Attachment 2

LACBWR Offsite Dose Calculation Manual
Revision 2

LACROSSE SOLUTIONS

LACBWR Site Restoration Project Work Control Procedure

Offsite Dose Calculation Manual

Procedure No. LC-RP-PG-005

Revision No. 2

Preparer Joe Jacobsen	Joseph O. Jacobsen	Date:	2/14/2017
Secondary Reviewer Greg Peterschmidt		Date:	2/15/2017

Regulatory Required Reviews (attach completed LC-RA-PR-001 and QTR forms, as applicable)		
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Summary of Changes:

1) Minor formatting changes that did not affect the technical content of this procedure.

2) Made changes to document to make it consistent with other related environmental program and procedural documents.

3) Added discussion of assumptions and method used to calculate dose from ground level airborne releases, since the stack is no longer used for releases.

1. PURPOSE AND SCOPE

1.1. Purpose

The Offsite Dose Calculation Manual (ODCM) contains the methodology, parameters and descriptions for the calculation of offsite doses resulting from direct exposures, radioactive liquid effluents and airborne particulate effluents released during LaCrosse Boiling Water Reactor (LACBWR) Decommissioning activities. Reporting requirements in the ODCM, the Radioactive Effluent Control Program, and the Radiological Environmental Monitoring Program are described. This procedure describes routine and special reports that must be submitted to the Nuclear Regulatory Commission (NRC).

1.2. Scope

This procedure applies to those personnel responsible for performing any of the actions related to the ODCM including effluent control, radiological environmental monitoring and those personnel who prepare any reports in this procedure.

2. REFERENCES

2.1. Nuclear Regulatory Commission (NRC), Title 10, Part 100, Reactor Site Criteria

2.2. NRC, Title 10, Part 20, Standards for Protection Against Radiation, Appendix B, Table 2, Columns 1 and 2

2.3. NRC, Regulatory Guide 1.109, Rev. 1, Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I

2.4. NRC, Title 10, Part 50.36a, Technical Specifications on Effluents from Nuclear Power Reactors

2.5. NRC, Title 10, Part 50, Domestic Licensing of Production and Utilization Facilities, Appendix I

2.6. Environmental Protection Agency (EPA), Title 40, Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations

2.7. NRC, NUREG-0473, Rev. 2, Draft Radiological Effluent Technical Specifications

2.8. NRC, Regulatory Guide 1.21, Rev. 1, Measuring, Evaluating, and Reporting Radioactive Material in Liquid and Gaseous Effluents and Solid Waste

2.9. NRC, NUREG 1302, Offsite Dose Calculation Manual Guidance: Radiological Effluent Controls for Boiling Water Reactors

2.10. LaCrosse*Solutions* Procedure LC-RP-PR-007, LACBWR Environmental Monitoring Program

2.11. LaCrosse*Solutions* Procedure LC-RP-TSD-002, Calculation of Liquid Effluent Maximum Permissible Concentration Values

2.12. LaCrosse*Solutions* procedure LC-OP-PR-001, LaCrosse Mobile LWP System Operating Procedure

2.13. LaCrosse*Solutions* procedure LC-RP-TSD-001, Dose to members of the Public from Onsite Radiation Sources

2.14. LaCrosse*Solutions* procedure LC-RP-PR-026, Radiological Air Sampling Process Job Specific General Air Monitoring

3. GENERAL

3.1. Definitions

3.1.1 Effluent Release Boundary - The Dairyland Power Cooperative property line within the 1109-feet (338-meter) radius Exclusion Area is the Effluent Release Boundary (See Figure 5.1.)

3.1.2 Exclusion Area - The Exclusion Area is defined as the area within an 1109-feet (338-meter) radius from the centerline of the Reactor Building. This was the area established per 10 CFR 100 (Reference 2.1) as the Exclusion Area for plant siting and operation.

3.1.3 Maximum Permissible Concentration (MPC) - The limiting liquid effluent concentration value in 10 CFR 20, Appendix B, Table 2, Column 2 (Reference 2.2).

3.1.4 Member of the Public - Any individual, except when he or she is receiving an occupational dose. The definition includes any individual who can receive a radiation dose in the general environment, independent of whether the individual may also be exposed to radiation in an occupation associated with the nuclear fuel cycle. This definition includes DPC employees working inside the Exclusion Area when they are not monitored for radiation exposure.

3.1.5 Operable/Operability - A system, subsystem, train, component or device is Operable or has Operability when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, a normal electrical power source, cooling or seal water, lubrication or other auxiliary equipment that are required for the system, subsystem, train, component or device to perform its function(s) are also capable of performing their related support function(s).

3.2. Responsibilities

3.2.1 The Radiation Protection Manager (RPM) is responsible for:

1.) Ensuring the requirements in this document are implemented.

2.) Developing and approving the Annual Radioactive Effluent Release Report and the Radiological Environmental Monitoring Program Report.

3.) Calculating dose commitments from liquid effluents to the total body and to each organ of an individual, in each age specified group.

4.) Calculating dose commitments from airborne particulate effluents to the total body and to each organ of an individual.

5) Calculating dose commitments from direct radiation sources to the total body..

