respectively.

The temporary system consisted of temporary fill and return lines connected between shielded filter units (located on the refuel floor and the first floor of the TB) and the RWCU system. Periodic surveys by RP personnel indicated average contact readings of 1-3 millirem (10-30 microSv) per hour on the temporary piping and 3-5 rem (30-50 mSv) and 10 rem (100 mSv) per hour (inside shielding) on the refuel floor and TB demineralizer units, respectively. These readings were verified by the inspector during routine walkdowns.

Contact (inside shielding) dose rates on the TB demineralizer unit rose from 2 to 10 rem (20 to 100 mSv) per hour following a crud burst from inadvertent RWCU system trips; the refuel floor filter was apparently unaffected. The high dose rate necessitated the changeout of the TB demineralizer, which produced an associated exposure of 0.025 person-rem (0.25 person-mSv). The inspector noted excellent ALARA controls (Section 3) and a professional attitude among workers, during the changeout.

No violations or deviations were identified.

7. <u>CST Cleanup and February 24 - 25, 1994, Discharge (IP 84750)</u>

Following the December 25, 1993, event, the CST contained about 530,000 gallons of slightly contaminated water. Because of the need to process more seriously contaminated water, the licensee decided to clean the CST water to a pre-decided activity and discharge it to the lake. The cleanup and discharge activities were reviewed against relevant NRC criteria and are discussed below:

a. **Cleanup of CST Water Through Temporary Demineralizers**

The CST water was processed through several portable demineralizer vessels (vendor supplied) designed to provide filtration and ion exchange. This equipment was housed inside a trailer adjacent to the CST. A hydraulically driven pump inside the CST provided flow (about 400 gallons per minute (gpm)) through the vessels and back to the CST. A liner was located adjacent to the trailer for sluicing spent resins as needed.

The vessels met American Society of Mechanical Engineers (ASME) code Section VIII specifications, and all hoses, piping and valves were hydrostatically tested at 125% of operating pressure (100 psi). The trailer was heated, and outside components were heat traced to prevent freezing. Leak prevention measures included locating all valves and fittings inside diked areas, sleeving hoses between diked areas in PVC piping, and temporarily sealing nearby storm drains. Administrative controls were also established. An NRC inspector reviewed these controls and verified the system setup; no problems were identified.

The licensee periodically sampled the CST to monitor the cleanup. An inspector questioned the length of the licensee's analysis times based on the very low activity of the CST and precision of the measurement. The licensee and an inspector reviewed the minimum detectable activities (MDAs) at the current analysis times, which met required MDAs specified in the licensee's Offsite Dose Calculation Manual. The licensee chose to extend those times to achieve better precision and further improve the MDAs.

On February 16, 1994, at about 7:22 p.m. (EST), the amount of radioactive material (such as cesium (Cs)-134 and Cs-137) had been reduced to the desired level and the licensee placed the CST into a recirculation mode to ensure proper mixing prior to discharge. The licensee estimated that 20 hours of recirculation at a flowrate of 800 gpm would effectively displace 2 full tank volumes of water. After mixing, two independent samples were to be analyzed to verify tank homogeneity and activity. One of these samples was to be split between the NRC and the licensee to provide independent verification of the licensee's analysis and offsite dose calculations.

In a February 17, 1994, meeting with local officials of the City of Monroe, Frenchtown Charter Township, and County of Monroe, the licensee agreed to postpone the discharge until at least 12:01 a.m. Thursday, February 24, 1994. This delay allowed the officials to find an additional independent scientific expert (ISE) to evaluate the licensee's measurements and calculations (Section 7b). A subsequent public meeting was scheduled for Wednesday, February 23, 1994, to discuss the results and address public concerns (Section 7c). In the interim, the licensee returned the CST to the cleanup mode to further reduce the level of contamination.

b. **Independent Analyses of CST Activity**

The licensee obtained a sample from the CST on February 21, 1994, under observation by the NRC resident inspector and the ISE. The sample, obtained via the normal CST sampling equipment, was split between the NRC and the State of Michigan Department of Health for gamma isotopic analysis. The NRC and licensee results are presented in Table 1, with the criteria for comparison in Attachment 1. The licensee's results were in good agreement with the NRC's results, as well as the State of Michigan's results.

The NRC performed an offsite dose calculation based on the analytical results and the estimated discharge volume of about 500,000 gallons. These dose calculations were based on the modeling and parameters for liquid effluents described in Regulatory Guide 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents For The Purposes of Evaluating Compliance With 10 CFR 50, Appendix I," and included both fish and drinking water ingestion pathways. The NRC calculations projected a maximum, individual offsite whole body exposure of about 0.02 mrem (0.2 micro Sieverts (uSv)) and a maximum organ dose of about 0.03 mrem (0.3 uSv) to the liver. These doses were significantly below the appropriate federal annual limit of 100 mrem (1 mSv) total effective dose equivalent to a member of the public (10 CFR 20.1301(a)(1)) and the more restrictive licensee Technical Specification annual limit of 3 mrem (30 uSv), based on 10 CFR 50, Appendix I.

c. **Public Informational Meeting**

An informational meeting was held at 7:30 p.m. (EST) on February 23, 1994, at the Cantrick Junior High School in Monroe, Michigan. During the meeting, information was presented by Mr. Douglas Gipson, Senior Vice President, Detroit Edison; Dr. Ronald Flemming, University of Michigan (ISE); Dr. David J. Lieberman, Director, Monroe County Health Department; Michigan Department of Public Health; Michigan Department of Natural Resources; Mr. Wilfred LePage, City of Monroe Water Treatment Superintendent; and Mr. William L. Axelson, Director, Division of Radiation Safety and Safeguards, US NRC Region III.

