172/174/182/195

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 15, 1997

Mr. Richard R. Grigg
Chief Nuclear Officer
Wisconsin Electric Power Company
231 West Michigan Street, Room P379
Milwaukee, WI 53201

SUBJECT: POINT BEACH NUCLEAR PLANT, UNIT NOS. 1 AND 2 - REQUEST FOR ADDITIONAL INFORMATION RE: TECHNICAL SPECIFICATION CHANGE REQUESTS RELATING TO RADIATION PROTECTION (TAC NOS. M92346/7, M95350/1, M96261/2, AND M97839/40)

Dear Mr. Grigg:

Additional information is required to continue the review on Technical Specifications Change Requests (TSCR) -172, TSCR-174, TSCR-182, and TSCR-195 for the Point Beach Nuclear Plant (PBNP). TSCR-172, submitted May 2, 1995, and supplemented on October 12, 1995, and March 26, 1996, proposes to eliminate the minimum frequencies for checks, calibrations, and testing of the radiation monitoring system instrument channels (TS Table 15.4.1-1, Item 36) except for the main steam line radiation monitors. TSCR-174, submitted April 24, 1996, proposes to eliminate all radioactive liquid and gaseous effluent monitors in accordance with guidance provided in Generic Letter 89-01. TSCR-182, submitted November 17, 1995, and supplemented on July 29, 1996, requests replacing the Health Physics Manager with the Health Physicist. TSCR-195, submitted January 21, 1997, requests updating references to 10 CFR Part 20.

Additional information is needed on the types of radiation monitors included in the radiation monitoring system, those radiation monitors listed as effluent monitors that provide only a monitoring function, the health physicist position description, and the extent of PBNP's adherence to 10 CFR Part 20 requirements. The request for additional information (RAI) is enclosed. Please respond to the RAI within 120 days of receipt and provide the needed changes to the submittals. Supplemental information in response to specific TSCRs can be submitted separately any time prior to the end of the 120-day period.

If you have additional questions, please contact Linda L. Gundrum at 301 415-1380.

Sincerely,

Linda L. Gundrum

Linda L. Gundrum, Project Manager
Project Directorate III-1
Division of Reactor Projects - III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-266 and 50-301

Enclosure: RAI

cc w/encl: See next page

Mr. Richard R. Grigg
Wisconsin Electric Power Company

Point Beach Nuclear Plant
Unit Nos. 1 and 2

cc:

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REQUEST FOR ADDITIONAL INFORMATION

TSCR-172 Operational Safety Review - Radiation Monitoring System

As discussed in Generic Letter 95-10, issued December 15, 1995, four criteria were established to determine which design conditions and associated surveillances should be located in the TS as limiting conditions for operation. Four criteria were subsequently incorporated into the regulations by an amendment to 10 CFR 50.36. These four criteria are: (1) installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary; (2) a process variable, design feature, or operating restriction that is an initial condition of a design-basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier; (3) a structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design-basis accident (DBA) or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier; and (4) a structure, system, or component which operating experience or probabilistic safety assessment has shown to be significant to public health and safety.

Based on the 10 CFR 50.36 criteria, Attachment A lists examples of radiation monitors that may need to be retained in standard technical specifications. Please note that the radiation monitors are part of the system specification. The radiation monitors on closed systems need to be included if the monitors provide signals for equipment that must reposition to maintain the system as closed.

Providing answers to the following questions, will assist in the review of TSCR-172.

1. It is the NRC's understanding that PBNP has three categories of monitors in the radiation monitoring system: area monitors, effluent monitors and process monitors. Please verify the lists of radiation monitors in Attachment B, Tables 1, 2, and 3 include all radiation monitors in the radiation monitoring system.

2. In each category, some of the monitors, listed in Attachment B, Table 4, have control functions that may meet the requirements of 10 CFR 50.36. Please address those monitors listed in Attachment B, Tables 1, 2, 3, and 4 which have control functions and provide additional information on why these monitor do/do not meet any of the criteria of 10 CFR 50.36.

3. Please provide information on other radiation monitors, identified by item 1, that meet the criteria of 10 CFR 50.36. Provide justification on why these monitors, if any, are not included in technical specifications (TS).

4. Submit the appropriate TS changes, in accordance with 10 CFR 50.36, for those radiation monitors that should/must remain in TS. Include limiting conditions for operation, applicability, action statements with conditions, required action and completion time specified, surveillance requirements, surveillance frequencies, required number of monitors, monitor setpoints, and bases.

TSCR-174 Radiological Effluent Technical Specifications

5. New guidance (Attachment C) was provided to the Nuclear Energy Institute (NEI) on April 9, 1997, on TS for the radioactive effluent controls program. This new guidance includes 10 CFR Part 20 changes. Please review the new guidance and revise your submittal as appropriate.

 ENCLOSURE

6. Revise submittal to remove only those radiological effluent monitors that do not meet the requirements of 10 CFR 50.36.

TSCR-182 Health Physics Manager Qualification

7. Please provide sufficient information to describe the Health Physicist position description. The description should document that the position is in a professional, supervisor position that affords adequate authority and opportunity to represent program interests on a plant-wide basis. Additionally, describe the involvement of the designated Health Physicist in the day-to-day operation and oversight of the plant radiation protection program.

TSCR-195 Radiation Protection Program

8. New guidance (Attachment D) was provided to NEI on April 9, 1997, on TS administrative controls for a high radiation area. This new guidance includes 10 CFR Part 20 changes. Please review the new guidance and revise your submittal as appropriate.

9. If you choose not to revise your submittal per the new guidance, please describe how your program complies with the new Part 20 requirements for high radiation areas with dose rates greater than 1.0 rem/hour at 30 centimeters from the radiation source or from any surface penetrated by the radiation, but less than 500 rads/hour at 1 meter from the radiation source or from any surface penetrated by the radiation.

Attachments: A through D

STANDARD TECHNICAL SPECIFICATION RADIATION MONITORS

The following Technical Specifications (TS) provide limiting conditions for operation and applicability statements, action statements, surveillance requirements, and a bases section which discusses the background and applicable safety analyses. The need to include radiation monitors in the TS is established by the consequences of the limiting Design Basis Accident analysis and whether the control functions performed by the radiation monitor are credited in the accident analysis. If the radiation monitor is not relied upon in the analysis, the consequences must not exceed the consequences of a DBA.

TS 3.3.3 Post Accident Monitoring (PAM) Instrumentation
Includes containment area radiation monitors (High Range)

TS 3.3.5 Containment Ventilation Isolation Instrumentation
Includes containment radiation gaseous and particulate monitors

TS 3.3.6 Control Room Emergency Air Treatment System Actuation Instrumentation
Includes control room intake iodine, noble gas, and particulate radiation monitors

TS 3.4.15 RCS Leakage Detection Instrumentation
Includes containment atmosphere radioactivity monitors relied upon to detect leakage of reactor coolant into the containment. Plant vent gaseous or particulate radiation monitors need to be addressed if they perform a leakage detection function.

TS 3.7.7 Component Cooling Water System
Radioactivity monitor may need to be included if the system is not a normally closed system outside of containment and the radiation monitor provides a signal to ensure system closure.

TS 3.7.8 Service Water System
Radioactivity monitors may need to be included in TS if the radiation monitors provide control input to isolate valves that prevent discharges.

TS 3.7.9 Control Room Emergency Air Treatment System
Includes gaseous, particulate, and iodine radiation monitors which result in actuation.

TS 3.7.10 Auxiliary Building Ventilation System
Includes noble gas, particulate, and iodine monitors for the plant vent stack which result in actuation of equipment.

TABLE 1
RADIATION MONITORING SYSTEM - AREA MONITORS

DETECTOR NO.	NAME	INDICATION
RE-101[1]	control room monitor	indicates dose rates in control room
1(2)RE-102	containment low range monitor	provides dose rates within containment around access hatch
RE-103	chemistry lab area monitor	provides indication of dose rates in chemistry lab and associated hallways
1(2)RE-104	charging pumps low-range area monitor	indicates dose rates in hallways east of charging pump cubicles
RE-105	spent fuel pit low range area monitor	provides indication of dose rates in the vicinity of spent fuel pit (affected by high radiation levels in containment)
1(2)RE-106	primary side sample room low range area monitor	indicates dose rate inside sample room when sampling system is in operation
1(2)RE-107	seal table area monitor	provides an indication of general dose rate near seal table
RE-108	drumming station area monitor	provides dose rate indication within the drumming station
1(2)RE-109	post-accident sample line monitor	provides an indication of failed fuel by monitoring the primary coolant sample activity
RE-110	Safety Injection (SI) pump room low range monitor	provides an indication of the dose rate in general area of SI pumps
RE-111	C59 panel area monitor	provides general area dose rate near C59 panel
RE-112	central PAB	indicates general area dose rate on PAB El. 8'
RE-113	PAB Elevation (El.) -19' area monitor	provides an indication of the dose rate in PAB El. -19' sump and general area
RE-114	CVCS holdup tank area monitor	indicates general area dose rate in cubicle
RE-116	letdown system valve gallery area monitor	indicates general area dose rate in letdown valve gallery
1(2)RM-126 1(2)RM-127 1(2)RM-128	unit 1(2) containment high range radiation monitors	indication is via readout module in the computer room and on the auxiliary safety instrumentation panels

DETECTOR NO.	NAME	INDICATION
1(2)RE-134	charging pump room high range area monitor	provides an indication of general area dose rates in the event low range monitor saturates
RE-135	spent fuel pit high range area monitor	provides an indication of general area dose rates in the event low range monitor saturates
1(2)RE-136	primary side sample room high range area monitor	provides an indication of general area dose rates in the event low range monitor saturates
RE-140	SI pump room high range are monitor	provides an indication of general area dose rates in the event low range monitor saturates
RE-239[2]	technical support center (TSC) area monitor	indicates general area TSC dose rates
RE-240[2]	TSC El. 18.5' assembly area monitor	indicates general area El. 18.5' dose rates
RE-243[2]	emergency operations facility (EOF) area monitor	indicates general area EOF dose rates

[1] Refer to Table 4 for control function
[2] Monitors not part of main RMS

TABLE 2
RADIATION MONITORING SYSTEM - PROCESS MONITORS

DETECTOR NO.	NAME	INDICATION
1(2)RE-211	containment air particulate monitor	indicates particulate activity inside containment or purge exhaust stack
1(2)RE-211B	background monitor for RE-211	background data for both RE-211 and RE-212
1(2)RE-212(1)	containment noble gas monitor	provides indication of containment, or purge exhaust stack noble gas activity
RE-214(1)	PAB	indicates high gaseous activity release from gas decay tanks or potential PAB airborne activity
1(2)RE-215	condenser air ejector noble gas monitor	indicative of steam generator primary-to-secondary leak. May be indicative of potential airborne radiation exposure in turbine hall.
1(2)RE-216	containment fan coolers liquid process monitor	provides indication of potential contamination of cooling water (service water return)
1(2)RE-216B	background monitor for 1RE-216	provides background data for RE-216
1(2)RE-217(1)	component cooling water liquid process monitor	provides indication of component cooling water contamination
RE-218(1)	waste disposal system discharge liquid process monitor	monitors waste condensate activity being discharged
RE-218B	background monitor for RE-220	provides background data for RE-218
1(2)RE-219(1)	steam generator blowdown liquid process monitor	provides indication of steam generator blowdown activity and steam generator tube leak rates
1(2)RE-219B	background monitor for RE-219	provides background data for RE-219
RE-220	spent fuel pit (SFP) heat exchanger service water liquid process monitor	provides indication of service water contamination from a spent fuel pool heat exchanger tube leak
RE-220B	background monitor for RE-220	provides background data for RE-220
RE-221	drumming area vent stack noble gas monitor	indicates noble gas activity released from spent fuel pit and drumming area, which may be indicative of a potential PAB airborne release
1(2)RE-222(1)	steam generator blowdown tank outlet liquid process monitor	indicates activity level in blowdown tank

DETECTOR NO.	NAME	INDICATION
RE-223[1]	waste distillate discharge liquid process monitor	monitors activity of waste distillate being discharged
RE-223B	background monitor for RE-223	provides background for RE-223
RE-224	gas stripper building exhaust noble gas monitor	indicates activity of gaseous release from letdown gas stripper building
RE-225	combined air ejector low range noble gas monitor	indicative of primary-to-secondary leak in steam generators. may also indicate potential radiation exposure sources within turbine building
RE-226	combined air ejector high range noble gas monitor	indicative of primary-to-secondary leak in steam generators. may also indicate potentia radiation exposure sources within turbine building
1(2)RE-229	service water discharge liquid process monitor	monitors activity of service water discharge
1(2)RE-229B	background monitor for Re-229	provides background data for RE-229
RE-230	retention pond discharge liquid process monitor	monitors activity level in retention pond effluent
RE-230B	background monitor for RE-230	provides background data for Re-230
1(2)RE-231	steam line "A" atmospheric release monitor	monitors activity of steam released - steam line "A"
1(2)RE-232	steam line "B" atmospheric release monitor	monitors activity of steam released - steam line "B:
RE-234	control room iodine monitor	monitors iodine activity in control room
RE-234B	control room iodine and noble gas sample system background monitor	provides background data for RE-234
RE-235[1]	control room noble gas monitor	monitors noble gas activity in control room
RE-237[2]	TSC iodine monitor	monitors noble gas activity in control room
RE-238[2]	site boundary control center (SBCC) iodine monitor	monitors iodine activity of air supply to SBCC
RE-242[2]	SBCC noble gas monitor	monitors noble gas activity of supply air to SBCC