6) Upon verification that any of the limits given in Sections 4.2.4 or 4.2.6 have been exceeded or there has been a REMP Non-Conformance per Section 4.5.2, promptly reporting the results to Regulatory Affairs.

3.2.2 Regulatory Affairs is responsible for:

1.) Transmitting reports to the NRC if the total dose to a member of the public exceeds the limits provided in Section 4.2.4 or Section 4.2.6 or if or there has been a REMP Non-Conformance per Section 4.5.2.

2.) Submitting the routine, special and non-conformance reports to the NRC as required in Sections 4.2.4, 4.2.6, 4.2.7 and 4.5.2.

3.) Reporting any other circumstances that are required to be reported to the NRC per this ODCM.

3.2.3 The Radiation Protection Supervisor (RPS) is responsible for:

1.) Ensuring the requirements for monitoring, surveillance, sampling, analysis and calculations specified in this document are completed

2.) Upon verification that any of the limits given in Sections 4.2.4 or 4.2.6 have been exceeded or there has been a REMP Non-Conformance per Section 4.5.2, promptly reporting the results to the RPM

3.) Assisting with preparation of the Radiological Environmental Monitoring Program Report as per RPM request.

4.) Assisting the RPM in performing calculations of radioactivity concentrations in effluents released to areas beyond the Effluent Release Boundary and performing independent reviews of all calculations performed by RPTs.

3.2.4 Radiation Protection Technicians (RPTs) are responsible for:

1.) Performing radioactive liquid waste sampling and analysis.

2.) Performing representative environmental type air sampling.

3.) Performing calculations of Lower Limits of Detection (LLD) for radioactivity analyses.

4.) Performing calculations of radioactivity concentrations in effluents released to areas beyond the Effluent Release Boundary.

5.) If any of the assumptions or average values cited in the ODCM change in a non-conservative manner (e.g., would result in higher doses to a member of the public), notifying the RPS promptly.

6.) Upon verification that any of the limits given in Sections 4.2.4 or 4.2.6 have been exceeded or there has been a REMP Non-Conformance per Section 4.5.2, promptly reporting the results to the RPS.

3.3. Precautions, Limitations and Prerequisites

3.3.1 If any of the assumptions or average values cited in the ODCM change in a non-conservative manner (e.g., would result in higher doses to a member of the public), the RPS must be notified.

3.3.2 Ensure that upon verification that any of the limits given in Sections 4.2.4 or 4.2.6 have been exceeded or there has been a REMP Non-Conformance per Section 4.5.2, the results are promptly reported to the appropriate individual or organization.

3.4. Records

3.4.1 System and Device Operability Checks

3.4.2 Radioactive Liquid Waste Sampling and Analysis results

3.4.3 Calculations of Lower Limits of Detection for radioactivity analyses

3.4.4 Calculations of Instantaneous Allowable Release Rates for liquid effluents

3.4.5 Calculations of Liquid Effluent Dose Contribution

3.4.6 Calculations of dose commitments from liquid effluents to the total body and to each organ of an individual, in each age specified group

3.4.7 Calculations of dose commitments from airborne particulate effluents to the total body and to each organ of an individual

3.4.8 Calculations of radioactivity concentrations in effluents released to areas beyond the Effluent Release Boundary

3.4.9 All Corrective Actions and Radiological Effluent Control Program non-compliances

3.4.10 Calculations of total dose to a member of the public, including dose from direct radiation, liquid effluents and airborne releases, to determine if the total dose limits in Section 4.2.6 have been exceeded

3.4.11 Results of the Interlaboratory Comparison Program

3.4.12 Copies of all reports sent to the NRC, including the Radiological Environmental Monitoring Report and the Annual Radioactive Effluent Release Report

4. PROCEDURE

4.1. Offsite Dose Calculations

4.1.1 Calculation of Allowable Liquid Release Rates

The LACBWR Decommissioning related water infiltration and D&D related water usage is pumped to the liquid waste discharge system. In order to verify liquid release will meet the 0.5 MPC release limit, assess the lab analysis data by following the step-by-step method. The form presented in Table 5.1 is to be used as a worksheet for these calculations.

4.1.2 Liquid Effluent Dose Contribution

To demonstrate compliance with the dose limits in Section 4.2.4, dose contributions are calculated at a maximum interval of once every calendar quarter for all radionuclides identified in liquid effluents released to unrestricted areas, using the methodology presented in NRC Regulatory Guide 1.109 (Reference 2.3). This methodology takes the form of the following general equation:

$$D_{a\tau} = \sum_i (A_{ai\tau} \sum_{j=1}^{m} C_i/F_j)$$

Where:

$D_{a\tau}$ = the cumulative dose commitment to the total body or any organ τ, of an individual in age group (a), from the liquid effluents released (m), expressed in mrem.

C_{ij} = the total quantity of radionuclide (i) released (j), in curies (Ci).

$A_{ai\tau}$ = the site-related ingestion dose commitment factor to the total body or any organ (τ), of an individual in age group (a), for each identified principal gamma and/or beta emitter, in mrem-gal-min^{-1}-Ci^{-1}.