Dr. Flemming described the February 21, 1994, CST sample analysis and indicated that sampling and analyses were properly performed by the licensee. He further described the fundamentals of the gamma isotopic analyses, the low levels of radioactive contamination in the CST water, and the methods of dose modeling.

Mr. Axelson, US NRC Region III, explained the NRC results and dose calculations, stated the federal limits for offsite exposure and effluents from nuclear power facilities, and compared the NRC calculated doses (Section 7b) from the planned CST release to those limits.

The licensee, local officials, and NRC representative answered a number of questions from the audience related to the release and the December 25, 1993, turbine-generator event. Following the question and answer session, the local officials released a joint statement which indicated their satisfaction with the results of the analyses and meeting.

d. **Discharge of CST Water to the Lake**

The discharge pathway consisted of diverting flow from the CST pump, through temporary carbon steel piping, to a filtration unit located in the Auxiliary Boiler House (ABH). Downstream of the filter (inside the ABH), a manually operated isolation valve, offline radiation monitor, and ultrasonic flow meter were installed. The flow was then routed to the neutralization tank waste water discharge line, which was a discharge pathway addressed in the UFSAR.

The discharge controls were similar to those implemented during the cleanup phase. The temporary piping was hydrostatically tested prior to use, and nearby drains in the ABH (excepting those vital to AB operation) were plugged. Freeze protection of exposed hose was accomplished by maintaining a continuous flow of general service water when not discharging. These actions were also addressed by administrative controls. The licensee's ODCM, was revised to allow use of the CST as a batch release tank. The revision implemented controls similar to those for waste sample tank releases, an already existing release pathway. These controls were reviewed by the inspectors with no problems identified.

The licensee sampled the CST (under NRC observation) prior to discharge at 12:52 p.m. (EST) on February 24, 1994, and provided an aliquot of this sample to the NRC for confirmatory analysis and dose calculations. The licensee's analytical results were in good agreement with NRC results (Table 1). As shown in Table 2, the concentration of radioactive materials in the CST was below the limits of 10 CFR 20.1302(b)(2)(i), and the total activity was less than 1 curie (37 gigaBecquerels). The associated dose calculations were consistent with earlier results (Section 7c) and are presented in Table 3. The estimated maximum, individual doses of 0.02 mrem (0.2 uSv) to the whole body and 0.03 mrem (0.3 uSv) to the liver were well below applicable federal limits.

The licensee proceeded to discharge the CST contents (about 480,500 gallons) over a 24-hour period starting at 7:21 p.m. (EST) on February 24, 1994. The NRC inspectors provided continuous coverage of the evolution and analyzed additional CST samples (Table 4). The NRC results indicated that the CST was properly mixed and that no stratification of radioactive material had occurred. The licensee calculated the expected radiation monitor readings and flow rate readings and provided direction to operators if indications were outside of acceptance bands. Licensee oversight and monitoring appeared very good throughout the discharge.

During the discharge, the licensee detected one leaking flange in temporary piping within the neutralization tank. The licensee monitored this flange closely and readily contained the leakage. This flange was resealed prior to the second release.

e. **Environmental Monitoring**

The NRC provided added assurance of the safety of the local water supply via sampling at the Fermi 2 decant line and at the Monroe Water Intake structure. The NRC sample results (Tables 4, 5, and 6) identified only naturally occurring radioactivity (such as potassium-40) at the two locations, with no detectable radioactivity attributable to the operation of the Fermi 2 Nuclear Facility nor to the discharge of the CST.

No violations or deviations were identified.

8. CST Cleanup and the March 15 - 16, 1994, Discharge (IP 84750)

Following the February 24 - 25, 1994, CST discharge, the contents of the condenser hotwell (i.e., water originally moved from the RWBB (Section 6a)) was transferred to the CST for processing. The processing occurred as described in Section 7. Discharging of the CST contents (about 523,000 gallons) commenced at 8:15 p.m. (EST) on March 15, 1994, and continued for about 24 hours. The controls described in Section 7d were employed throughout the evolution. The total activity discharged was about 667 mCi (24.7 gigaBecquerels).

The NRC performed similar independent CST analyses prior to and during discharge. Again, the samples were collected by the licensee under NRC observation, prior to analysis in the Region III laboratory. As before, the NRC's recirculation and discharge sample results were consistent (Table 7), with no evidence of stratification within the CST. The pre-discharge sample comparison between the licensee and NRC results are summarized in Table 1 and the associated comparison criteria in Attachment 1. These results were also in good agreement.

Confirmatory dose calculations (described in Section 7) for the release were comparable to those for the February 24 - 25, 1994, discharge and again verified that the limits of 10 CFR 20 and 10 CFR 50, Appendix I were not exceeded (Tables 8 and 9).

A subsequent discharge (expected in April 1994) will be discussed in a future inspection report.

No violations or deviations were identified.