[1] Refer to Table 4 for control function

[2] Monitors not part of main RMS

TABLE 3
SPECIAL PARTICULATE, IODINE, AND NOBLE GAS MONITORS

DETECTOR NO.	NAME	INDICATION
1(2)RE-301	containment purge exhaust monitor (beta particulate)	indicates activity in containment purge exhaust
1(2)RE-302	containment purge exhaust monitor (alpha particulate)	indicates activity in containment purge exhaust
1(2)RE-303	containment purge exhaust monitor (iodine)	indicates activity in containment purge exhaust
1(2)RE-305[1]	containment purge exhaust monitor (low range gas)	indicates activity in containment purge exhaust
1(2)RE-306	containment purge exhaust monitor (area monitor)	indicates activity in containment purge exhaust
1(2)RE-307	containment purge exhaust monitor (mid range gas)	indicates activity in containment purge exhaust
1(2)RE-308	containment purge exhaust monitor (low range gas background)	indicates activity in containment purge exhaust
1(2)RE-309	containment purge exhaust monitor (high range gas)	indicates activity in containment purge exhaust
RE-311	auxiliary building exhaust monitor (beta particulate)	indicates activity in auxiliary building exhaust
RE-312	auxiliary building exhaust monitor (alpha particulate)	indicates activity in auxiliary building exhaust
RE-313	auxiliary building exhaust monitor (iodine)	indicates activity in auxiliary building exhaust
RE-315	auxiliary building exhaust monitor (low range gas)	indicates activity in auxiliary building exhaust
RE-316	auxiliary building exhaust monitor (area monitor)	indicates activity in auxiliary building exhaust
RE-317	auxiliary building exhaust monitor (mid range gas)	indicates activity in auxiliary building exhaust
RE-318	auxiliary building exhaust monitor (low range gas background)	indicates activity in auxiliary building exhaust
RE-319	auxiliary building exhaust monitor (high range gas)	indicates activity in auxiliary building exhaust
RE-321	drumming area exhaust monitor (beta particulate)	indicates activity in drumming area exhaust

DETECTOR NO.	NAME	INDICATION
RE-322	drumming area exhaust monitor (alpha particulate)	indicates activity in drumming area exhaust
RE-323	drumming area exhaust monitor (iodine)	indicates activity in drumming area exhaust
RE-325	drumming area exhaust monitor (low range gas)	indicates activity in drumming area exhaust
RE-326	drumming area exhaust monitor (area monitor)	indicates activity in drumming area exhaust
RE-327	drumming area exhaust monitor (mid range gas)	indicates activity in drumming area exhaust
RE-328	drumming area exhaust monitor (low range gas background)	indicates activity in drumming area exhaust

(1) Refer to Table 4 for control function

TABLE 4
RADIATION MONITOR CHANNELS WITH CONTROL FUNCTIONS

DETECTOR NO.	NAME	INDICATION
RE-101	control room area	shifts control room ventilation to Mode 3 (100 percent recirculation)
1(2)RE-212	containment noble gas	containment ventilation isolation closes purge valves, secures forced vent and puts monitor in recirculation
RE-214	PAB vent	closes vent gas release valve and switches PAB vent discharge to charcoal filters
RE-217	component cooling water	closes CCW surge tank vent
RE-218	waste condensate overboard	closes waste condensate pump valve
1(2)RE-219	steam generator blowdown	shuts blowdown valves, blowdown tank outlet valve, and steam generator sample valves
1(2)RE-222	blowdown tank area	shuts blowdown valves and blowdown tank outlet valve
RE-223	waste distillate overboard	closes discharge valve
RE-235	control room noble gas	shifts control room ventilation to Mode 3 (100 percent recirculation)
1(2)RE-305	containment noble gas	containment ventilation isolation

Radioactive Effluent Controls Program

This program conforms to 10 CFR 50.36a for the control of radioactive effluents and for maintaining the doses to members of the public from radioactive effluents as low as reasonably achievable. The program shall be contained in the ODCM, shall be implemented by procedures, and shall include remedial actions to be taken whenever the program limits are exceeded. The program shall include the following elements:

a. Limitations on the functional capability of radioactive liquid and gaseous monitoring instrumentation including surveillance tests and setpoint determination in accordance with the methodology in the ODCM;

b. Limitations on the concentrations of radioactive material released in liquid effluents to unrestricted area, conforming to 10 times the concentration value in Appendix B, Table, 2, Column 2 to 10 CFR 20.1001 - 20.2402;

c. Monitoring, sampling, and analysis of radioactive liquid and gaseous effluents in accordance with 10 CFR 20.1302 and with the methodology and parameters in the ODCM;

d. Limitations on the annual and quarterly doses or dose commitment to a member of the public from radioactive materials in liquid effluents released from each unit to unrestricted areas, conforming to 10 CFR 50, Appendix I;

e. Determination of cumulative and projected dose contributions from radioactive effluents for the current calendar quarter and current calendar year in accordance with the methodology and parameters in the ODCM at least every 31 days;

f. Limitations on the functional capability and use of the liquid and gaseous effluent treatment systems to ensure that appropriate portions of these systems are used to reduce releases of radioactivity when the projected doses in a period of 31 days would exceed 2 percent of the guidelines for the annual dose or dose commitment, conforming to 10 CFR 50, Appendix I;

g. Limitations on the dose rate resulting from radioactive material released in gaseous effluents from the site to areas at or beyond the site boundary shall be limited to the following:

   1. For noble gases: less than or equal to a dose rate of 500 mrem per year to the total body and less than or equal to a dose of 3000 mrems per year to the skin, and

   2. For iodine-131, iodine-133, tritium, and for all radionuclides in particulate form with half-lives greater than 8 days: less than or equal to a dose rate of 1500 mrem/year to any organ.

h. Limitations on the annual and quarterly air doses resulting from noble gases released in gaseous effluents from each unit to areas beyond the site boundary, conforming to 10 CFR 50, Appendix I;

i. Limitations on the annual and quarterly doses to a member of the public from iodine-131, iodine-133, tritium, and all radionuclides in particulate form with half lives > 8 days in gaseous effluents released from each unit to areas beyond the site boundary, conforming to 10 CFR 50, Appendix I; and

j. Limitations on the annual dose or dose commitment to any member of the public, beyond the site boundary, due to releases of radioactivity and to radiation from uranium fuel cycle sources, conforming to 40 CFR 190.

High Radiation Area

As provided in paragraph 20.1601(c) of 10 CFR Part 20, the following controls shall be applied to high radiation areas in place of the controls required by paragraph 20.1601(a) and (b) of 10 CFR Part 20:

High Radiation Areas with Dose Rates Not Exceeding 1.0 rem/hour at 30 Centimeters from the Radiation Source or from Any Surface Penetrated by the Radiation;

a. Each entryway to such an area shall be barricaded and conspicuously posted as a high radiation area. Such barricades may be opened as necessary to permit entry or exit of personnel or equipment.

b. Access to, and activities in, each such area shall be controlled by means of Radiation Work Permit (RWP) or equivalent that includes specification of radiation dose rates in the immediate work area(s) and other appropriate radiation protection equipment and measures.

c. Individuals qualified in radiation protection procedures (e.g., health physics technicians) and personnel continuously escorted by such individuals may be exempted from the requirement for an RWP or equivalent while performing their assigned duties provided that they are following plant radiation protection procedures for entry to, exit from, and work in such area.

d. Each individual or group entering such an area shall possess:

   1. A radiation monitoring device that continuously displays radiation dose rates in the area; or

   2. A radiation monitoring device that continuously integrates the radiation dose rates in the area and alarms when the device's dose alarm setpoint is reached, with an appropriate alarm setpoint, or

   3. A radiation monitoring device that continuously transmits dose rate and cumulative dose to a remote receiver monitored by radiation protection personnel responsible for controlling personnel radiation exposure within the area, or

   4. A self-reading dosimeter (e.g., pocket ionization chamber or electronic dosimeter) and,

      (i) Be under the surveillance, as specified in the RWP or equivalent, while in the area, of an individual qualified in radiation protection procedures, equipped with a radiation monitoring device that continuously displays radiation dose rates in the are; who is responsible for controlling personnel exposure within the area, or

ATTACHMENT D

(ii) Be under the surveillance as specified in the RWP or equivalent, while in the area, by means of closed circuit television, of personnel qualified in radiation protection procedures, responsible for controlling personnel radiation exposure in the area, and with the means to communicate with and control every individual in the area.

e. Except for individuals qualified in radiation protection procedures, entry into such areas shall be made only after dose rates in the area have been determined and entry personnel are knowledgeable of them.

High Radiation Areas with Dose Rates Greater than 1.0 re /hour a 30 Centimeters from the Radiation Source or from Any Surface Penetrated by the adiation, but Less than 500 rads/hour at 1 Meter from the Radiation Source or fro ny Surface Penetrated by the Radiation:

a. Each entryway to such an area shall be nspicuously posted as a high radiation area and shall be provided with locked door or gate that prevents unauthorized entry, and, in addition:

1. All such door and gate keys shall be maintained under the administrative control of the shift supervisor, radiation protection manager, or his or her designee.

2. Doors and gates shall remain locked except during periods of personnel or equipment entry or exit.

b. Access to, and activities in, each such area shall be controlled by means of an RWP or equivalent that includes specification of radiation dose rates in the immediate work area(s) and other appropriate radiation protection equipment and measures.

c. Individuals qualified in radiation protection procedures may be exempted from the requirement for an RWP or equivalent while performing radiation surveys in such areas provided that they are following plant radiation protection procedures for entry to, exit from, and work in such areas.

d. Each individual or group entering such an area shall possess:

1. A radiation monitoring device that continuously integrates the radiation rates in the area and alarms when the device's dose alarm setpoint is reached, with an appropriate alarm setpoint, or

2. A radiation monitoring device that continuously transmits dose rate and cumulative dose information to a remote receiver monitored by radiation protection personnel responsible f controlling personnel radiation exposure within the area with the means to communicate with and control every individual in the area, or

3. A self-reading dosimeter (e.g., pocket ionization chamber or electronic dosimeter) and,

(i) Be under the surveillance, as specified in the RWP or equivalent, while in the area, of an individual qualified in radiation protection procedures, equipped with a radiation monitoring device that continuously displays radiation dose rates in the area; who is responsible for controlling personnel exposure within the area, or

(ii) Be under the surveillance as specified in the RWP or equivalent, while in the area, by means of closed circuit television, of personnel qualified in radiation protection procedures, responsible for controlling personnel radiation exposure in the area, and with the means to communicate with and control every individual in the area, or

4. In those cases where options (2) an (3), above, are impractical or determined to be inconsistent with the "As Low As is Reasonably Achievable" principle, a radiation monitoring device that continuously displays radiation dose rates in the area.

e. Except for individual qualified in radiation protection procedures, entry into such areas shall be made only after dose rates in the area have been determined and entry personnel are knowledgeable of them.

f. Such individual areas that are within a larger area that is controlled as a high radiation area, where no enclosure exists for the purpose of locking and where no enclosure can reasonably be constructed around the individual area need not be controlled by a locked door or gate, but shall be barricaded and conspicuous, clearly visible flashing light shall be activated at the area as a warning device.

Wisconsin Electric POWER COMPANY
231 W MICHIGAN, P.O. BOX 2046, MILWAUKEE, WI 53201 (414) 277-2345

VPNPD-87-430
NRC-87-104

October 8, 1987

U.S. NUCLEAR REGULATORY COMMISSION
Document Control Desk
Washington, D.C. 20555

Gentlemen:

DOCKET NOS. 50-266 AND 50-301
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
FOR 10 CFR 20.302 APPLICATION
POINT BEACH NUCLEAR PLANT

On July 14, 1987, Wisconsin Electric Power Company submitted an application, under the provisions of 10 CFR 20.302, for approval of a proposed procedure to dispose of sewage treatment sludge containing minute quantities of radioactive materials. Subsequent to the application, Mr. Ted Quay of the NRC staff requested additional information regarding the environmental characteristics of the area surrounding the Point Beach Nuclear Plant. The responses to this request were furnished in our submittal dated August 6, 1987.

By letter dated September 9, 1987, the NRC has requested Wisconsin Electric supply additional information in order to complete the review of our application. This Request for Additional Information (RAI) contains ten specific items which require responses or commitments from Wisconsin Electric. In addition, the NRC requests the previously submitted information and the information supplied in response to the RAI be compiled into "one complete, extensive, and self-contained package". To facilitate your review, Attachment I is included to provide direct responses to the ten items contained in the RAI. Attachment II is provided as the complete application, including the information from our letters dated July 14, 1987, and August 6, 1987, and information supplied in response to the NRC RAI.

We request that you complete your review of this complete, self-contained package and issue an approval of our application as soon as possible. In order to facilitate your review and to expedite processing, we would be pleased to discuss these matters or provide additional information by telephone. Please feel free to contact us.