F_j = the average dilution water flow rate during release (j), in gallons per minute.

Equation 4.4 requires the use of a dose factor ($A_{ai\tau}$) for each radionuclide (i), organ (τ) and individual in age group (a), which includes the factors which determine the ultimate dose received, such as pathway transfer factors (e.g., bioaccumulation factors), pathway usage factors, ingestion dose factors and dilution factors. The following site-specific conditions determine the site-specific factors incorporated into the liquid effluent dose calculation model at LACBWR:

1.) Liquid Dose Pathways

Due to the LACBWR status as a fresh water site, there is no invertebrate pathway. The drinking water pathway is not included, since the nearest community that obtains its drinking water supply from the Mississippi River is located at Davenport, Iowa, which is 195 miles downstream. The drinking water pathway represents < 0.01% of the dose to any organ. The irrigated foods pathway is not included since the river water is not used for irrigation in this area and the shoreline deposits pathway is insignificant for the Mississippi River. The only possibly significant dose pathway is the dose commitment due to ingestion of fish from the Mississippi River.

2.) Liquid Release Dilution

The liquid effluent flow collected by the decommissioning work activities is typically diluted by Circulating Water from G-3. For offsite dose calculations, no dilution by the Mississippi River flow is considered. Also, discharges of influx river water normally take place on average during less than 75 hours per month (< approximately 10% of the time). Therefore, no fish in the river are continuously exposed to a radioactive environment produced by LACBWR liquid, as assumed in the calculation of published bioaccumulation factors for fish.

Based on the above site-specific criteria, the dose factor ($A_{ai\tau}$) is defined as follows:

$$A_{ai\tau}=K_o(UF_a)(BF_j)(DF_{ai\tau})$$

Where:

K_o = a units conversion constant, 5.03 E+5 =

(1 E+12 pCi/Ci x 0.2642 gal/ l) / (8760 hrs/yr x 60 min/hr)

UF_a = fish consumption usage factor for an individual in age group (a), in kg/yr.

BF_j = the fish bioaccumulation factor for nuclide (i), in pCi/kg per pCi/ l.

$DF_{ai\tau}$ = the ingestion dose factor for age group (a), for nuclide (i), in organ (τ), in mrem/pCi.

4.1.3 Calculation of Dose Commitments from Liquid Effluents

The equations for this calculation have been formatted on a computer-based spreadsheet. The values of (BF_j), and (DF_{air}), or equivalent terms specified in NRC Regulatory Guide 1.109, are determined based on site-specific factors, and those values plus the constant (K_o) have been entered on the spreadsheet.

To perform the calculation, enter the following information in the appropriate cells of the spreadsheet for each liquid effluent released during the period of interest:

1.) Date

2.) Release interval, hours (hrs)

3.) Waste volume, gallons (gal)

4.) Circulating Water flow rate, GPM

5.) Activity concentration of each isotope (i) in waste, μCi/ml

The spreadsheet program will calculate and display the total quarterly dose in mrem to the total body and each organ of an individual in each age group. The cumulative calendar year doses and the percentage of the dose limits set forth in Section 4.2.4 are also calculated. This spreadsheet may also be used to print the data tables for the liquid effluent section of the annual Radioactive Effluent Release Report.

4.1.4 Allowable Airborne Release Rates

The LACBWR Decommissioning work may cause airborne particulate radionuclides to be released and reach unrestricted areas. The stack is not being used and in decommissioning so any potential airborne releases will be treated as ground releases. The airborne concentrations will be maintained at levels that will prevent areas from becoming Airborne Radioactivity Areas as defined in 10 CFR 20. Where necessary, outside work may be tented and/or the air exhausted through HEPA filters to ensure that airborne concentrations remain as low as reasonable achievable.

4.1.5 Airborne Particulate Effluent Dose Contribution

To demonstrate compliance with the dose limits in Sections 4.2.1, 4.2.5, and 4.2.6, dose contributions are calculated at a maximum interval of once every calendar quarter for all radionuclides identified in airborne effluents released to unrestricted areas. Doses from airborne effluents will normally be calculated every 2-3 weeks.

4.1.6 Calculation of Dose Commitments from Airborne Effluents

The calculation of dose to a member of the public from ground level airborne releases is performed using a computer-based spreadsheet. The values of (BR), and (DCF_i), or equivalent terms are published in regulatory guidance documents and industry accepted technical publications, and those values have been entered on the spreadsheet.

The equation for calculating dose to a member of the public from ground level airborne releases is as follows:

$$D_{a\tau} = \sum_i (A_i \; DCFi \; BR)$$

Where:

$D_{a\tau}$ = the cumulative dose commitment to the total body or any organ τ during a week, of an individual i, from airborne effluents released, expressed in mrem.

A_i = airborne concentration for radionuclide "i" based on air sample results, in µCi/ml

DCF_i = inhalation dose conversion factor for each radionuclide "i", for effective dose or organ dose, in mrem/µCi

BR = the breathing rate for the individual, in ml/week

To perform the calculation, enter the following information in the appropriate cells of the spreadsheet for the appropriate air sample during the period of interest:

1.) For each quarter, the results (µCi/ml) of the weekly or semi-weekly air sample of interest, for each radionuclide

2.) On the Report page, the year and the gross alpha and gross beta analysis results for each calendar quarter

The spreadsheet program will calculate and display the total quarterly effective dose in mrem (total body dose) and the dose to each organ of an individual member of the public. The Report page will display the effective dose and the dose to the organ that receives the highest dose for the quarter and the year, and summary data for each quarter.