9. <u>Exit Meeting</u>

Exit meetings were held with licensee representatives (Section 1) on January 28 and February 28, 1994. No information was identified as proprietary. Overall, recovery actions (sections 6, 7, and 8) were good with strong management involvement (Section 2). Radiological performance (Sections 3 - 5) was also good given the work scope. Specific items addressed during the meeting included:

- Communication weakness (Section 4)
- Operator found inattentive in RRA (Section 3)
- QA finding concerning oil skimming SE (Section 6a(1))
- Adherence to RP instructions (Section 3)
- CST Discharge, including NRC sampling results (Section 7)

In addition, NRC representatives discussed with the licensee the analyses of the March 15 - 16, 1994, CST discharge.

Enclosures:
1. Attachment 1, Criteria for Comparing Analytical Measurements
2. Table 1, Fermi 2 Nuclear Station Confirmatory Measurements
3. Table 2, Fermi 2 CST Discharge Activity Calculation, (February 24 - 25 discharge)
4. Table 3, Fermi 2 CST Discharge, Summary of NRC Dose Calculations (February 24-25 discharge)
5. Table 4, Fermi 2 Nuclear Station, Decant Line Sample Point Isotopic Results (February 24-25 discharge)
6. Table 5, Monroe Public Water Intake Structure Isotopic Results (February 24-25 discharge)
7. Table 6, Minimum Detectable Activity (for environmental analyses summarized in Tables 4 and 5)
8. Table 7, Fermi 2 Nuclear Station, Condensate Storage Tank Isotopic Results (March 15-16 discharge)
9. Table 8, Fermi 2 CST Discharge Activity Calculation (March 15-16 discharge)
10. Table 9, Fermi 2 CST Discharge, Summary of NRC Dose Calculations (March 15-16 discharge)

## ATTACHMENT 1

## CRITERIA FOR COMPARING ANALYTICAL MEASUREMENTS

This attachment provides agreement criteria for comparing results of verification measurements. The Criteria result from professional judgment based on prior experience.

In these Criteria, the acceptance limits are variable and depend upon the ratio of the NRC's measurement to its associated uncertainty. As this ratio, termed resolution, increases, the acceptance criteria for the licensee's measurements become more restrictive. Conversely, more liberal acceptance criteria are considered acceptable as the resolution decreases.

| RESOLUTION | ACCEPTANCE CRITERIA (Ratio) |
|---|---|
| < 4 | NO COMPARISON |
| 4 - 7 | 0.5 - 2.0 |
| 8 - 15 | 0.6 - 1.66 |
| 16 - 50 | 0.75 - 1.33 |
| 51 - 200 | 0.80 - 1.25 |
| > 200 | 0.85 - 1.18 |

Some discrepancies may result from the use of different equipment, techniques, and for some specific nuclides. These may be factored into the acceptance criteria and identified on the data sheet.