Very truly yours,

C. W. Fay
Vice President
Nuclear Power

bjm

Attachments

Copies to NRC Resident Inspector
NRC Regional Administrator, Region III

Blind copies to Britt/Gorske/Finke, Burstein, Charnoff, Fay, Kriesel, Lipke, Newton, Zach

ATTACHMENT I

RESPONSES TO QUESTIONS CONTAINED IN THE
REQUEST FOR ADDITIONAL INFORMATION (RAI)
ON POINT BEACH 1 AND 2 REQUEST
FOR DISPOSAL OF LOW LEVEL RADIOACTIVITY
CONTAMINATED SEWAGE SLUDGE BY LAND APPLICATION
WISCONSIN ELECTRIC POWER COMPANY
UNDER 10 CFR 20.302(a)

The numbering system used in these responses corresponds directly to numbering used in the NRC RAI, dated September 9, 1987.

1. a. This request is for multiple applications, approximately 2 to 4 per year.
   b. This request is for multiple years, expiration to coincide with conclusion of decommissioning activities associated with retirement of PBNP Units 1 & 2.
   c. Please refer to the response to question number 10.

2. The pathways used to determine doses to both the maximally exposed individual and the inadvertent intruder are documented in Attachment II, Appendices D and E.

   Due to the extremely low concentrations of radionuclides in the sewage sludge and the associate low doses, Wisconsin Electric will control access to the disposal sites by conditions of use defined in lease agreements with the lease. Use of the land is not controlled beyond the conditions of the lease, thereby not restraining a casual visitor from the disposal site. However continuous occupancy would be readily observed, and remedial action would be taken.

3. Information contained in previous submittals has been included in Attachment II with modifications to provide specific commitments to the NRC.

4. Please refer to the response to question number 10.

5. Site maps have been updated and are included in Attachment II, Appendix C.

6. The direct grazing of cattle on the proposed disposal sites is controlled by restrictions contained in the lease agreement.

   There will be no restrictions placed on fishermen on Lake Michigan. Calculations of doses due to all pathways associated with a release to Lake Michigan (Attachment II, Appendix E) do not indicate a need to apply restrictions to fishermen.

7. Please refer to revised site maps included in Attachment II, Appendix C. Site number 5 is located on company owned land beyond the PBNP site boundary. All other sites are within the PBNP site boundary area.

8. a. Please refer to Attachment II, Section 3.2, Disposal Procedure.
   b. Please refer to Attachment II, Section 3.2, Disposal Procedure.
   c. Please refer to Attachment II, Section 3.2, Disposal Procedure.
   d. Please refer to Attachment II, Appendix A.

9. Please refer to Attachment II, including Appendix D and Appendix E for additional pathways analyzed for this submittal. These identified pathways will be analyzed prior to all subsequent disposals to insure doses are maintained within prescribed limits, i.e., 1 mrem/year to the maximally exposed individual and 5 mrem/year to the inadvertent intruder.

10. A limiting concentration level for the sludge contained in the storage tank is discussed, in Attachment II, Appendix F. Since this application is for multiple applications over multiple years, Attachment II, Appendix F also addresses an activity limit.

ATTACHMENT II

COMPLETE ANALYSIS AND EVALUATION

POINT BEACH NUCLEAR PLANT

10 CFR 20.302(a) APPLICATION

1.0 Purpose

By this submittal Wisconsin Electric Power Company requests approval of the U.S. Nuclear Regulatory Commission for a proposed procedure to dispose of sewage treatment sludge containing trace quantities of radionuclides generated at the Point Beach Nuclear Plant. This request is submitted in accordance with the provisions of 10 CFR 20.302(a).

2.0 Waste Description

The waste involved in this disposal process consists of the residual solids remaining in solution upon completion of the aerobic digestion sewage treatment process utilized at PBNP. The PBNP sewage treatment plant is used to process waste water from the plant sanitary and potable water systems. These systems produce non-radioactive waste streams with the possible exception of wash basins located in the radiologically controlled area of the plant. These wash basins are believed to be the primary source of the extremely small quantities of radionuclides in the sludge.

The sewage sludge generated at PBNP is allowed to accumulate in the sewage plant digestor and aeration basin. Two to four times annually, depending on work activities and corresponding work force at PBNP, the volume of the sludge in the digestor and aeration basin needs to be reduced to allow continued efficient operation of the treatment facility. The total volume of sludge removed during each disposal operation is typically on the order of 15,000 gallons. The maximum capacity for the entire PBNP treatment facility and hence the maximum disposal volume is about 30,000 gallons. In the case of a maximum capacity disposal, doses would not necessarily increase in proportion to the volume, since more than one disposal site may be used.

Trace amounts of radionuclides have been identified in PBNP sludge currently being stored awaiting disposal. The radionuclides identified and their concentrations in the sludge are summarized below:

Nuclide	Concentration (μCi/cc)
Co-60	2.33E-07
Cs-137	1.50E-07

The total activity of the radionuclides in the stored sludge, based on the identified concentrations and a total volume of 15,000 gallons of sewage sludge, are as follows:

Nuclide	Activity (μCi)
Co-60	13.2
Cs-137	8.5

These concentrations and activities are consistent with expected values based on prior analyses of sewage sludge. The radionuclide concentration in the sewage sludge has remained relatively constant during sampling conducted since December 30, 1983. A detailed summary of the results of this sampling program are contained in Appendix A for your review.

In addition to monitoring for the radionuclide content of the sludge, the WDNR requires several other physical and chemical properties of the sludge to be determined. These properties are the percent total solids, percent total nitrogen, percent ammonium nitrogen, pH, percent total phosphorus, percent total potassium, cadmium, copper, lead, nickel, mercury, zinc, and boron. An example of a typical sludge sample analysis is included in Appendix B.

3.0 Disposal Method

In the context of this application, Wisconsin Electric commits to the following methodology. No distinction is made or intended between "shall" or "will", as used in the descriptions contained in this section.

3.1 Transport of Sludge

The method used to dispose of the sludge shall utilize a technique approved by the WDNR. The process of transporting the sewage sludge for disposal involves pumping the sludge from the PBNP sewage treatment plant storage tanks into a truck mounted tank. The truck mounted tank shall be required to be maintained tightly closed to prevent spillage while in transit to the disposal site. The sludge shall be transported to one or more of the six sites approved by the WDNR for land application of the sewage sludge from PBNP.

3.2 Disposal Procedure

The radionuclide concentrations in the sludge shall be determined prior to each disposal by obtaining three representative samples from each of the sludge storage tanks. The sludge contained in the sludge tanks is prevented from going septic by a process known as complete mix and continuous aeration. This process completely mixes the sludge allowing for representative samples to be obtained.

The samples shall be counted utilizing a GeLi detector and multi-channel analyzer with appropriate geometry. The detection system is routinely calibrated and checked to ensure the lower limits of detection are within values specified in the Radiological Effluent Technical Specifications (RETS).

To insure the samples are representative of the overall concentration in the storage tanks, the radionuclide concentration determination for each of the three samples shall be analyzed to insure each sample is within two standard deviations of the average value of the three samples. If this criteria is not met, additional samples will be obtained and analyzed to insure a truly representative radionuclide concentration is utilized for dose calculations and concentration limit determinations. The average of all statistically valid concentration determinations will be utilized in determining the storage tank concentration values.

Prior to disposal the waste stream will be monitored to determine the physical and chemical properties of the sludge, as discussed in the last paragraph of Section 2.0, Waste Description. The results will be compared to State of Wisconsin limits to insure the sludge does not pose a chemical hazard to people or to the environment.

The radionuclides identified in the sludge, along with their respective concentrations, will be compared to concentration limits prior to disposal. The methodology discussed in Appendix F will be used in determining compliance with the proposed concentration limit. The total activity of the proposed disposal will be compared to the proposed activity limit as described in Appendix F.

If the concentration and activity limit criteria are met, the appropriate exposure pathways (as described in Appendix D) will be evaluated prior to each application of sludge. These exposures will be evaluated to insure the dose to the maximally exposed individual will be maintained less than 1 mrem/year and the dose to the inadvertent intruder is maintained less than 5 mrem/year. The exposures will be calculated utilizing the methodology used in Appendix E, including the current activity to be landspread along with the activity from all prior disposal. The remaining radioactivity from prior disposals will be corrected for radiological decay prior to performing dose calculations for the meat, milk, and vegetable ingestion pathways, the inhalation of resuspended radionuclides, and all pathways associated with a release to Lake Michigan. The residual radioactivity will be corrected for radiological decay and, if appropriate, the mixing of the radionuclides in the soil by plowing prior to performing external exposure calculations.

The sewage sludge is applied on the designated area of land utilizing the WDNR approved technique and adhering to the following requirements of WPDES Permit Number WI-0000957-3.

- Discharge to the land disposal system shall be limited so that during surface spreading all of the sludge and any precipitation falling onto or flowing onto the disposal field shall not overflow the perimeter of the system.

- Sludge shall not be land spread on land with a slope greater than 12%. During the period from December 15 through March 31 sludge shall not be land spread on land with a slope greater than 6% unless the wastes are injected immediately into the soil.

- Sludge shall not be surface spread closer than 500 feet from the nearest inhabited dwelling except that this distance may be reduced with the dwelling owner's written consent.

- Sludge shall not be spread closer than 1,000 feet from a public water supply well or 250 feet from a private water supply well.

- Sludge shall not be land spread within 200 feet of any surface water unless a vegetative buffer strip is maintained between the surface watercourse and the land spreading system, in which case a minimum separation distance of at least 100 feet is required between the system and the surface watercourse.

- Depth to groundwater and bedrock shall be greater than 3 feet from the land surface elevation during use of any site.

- Sludge shall not be land spread in a floodway.

- Sludge shall not be land spread within 50 feet of a property line road or ditch unless the sludge is incorporated with the soil, in which case a minimum separation distance of at least 25 feet is required.

- The pH of the sludge-soil mixture shall be maintained at 6.5 or higher.

- Low areas of the approved fields, subject to seasonally high groundwater levels, are excluded from the sludge application.

- Crops for human consumption shall not be grown on the land for up to one year following the application of the sludge.

- The sludge shall be plowed, disked, injected or otherwise incorporated into the surface soil layer at appropriate intervals.

The flexibility implied in the latter provision for soil incorporation is intended to allow for crops which require more than a one year cycle. For the Point Beach disposal sites, alfalfa is a common crop which is harvested for several years after a single planting. Sludge disposal on an alfalfa plot constitutes good fertilization, but the plot cannot be plowed without destroying the crop. The alfalfa in this case aids in binding the layer of sludge on the surface of the plot. At a minimum, however, plowing (or disking or other method of injection and mixing to a nominal depth of 6 inches) shall be done prior to planting any new crop, regardless of the crop.

3.3 Administrative Procedures

Complete records of each disposal will be maintained. These records will include the concentration of radionuclides in the sludge, the total volume of sludge disposed, the total activity, the plot on which the sludge was applied, the results of the chemical composition determinations, and all dose calculations.

The annual disposal rate for each of the approved land spread sites will be limited to 4,000 gallons/acre, provided WDNR chemical composition, NRC dose guidelines, and concentration and activity limits are maintained within the appropriate values.

The farmer leasing the site used for the disposal will be notified of the applicable restrictions placed on the site due to the land spreading of sewage sludge.

4.0 Evaluation of Environmental Impact

4.1 Site Characteristics

4.1.1 Site Topography

The disposal sites are located in the Town of Two Creeks in the northeast corner of Manitowoc County, Wisconsin, on the west shore of Lake Michigan about 30 miles southeast of the center of the city of Green Bay, and 90 miles NNE of Milwaukee. This site is located at longitude 87° 32.5'W and latitude 44° 17.0'N. The six sites are on property owned and controlled by Wisconsin Electric and are within or directly adjacent to the Point Beach site boundary. The sites are described below and are outlined on the map contained in Appendix C as Figure 3.

Site No. PB-01 - The approximately 15 acres located in the NE 1/4 of the NE 1/4 of Section 23, T. 21N - R. 24E.

Site No. PB-02 - The approximately 20 acres located in the SE 1/4 of the SE 1/4 of Section 14, T. 21N - R. 24E.

Site No. PB-03 - The approximately 5 acres located in the NW 1/4 of Section 24, T. 21N - R. 24E.

Site No. PB-04 - The approximately 5 acres located in the NW 1/4 of the SW 1/4 of Section 24, T. 21N - R. 24E.

Site No. PB-05 - The approximately 5 acres located in the NE 1/4 of the NW 1/4 of Section 25 T. 21N - R. 24E.

Site No. PB-06 - The approximately 5 acres located in the NE 1/4 of the SW 1/4 of Section 14, T. 21N - R. 24E.

The overall ground surface at the site of the Point Beach Nuclear Plant is gently rolling to flat with elevations varying from 5 to 60 feet above the level of Lake Michigan. Subdued knob and kettle topography is visible from aerial photographs. The land surface slopes gradually toward the lake from the higher glacial moraine areas west of the site. Higher ground adjacent to the lake. however, diverts the drainage to the north and south.