4.2. Radioactive Effluent Control Program

4.2.1 Program Requirements

1.) The Radioactive Effluent Control Program (RECP) conforms to the guidance of 10 CFR 50.36 (Reference 2.4) for the control of radioactive effluents and for maintaining the doses to members of the public from radioactive effluents as low as reasonably achievable. This program establishes the requirements for monitoring, sampling and analysis of radioactive liquid and airborne particulate effluents released from LACBWR to ensure the concentrations in effluents released to areas beyond the Effluent Release Boundary conform to 10 CFR Part 20, Appendix B, Table 2, Columns 1 and 2. The program provides limitations on the annual and quarterly dose commitment to a member of the public from radioactive effluents in conformance with Appendix I of 10 CFR Part 50 (Reference 2.5).

2.) In accordance with provisions of 40 CFR 190 (Reference 2.6), the restrictions and surveillance requirements for total dose to any member of the public from all LACBWR related sources and dose pathways (direct exposures, liquid effluents, and airborne particulate effluents) are evaluated on a quarterly and an annual basis.

4.2.2 Liquid Effluents Sampling and Analysis

1.) All liquid effluent releases at LACBWR will normally be released from the LACBWR original piping system to the DPC NPDES release point at the Mississippi River. Prior to discharge, representative sample(s) will be analyzed after the liquid effluent has been processed through an appropriate filtration and demineralizer system. The radioactive content of each discharge is determined in accordance with Table 5.1 or similar.

2.) The results of pre-release analyses are used in accordance with the Offsite Dose Calculations methodology to assure that the concentration at the point of release is maintained within the limits specified in this document.

4.2.3 Airborne Particulate Sampling and Analysis

1) Environmental air samplers are running continuously at four locations outside the posted radiologically controlled areas and either inside or outside the Exclusion Area for trending purposes. The two air samplers located inside the Exclusion Area are in historically predominant wind directions from the LACBWR Facilities and are also used to evaluate for potential routine ground releases from decommissioning work. These air sampler operations and the sampling analysis are discussed in Reference 2.10. When facilities inside the radiologically controlled area are demolished, environmental air samplers will be minimally triangulated in representative areas where public receptors are present and the wind is directed. Also, when directing HEPA ventilation equipment exhaust outside facilities, representative air monitoring will be established to evaluate for the possibility of a ground type release. This air sampling equipment will be operated during the course of the facility demolition work activity and samples will be analyzed as per the requirements of Reference 2.14.

4.2.4 Liquid Effluent Release Limitation

1.) Concentration

A. The concentration of radioactive material released in liquid effluents at any time to areas beyond the Effluent Release Boundary is limited to concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

B. If the concentration of radioactive material released beyond the Effluent Release Boundary exceeds the above limits, restore the concentration to within the above limits as soon as possible. Report such situations to the RPS in a timely manner.

C. This effluent release limit is provided to ensure that the concentration of radioactive materials released in liquid waste from the site will be less than the concentration levels specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

2.) Dose Limits

A. The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released to areas beyond the Effluent Release Boundary is limited to:

Calendar Quarter	Calendar Year
< 1.5 mrem total body	< 3 mrem total body
< 5 mrem to any organ	< 10 mrem to any organ

B. The cumulative dose contribution from liquid effluents is determined at least once per calendar quarter, in accordance with Sections 4.1.2 and 4.13.

C. If this calculated dose exceeds the above limits, the RPM will prepare a Special Report, which identifies the cause(s) for exceeding the limit(s) and defines the corrective actions, which have been or will be taken to assure that subsequent releases are in compliance with the above limits.

D. The RPM will review and approve the report and submit the Special Report to Regulatory Affairs.

E. Regulatory Affairs will review, approve and submit the Special Report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days.

F. These dose limits are provided to implement the requirements of Sections II.A, III.A, IV.A of Appendix I, 10 CFR Part 50. The dose calculations implement the requirement in Section III.A of Appendix I. Conformance with the guides of Appendix I is shown by calculational procedures based on models and data, such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated.

1.) 4.2.5 Airborne Effluent Release Limitations Particulate airborne effluents and resulting doses will be limited by the requirements of References 2.2, 2.5 and 2.6.

2.) The annual dose limits contained in 40 CFR 190 (Reference 2.6), are 25 mrem to the whole body, 75 mrem to the thyroid and 25 mrem to any other organ from <u>all</u> sources of radiation and effluent pathways.

3) 10 CFR 50, Appendix I (Reference 2.5), state that the annual total quantity of all radioactive material in particulate form released in

effluents to the atmosphere will not result in an estimated annual dose or dose commitment to any individual in an unrestricted area in excess of 15 millirems to any organ. In addition, it states that if the quantity of radioactive material actually released in effluents to unrestricted areas during any calendar quarter is such that the resulting radiation exposure, would exceed one-half the annual exposure (i.e., 7.5 mrem organ dose), the licensee will an investigate to identify the causes for such release, initiate correction actions and submit a report to the NRC (see Section 4.2.6).