Table 1

Fermi 2 Nuclear Station
Confirmatory Measurements

| SAMPLE | NUCLIDE | NRC VAL.[1] | NRC ERR.[1] | LIC.VAL.[1] | LIC.ERR.[1] | RATIO[2] | RES[3] | RESULT |
|---|---|---|---|---|---|---|---|---|
| | | | | **Split Sample Between NRC, Licensee, and State of Michigan** | | | | |
| CST | Cr-51 | 3.08E-07 | 1.28E-07 | 6.10E-07 | 1.80E-07 | 1.98 | 2.4 | No Comparison |
| TANK | Sb-125 | 9.13E-08 | 2.85E-08 | 1.20E-07 | 4.70E-08 | 1.31 | 3.2 | No Comparison |
| | Co-58 | 8.74E-08 | 1.93E-08 | 1.00E-07 | 2.20E-08 | 1.14 | 4.5 | Agreement |
| 2/21/94 | Co-60 | 5.06E-07 | 3.73E-08 | 5.20E-07 | 5.00E-08 | 1.03 | 13.6 | Agreement |
| | I-131 | 6.65E-08 | 2.16E-08 | 6.00E-08 | 1.40E-08 | 0.90 | 3.1 | No Comparison |
| | Cs-134 | 1.30E-07 | 2.49E-08 | 1.50E-07 | 3.20E-08 | 1.15 | 5.2 | Agreement |
| | Cs-137 | 1.00E-07 | 2.33E-08 | 6.70E-08 | 3.20E-08 | 0.67 | 4.3 | Agreement |
| | | | | **Split Sample Between NRC and Licensee Prior to February 24-25 Discharge** | | | | |
| CST | Cr-51 | 2.76E-07 | 9.24E-08 | 2.89E-07 | 1.20E-07 | 1.05 | 3.0 | No Comparison |
| PRE- | Co-58 | 6.47E-08 | 1.29E-08 | < MDA[4] | | | 5.0 | No Comparison |
| DISCH | Co-60 | 4.26E-07 | 2.36E-08 | 5.06E-07 | 4.45E-08 | 1.19 | 18.0 | Agreement |
| 2/24/94 | I-131 | 3.02E-08 | 1.08E-08 | 7.30E-08 | 2.01E-08 | 2.42 | 2.8 | No Comparison |
| 1252 HRS | Cs-134 | 1.47E-07 | 1.69E-08 | 1.64E-07 | 3.53E-07 | 1.12 | 8.7 | Agreement |
| | Cs-137 | 1.68E-07 | 1.69E-08 | 1.11E-07 | 3.00E-08 | 0.66 | 10.0 | Agreement |
| | | | | **Split Samples Between NRC and Licensee During February 24-25 Discharge** | | | | |
| CST | Cr-51 | 3.73E-07 | 8.89E-08 | 2.63E-07 | 1.43E-07 | 0.71 | 4.2 | Agreement |
| TANK | Co-58 | 6.48E-08 | 1.09E-08 | 8.14E-08 | 3.13E-08 | 1.26 | 6.0 | Agreement |
| 2/24/94 | Co-60 | 4.73E-07 | 2.86E-08 | 5.10E-07 | 4.65E-08 | 1.08 | 16.5 | Agreement |
| 2327 HRS | I-131 | 2.15E-08 | 8.93E-09 | < MDA | | | 2.4 | No Comparison |
| | Cs-134 | 1.44E-07 | 1.72E-08 | 2.02E-07 | 3.47E-08 | 1.41 | 8.4 | Agreement |
| | Cs-137 | 1.84E-07 | 1.55E-08 | 1.89E-07 | 2.71E-08 | 1.03 | 11.9 | Agreement |
| CST | Cr-51 | 3.30E-07 | 8.96E-08 | 3.77E-07 | 1.48E-07 | 1.14 | 3.7 | No Comparison |
| TANK | Co-58 | 6.57E-08 | 1.27E-08 | < MDA | | | 5.2 | No Comparison |
| 2/25/94 | Co-60 | 4.92E-07 | 2.56E-08 | 4.93E-07 | 4.58E-08 | 1.00 | 19.2 | Agreement |
| 0730 HRS | I-131 | 3.64E-08 | 1.39E-08 | 3.77E-08 | 1.94E-08 | 1.03 | 2.6 | No Comparison |
| | Cs-134 | 1.71E-07 | 1.73E-08 | 1.92E-07 | 3.58E-08 | 1.12 | 9.9 | Agreement |
| | Cs-137 | 1.69E-07 | 1.67E-08 | 1.41E-07 | 3.24E-08 | 0.84 | 10.1 | Agreement |
| CST | Cr-51 | 3.17E-07 | 9.35E-08 | 4.17E-07 | 1.16E-07 | 1.32 | 3.4 | No Comparison |
| TANK | Co-58 | 5.90E-08 | 1.47E-08 | 8.47E-08 | 1.83E-08 | 1.43 | 4.0 | Agreement |
| 2/25/94 | Co-60 | 3.91E-07 | 2.79E-08 | 5.04E-07 | 5.78E-08 | 1.29 | 14.0 | Agreement |
| 1130 HRS | I-131 | 5.71E-08 | 1.21E-08 | < MDA | | | 4.7 | No Comparison |
| | Cs-134 | 1.56E-07 | 1.92E-08 | 1.89E-07 | 2.88E-08 | 1.21 | 8.1 | Agreement |
| | Cs-137 | 1.47E-07 | 2.43E-08 | 1.95E-07 | 3.54E-08 | 1.32 | 6.1 | Agreement |

Table 1 (cont.)

| SAMPLE | NUCLIDE | NRC VAL.[1] | NRC ERR.[1] | LIC.VAL.[1] | LIC.ERR.[1] | RATIO[2] | RES[3] | RESULT |
|---|---|---|---|---|---|---|---|---|
| **Split Sample Between NRC and Licensee Prior to March 15-16 Discharge** | | | | | | | | |
| CST | Mn-54 | 1.10E-07 | 2.53E-08 | 1.64E-07 | 3.68E-08 | 1.50 | 4.3 | Agreement |
| TANK | Co-58 | 9.04E-08 | 2.26E-08 | 1.26E-07 | 4.30E-08 | 1.40 | 4.0 | Agreement |
| 3/15/94 | Co-60 | 6.69E-07 | 4.58E-08 | 8.11E-07 | 6.02E-08 | 1.21 | 14.6 | Agreement |
| 0740 HRS | Zn-65 | 1.67E-07 | 5.59E-08 | < MDA | | | 3.0 | No Comparison |
| | Sb-125 | 2.16E-07 | 6.95E-08 | 3.88E-07 | 7.81E-08 | 1.79 | 3.1 | No Comparison |
| | I-131 | 2.85E-08 | 1.72E-07 | < MDA | | | 0.2 | No Comparison |
| | Cs-134 | 2.76E-07 | 2.62E-08 | 2.73E-07 | 4.36E-08 | 0.99 | 10.5 | Agreement |
| | Cs-137 | 2.33E-07 | 2.76E-08 | 2.27E-07 | 3.91E-08 | 0.98 | 8.4 | Agreement |

[1] These quantities are in the units of microcurie per milliliter.