The major surface drainage features are two small creeks which drain to the north and south. One creek discharges into the lake about 1500 feet above the northern corner of the site and the other near the center of the site. During the spring, ponds of water may occupy the shallow depressions. As mentioned in Section 3.2, Disposal Procedure, these low areas are excluded from the sludge application.

A site topographic map covering details out to a 5 mile radius may be found in the FSAR at Figure 2.2-3 and is included in Appendix C as Figure 2.

The disposal of sewage sludge at these six sites will have no impact on the topography of this area.

4.1.2 <u>Site Geology</u>

Prior to construction of the Point Beach Nuclear Plant, an evaluation of the geological characteristics of the area in and surrounding the site was made. The geologic structure of the region is essentially simple. Gently dipping sedimentary rock strata of Paleozoic age outcrop in a horseshoe pattern around a shield of Precambrian crystalline rock which occupies the western part of the region. The site is located on the western flank of the Michigan Basin, which is a broad downwarp ringed by discontinuous outcrops of more resistant formations. The bedrock formations are principally limestones, dolomites, and sandstones with subordinate shale layers. The rocks form a succession of extensive layers that are relatively uniform in thickness. The bedrock strata dip very gently towards Lake Michigan at rates from 15 to 35 feet per mile.

The uppermost bedrock under the site is Niagara Dolomite. Bedrock does not outcrop on the site but is covered by glacial till and lake deposits. The soils contain expansive clay minerals and have moderately high base exchange capacity.

In the area of the site, the overburden soils are approximately 70 to 100 feet in thickness. Although the character of the glacial deposits may vary greatly within relatively short distances, a generalized section through the overburden soils adjacent to Lake Michigan at the site consists of the following sequence:

1. An upper layer of brown clay silt topsoil underlain with several feet of brown silty clay with layers of silty sand;

2. A layer of 20 feet of reddish-brown silty clay with some sand and gravel and occasional lenses of silt;

3. A layer of 25 feet of reddish-brown silty clay with layers of silty sand and lenses of silt;

4. A layer of 50 feet of reddish-brown silty clay with some sand and gravel, the lower portion of which contains gravels, cobbles, and boulders resting on a glacial eroded surface of Niagara dolomite bedrock.

Site drainage is poor due to the high clay content of the soil combined with the pock-marked surface. Additional information on site geology may be found in Section 2.8 of the FSAR.

The use of these sites for disposal of sewage sludge will not impact the geology of the area.

4.2 Area Characteristics

4.2.1 Meteorology

The climate of the site region is influenced by the general storms which move eastward along the northern tier of the United States and by those which move northeastward from the southwestern part of the country to the Great Lakes. This continental type of climate is modified by Lake Michigan. During spring, summer, and fall months the lake temperature differs markedly from the air temperature. Wind shifts from westerly to easterly directions produce marked cooling of day-time temperatures in spring and summer. In autumn the relatively warm water to the lake prevents night-time temperatures from falling as low as they do a few miles inland from the shoreline. Summer time temperatures exceed 90°F for six days on the average. Freezing temperatures occur 147 days and below zero on 14 days of the winter on the average. Rainfall averages about 28 inches per year with 55 percent falling in the months of May through September. Snowfall averages about 45 inches per year. Sludge spreading shall be managed such that the surface spreading together with any precipitation falling on the field shall not overflow the perimeter of the field. Additional information on site meteorology may be found in Section 2.6 of the FSAR.

There will be no impact on the meteorology of the area due to the disposal of the sewage sludge.

4.2.2 Hydrology

The dominant hydrological feature of this site is Lake Michigan, one of the largest of the Great Lakes. The normal water level in Lake Michigan is approximately 580 feet above mean sea level. In the general vicinity of the site, the 30 foot depth contour is between 1 and 1-1/2 miles offshore and the 60 foot contour is 3 to 3-1/2 miles off shore. The disposal sites are twenty or more feet above the normal lake level. There is no record that the sites have been flooded by the lake during modern times. There are no rivers or large streams which could create a flood hazard at or near the sites.

The subsurface water table at the Point Beach site has a definite slope eastward toward the lake. The gradient indicated by test drilling on the site is approximately 30 feet per mile. It is therefore extremely unlikely that any release of radioactivity on the site could spread inland. Furthermore, the rate of subsurface flow is small due to the relative impervious nature of the soil and will not promote the spread of releases. Further information on site hydrology is detailed in the PBNP FSAR Section 2.5.

There will be no adverse impact on hydrology of the area due to disposal of sewage sludge by land spreading.

4.3 Water Usage

4.3.1 Surface Water

Lake Michigan is used as the source of potable water supplies in the vicinity of the site for the cities of Two Rivers (12 miles south), Manitowoc (16 miles sourth), Sheboygan (40 miles south), and Green Bay (intake at Rostok 1 mile north of Kewaunee, 13 miles north). No other potable water uses are recorded within 50 miles of the site along the lake shore. All public water supplies drawn from Lake Michigan are treated in purification plants. The nearest surface water used for drinking other than Lake Michigan are the Fox River 30 miles NW and

Lake ..nebugo 40 miles W of the site.

Lake Michigan is also utilized by various recreational activities, including fishing, swimming and boating.

There will be no impact on surface water usage due to the disposal of sewage sludge.

4.3.2 Ground Water

Ground water provides the remaining population with potable supplies. Public ground water supplies within a 20 mile radius of the site are listed in Table 2.5-3 of the FSAR. Additional wells for private use are in existence throughout the region. The location of private wells within a two mile radius of PBNP are indicated on Figure 3, Appendix C.

The potable water for use at the Point Beach Nuclear Plant is drawn from a 257 feet deep well located at the southwest corner of the plant yard. Water from this well is routinely sampled as part of the environmental monitoring program.

There will be no adverse impact on ground water usage due to the disposal of sewage sludge.

4.4 Land Usage

Manitowoc County, in which the site is located, and the adjacent counties of Kewaunee, Brown, Calumet, and Sheboygan are predominantly rural. Agricultural pursuits account for approximately 90% of the total county acreage. With the exception of the Kewaunee Nuclear Plant located 4.5 miles north, the region within a radius of five miles of the site is presently devoted exclusively to agriculture. Dairy products and livestock account for 85% of the counties' farm production, with field crops and vegetables accounting for most of the remainder. The principal crops are grain corn, silage corn, oats, barley, hay, potatoes, green peas, lima beans, snap beans, beets, cabbage, sweet corn, cucumbers, and cranberries. Within the township of Two Creeks surrounding the site (15 sq. miles), there are about 800 producing cows on about 40 dairy farms. Some beef cattle are raised 2.5 miles north of the site. Cows are on pasture from the first of June to late September or early October. During the winter, cows are fed on locally produced hay and silage. Of the milk produced in this area, about 25 percent is consumed as fluid milk and 50 percent is converted to cheese, with the remainder being used in butter making and other by-products.

It has been the policy of Wisconsin Electric to permit the controlled use of crop land and pasture land on company owned property. No direct grazing of dairy or beef cattle or other animals is permitted on these company owned properties. Crops intended for human consumption shall not be grown on the disposal sites for at least one year following the application of the sludge.

The proposed land application of sewage sludge will not have any direct effect on the adjacent facilities. Additional land use information may be found in Section 2.4 of the FSAR.

4.5 Radiological Impact

The rate of sewage sludge application on each of the six proposed sites will be monitored to insure doses are maintained within applicable limits. These limits are based on NRC Nuclear Reactor Regulation (NRR) staff proposed guidance (described in AIF/NESP-037, August, 1986). These limits require doses to the maximally exposed member of the general public to be maintained less than 1 mrem/year due to the disposal material. In addition, NRR guidance requires doses of less than 5 mrem/year to an inadvertent intruder.

To assess the doses received by the maximally exposed individual and the inadvertent intruder, six credible pathways have been identified for the maximally exposed individual and four credible pathways for the inadvertent intruder. The identified credible pathways are described in Appendix D.

Calculations detailed in Appendix E demonstrate the disposal of the currently stored PBNP sewage sludge would remain below these limits. The total annual exposure to the maximally exposed individual based on the identified exposure pathways is equal to 0.072 mrem. The dose to a hypothetical intruder assuming an overly conservative occupancy factor of 100% is calculated to be 0.115 mrem/year. By definition, the inadvertent intruder would not be exposed to the processed food pathways (meat and milk).

The calculational methodology used in determining doses for the proposed disposal of sludge stored at PBNP shall be utilized prior to each additional land application to insure doses are maintained less than those proposed by NRR. This calculation will include radionuclides disposed of in previous sludge applications. The activity from these prior disposals will be corrected for radiological decay prior to performing dose calculations for the meat, milk, and vegetable ingestion pathways, the inhalation of resuspended radionuclides, and all pathways associated with a potential release to Lake Michigan. The residual radioactivity will be corrected for radiological decay and, if applicable, the mixing of radionuclides in the soil prior to performing external exposure calculations. In addition, the dose to a farmer potentially leasing more than one application site will be addressed by summing the doses received from the external exposure from a ground plane source and resuspension inhalation pathways for each leased site. In addition, the maximum site specific dose due to the other pathways identified in Appendix D, will be utilized in the total exposure estimation.

5.0 Radiation Protection

The disposal operation will follow the applicable PBNP procedures to maintain doses as low as reasonably achievable. Technical review and guidance will be provided by the PBNP Superintendent - Health Physics.

APPENDIX A

SUMMARY OF RADIOLOGICAL ANALYSES OF SEWAGE SLUDGE SINCE DECEMBER 30, 1983

Sample Date	Tank	Tank Volume (Gallons)	Radionuclide	Concentration (μCi/cc)
12-30-83	Digester	8400	Co-58	5.58E-07
			Co-60	1.87E-06
			Cr-51	4.88E-07
			Cs-134	1.59E-07
			Cs-137	3.57E-07
4-06-84	Digester	7560	Co-60	7.89E-07
	Aeration	6667	Co-60	1.87E-07
12-05-84	Digester	7560	Co-58	1.75E-07
	Aeration	6667	Co-60	8.29E-07
6-03-85	Digester	7560	Co-60	8.29E-07
			Cs-137	2.46E-07
	Aeration	6700	Co-60	3.27E-07
			Cs-137	1.33E-07
4-10-86	Digester	7560	Co-60	6.79E-07
			Cs-137	1.72E-07
			Mn-54	4.91E-08
			Co-60	1.65E-07
11-04-86	Digester	7560	Co-58	8.04E-08
	Aeration & Clarifier	25100	Co-58	1.37E-07
			Co-60	2.18E-07
			Cs-137	1.64E-07

APPENDIX B

CHEMICAL COMPOSITION ANALYSIS OF SEWAGE SLUDGE

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

SLUDGE CHARACTERISTIC
Wisconsin Statute 147.07(1) and
Wisconsin Administrative Code NR 110.27(6)
FORM 3400-49 REV. 10-80

Sewage Treatment Plant Sludge

Please complete this form and send to the Department of Natural Resources appropriate District/Area Office. Keep one copy for your records.
For additional forms, please contact your appropriate District/Area Office.

PERMITTEE: Wisconsin Electric Power Company	WPDES PERMIT NUMBER: WI 00957
STREET OR ROUTE: 231 W. Michigan Street	COUNTY: Milwaukee
CITY, STATE, ZIP CODE: Milwaukee, WI 53203	TELEPHONE NUMBER (INCLUDE AREA CODE): 414-277-2158

1. Please report laboratory testing results for the following parameters:

*Parameter	Abbreviation	Result	*Parameter	Abbreviation	Result
Total Solids, %	--	1.63	Chromium, ppm	Cr	[illegible]
Total Nitrogen, %	TOT N	1.0	Copper, ppm	Cu	2200
Ammonium Nitrogen, %	NH_4^+—N	0.34	Lead, ppm	Pb	190
Total Phosphorous, %	P	< 0.01	Mercury, ppm	Hg	3.6
Total Potassium, %	K	0.25	Nickel, ppm	Ni	12
Arsenic, ppm	As	1.0	Zinc, ppm	Zn	2800
Cadmium, ppm	Cd	12.	pH	--	7.0

*Suggested analysis procedures for the above parameters can be found in NR 219, analytical tests and procedures, Wisconsin Administrative Code. All parameters other than percent solids and pH shall be reported on a dry weight basis.