4) Appendix B, Table 2 of 10 CFR 20 (Reference 2.2) contains the Maximum Permissible Concentration (MPC) values for radionuclides released in water and air that result in dose to the public. The effluent concentration values given in 10 CFR 20, Table 2 are concentrations, which, if inhaled or ingested continuously over the course of a year, would produce a total effective dose equivalent of 50 mrem. These effluent concentrations can be exceeded for a period of time, but only if the quarterly and annual dose limits in #2) and #3) above are not exceeded.

4.2.6 Total Dose to a Member of the Public Limits and Reporting Requirements

1.) The total dose equivalent to any member of the public due to release of radioactivity from all LACBWR effluent sources (liquid and airborne) and direct radiation from LACBWR, shall be limited to < 25 mrem to the total body or any organ (except the thyroid, which is limited to < 75 mrem) over a period of one calendar year.

2.) When calculated doses from the release of radioactive materials in liquid effluents exceed twice the calendar year dose limits specified in Section 4.2.4, a determination must be made if the dose limits from all LACBWR liquid and airborne effluent releases and direct radiation in Step 1 above have been exceeded. The total dose equivalent must include all radioactivities in liquid and airborne effluents and direct radiation from all potential sources (including the ISFSI).

3.) If the annual dose limits to a member of the public from all pathways/sources have been exceeded, notify the RPM.

4.) The RPS or RPM will prepare a Special Report (including the analysis, which estimates the radiation dose to a member of the public for the calendar year) and submit it to Regulatory Affairs. For conservatism in compliance with the limit on the dose equivalent due to release of radioactivity and radiation, the maximum total dose to any member of the public will be assumed to be the sum of the maximum doses from each dose pathway/source, even though the actual maximally exposed individual for each of the pathways may not be the same person.

5.) Regulatory Affairs will review, approve and submit the Special Report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days, which includes the estimated total body and organ doses and defines the corrective actions to be taken to reduce subsequent releases to prevent recurrence of exceeding these limits. If the release condition resulting in the limits being exceeded has not already been corrected, the Special Report shall include a request for a variance in accordance with the provisions of 40 CFR 190. Submittal of the Special Report is considered a timely request, and a variance is granted until staff action on the request is complete.

6.) Cumulative dose contributions from liquid effluents shall be determined quarterly and annually in accordance with Section 4.1.3. This requirement is provided to meet the dose limitations of 40 CFR 190.

7.) If calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I, 10 CFR Part 50 (i.e., > 15 mrem annual dose to any organ), notify the RPM.

8.) The RPS or the RPM will prepare a Special Report which shows the calculated doses and describes a course of action which should result in the limitation of dose to a real individual for 12 consecutive months to within the 10 CFR 50, Appendix I dose limits (i.e., < 7.5 mrem to any organ for a quarter and < 15 mrem annual dose to any organ) and within the 40 CFR 190 limits (i.e., annual dose equivalent dose not to exceed 25 millirem to the whole body, 75 millirem to the thyroid, and 25 millirem to any other organ).

9.) The RPM will review and approve the report and submit the Special Report to Regulatory Affairs.

10.) Regulatory Affairs will review, approve and submit the report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days.

4.2.7 Radioactive Effluent Release and Control Reporting Requirements

1.) Radioactive Effluent Release Report

A. Paragraph (a) (2) of 10 CFR 50.36, requires that a Radioactive Effluent Release Report be made to the NRC annually. The report shall specify the quantity of each of the principal radionuclides released to unrestricted areas by liquid or gaseous effluents during the previous year. With the exception of the collection of hourly meteorological data (which is not applicable for the LACBWR site), the information submitted must be in accordance with Appendix B of Regulatory Guide 1.21 (Reference 2.8), with data summarized on at least a quarterly basis.

B. This same report must include an assessment of radiation doses to members of the public from radioactive liquid effluents released beyond the effluent release boundary. This report shall also contain any changes made to the ODCM during the previous twelve months.

C. The RPS or RPM will prepare the report and submit it to Regulatory Affairs.

D. Regulatory Affairs will review, approve and submit the report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555. The Radioactive Effluent Release Report must be submitted by March 1 for the previous calendar year.

2.) Radiological Effluent Monitoring and Control Program Non-Conformance Reporting

A. If the Radiological Effluent Monitoring and Control Program is not being conducted in conformance with any of the requirements in Sections 4.1 or 4.2, notify the RPS.

B. The RPS or the RPM will prepare a Special Report, which identifies the causes for non-conformances or exceeding dose limits and defines the corrective actions, which have been or will be taken to assure that subsequent releases will be in compliance with the stated limits.

C. The RPM will review and approve the report and submit the Special Report to Regulatory Affairs.

D. Regulatory Affairs will review, approve and submit the report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days.