[2] Ratio = Licensee Value / NRC Value

[3] Resolution = NRC Value / NRC Error (one standard deviation)

[4] MDA = Minimum Detectable Activity

Table 2

Fermi 2 CST Discharge Activity Calculation
(February 24-25 Discharge)

Date of analysis: Average of February 24 - 25, 1994

Volume(gallons)= 480528
(liters)= 1.819E+06

Flow Rates: (gallons per minute)
Dilution = 15500
CST discharge= 380

| Nuclide | EC[1] uCi/ml | Conc.[2] uCi/ml | Conc./EC[3] | Activity (mCi) |
|---|---|---|---|---|
| Cr-51 | 5.000E-04 | 3.240E-07 | 1.551E-05 | 5.894E-01 |
| Co-58 | 2.000E-05 | 6.355E-08 | 7.604E-05 | 1.156E-01 |
| Co-60 | 3.000E-06 | 4.455E-07 | 3.554E-03 | 8.104E-01 |
| I-131 | 1.000E-06 | 3.630E-08 | 8.686E-04 | 6.603E-02 |
| Cs-134 | 9.000E-07 | 1.545E-07 | 4.108E-03 | 2.810E-01 |
| Cs-137 | 1.000E-06 | 1.670E-07 | 3.996E-03 | 3.038E-01 |
| Sr-89 | 8.000E-06 | 1.200E-06 | 3.589E-03 | 2.183E+00 |
| H-3 | 1.000E-03 | 4.800E-04 | 1.149E-02 | 8.731E+02 |
| Totals[4] | | 4.824E-04 | | 8.775E+02 |
| (w/Dilution)[5] | | 1.154E-05 | 2.769E-02 | |

[1] Effluent concentrations for release to unrestricted areas as listed in 10 CFR 20, Appendix B, Table 2, Column 2.

[2] Result of gamma isotopic analysis of Condensate Storage Tank performed in NRC Mobile Laboratory. Gross beta activity is assigned to strontium-89. Tritium and gross beta were analyzed in the Region III laboratory.

[3] Fraction of 10 CFR 20 effluent concentrations. This fraction is calculated as the concentration of effluent as it enters the lake, including the dilution flow.

[4] Total, undiluted activity from condensate storage tank.

[5] Totals with dilution credit from recirculation water.

Table 3

Fermi 2 CST Discharge
(February 24-25 Discharge)

Summary of NRC Dose Calculations

ANNUAL ADULT TOTAL DOSE RECEIVED PER ORGAN
(mrem)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli[1] |
|---|---|---|---|---|---|---|---|
| Cr-51 | | | 1.42E-07 | 8.4[illegible]E-08 | 3.12E-08 | 1.88E-07 | 3.56E-05 |
| Co-58 | | 1.37E-06 | 3.07E-06 | | | | 2.78E-05 |
| Co-60 | | 2.59E-05 | 5.72E-05 | | | | 4.87E-04 |
| I-131 | 6.60E-07 | 9.45E-07 | 5.41E-07 | 3.10E-04 | 1.62E-06 | | 2.49E-07 |
| Cs-134 | 5.82E-03 | 1.38E-02 | 1.13E-02 | | 4.48E-03 | 1.49E-03 | 2.42E-04 |
| Cs-137 | 8.54E-03 | 1.17E-02 | 7.65E-03 | | 3.96E-03 | 1.32E-03 | 2.26E-04 |
| Sr-89 | 2.85E-03 | | 8.18E-05 | | | | 4.57E-04 |
| H-3 | | 4.84E-05 | 4.84E-05 | 4.84E-05 | 4.84E-05 | 4.84E-05 | 4.84E-05 |
| TOTALS | 1.72E-02 | 2.56E-02 | 1.92E-02 | 3.58E-04 | 8.50E-03 | 2.85E-03 | 1.53E-03 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

ANNUAL TEEN TOTAL DOSE RECEIVED PER ORGAN
(mrem)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli[1] |
|---|---|---|---|---|---|---|---|
| Cr-51 | | | 1.46E-07 | 8.09E-08 | 3.19E-08 | 2.08E-07 | 2.45E-05 |
| Co-58 | | 1.36E-06 | 3.13E-06 | | | | 1.87E-05 |
| Co-60 | | 2.59E-05 | 5.83E-05 | | | | 3.37E-04 |
| I-131 | 7.00E-07 | 9.80E-07 | 5.27E-07 | 2.86E-04 | 1.69E-06 | | 1.94E-07 |
| Cs-134 | 5.96E-03 | 1.40E-02 | 6.51E-03 | | 4.46E-03 | 1.70E-03 | 1.75E-04 |
| Cs-137 | 9.14E-03 | 1.22E-02 | 4.24E-03 | | 4.14E-03 | 1.61E-03 | 1.73E-04 |
| Sr-89 | 3.09E-03 | | 8.85E-05 | | | | 3.68E-04 |
| H-3 | | 3.51E-05 | 3.51E-05 | 3.51E-05 | 3.51E-05 | 3.51E-05 | 3.51E-05 |
| TOTALS | 1.82E-02 | 2.63E-02 | 1.09E-02 | 3.21E-04 | 8.64E-03 | 3.35E-03 | 1.13E-03 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

Table 3 (cont)

ANNUAL CHILD TOTAL DOSE RECEIVED PER ORGAN
(mrem)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli[1] |
|---|---|---|---|---|---|---|---|
| Cr-51 | | | 1.60E-07 | 8.88E-08 | 2.43E-08 | 1.62E-07 | 8.48E-06 |
| Co-58 | | 1.13E-06 | 3.47E-06 | | | | 6.62E-06 |
| Co-60 | | 2.20E-05 | 6.47E-05 | | | | 1.22E-04 |
| I-131 | 1.02E-06 | 1.03E-06 | 5.85E-07 | 3.40E-04 | 1.69E-06 | | 9.16E-08 |
| Cs-134 | 7.23E-03 | 1.19E-02 | 2.50E-03 | | 3.68E-03 | 1.32E-03 | 6.39E-05 |
| Cs-137 | 1.16E-02 | 1.11E-02 | 1.63E-03 | | 3.61E-03 | 1.30E-03 | 6.93E-05 |
| Sr-89 | 4.26E-03 | | 1.22E-04 | | | | 1.65E-04 |
| H-3 | | 5.40E-05 | 5.40E-05 | 5.40E-05 | 5.40E-05 | 5.40E-05 | 5.40E-05 |
| TOTALS | 2.31E-02 | 2.30E-02 | 4.38E-03 | 3.94E-04 | 7.34E-03 | 2.67E-03 | 4.89E-04 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