2. What is the name of the laboratory that did the analysis and when was it performed?

Laboratory Name: Wisconsin Electric Power Co. Laboratory Services Division   Date sent to lab: April 12, 1983

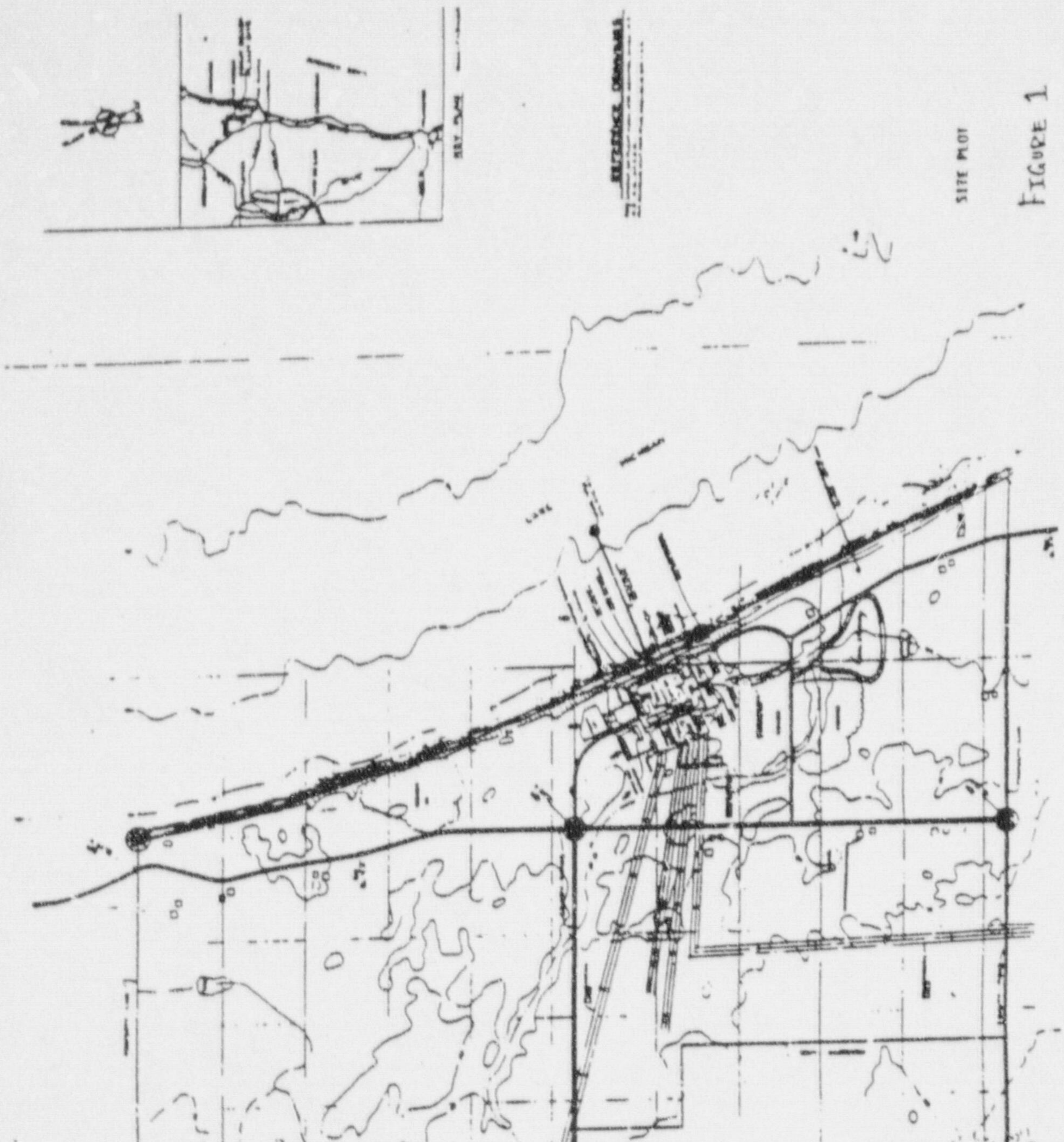
Where at the treatment plant was the sample taken? From sludge holding tank prior to hauling

When was the sample taken? April 12, 1983

SIGNATURE	TITLE	DATE
[illegible]	Water Quality Engineer	—

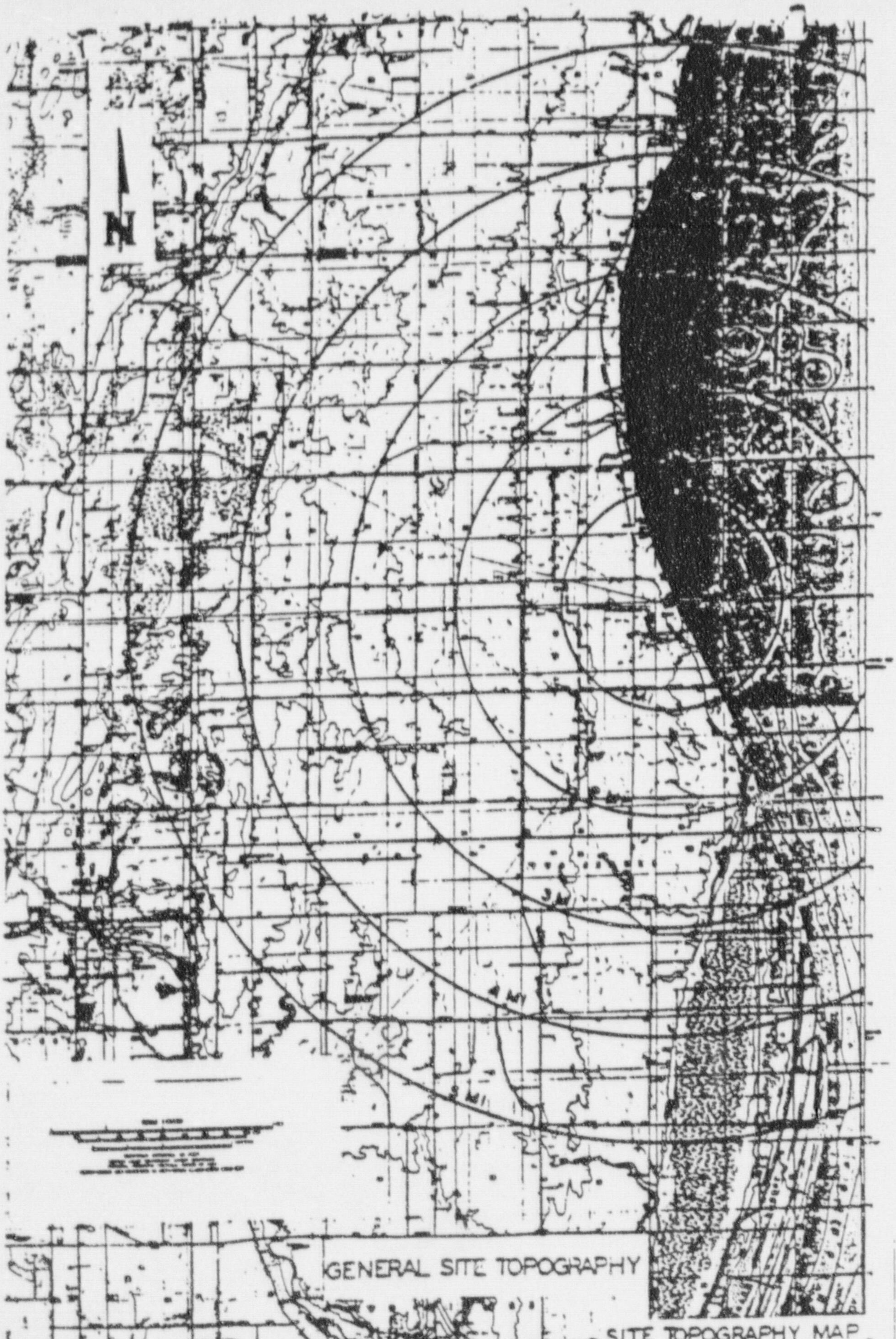
APPENDIX C

SITE MAPS



SITE PLOT

FIGURE 1



SITE TOPOGRAPHY MAP
FIG 2

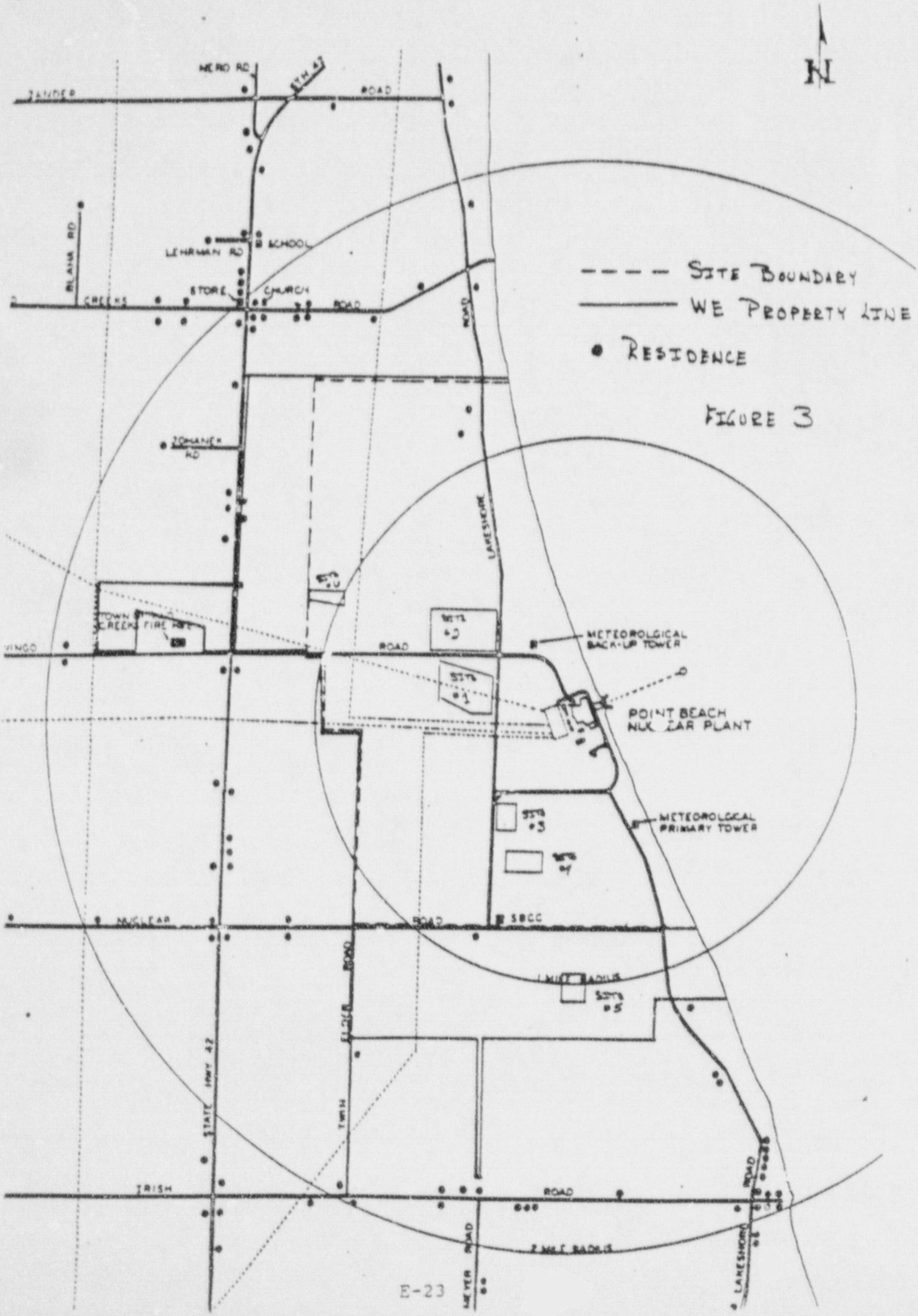

N
SITE BOUNDARY
WE PROPERTY LINE
RESIDENCE
ZANDER ROAD
HERO RD
CREEKS ROAD
LEHRMAN RD
SCHOOL
STORE
CHURCH
BLAHA RD
ZOMANEK RD
TOWN OF TWO CREEKS FIRE HSE
VINGO ROAD
LAKESHORE ROAD
METEOROLGICAL BACK-UP TOWER
POINT BEACH NUCLEAR PLANT
METEOROLGICAL PRIMARY TOWER
NUCLEAR ROAD
SBCC
1 MILE RADIUS
STATE HWY 42
TWIN ELDER ROAD
IRISH ROAD
MEYER ROAD
2 MILE RADIUS
LAKESHORE ROAD

FIGURE 3

APPENDIX D

EXPOSURE PATHWAYS

I. EXPOSURE PATHWAYS - MAXIMALLY EXPOSED INDIVIDUAL

1. External whole body exposure due to a ground plane source of radionuclides.

2. Milk ingestion pathway from cows fed alfalfa grown on plot.

3. Meat ingestion pathway from cows fed alfalfa grown on plot.

4. Vegetable ingestion pathway from vegetables grown on plot.

5. Inhalation of radioactivity resuspended in air above application site.

6. Pathways associated with a release to Lake Michigan. Ingestion of potable water at Two Rivers, Wisconsin municipal water supply, ingestion of fish from edge of initial mixing zone of radionuclide release, ingestion of fresh and stored vegetables irrigated with water source as Lake Michigan, ingestion of milk and meat from cows utilizing Lake Michigan as drinking water source, swimming and boating activities at edge of initial mixing zone, and shoreline deposits.

II. EXPOSURE PATHWAYS - INADVERTENT INTRUDER

1. External whole body exposure due to a ground plane source of radionuclides.

2. Vegetable ingestion pathway from vegetables grown on plot.

3. Inhalation of radioactivity resuspended in air above application site.

4. Pathways associated with a release to Lake Michigan. Ingestion of potable water at Two Rivers, Wisconsin municipal water supply, ingestion of fish from edge of initial mixing zone of radionuclide release, ingestion of fresh and stored vegetables irrigated with water source as Lake Michigan, ingestion of milk and meat from cows utilizing Lake Michigan as drinking water source, swimming and boating activities at edge of initial mixing zone, and shoreline deposits.