4.3. Radiological Environmental Monitoring Program

4.3.1 Radiological Environmental Monitoring Program (REMP)

1.) The REMP conforms to the guidance of Appendix I to 10 CFR Part 50 (Reference 2.5). The REMP provides the requirements for monitoring, sampling, analyzing and reporting radiation exposure and radionuclides in the environment resulting from direct radiation emanating from the LACBWR facility and from effluents released to the environment. These requirements have been established to ensure measurements of direct radiation and of radioactive material in potential exposure pathways to members of the public are performed.

2.) An Interlaboratory Comparison Program, described in Section 4.4, has been established to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in the environmental sample matrices are performed, as part of quality control for environmental monitoring.

3.) The radiological monitoring program provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures to individual members of the public resulting from site operations.

4.) The requirement for participation in an Interlaboratory Comparison Program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental samples are performed to demonstrate that the results are reasonably valid.

4.3.2 REMP Description

Radiological Environmental Monitoring Program water and sediment samples are collected and analyzed in accordance with Table 5.3. The specific sample locations are listed in Ref. 2.10 "LACBWR Environmental Monitoring Program", which also contains specific guidance for personnel in the collection and analysis of each environmental sample. Environmental TLDs that are used to assess ambient dose conditions to the public and environmental air sampler locations established to trend radiological air conditions during D&D work are discussed and locations described in Ref. 2.10.

4.3.3 REMP Lower Limits of Detection (LLD)

The sampling techniques and counting equipment used for the analysis of samples collected as requirements of the REMP, meet LLDs calculated in accordance with criteria of NUREG 0473, Rev. 2 (Reference 2.7). Table 5.4 lists the typical LLD values. The REMP LLDs for LACBWR are calculated as follows and are essentially the same as those found in NUREG-0473.

1.) Calculation of Lower Limits of Detection

The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability, with 5% probability of falsely concluding that a blank observation represents a "real" signal.

A. For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ S_b}{E \times V \times 2.22\ E6 \times Y \times \exp(-\lambda \Delta t)}$$

2.) Where:

A. LLD = the *a priori* lower limit of detection (as microcurie per unit volume) (e.g., μCi/ml)

B. S_b = standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute)

C. E = counting efficiency (as counts per gamma)

D. V = sample size (in units of volume)

E. 2.22 E6 = number of transformations per minute per microcurie

F. Y = gamma abundance for isotope of interest

G. λ = radioactive decay constant for the particular radionuclide

H. Δt = elapsed time between sample collection (or end of the sample collection period) and time of counting

The above equation simplifies as follows for gamma spectroscopy analysis of air samples:

$$LLD_{gamma} = \frac{4.66 \times S_b}{E \times V \times 2.22\ E6 \times Y}$$ for gamma emitters

Gamma spectroscopy LLD values vary for each radionuclide and with each analysis, depending on several factors such as count time, total background, interference from radionuclides with similar gamma energies, etc. In calculating LLD for gamma spectroscopy, the background must include the typical radionuclides normally present in samples. The gamma background count rate is calculated from the background counts that are determined to be within +/- one FWHM (Full-Width-at-Half-Maximum) energy band about the energy of the gamma ray peak used for the quantitative analysis for that radionuclide. The principal gamma emitters for which LLD applies exclusively are the following: Mn-54, Co-60, Zn-65, Cs-134, and Cs-137.. This does not mean that only these nuclides are to be reported.

4.4. Interlaboratory Comparison Program

An Interlaboratory Comparison Program has been established to ensure that the analyses being performed to comply with the REMP are accurate and repeatable. An offsite laboratory is used to supply NIST traceable or equivalent standard spiked sample media for analysis. The offsite laboratory supplies a report of the comparison of LACBWR results and the known radioactivity in the spiked standards. The Interlaboratory Comparison is conducted annually. The results of this comparison are included in the annual Radiological Environmental Monitoring Report.

4.5. Radiological Environmental Monitoring Report Requirements

4.5.1 Radiological Environmental Monitoring Report

1.) The Radiological Environmental Monitoring Report is prepared annually. This report includes summarized and tabulated monitoring results, including interpretations and analysis of data trends, for environmental samples taken during the previous calendar year.

2.) In the event that some results are not available for inclusion with the report, the report shall be submitted noting and explaining the reasons for the missing results. The missing data shall be submitted as soon as possible in a supplementary report.

3.) The report also includes the following: a summary description of the Radiological Environmental Monitoring Program, a map of all sampling locations keyed to a table giving distances and directions from the plant, the results of the Interlaboratory Comparison Program and a discussion of all analyses in which the LLD was not achievable.

4.) The RPS or RPM will prepare the Radiological Environmental Monitoring Report and submit it to Regulatory Affairs.

5.) Regulatory Affairs will review, approve and submit the report to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, by March 1 for the previous calendar year.

4.5.2 REMP Non-Conformance Reporting

1.) If the Radiological Environmental Monitoring Program is not being conducted as specified in Table 5.3 or if there are unexpected results, notify the RPS.

2.) The RPS or the RPM will investigate the non-conformance and include in the Radiological Environmental Monitoring Report a description of the reasons for not conducting the program as required, analysis of the cause of unexpected results and the plans for preventing a recurrence.