ANNUAL TOTAL DOSE SUMMARY REPORT

| Group | Organ | Total(mrem) |
|---|---|---|
| Adult | Bone | 1.72E-02 |
| Adult | Liver | 2.56E-02 |
| Adult | Tot Body | 1.92E-02 |
| Adult | Thyroid | 3.58E-04 |
| Adult | Kidney | 8.50E-03 |
| Adult | Lung | 2.85E-03 |
| Adult | Gi-Lli | 1.53E-03 |
| Teen | Bone | 1.82E-02 |
| Teen | Liver | 2.63E-02 |
| Teen | Tot Body | 1.09E-02 |
| Teen | Thyroid | 3.21E-04 |
| Teen | Kidney | 8.64E-03 |
| Teen | Lung | 3.35E-03 |
| Teen | Gi-Lli | 1.13E-03 |
| Child | Bone | 2.31E-02 |
| Child | Liver | 2.30E-02 |
| Child | Tot Body | 4.38E-03 |
| Child | Thyroid | 3.94E-04 |
| Child | Kidney | 7.34E-03 |
| Child | Lung | 2.67E-03 |
| Child | Gi-Lli | 4.89E-04 |

[1] Gi-Lli: Gastro-intestinal tract, including the lower large intestine.

Table 4

Fermi 2 Nuclear Station
Decant Line Sample Point Isotopic Results
(February 24-25 Discharge)

| Nuclide | 2/24/94 1340 hrs (uCi/ml)[1] | 2/25/94 2230 hrs (uCi/ml) | 2/25/94 0610 hrs (uCi/ml) | 2/25/94 1400 hrs (uCi/ml) | 2/26/94 1205 hrs (uCi/ml) |
|---|---|---|---|---|---|
| K-40 | 1.480E-06 | 2.291-06 | 2.325E-06 | 1.992E-06 | 1.667E-06 |
| Cr-51 | < MDA[2] | < MDA | < MDA | < MDA | < MDA |
| Co-58 | < MDA | < MDA | < MDA | < MDA | < MDA |
| Co-60 | < MDA | < MDA | < MDA | < MDA | < MDA |
| I-131 | < MDA | < MDA | < MDA | < MDA | < MDA |
| Cs-134 | < MDA | < MDA | < MDA | < MDA | < MDA |
| Cs-137 | < MDA | < MDA | < MDA | < MDA | < MDA |

[1] uCi/ml = microcuries per milliliter. 1 uCi/ml = 37 kiloBecquerels per milliliter.

[2] MDA = Minimum Detectable Activity. This is defined as the product of 4.66 and the one standard deviation error of the background count.

Table 5
Monroe Public Water Intake Structure Isotopic Results
(February 24-25 Discharge)

| Nuclide | 2/24/94 1830 hrs (uCi/ml)[1] | 2/25/94 0125 hrs (uCi/ml) | 2/25/94 0710 hrs (uCi/ml) | 2/25/94 1325 hrs (uCi/ml) |
|---|---|---|---|---|
| K-40 | 2.184E-06 | 1.890E-06 | 2.161E-06 | 2.044E-06 |
| Cr-51 | < MDA[2] | < MDA | < MDA | < MDA |
| Co-58 | < MDA | < MDA | < MDA | < MDA |
| Co-60 | < MDA | < MDA | < MDA | < MDA |
| I-131 | < MDA | < MDA | < MDA | < MDA |
| Cs-134 | < MDA | < MDA | < MDA | < MDA |
| Cs-137 | < MDA | < MDA | < MDA | < MDA |

| Nuclide | 2/25/94 1930 hrs (uCi/ml) | 2/26/94 0330 hrs (uCi/ml) | 2/26/94 1140 hrs (uCi/ml) | 2/26/94 1830 hrs (uCi/ml) |
|---|---|---|---|---|
| K-40 | 2.150E-06 | 1.810E-06 | 1.926E-06 | 2.022E-06 |
| Cr-51 | < MDA | < MDA | < MDA | < MDA |
| Co-58 | < MDA | < MDA | < MDA | < MDA |
| Co-60 | < MDA | < MDA | < MDA | < MDA |
| I-131 | < MDA | < MDA | < MDA | < MDA |
| Cs-134 | < MDA | < MDA | < MDA | < MDA |
| Cs-137 | < MDA | < MDA | < MDA | < MDA |

| Nuclide | 2/27/94 0325 hrs (uCi/ml) | 2/27/94 1130 hrs (uCi/ml) | 2/27/94 1930 hrs (uCi/ml) |
|---|---|---|---|
| K-40 | 2.004E-06 | 1.706E-06 | 2.364E-06 |
| Cr-51 | < MDA | < MDA | < MDA |
| Co-58 | < MDA | < MDA | < MDA |
| Co-60 | < MDA | < MDA | < MDA |
| I-131 | < MDA | < MDA | < MDA |
| Cs-134 | < MDA | < MDA | < MDA |
| Cs-137 | < MDA | < MDA | < MDA |

[1] uCi/ml = microcuries per milliliter. 1 uCi/ml = 37 kiloBecquerels per milliliter.