The milk and meat pathways are not included in calculating the dose to the inadvertent intruder. The doses due to these pathways are calculated based on feeding the cows alfalfa grown on the sludge applied land. Since direct grazing on these lands is prohibited, the alfalfa must be cropped prior to being used as feed. This effectively removes the availability of these pathways to the inadvertent intruder, who by definition occupies the sludge applied land continuously.

III. GROUND WATER PATHWAY

The ingestion of groundwater is not a credible exposure pathway. The two factors contributing to this determination are as follows:

1. The site map in Appendix C, Figure 3 details the spatial relationship between the proposed disposal sites and the local ground water wells. The flow gradient of ground water was determined for the PBNP FSAR to be towards Lake Michigan. Reviewing the sites and local wells shows no private well located in the path of radionuclide migration towards Lake Michigan.

   The PBNP site well is located on the plant site, potentially in a path of radionuclide migration. The PBNP well is routinely sampled as a requirement of the PBNP environmental monitoring program.

2. The cation exchange capacity (CEC) of the soils at each site has been determined.

Site	Cation Exchange Capacity (MEQ/100g)
1	16
2	11
3	11
4	10
5	8
6	9

The cation exchange capacity of soil is dependent on the valance of the radionuclides and is determined by the relation:

$$MEQ = \frac{\text{ATOMIC WEIGHT}}{\text{VALANCE}} * 1.0E-03$$

Radionuclide	Valance	CEC (MEQ/100g)
Co-60	+2	3.00E-02
Co-58	+2	2.90E-02
Cs-137	+1	1.37E-01
Mn-54	+2	2.70E-02
Cr-51	+3	1.70E-02
Cs-134	+1	1.34E-01

Using the values for Cs-137 and site 5 which has the lowest CEC, the total exchange capacity of the soil is

$$\frac{\text{1.10 grams of Cs-137}}{\text{100 grams of soil}}$$

Calculating the specific activity of Cs-137,

$$\text{Specific Activity} = \frac{3.578E+05}{T_{1/2}(\text{yrs.}) \cdot \text{ATOMIC MASS}} = \frac{3.578E+05}{30 \cdot 137}$$

$$= 87.1 \text{ Ci/gram}$$

The cation exchange capacity of the soil expressed in the number of Curies of radionuclide per 100 grams of soil is

$$\frac{95.8 \text{ Ci Cs-137}}{100 \text{ grams of soil}}$$

Since the proposed disposal of sewage sludge contains quantities of radionuclides on the order of 10-100 μCi the soil at each site has the capacity to effectively eliminate the migration of the radionuclide to ground water.

APPENDIX E

EXPOSURE ANALYSIS

GENERAL ASSUMPTIONS

1. Sewage sludge is uniformly applied over plot acreage.

2. Sewage sludge is applied to one of the 5 acre plots, site PB-03, PB-04, PB-05, or PB-06. (Assuming the smallest site size is conservative for the calculation methodology herein.)

3. Based on the sewage sludge currently stored at PBNP, the following data is used in the calculations.

Radionuclide	Sludge Volume (Gallons)	Sludge Volume (cm^3)	Activity (µCi)	Concentration (µCi/cm^3)	Ground Plane Concentration (µCi/cm^2)
Co-60	15,000	5.68E+07	13.2	2.33E-07	6.53E-08
Cs-137	15,000	5.68E+07	8.5	1.50E-07	4.21E-08

I. CALCULATION OF EXTERNAL EXPOSURES

A. Specific Assumptions

1. Conservatively assume radioactivity remains on surface of land plot. Calculation ignores any plowing or mixing of radioactivity within soil. Calculations for the proposed disposal will therefore ignore self absorption or shielding from soil.

   The external exposure at the application site due to prior disposals will be calculated utilizing the methodology in Appendix G and added to that calculated for the proposed disposal.

2. The plots are owned by Wisconsin Electric and have been approved by the Wisconsin Department of Natural Resources (DNR) as disposal sites. The land is leased and potentially farmed. Occupancy of the land can be realistically expected only during plowing, planting and harvesting. Occupancy has been estimated to be 64 hours per year.

B. Summary of Calculational Methodology

1. Calculate ground plane radionuclide concentrations in pCi/cm^2.

2. The dose from a plane of uniformly deposited radionuclides is calculated using Regulatory Guide 1.109, Revision 1, Appendix C, Formula C-2.

3. Dose rates were calculated assuming continuous occupancy then adjusted for realistic occupancy factors.

C. External Exposure Rate Calculations

The dose from a plane of uniformly deposited radionuclides is calculated using Regulatory Guide 1.109, Revision 1, Appendix C, formula C-2

$$D_j^G(r,\theta) = 8760\, S_F \sum_i C_i^G(r,\theta)\, DFG_{ij}$$

where

$D_j^G(r,\theta)$ = yearly dose

8760 = hours per year

S_F = 1.0, since no dose reduction due to residential shielding is applicable.

$C_i^G(r,\theta)$ = ground plane radionuclide concentration (pCi/m^2)

$DFG(i,j)$ = external dose factor for standing on contaminated ground as given in Table E-6 of Regulatory Guide 1.109, Revision 1.

Radionuclide	γ Dose Factor (mrem/hr per pCi/m^2)	Ground Plane Concentration ($\mu Ci/cm^2$)	Ground Plane Concentration (pCi/m^2)	γ Dose Rate (mrem/yr)
Co-60	1.70E-08	6.53E-08	6.53E+02	9.72E-02
Cs-137	4.20E-09	4.21E-08	4.21E+02	1.55E-02

TOTAL: 1.13E-01 mrem/year

These calculated dose rates assume continuous occupancy. In reality, these sites will be occupied only during plowing, planting, and harvesting. Assuming an occupancy of 2 hours per day, 1 day per week, and 32 weeks (8 month growing season) per year, the occupancy factor becomes

2 hr/day * 1 day/week * 32 weeks/yr * 1/8760 hours/yr = 7.3E-03.

EXTERNAL EXPOSURE DOSE RATE (mrem/year)

Radionuclide	Continuous Occupancy	Realistic Occupancy
Co-60	9.72E-02	7.10E-04
Cs-137	1.55E-02	1.13E-04
TOTAL:	1.13E-01	8.23E-04

II. CALCULATION OF MEAT AND MILK INGESTION PATHWAY EXPOSURES

A. Specific Assumptions

1. All feed consumed by cow is grown on sludge applied acreage.

2. All meat and milk consumed by human is from cattle exclusively fed feed from sludge applied land.

3. Stable element transfer coefficients (B_{iv}) are utilized from Regulatory Guide 1.109 to estimate the fraction of radioactivity which is transferred from the soil to the feed.

Radionuclide	B_{iv}
Co-60	9.4E-03
Cs-137	1.0E-02

4. Alfalfa has typically been grown on the plots. Soil tests have indicated a minimum alfalfa yield of 4.1 tons per acre can be expected.

B. Summary of Calculational Methodology

1. The concentration of radionuclides in feed grown on the disposal plots is estimated. Transfer coefficients (B_{iv}) from Table E-1 of Regulatory Guide 1.109 were used to estimate the fraction of radionuclide which may be expected to transfer to the feed from the soil.

2. Concentrations of radionuclides in milk and meat were estimated using Formula A-11 from Regulatory Guide 1.109.

3. Ingestion dose rates were estimated using Formula A-12 from Regulatory Guide 1.109.

C. Milk and Meat Ingestion Pathway Dose Rate Calculation

1. Concentration in feed.

Activity in Feed = B_{iv} * Activity in Soil

Concentration in Feed = Activity in Feed/($\frac{\text{kg of Feed}}{\text{Acre}}$ * 5 Acres)

Radionuclide	Activity in Soil (μCi)	Activity in Feed (μCi)	Radionuclide Concentration in Feed (pCi/kg)
Co-60	13.2	1.24E-01	6.67E+00
Cs-137	8.5	8.50E-02	4.57E+00

2. Concentration in Milk and Meat

Calculate concentrations of radionuclides in milk and meat using

Formula A-11 in Regulatory Guide 1.109, Revision 1 which is

$$C_{iA} = F_{iA}*C_{iF}*Q_F$$

where C_{iA} = radionuclide concentration of i in component A
F_{iA} = stable element transfer coefficient whose values are in Table E-1 of the Regulatory Guide
C_{iF} = radionuclide concentration in feed
Q_F = consumption rate of feed = 50 kg/d (wet weight) from Regulatory Guide 1.109

Use the following Regulatory Guide 1.109 values for F_{iA}

Element	$F_{iA}=F_m$ (d/l) for milk	$F_{iA}=F_f$ (d/kg) for meat
Co	1.0E-03	1.3E-02
Cs	1.2E-02	4.0E-03

Radionuclide	Concentration in Milk (pCi/l)	Concentration in Meat (pCi/kg)
Co-60	3.34E-01	4.34E+00
Cs-137	2.74E+00	9.14E-01

3. Calculated Dose rates

The formula for total dose from eating animal products fed vegetation (alfalfa) grown on PBNP sludge applied land is given in Regulatory Guide 1.109, Revision 1, Formula A-12, page 1.109-16. But, as noted following equation A-13, it is necessary to compute separately the milk and meat portions of the dose.

$$DOSE = \Sigma(U_{ap}*D_{iapg}*\exp(-\lambda_i t_s))$$

where U_{ap} = consumption rate of animal product
C_{iA} = conc of radionuclide i in animal product A
D_{iapg} = dose factor
t_s = average time between milking or slaughtering and consumption

	U_{ap} by Age Group			
	Infant	Child	Teenager	Adult
Milk (l/yr)	330	330	400	310
Meat (kg/yr)	-	41	65	110

C_{iA} = concentration calculated above

D_{iapg} = DF whole body dose factors, Regulatory Guide 1.109, Revision 1.

Whole Body Dose Factors (mrem/pCi Ingested)

Nuclide	Infant Ingestion	Child Ingestion	Teenager Ingestion	Adult Ingestion
Co-60	2.55E-05	1.56E-05	6.33E-06	4.72E-06
Cs-137	4.33E-05	4.62E-05	5.19E-05	7.14E-05

T_s = 0 for milk (assume consumption on farm)
= 20 days for meat (Regulatory Guide 1.109, Revision 1, Table E-15)

MILK INGESTION DOSE RATE (mrem/year)

Radionuclide	Infant	Child	Teenager	Adult
Co-60	2.81E-03	1.72E-03	8.46E-04	4.89E-04
Cs-137	3.92E-02	4.18E-02	5.69E-02	6.06E-02
TOTALS:	4.20E-02	4.35E-02	5.77E-02	6.11E-02

MEAT INGESTION DOSE RATE (mrem/year)

Radionuclide	Infant	Child	Teenager	Adult
Co-60	-	2.76E-03	1.77E-03	2.24E-03
Cs-137	-	1.73E-03	3.08E-03	7.18E-03
TOTALS:	-	4.49E-03	4.85E-03	9.42E-03

MEAT AND MILK INGESTION PATHWAY DOSE RATES (mrem/year)

Infant - 4.20E-02
Child - 4.80E-02
Teenager - 6.26E-02
Adult - 7.05E-02

III. CALCULATION OF VEGETABLE INGESTION PATHWAY EXPOSURES

A. Specific Assumptions

1. The WPDES permit issued to PBNP for the disposal of sewage sludge prohibits the growing of crops for human consumption for one year following the application of the sewage sludge. Therefore, prior to planting vegetables on the application site, the soil would be plowed. Plowing is assumed to uniformly mix the top 6 inches of soil.

2. The soil density is assumed to be 1.3 grams/cm³.

3. All vegetables consumed by the individual of interest are grown on the sludge applied acreage.

4. Stable element transfer coefficients (B_{iv}) from Regulatory Guide 1.109 are used to estimate the fraction of radioactivity transfered from the soil to the vegetables.

Radionuclide	B_{iv}
Co-60	9.4E-03
Cs-137	1.0E-02

5. The consumption factors of food medium (U_{ap}) and the mass basis distributions from Regulatory Guide 1.109, Table E-5 are used to determine annual consumption of vegetables.

U_{ap} by Age Group*

Infant	Child	Teen	Adult
-	280 kg/yr	340 kg/yr	280 kg/yr

*Based on 54% vegetable consumption by mass of fruit, vegetable, and grain.

6. The Ingestion Dose Factors by age group are from Regulatory Guide 1.109, Tables E-11, E-12, E-13, and E-14.

Whole Body Ingestion Dose Factors (mrem/pCi ingested)

Radionuclide	Infant	Child	Teen	Adult
Co-60	2.55E-05	1.56E-05	6.33E-06	4.72E-06
Cs-137	4.33E-05	4.62E-05	5.19E-05	7.14E-05

7. Radiological decay of the radionuclides applied to the plot is not taken into account in these calculations.

B. Summary of Calculational Methodology

1. The radionuclide concentration in the soil is calculated in units of pCi/kg based on uniform application over 5 acre plot, plowing to a depth of 6 inches, and a soil density of 1.3 g/cm³.

2. The B_{iv} values are applied to the soil concentration values to obtain the radionuclide concentration in the vegetables.

3. The consumption factors (U_{ap}) for each age group are then used to determine the annual radionuclide intake by age group due to eating these vegetables.

