DAIRYLAND POWER COOPERATIVE

LA CROSSE BOILING WATER REACTOR

OFFSITE DOSE CALCULATION MANUAL

REVISION 14

PREPARED BY Jeff McRill DATE 8/6/13
Technical Support Engineer, Licensing

REVIEWED BY [signature] DATE 8-6-13
Health Physics Supervisor

APPROVED BY [signature] DATE 8/6/13
Plant/ISFSI Manager

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Purpose

The Offsite Dose Calculation Manual (ODCM) contains the methodology and parameters used in (1) the calculation of offsite doses resulting from radioactive liquid and gaseous effluents from LACBWR, and (2) the calculation of liquid and gaseous effluent monitoring Alarm/Trip Setpoints. The ODCM also contains the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs.

1.2 Defintions

CHANNEL CALIBRATION

A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds with the necessary range and accuracy to known values of the parameter which the channel monitors. The CHANNEL CALIBRATION shall encompass the entire channel including the sensor and alarm and/or trip functions, and shall include the CHANNEL FUNCTIONAL TEST. The CHANNEL CALIBRATION may be performed by any series of sequential, overlapping or total channel steps such that the entire channel is calibrated.

CHANNEL CHECK

A CHANNEL CHECK shall be the qualitative assessment of channel behavior during operation by observation. This determination shall include, where possible, comparison of the channel indication and/or status with other indications and/or status derived from independent instrument channels measuring the same parameter.

CHANNEL FUNCTIONAL TEST

A CHANNEL FUNCTIONAL TEST shall be:

a. Analog channels – the injection of a simulated signal into the channel as close to the sensor as practicable to verify OPERABILITY including alarm and/or trip functions and channel failure trips.

b. Bistable channels – the injection of a real or simulated signal into the sensor to verify OPERABILITY including alarm and/or trip functions.

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 1.1.)

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 as the EXCLUSION AREA for plant siting and operation.

MAXIMUM PERMITTED CONCENTRATION (MPC)

The limiting liquid effluent concentration value 10 CFR 20, Appendix B, Table 2, Column 2.

MEMBER OF THE PUBLIC

MEMBER OF THE PUBLIC shall mean an individual in a CONTROLLED or UNRESTRICTED AREA. However, an individual is not a MEMBER OF THE PUBLIC during any period in which the individual receives an occupational dose.

OPERABLE-OPERABILITY

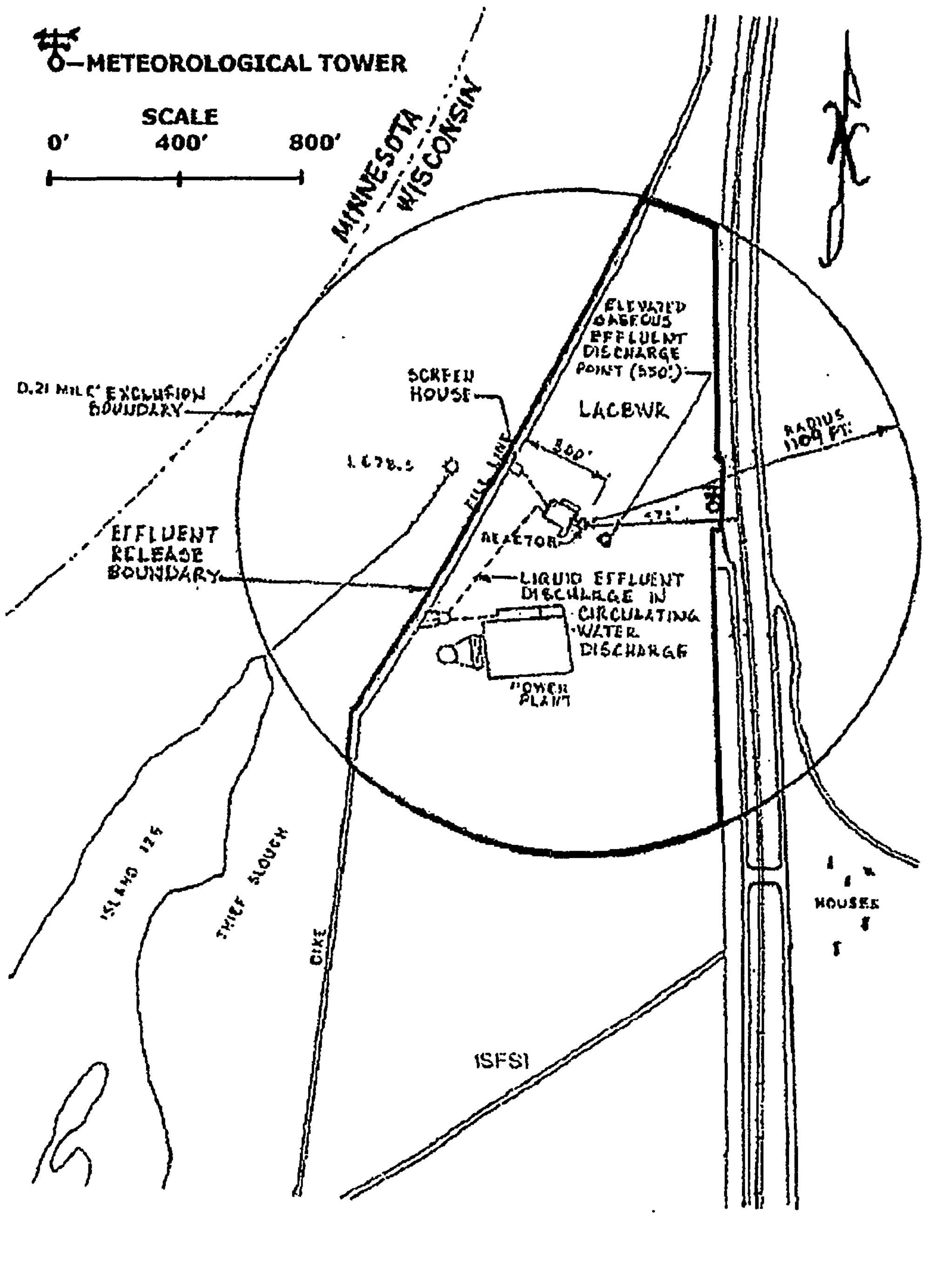
A system, subsystem, train, component or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified function(s) and when all necessary attendant instrumentation, controls, a normal or an emergency electrical power source, cooling or seal water, lubrication or other auxiliary 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).