[2] MDA = Minimum Detectable Activity. This is defined as the product of 4.66 and the one standard deviation error of the background count.

Table 6

Minimum Detectable Activity[1]
(for enviromental analyses summarized in Tables 4 and 5)

| Nuclide | Activity (uCi/ml)[2] | Activity (Bq/ml)[3] |
|---|---|---|
| Cr-51 | 1.5E-07 | 5.6E-03 |
| Co-58 | 2.2E-08 | 8.1E-04 |
| Co-60 | 3.5E-08 | 1.3E-03 |
| I-131 | 1.8E-08 | 6.7E-04 |
| Cs-134 | 1.8E-08 | 6.7E-04 |
| Cs-137 | 2.8E-08 | 1.0E-03 |

[1] Minimum Detectable Activity: This is defined as the product of 4.66 and the one standard deviation error of the background count (applicable for Tables 6 and 7).

[2] uCi/ml = microcuries per milliliter

[3] Bq/ml = Becquerels per milliliter

Table 7

Fermi 2 Nuclear Station
Condensate Storage Tank Isotopic Results
(March 15-16 Discharge)

| Nuclide | 3/14/94 1711 hrs (uCi/ml)[1] | 3/15/94 0740 hrs (uCi/ml) | 3/16/94 0805 hrs (uCi/ml) |
|---|---|---|---|
| Mn-54 | 1.586E-07 | 1.096E-07 | 1.215E-07 |
| Co-58 | 9.055E-08 | 9.044E-08 | 9.284E-08 |
| Co-60 | 7.515E-07 | 6.687E-07 | 6.704E-07 |
| Zn-65 | < MDA[2] | 1.670E-07 | 1.520E-07 |
| Sb-125 | 3.351E-07 | 2.162E-07 | 2.059E-07 |
| I-131 | < MDA | 2.849E-08 | < MDA |
| Cs-134 | 1.578E-07 | 2.756E-07 | 2.513E-07 |
| Cs-137 | 1.962E-07 | 2.328E-07 | 1.745E-07 |

[1] uCi/ml = microcuries per milliliter. 1 uCi/ml = 37 kiloBecquerels per milliliter.

[2] MDA(Minimum Detectable Activity) = the product of 4.66 and the one standard deviation error of the background count.

Table 8

Fermi 2 CST Discharge Activity Calculation
(March 15-16 Discharge)

Date of analysis: March 15, 1994

Volume(gallons) = 522850
(liters)= 1.979E+06

Flow Rates: (gallons per minute)
Dilution = 16800
CST discharge= 380

| Nuclide | EC[1] uCi/ml | Conc.[2] uCi/ml | Conc./EC[3] | Activity (mCi) |
|---|---|---|---|---|
| Mn-54 | 3.000E-05 | 1.096E-07 | 8.496E-05 | 2.169E-01 |
| Co-58 | 2.000E-05 | 9.044E-08 | 1.052E-04 | 1.790E-01 |
| Co-60 | 3.000E-06 | 6.687E-07 | 5.184E-03 | 1.323E+00 |
| Zn-65 | 5.000E-06 | 1.670E-07 | 7.767E-04 | 3.305E-01 |
| I-131 | 1.000E-06 | 2.849E-08 | 6.626E-04 | 5.639E-02 |
| Sb-125 | 3.000E-05 | 2.162E-07 | 1.676E-04 | 4.279E-01 |
| Cs-134 | 9.000E-07 | 2.756E-07 | 7.121E-03 | 5.455E-01 |
| Cs-137 | 1.000E-06 | 2.328E-07 | 5.414E-03 | 4.608E-01 |
| H-3 | 1.000E-03 | 3.350E-04 | 7.791E-03 | 6.630E+02 |
| | | | | |
| Totals[4] | | 3.368E-04 | | 6.666E+02 |
| (w/Dilution)[5] | | 7.832E-06 | 2.731E-02 | |

[1] Effluent concentrations for release to unrestricted areas as listed in 10 CFR 20, Appendix B, Table 2, Column 2.

[2] Result of gamma isotopic and tritium analyses of Condensate Storage Tank performed in NRC Region III Laboratory.

[3] Fraction of 10 CFR 20 effluent concentrations. This fraction is calculated as the concentration of effluent as it enters the lake, including the dilution flow.

[4] Total, undiluted activity from condensate storage tank.

[5] Totals with dilution credit from recirculation water.