4. Finally, the age dependent ingestion dose factors are used to obtain annual doses by age group.

C. Vegetable Pathway Ingestion Dose Rate Calculations

1. Concentration in soil

Radionuclide	Activity Applied (µCi)	Soil Volume (cm^3)	Soil Mass (kg)	Concentration In Soil (pCi/kg)
Co-60	13.2	3.08E+09	4.00E+06	3.30E+00
Cs-137	8.5	3.08E+09	4.00E+06	2.13E+00

2. Concentration in vegetables

Radionuclide	Concentration In Soil (pCi/kg)	B_{iv}	Concentration In Vegetables (pCi/kg)
Co-60	3.30E+00	9.4E-03	3.10E-02
Cs-137	2.13E+00	1.0E-02	2.13E-02

3. Calculated Dose Rates

The dose rate for direct ingestion of vegetables grown on the sludge applied land is given by the equation.

$$\text{DOSE RATE} = \Sigma\, U_{ap} * D_{iapj} * \text{EXP}\,(-\lambda_i t) * C_i$$

where

U_{ap} = consumption rate of food medium
D_{iapj} = dose factor for radionuclide, i
λ_i = radiological decay constant
t = time between harvest and consumption
C_i = concentration of radionuclide, i, in food medium.

t, the time between harvest and ingestion, is assumed to be zero for this calculation.

VEGETABLE INGESTION DOSE RATE (mrem/year)

Radionuclide	Infant	Child	Teen	Adult
Co-60	-	1.35E-04	6.67E-05	4.10E-05
Cs-137	-	2.75E-04	3.76E-04	4.26E-04
TOTAL	-	4.11E-04	4.43E-04	4.67E-04

IV. CALCULATION OF INHALATION OF RESUSPENDED RADIONUCLIDES PATHWAY EXPOSURE

A. Specific Assumptions

1. The model used to determine the radionuclide concentration in air above the sludge applied land is taken from WASH-1400, USNRC, Reactor Safety Study - An Assessment of Accident Risks in Commercial Nuclear Power Plants, Appendix VI.

2. The radionuclide concentration in air remains constant for year of interest, i.e., radiological decay and decrease in resuspension factor are not taken into account for this calculation.

3. The maximally exposed member of the general public is assumed to be the farmer using the plot of land with an occupancy of 64 hours per year.

4. The inadvertent intruder is assumed to occupy the plot of land for the entire year.

5. The Inhalation Dose Factors by age group are from Regulatory Guide 1.109, Tables E-7, E-8, E-9, and E-10.

WHOLE BODY INHALATION DOSE FACTORS (mrem/pCi inhaled)

Radionuclide	Infant	Child	Teen	Adult
Co-60	8.41E-06	6.12E-06	2.48E-06	1.85E-06
Cs-137	3.25E-05	3.47E-05	3.89E-05	5.35E-05

LUNG INHALATION DOSE FACTORS (mrem/pCi inhaled)

Radionuclide	Infant	Child	Teen	Adult
Co-60	3.22E-03	1.91E-03	1.09E-03	7.46E-04
Cs-137	5.09E-05	2.81E-05	1.51E-05	9.40E-06

6. The age dependent inhalation rates are obtained from Regulatory Guide 1.109, Table E-5.

Inhalation Rates (m^3/yr)

Infant	Child	Teen	Adult
1400	3700	8000	8000

B. Summary of Calculational Methodology

1. The ground plane radionuclide concentrations in pCi/m^2.

2. Calculate the resuspension factor utilizing equation given in WASH-1400.

3. Obtain the radionuclide concentration in air (pCi/m^3) above plot utilizing methodology in WASH-1400.

4. Using parameters contained in Regulatory Guide 1.109, calculate annual dose for continuous occupancy and for realistic occupancy.

C. Inhalation of Resuspended Radionuclides in Air Pathway Dose Rate Calculations - Resuspension of Radionuclide in Air

1. Ground plane radionuclide concentration

Radionuclide	Ground Plane Concentration ($\mu Ci/cm^2$)	Ground Plane Concentration (pCi/m^2)
Co-60	6.53E-08	6.53E+02
Cs-137	4.21E-08	4.21E+02

2. Calculation of resuspension factor, K (m^{-1})

From WASH-1400,
K(t) = 1.0E-09 + 1.0E-05 * EXP [-0.6769 * t]

where t = time since radionuclides were deposited on ground surface.

t is assumed to be 0 for these calculations, thereby maximizing the resuspension factor.

Therefore,

K = 1.0E-05 m^{-1}

3. Calculate radionuclide concentration (pCi/m^3) in air.

From WASH-1400,

$$K(m^{-1}) = \frac{\text{air concentration } (pCi/m^2)}{\text{surface deposit } (pCi/m^2)}$$

or

Air Concentration (pCi/m^3) = surface deposit (pCi/m^2) * K(m^{-1})

AIR CONCENTRATIONS

Radionuclide	Air Concentrations (pCi/m^3)
Co-60	6.53E-03
Cs-137	4.21E-03

4. Dose Rate Calculations

Dose Rate (mrem/yr) = Inhalation Rate (m^3/yr) * Air Conc. (pCi/m^3) * Dose Conversion Factor (mrem/pCi)

WHOLE BODY INHALATION DOSE RATE (mrem/year)

Radionuclide	Infant	Child	Teen	Adult
Co-60	7.69E-05	1.48E-04	1.30E-04	9.66E-05
Cs-137	1.92E-04	5.41E-04	1.31E-03	1.80E-03
TOTAL	2.69E-04	6.89E-04	1.44E-03	1.90E-03

LUNG INHALATION DOSE RATE (mrem/year)

Radionuclide	Infant	Child	Teen	Adult
Co-60	2.94E-02	4.61E-02	5.69E-02	3.90E-02
Cs-137	3.00E-04	4.38E-04	5.09E-04	3.17E-04
TOTAL	2.97E-02	4.65E-02	5.74E-02	3.93E-02

INHALATION OF RESUSPENDED RADIONUCLIDES IN AIR DOSE RATES

WHOLE BODY DOSE RATE (mrem/year)

Occupancy	Infant	Child	Teen	Adult
Continuous	2.69E-04	6.89E-04	1.44E-03	1.90E-03
Realistic	1.96E-06	5.03E-06	1.05E-05	1.39E-05

LUNG DOSE RATE (mrem/year)

Occupancy	Infant	Child	Teen	Adult
Continuous	2.97E-02	4.65E-02	5.74E-02	3.93E-02
Realistic	2.17E-04	3.39E-04	4.19E-04	2.87E-04

V. CALCULATION OF WHOLE BODY EXPOSURES DUE TO RELEASE TO LAKE MICHIGAN

A. Specific Assumptions

1. The methodology contained in the PBNP Offsite Dose Calculation Manual (ODCM) is used to perform this calculation.

2. The entire activity contained in the sludge is released into Lake Michigan.

3. The exposure pathways addressed by the ODCM methodology are ingestion of potable water from Two Rivers, WI water supply, ingestion of fish at edge of initial mixing zone, ingestion of fresh and stored vegetables, irrigated with Lake Michigan as source of water, ingestion of milk and meat from cows utilizing Lake Michigan as drinking water source, swimming and boating activities at edge of initial mixing zone, and shoreline deposits.

B. Summary of Calculational Methodology

1. The activity released in the sludge is converted into Co-60 dose equivalent Curies.

2. The annual design release limit from the ODCM is 94.7 Co-60 equivalent curies.

3. The annual design release limit is based on a limiting dose of 6 mrem adult whole body. The annual dose due to sewage sludge is calculated by a ratio of calculated release compared to release limit.

C. Whole Body Exposure Calculations

1. Co-60 equivalent Curies

Radionuclide	Activity (μCi)	DF_i/DF_{Co-60}	Co-60 eq. Activity (μCi)
Co-60	13.2	1.00E+00	13.2
Cs-137	8.5	1.51E+01	128.4
		TOTAL	141.6μCi Co-60 equivalent

2. Ratio of dose limit to annual design release limit

$$\frac{6 \text{ mrem}}{94.7 \text{ Co-60 equivalent curies}}$$

3. Whole Body Dose Calculation

$$\frac{\text{Dose}}{141.6\mu\text{Ci}} = \frac{6 \text{ mrem}}{94.7\times10^6\mu\text{Ci}}$$

Dose = 8.97E-06 mrem

WHOLE BODY DOSE RATE (mrem/year)

DOSE SUMMARY

Maximally Exposed Individual

The identified credible exposure pathways for the maximally exposed individual are:

1.) External exposure from ground plane source (realistic occupancy)
2.) Milk ingestion pathway
3.) Meat ingestion pathway
4.) Vegetable ingestion pathway
5.) Resuspension inhalation pathway (realistic occupancy)
6.) Pathways identified due to release to Lake Michigan.

	AGE GROUP			
Pathway	Infant	Child	Teen	Adult
External	8.23E-04	8.23E-04	8.23E-04	8.23E-04
Milk	4.20E-02	4.35E-02	5.77E-02	6.11E-02
Meat	-	4.49E-03	4.85E-03	9.42E-03
Vegetable	-	4.11E-04	4.43E-04	4.67E-04
Inhalation	1.96E-06	5.03E-06	1.05E-05	1.39E-05
Water	8.97E-06	8.97E-06	8.97E-06	8.97E-06
TOTAL: (mrem/year)	0.043	0.049	0.064	0.072

Inadvertent Intruder

The identified credible exposure pathways for the inadvertent intruder are:

1.) External exposure from ground plane source (continuous occupancy)
2.) Vegetable ingestion pathway
3.) Resuspension inhalation pathway (continuous occupancy)
4.) Pathways identified due to release to Lake Michigan.

	AGE GROUP			
Pathway	Infant	Child	Teen	Adult
External	1.13E-01	1.13E-01	1.13E-01	1.13E-01
Vegetable	-	4.11E-04	4.43E-04	4.67E-04
Inhalation	2.96E-04	6.89E-04	1.44E-03	1.90E-03
Water	8.97E-06	8.97E-06	8.97E-06	8.97E-06
TOTAL: (mrem/year)	0.113	0.114	0.115	0.115

Reviewing these tables, the calculated limiting doses for both the maximally exposed individual and the inadvertent intruder occur for the adult age group. These doses are:

Maximally Exposed Individual:	0.072 mrem/year
Inadvertent Intruder:	0.115 mrem/year

APPENDIX F

BASIS FOR SETTING CONCENTRATION LIMITS AND ACTIVITY LIMIT FOR DISPOSAL OF SLUDGE

Analyses of previously disposed sewage sludge have identified six different radionuclides in the sludge. All six radionuclides did not occur in each disposal. Therefore, it is difficult to determine a single concentration limit for regulating the disposal of the sludge from the storage tanks.

To provide a basis to regulate the disposal of the sewage sludge based on identified radionuclide concentrations, the following relation is proposed.

$$\sum_{i=1}^{N} \frac{C_i}{0.1 * MPC_i} \leq 1$$

where

N = number of different radionuclides identified in the sewage sludge.

C_i = concentration of the ith radionuclide in the sewage sludge.

MPC_i = the MPC value of the ith radionuclide in the sewage sludge, as listed in 10 CFR Part 20 Appendix B, Table II, Column 2.

If this criteria is met, the sewage sludge may be disposed of by land spreading provided the dose calculations (as identified in Appendix E) indicate dose rates within the prescribed limits.

The attachment to this Appendix details calculations performed to determine doses from four radionuclides identified in the sludge. The calculations are based on an identified concentration equal to 10% of the 10 CFR Part 20, Appendix B, Table II, Column 2 valves. The calculations use the methodology in Appendix E along with the exposure pathways identified in Appendix D to determine the dose rates. These calculations indicate the use of this methodology will maintain radiation doses within the appropriate limits.