SOURCE CHECK

A SOURCE CHECK shall be the qualitative assessment of channel response when the channel sensor is exposed to a radioactive source.

FIGURE 1.1

SITE MAP INCLUDING EFFLUENT RELEASE BOUNDARY



2.0 OFFSITE DOSE CALCULATIONS

2.1 Compliance with the Limitations for Liquid Effluent Releases

2.1.1 Calculation of Liquid Effluent Monitor Alarm Setpoints

To assure compliance with the limitations of Section 3.2.2a, Radioactive Effluent Control Program (RECP), the liquid effluent monitor alarm setpoint is calculated as a function of the maximum effluent flow rate and the minimum dilution flow rate. The following equation is used to calculate the setpoint:

$$\frac{af}{k\,(F+f)} \leq C \qquad (2.1)$$

Where:

C = the effluent concentration limit implementing 10 CFR 20 for LACBWR, in µCi/ml.

a = the setpoint (in CPS above background) of the liquid effluent monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release is inversely proportional to the volumetric flow of the effluent line (f) and is proportional to the volumetric flow of the dilution stream plus the effluent stream (F + f). The setpoint represents a value which, if exceeded, could result in concentrations exceeding the limits of 10 CFR 20.

k = the conversion factor, CPS per µCi/ml, for the liquid waste effluent monitor based upon most recent calibration of the monitor.

f = the effluent line volumetric flow setpoint as measured at the liquid effluent monitor location, in gallons per minute.

F = the dilution stream, LACBWR and Genoa Station No. 3 (G-3) Circulating Water volumetric flow, in gallons per minute.

Since f << F, Equation 2.1 is satisfied when the following discharge line liquid effluent monitor setpoint is met:

$$a \leq \frac{kCF}{f} \qquad (2.2)$$

2.1.2 Calculation of Instantaneous Allowable Release Rates

LACBWR's liquid radwaste is released in batches. In order to assess the required liquid effluent monitor alarm setpoint, a, the following step-by-step method for obtaining data will be performed. The form presented in Figure 2.1 may be used as a worksheet for these calculations. The alarm setpoint calculation may be performed on an annual basis if the setpoint is determined to be sufficiently conservative so as to prevent exceeding 0.5 MPC at the discharge point where MPC is the isotope weighted effluent concentration release limit for a typical LACBWR waste batch based on 10 CFR 20, appendix B, Table 2, Column 2 values.

1) Go to Figure 2.1. Enter the date on the form.

2) Enter the concentration C_i (μCi/ml) for each isotope, i, in a typical LACBWR waste batch.

3) The values of f and F are determined and recorded at the top of Figure 2.1. F is the minimum volumetric dilution flow rate during release at the LACBWR/G-3 outfall which is equal to the LACBWR Circulating Water flow rate plus the G-3 Circulating Water flow rate in gallons per minute. The value f is the maximum radioactive liquid release flow rate (GPM) for the batches discharged during the period. A value of 17 GPM is normally specified for f.

4) The quantities ΣCi and $\Sigma Ci/MPCi$ are determined and recorded.

5) The monitor conversion factor, k, determined at last primary calibration is recorded on Figure 2.1, in CPS (net) per μCi/ml.