Table 9

Fermi 2 CST Discharge
(March 15-16 Discharge)

Summary of NRC Dose Calculations

ANNUAL ADULT TOTAL DOSE RECEIVED PER ORGAN
(MREM)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli[1] |
|---|---|---|---|---|---|---|---|
| Mn-54 | | 5.29E-05 | 1.01E-05 | | 1.57E-05 | | 1.62E-04 |
| Co-58 | | 9.25E-07 | 2.07E-06 | | | | 1.87E-05 |
| Co-60 | | 1.96E-05 | 4.33E-05 | | | | 3.69E-04 |
| Zn-65 | 4.25E-04 | 1.35E-03 | 6.11E-04 | | 9.05E-04 | | 8.52E-04 |
| I-131 | 5.37E-07 | 7.68E-07 | 4.40E-07 | 2.52E-04 | 1.32E-06 | | 2.03E-07 |
| Cs-134 | 9.02E-03 | 2.15E-02 | 1.75E-02 | | 6.94E-03 | 2.30E-03 | 3.75E-04 |
| Cs-137 | 9.76E-03 | 1.33E-02 | 8.74E-03 | | 4.53E-03 | 1.51E-03 | 2.58E-04 |
| H-3 | | 2.87E-05 | 2.87E-05 | 2.87E-05 | 2.87E-05 | 2.87E-05 | 2.87E-05 |
| TOTALS | 1.92E-02 | 3.63E-02 | 2.70E-02 | 2.81E-04 | 1.24E-02 | 3.84E-03 | 2.06E-03 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

ANNUAL TEEN TOTAL DOSE RECEIVED PER ORGAN
(MREM)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |
|---|---|---|---|---|---|---|---|
| Mn-54 | | 5.20E-05 | 1.03E-05 | | 1.55E-05 | | 1.07E-04 |
| Co-58 | | 9.16E-07 | 2.11E-06 | | | | 1.26E-05 |
| Co-60 | | 1.96E-05 | 4.41E-05 | | | | 2.55E-04 |
| Zn-65 | 3.85E-04 | 1.34E-03 | 6.24E-04 | | 8.56E-04 | | 5.67E-04 |
| I-131 | 5.69E-07 | 7.97E-07 | 4.28E-07 | 2.33E-04 | 1.37E-06 | | 1.58E-07 |
| Cs-134 | 9.24E-03 | 2.18E-02 | 1.01E-02 | | 6.91E-03 | 2.64E-03 | 2.71E-04 |
| Cs-137 | 1.04E-02 | 1.39E-02 | 4.84E-03 | | 4.73E-03 | 1.84E-03 | 1.98E-04 |
| H-3 | | 2.08E-05 | 2.08E-05 | 2.08E-05 | 2.08E-05 | 2.08E-05 | 2.08E-05 |
| TOTALS | 2.01E-02 | 3.71E-02 | 1.56E-02 | 2.53E-04 | 1.25E-02 | 4.50E-03 | 1.43E-03 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

Table 9 (cont.)

ANNUAL CHILD TOTAL DOSE RECEIVED PER ORGAN
(MREM)

| Nuclide | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |
|---|---|---|---|---|---|---|---|
| Mn-54 | | 4.10E-05 | 1.09E-05 | | 1.15E-05 | | 3.44E-05 |
| Co-58 | | 7.70E-07 | 2.36E-06 | | | | 4.49E-06 |
| Co-60 | | 1.67E-05 | 4.93E-05 | | | | 9.27E-05 |
| Zn-65 | 3.96E-04 | 1.05E-03 | 6.56E-04 | | 6.65E-04 | | 1.85E-04 |
| I-131 | 8.37E-07 | 8.42E-07 | 4.79E-07 | 2.78E-04 | 1.38E-06 | | 7.50E-08 |
| Cs-134 | 1.12E-02 | 1.83E-02 | 3.86E-03 | | 5.67E-03 | 2.04E-03 | 9.87E-05 |
| Cs-137 | 1.32E-02 | 1.26E-02 | 1.86E-03 | | 4.11E-03 | 1.48E-03 | 7.89E-05 |
| H-3 | | 3.30E-05 | 3.30E-05 | 3.30E-05 | 3.30E-05 | 3.30E-05 | 3.30E-05 |
| TOTALS | 2.47E-02 | 3.21E-02 | 6.48E-03 | 3.11E-04 | 1.05E-02 | 3.55E-03 | 5.27E-04 |
| | Bone | Liver | T.Body | Thyroid | Kidney | Lung | Gi-Lli |

ANNUAL TOTAL DOSE SUMMARY REPORT

| Group | Organ | Total (MREM) |
|---|---|---|
| Adult | Bone | 1.92E-02 |
| Adult | Liver | 3.63E-02 |
| Adult | Tot Body | 2.70E-02 |
| Adult | Thyroid | 2.81E-04 |
| Adult | Kidney | 1.24E-02 |
| Adult | Lung | 3.84E-03 |
| Adult | Gi-Lli | 2.06E-03 |
| Teen | Bone | 2.01E-02 |
| Teen | Liver | 3.71E-02 |
| Teen | Tot Body | 1.56E-02 |
| Teen | Thyroid | 2.53E-04 |
| Teen | Kidney | 1.25E-02 |
| Teen | Lung | 4.50E-03 |
| Teen | Gi-Lli | 1.43E-03 |
| Child | Bone | 2.47E-02 |
| Child | Liver | 3.21E-02 |
| Child | Tot Body | 6.48E-03 |
| Child | Thyroid | 3.11E-04 |
| Child | Kidney | 1.05E-02 |
| Child | Lung | 3.55E-03 |
| Child | Gi-Lli | 5.27E-04 |

[1] Gi-Lli: Gastro-intestinal tract, including the lower large intestine.