3.) The RPM will review and approve the report and submit the report to Regulatory Affairs.

4.) Regulatory Affairs will review, approve and submit the report to the U.S. Nuclear Regulatory Commission, Washington, DC 20555.

5.) If the Interlaboratory Comparisons not being performed, notify the RPS.

6.) The RPS or the RPM will investigate the non-conformance and include in the Radiological Environmental Monitoring Report documentation that the program was not performed and the corrective actions taken to prevent a recurrence.

7.) The RPM will review and approve the report and submit the report to Regulatory Affairs.

8.) Regulatory Affairs will review, approve and submit the report to the U.S. Nuclear Regulatory Commission, Washington, DC 20555.

9.) If radiological environmental sample analysis results are in excess of the Reporting Levels listed in Table 5.5, when averaged over any calendar quarter, notify the RPS.

10.) The RPS or the RPM will investigate the non-conformance and prepare a Special Report within 30 days, with a description of the reasons for exceeding these reporting levels.

11.) The RPM will review and approve the Special Report and submit the report to Regulatory Affairs.

12.) Regulatory Affairs will review, approve and submit the report to the U.S. Nuclear Regulatory Commission, Washington, DC 20555.

5. ATTACHMENTS

5.1. Figure 5.1, Site Map Including Effluent Release Boundary

5.2. Table 5.1, Liquid Release MPC Calculation Sheet

5.3. Table 5.2, Radioactive Liquid Waste Sampling and Analysis Requirements for Releases to the Environment

5.4. Table 5.3, Radiological Environmental Monitoring Samples

5.5. Table 5.4, Environmental Sample Analyses Typical Lower Limit of Detection (LLD) Values

5.6. Table 5.5, Reporting Levels (RLs) for Radioactivity Concentrations in Environmental Samples

Figure 5.1

Site Map Including Effluent Release Boundary

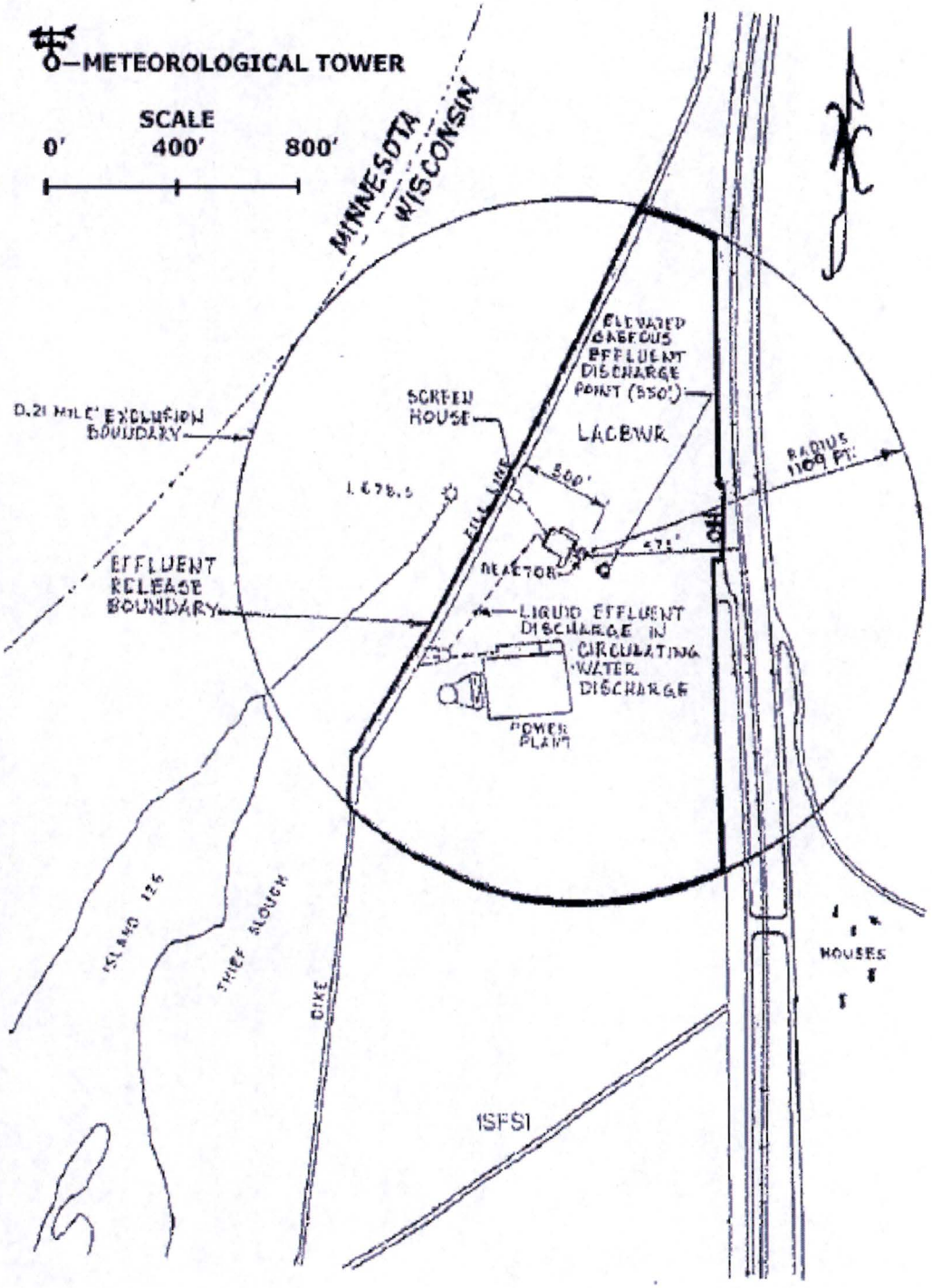

Table 5.1

Liquid Waste Batch Form

Discharge # _____

LIQUID WASTE BATCH FORM

LIQUID WASTE DISCHARGE TO STANDPIPE FROM _____

Sample Date and Time	
Activity	μCi/ml
Dilution Factor-Minimum	GPM.
Maximum Allowable Discharge Rate	GPM
Date and Time Allowable Discharge Rate Determined	

LABORATORY ANALYSIS PERFORMED BY: _____

DISCHARGE STARTED BY: _____

	START	COMPLETION
Discharge Date/Time		
G-3 Control Room Indicated Circulating Water Discharge Flow Rate at Discharge Start		GPM
G-3 Control Room Indicated Circulating Water Discharge Flow Rate At Discharge Completion		GPM
Total Hours of Discharge		HRS
Volume Discharged	:	GAL
Discharge Flow Rate	:	GPM

DISCHARGE COMPLETED BY: _____

Table 5.1 (cont'd)

LIQUID WASTE BATCH FORM

ISOTOPE	ACTIVITY (μCi/ml)	10 CFR 20 MPC micro-Ci/ml	No. of MPCs
Gross Alpha		2 E-08	
Gross Beta		5E-07	
Co-60		3 E-6	