The maximum allowable activity disposed of per year per acre is calculated utilizing 10% of the MPC value, 10 CFR Part 20, Appendix B, Table II, Column 2, for Co-58. Volume limit per acre has been proposed at 4,000 gallons/acre/year. Then,

$$1.0E\text{-}05\ \mu Ci/cc * 4{,}000\ gallons/acre/year \times 3.785.43\ cc/gallon$$
$$= 151.4\ \mu Ci/acre/year$$

Cs-134

Concentration in Sludge: 9.0E-07 mCi/ml

Sludge Volume (Gallons)	Sludge Volume (cm^3)	Concentration ($\mu Ci/cm^3$)	Activity (μCi)	Ground Plane Concentration ($\mu Ci/cm^2$)
15000	5.[illegible]+07	9.00E-07	5.11E+01	2.53E-07

External Exposure

γ Dose Factor (mrem/hr. per pCi/m^2)	Ground Plane Concentration (pCi/m^2)	γ Dose Rate (mrem/year)
1.20E-08	2.53E+03	2.66E-01

Continuous Occupancy: 2.66E-01 mrem/year
Realistic Occupancy: 1.94E-03 mrem/year

Meat & Milk Pathway

Activity in Soil (μCi)	Activity in Feed (μCi)	Concentration in Feed (pCi/Kg)	Concentration in Milk (pCi/ℓ)	Concentration in Meat (pCi/kg)
5.22E+01	5.11E-01	2.75E+01	1.65E+01	5.50E+00

Milk Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
3.87E-01	4.41E-01	6.03E-01	6.19E-01

Meat Dose Rate (mrem/year)

Infant	Child	Teenager	Adult
-	1.83E-02	3.27E-02	7.32E-02

Vegetable Pathway

Activity (μCi)	Soil Volume (Cm^3)	Soil Mass (Kg)	Concentration in Soil (pCi/Kg)	Concentration in Vegetables (pCi/Kg)
5.11E+01	3.08E+09	4.00E+06	1.28E+01	1.28E-01

Vegetable Pathway Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
-	2.90E-03	3.98E-03	4.34E-03

Inhalation Pathway

Ground Plane Concentration (pCi/m^2)	K_1 (m^{-1})	Air Concentration (pCi/m^3)
2.53E+03	1.0E-05	2.53E-02

Inhalation Pathway Dose Rates (mrem/year)

	Infant	Child	Teenager	Adult
Continuous Occupancy	1.88E-03	5.68E-03	1.39E-02	1.84E-02
Realistic Occupancy	1.38E-05	4.15E-05	1.01E-04	1.35E-04

Release to Lake Michigan

Activity (µCi)	DF_i/DF_{Co-60}	Co-60 eq. activity (µCi)
5.11E+01	2.56E+01	1.31E+03

$$\frac{6\ \text{mrem}}{94.7\ \text{Ci}} * 1.31\text{E+03} * \frac{1\ \text{Ci}}{1.0\text{E+06}\ \mu\text{Ci}} = 8.29\text{E-05 mrem}$$

Maximally Exposed Individual

	Infant	Child	Teenager	Adult
External	1.94E-03	1.94E-03	1.94E-03	1.94E-03
Milk	3.87E-01	4.41E-01	6.03E-01	6.19E-01
Meat	-	1.83E-02	3.27E-02	7.32E-02
Vegetable	-	2.90E-03	3.98E-03	4.34E-03
Inhalation	1.38E-05	4.15E-05	1.01E-04	1.35E-04
Water	8.29E-05	8.29E-05	8.29E-05	8.29E-05
Totals:	3.89E-01	4.64E-01	6.42E-01	6.99E-01

Inadvertent Intruder

	Infant	Child	Teenager	Adult
External	2.66E-01	2.66E-01	2.66E-01	2.66E-01
Vegetable	-	2.90E-03	3.98E-03	4.34E-03
Inhalation	1.88E-03	5.68E-03	1.39E-02	1.84E-02
Water	8.29E-05	8.29E-05	8.29E-05	8.29E-05
Totals:	2.68E-01	2.75E-01	2.84E-01	2.89E-01

Cs-137

Concentration in Sludge: 2.0E-06 µCi/ml

Sludge Volume (Gallons)	(cm³)	Concentration (µCi/cm³)	Activity (µCi)	Ground Plane Concentration (µCi/cm²)
15000	5.68E+07	2.00E-06	1.14E+02	5.62E-07

External Exposure

γ Dose Factor (mrem/hr. per pCi/m²)	Ground Plane Concentration (pCi/m²)	γ Dose Rate (mrem/year)
4.20E-09	5.62E+03	2.07E-01

Continuous Occupancy: 2.07E-01 mrem/year
Realistic Occupancy: 1.51E-03 mrem/year

Meat & Milk Pathway

Activity in Soil (µCi)	Activity in Feed (µCi)	Concentration in Feed (pCi/Kg)	Concentration in Milk (pCi/ℓ)	Concentration in Meat (pCi/kg)
1.14E+02	1.14E+00	6.13E+01	3.68E+01	1.23E+01

Milk Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
5.26E-00	5.61E-01	7.64E-01	8.15E-01

Meat Dose Rate (mrem/year)

Infant	Child	Teenager	Adult
-	2.33E-02	4.15E-02	9.56E-02

Vegetable Pathway

Activity (µCi)	Soil Volume (Cm³)	Soil Mass (Kg)	Concentration in Soil (pCi/Kg)	Concentration in Vegetables (pCi/Kg)
1.14E+02	3.08E+09	4.00E+06	2.85E+01	2.85E-01

Vegetable Pathway Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
-	3.69E-03	5.03E-03	5.70E-03

Inhalation Pathway

Ground Plane Concentration (pCi/m²)	K (m^{-1})	Air Concentration (pCi/m³)
5.62E+03	1.0E-05	5.62E-02

Inhalation Pathway Dose Rates (mrem/year)

	Infant	Child	Teenager	Adult
Continuous Occupancy	2.56E-03	7.22E-03	1.75E-02	2.41E-02
Realistic Occupancy	1.87E-05	5.27E-05	1.28E-04	1.76E-04

Release to Lake Michigan

Activity (μCi)	DF_i/DF_{Co-60}	Co-60 eq. activity (μCi)
1.14E+02	1.51E+01	1.72E+03

$$\frac{6\ \text{mrem}}{94.7\ \text{Ci}} * 1.72E{+}03 * \frac{1\ \text{Ci}}{1.0E{+}06\ \mu\text{Ci}} = 1.09E{-}04\ \text{mrem}$$

Maximally Exposed Individual

	Infant	Child	Teenager	Adult
External	1.51E-03	1.51E-03	1.51E-03	1.51E-03
Milk	5.26E-01	5.61E-01	7.64E-01	8.15E-01
Meat	-	2.33E-02	4.15E-02	5.70E-03
Vegetable	-	3.69E-03	5.03E-03	5.70E-03
Inhalation	1.87E-05	5.27E-05	1.28E-04	1.76E-04
Water	1.09E-04	1.09E-04	1.09E-04	1.09E-04
Totals:	5.28E-01	5.90E-01	8.12E-01	9.19E-01

Inadvertent Intruder

	Infant	Child	Teenager	Adult
External	2.07E-01	2.07E-01	2.07E-01	2.07E-01
Vegetable	-	3.69E-03	5.03E-03	5.70E-03
Inhalation	2.56E-03	7.22E-03	1.75E-02	2.41E-02
Water	1.09E-04	1.09E-04	1.09E-04	1.09E-04
Totals:	2.10E-01	2.18E-01	2.30E-01	2.37E-01

Co-58

Concentration in Sludge: 1.00E-05 µCi/ml

Sludge Volume (Gallons)	Sludge Volume (cm^3)	Concentration ($\mu Ci/cm^3$)	Activity (μCi)	Ground Plane Concentration ($\mu Ci/cm^2$)
15000	5.68E+07	1.00E-05	5.68E+02	2.81E-06

External Exposure

γ Dose Factor (mrem/hr. per pCi/m^2)	Ground Plane Concentration (pCi/m^2)	γ Dose Rate (mrem/year)
7.00E-09	2.81E+04	1.72E+00

Continuous Occupancy: 1.72E+00 mrem/year
Realistic Occupancy: 1.26E-02 mrem/year

Meat & Milk Pathway

Activity in Soil (µCi)	Activity in Feed (µCi)	Concentration in Feed (pCi/Kg)	Concentration in Milk (pCi/ℓ)	Concentration in Meat (pCi/kg)
5.68E+02	5.34E+00	2.87E+02	1.44E+01	1.87E+02

Milk Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
4.27E-02	2.62E-02	1.29E-02	7.45E-03

Meat Dose Rate (mrem/year)

Infant	Child	Teenager	Adult
-	4.22E-02	2.72E-02	3.44E-02

Vegetable Pathway

Activity (µCi)	Soil Volume (Cm^3)	Soil Mass (Kg)	Concentration in Soil (pCi/Kg)	Concentration in Vegetables (pCi/Kg)
5.68E+02	3.08E+09	4.0[illegible]E+06	1.42E-04	1.33E+00

Vegetable Pathway Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
-	2.05E-03	1.01E-03	6.22E-04

Inhalation Pathway

Ground Plane Concentration (pCi/m²)	K_1 (m^{-1})	Air Concentration (pCi/m³)
2.81E+04	1.0E-05	2.81E-01

Inhalation Pathway Dose Rates (mrem/year)

	Infant	Child	Teenager	Adult
Continuous Occupancy	5.11E-04	8.89E-04	7.80E-04	5.82E-04
Realistic Occupancy	3.74E-06	6.49E-06	5.70E-06	4.25E-06

Release to Lake Michigan

Activity (µCi)	DF_i/DF_{Co-60}	Co-60 eq. activity (µCi)
5.68E+02	3.54E-01	2.01E+02

$$\frac{6\ \text{mrem}}{94.7\ \text{Ci}} * 2.01E{+}02\ \mu\text{Ci} * \frac{1\ \text{Ci}}{1.0E{+}06\ \mu\text{Ci}} = 1.27E{-}05\ \text{mrem}$$

Maximally Exposed Individual

	Infant	Child	Teenager	Adult
External	1.26E-02	1.26E-02	1.26E-02	1.26E-02
Milk	4.27E-02	2.62E-02	1.29E-02	7.45E-03
Meat	-	4.22E-02	2.72E-02	3.44E-02
Vegetable	-	2.05E-03	1.01E-03	6.22E-04
Inhalation	3.74E-06	6.49E-06	5.70E-06	4.25E-06
Water	1.27E-05	1.27E-05	1.27E-05	1.27E-05
Totals:	5.53E-02	8.31E-02	5.37E-02	5.51E-02

Inadvertent Intruder

	Infant	Child	Teenager	Adult
External	1.72E+00	1.72E+00	1.72E+00	1.72E+00
Vegetable	-	2.05E-03	1.01E-03	6.22E-04
Inhalation	5.11E-04	8.89E-04	7.80E-04	5.82E-04
Water	1.27E-05	1.27E-05	1.27E-05	1.27E-05
Totals:	1.72E+00	1.72E+00	1.72E+00	1.72E+00

Co-60

Concentration in Sludge: 5.0E-06 μCi/ml

Sludge Volume (Gallons)	(cm³)	Concentration (μCi/cm³)	Activity (μCi)	Ground Plane Concentration (μCi/cm²)
15000	5.68E+07	5.00E-06	2.84E+02	1.41E-06

External Exposure

γ Dose Factor (mrem/hr. per pCi/m²)	Ground Plane Concentration (pCi/m²)	Dose Rate (mrem/year)
1.70E-08	1.41E+04	2.09E+00

Continuous Occupancy: 2.09E+00 mrem/year
Realistic Occupancy: 1.53E-02 mrem/year

Meat & Milk Pathway

Activity in Soil (μCi)	Activity in Feed (μCi)	Concentration in Feed (pCi/Kg)	Concentration in Milk (pCi/ℓ)	Concentration in Meat (pCi/kg)
2.84E+02	2.67E+00	1.44E+02	7.18E+00	9.33E+01

Milk Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
6.04E-02	3.70E-02	1.82E-02	1.05E-02

Meat Dose Rate (mrem/year)

Infant	Child	Teenager	Adult
-	5.97E-02	3.84E-02	4.84E-02

Vegetable Pathway

Activity (μCi)	Soil Volume (Cm³)	Soil Mass (Kg)	Concentration in Soil (pCi/Kg)	Concentration in Vegetables (pCi/Kg)
2.84E+02	3.08E+09	4.00E+06	7.10E+01	6.67E-01

Vegetable Pathway Dose Rates (mrem/year)

Infant	Child	Teenager	Adult
-	2.91E-03	1.44E-03	8.82E-04

Inhalation Pathway

Ground Plane Concentration (pCi/m²)	K_1 (m^{-1})	Air Concentration (pCi/m³)
1.41E+04	1.0E-05	1.41E-01

Inhalation Pathway Dose Rates (mrem/year)

	Infant	Child	Teenager	Adult
Continuous Occupancy	1.66E-03	3.19E-03	2.80E-03	2.09E-03
Realistic Occupancy	1.21E-05	2.33E-05	2.05E-05	1.53E-05

Release to Lake Michigan

Activity (μCi)	DF_i/DF_{Co-60}	Co-60 eq. activity (μCi)

$$\frac{6\ \text{mrem}}{94.7\ \text{Ci}} * 2.84E{+}02\,\mu\text{Ci} * \frac{1\ \text{Ci}}{1.0E{+}06\ \mu\text{Ci}} = 1.80E{-}05\ \text{mrem}$$

Maximally Exposed Individual

	Infant	Child	Teenager	Adult
External	1.53E-02	1.53E-02	1.53E-02	1.53E-02
Milk	6.04E-02	3.70E-02	1.82E-02	1.05E-02
Meat	-	5.97E-02	3.84E-02	4.84E-02
Vegetable	-	2.91E-03	1.44E-03	8.82E-04
Inhalation	1.21E-05	2.33E-05	2.05E-05	1.53E-05
Water	1.80E-05	1.80E-05	1.80E-05	1.80E-05
Totals:	7.57E-02	1.15E-01	7.34E-02	7.51E-02

Inadvertent Intruder

	Infant	Child	Teenager	Adult
External	2.09E+00	2.09E+00	2.09E+00	2.09E+00
Vegetable	-	2.91E-03	1.44E-03	8.82E-04
Inhalation	1.66E-03	3.19E-03	2.80E-03	2.09E-03
Water	1.80E-05	1.80E-05	1.80E-03	1.80E-03
Totals:	2.09E+00	2.10E+00	2.10E+00	2.09E+00