Cs-137		1 E-6	
		////////////////////	////////////////////
		Total MPC	

Tritium		1 E-3	

ENSURE THE ACTUAL EXISTENCE OF ANY ISOTOPE NOT LISTED IN THIS TABLE BEFORE ADDING IT TO THE TABLE.

MPCs at Discharge Point:

_____ X _____ ÷ _____ = _____(Limit < 0.5)

(Total # of MPCs) (Discharge Flow GPM) (Circ. Water Flow GPM) [-Dilution Factor]

Reviewed By:_____ Date:_____

(Radiation Protection Manager)

Table 5.2

Radioactive Liquid Waste Sampling and Analysis Requirements for Releases to the Environment

	Type of Activity Analysis [a]	Sampling Frequency	Minimum Analysis Frequency
1	Principal gamma emitters[b]	Prior to discharge	Each discharge – prior to discharge
2	Gross Alpha/Gross Beta	Prior to discharge	Each discharge – prior to discharge
3	Tritium	Prior to discharge	Each discharge
4	Sr-90, Fe-55, Ni-59, Ni-63, Am-241, Pu-238, Pu-239/240, Pu-241	Prior to discharge	Quarterly Composite [c]

NOTES

(a) The principal gamma emitters for which the LLD specification will apply are to Co-60 and Cs-137. This does not mean that only these nuclides are to be analyzed for and reported. Other gamma peaks, which are measurable and identifiable, together with the above radionuclides, shall also be identified and reported.

(b) Methods of calculating the Lower Limits of Detection (LLD) are shown in Section 4.3.3, using the criteria of NUREG-0473 (Reference 2.7). LLD values for common radionuclides are shown in Table 5.4.

(c) A composite sample is one made up of individual samples which are proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen, which is representative of the liquid release.

Table 5.3

Radiological Environmental Monitoring and Environmental Air Samples

Exposure Pathway and/or Sample	Number of Samples [(a)]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. Waterborne (River Water)	Two (2)	Semi-annually	1) Gamma isotopic analysis semi-annually on each sample 2) Tritium analysis semi-annually on each sample
2. River Sediment	Two (2)	Semi-annually	Gamma isotopic analysis semi-annually on each sample
3. Air particulates (environmental)	Four (4)	Bi-weekly	1) Gross Beta 2) Gamma Spectroscopy

(a) Sample locations are given in LC-RP-PR-007, LACBWR Environmental Monitoring Program

Table 5.4

Environmental Sample Analyses
Typical Lower Limit of Detection (LLD) Values

Analysis	Sample Type		
	Water pCi/l	Sediment pCi/kg Dry	Air Particulates µCi/ml
Gross Alpha	N/A	N/A	4.0 E-16*
Gross Beta	6	N/A	8.5 E-16*
H-3	3500	N/A	N/A
Mn-54	15	N/A	N/A
Co-60	15	N/A	N/A
Zn-65	30	N/A	N/A
Cs-134	15	150	5 E-14 µCi/ml
Cs-137	18	180	6 E-14 µCi/ml

* When using the Tennelec Counter

Table 5.5

Reporting Levels (RLs) for Radioactivity Concentrations in Environmental Water Samples

Analysis	Water (pCi/l)
H-3	20,000
Mn-54	1,000
Co-60	300
Zn-65	300
Cs-134	30
Cs-137	50