6) The alarm setpoint, a (in CPS with a factor of 0.5 for conservatism), for the liquid effluent monitor measuring the radioactivity concentration in the effluent line is then determined by:

$$a = \frac{0.5kF\sum C_i}{f\sum C_i/MPC_i} \qquad (2.3)$$

FIGURE 2.1

LIQUID RELEASE MONITOR ALARM SETPOINT DETERMINATION

Date ____________________

Maximum Liquid Release Rate for Period, f = _______________ GPM

Minimum Dilution Flow Rate for Period, F= _______________ GPM

Nuclide i	Average Concentration (in Tanks) C_i (μCi/ml)	MPC_i (10 CFR Part 20, Appendix B Table 2, Col. 2)	C_i / MPC
Co-60		3 E-06	
Cs-137		1 E-06	
Cs-134		9 E-07	
Sr-90		5 E-07	
Fe-55		1 E-04	
ΣC_i =		$\Sigma C_i / MPC_i$ =	

Monitor Conversion Factor, k = _______________ $\frac{\text{CPS (net)}}{\mu\text{Ci/ml}}$

Liquid Release Monitor Alarm Setpoint,

$$a = \frac{0.5kF\sum C_i}{f\sum C_i/MPC_i} = \_\_\_\_\_\_\_\_\_\_ \text{ CPS above background}$$

2.1.3 Calculation of Liquid Effluent Dose Contribution

To demonstrate compliance with the limitations of Section 3.2.2b, 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, Rev. 1, October 1977. This methodology takes the form of the following general equation:

$$D_{a\tau} = \sum_i (A_{ai\tau} \sum_{j=1}^{m} C_i / F_j) \quad (2.4)$$

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 in batches m, expressed in mRem.

C_{ij} = the total quantity of radionuclide i, released by batch j, in 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 batch release j, in gallons per minute.

Equation 2.4 requires the use of a dose factor $A_{ai\tau}$ for each nuclide, organ 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 philosophy and site-specific conditions determine the site-specific factors incorporated into the liquid effluent dose calculation model:

1) Liquid Dose Pathways

Due to LACBWR's status as a fresh water site, there is no invertebrate pathway. The drinking water pathway is not included, since the nearest community which 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 significant dose pathway is the dose commitment due to ingestion of fish from the Mississippi River waters.

2) Dilution

The liquid effluent flow from the waste tanks is diluted by the combined Circulating Water flow for both LACBWR and G-3. For offsite dose calculations, no dilution by the Mississippi River flow is considered. Also, batch discharges of liquid effluent normally take place on average during less than 35 hours per month (< 5% of the time). Therefore, no fish in the river are continuously exposed to a radioactive environment produced by LACBWR liquid effluent as assumed in the calculation of the published bioaccumulation factors for fish.

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

$$A_{ai\tau}=K_o(UF_a)(BF_j)(DF_{ai\tau}) \qquad (2.5)$$

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 bioaccumulation factor in fish 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.

2.1.4 <u>Calculation of Dose Commitments from Liquid Effluents</u>

The equations for this calculation have been formatted on a computer-based spreadsheet. The values of UF_a, BF_j, and $DF_{ai\tau}$ specified in NRC Regulatory Guide 1.109 Rev. 1, October 1977, and the constant K_o have been entered on the spreadsheet.

To perform the calculation the following information is entered in the appropriate cells of the spreadsheet for each liquid batch released during the period of interest:

1) Date

2) Release interval, hrs

3) Waste volume, gal

4) Circulating Water flow rate, GPM

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

The spreadsheet program will then 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 limits set forth in Section 3.2.2b, are also calculated. This spreadsheet will also print the data tables for the liquid effluent section of the annual Radioactive Effluent Release Report.

2.2 Compliance with the Limitations for Gaseous Effluent Releases

2.2.1 Calculation of Gaseous Effluent Monitor Alarm Setpoints

To assure compliance with the limitations of Section 3.3.3.a, alarm setpoints are established for the gaseous effluent monitor. These setpoints are calculated or checked annually, or as required by procedure, to confirm that the current setpoints are set correctly for one or two stack blower operation.

The Dry Cask Storage project was completed in September 2012. All spent fuel has been removed from the plant and transferred to the ISFSI. For this reason, noble gas (Kr-85) releases will no longer be analyzed for.

2.2.2 H-3 and Particulates

The following mathematical relationship shall be used to implement the limitation for H-3 and Particulates with $T_{1/2} > 8$ days alarm setpoints:

$$D_{P\tau} = \sum_i P_{i\tau} Q_{Pi} (x/Q) \qquad (2.10)$$

Where:

$D_{P\tau}$ = the dose rate to organ τ, of an individual at or beyond the EFFLUENT RELEASE BOUNDARY, due to H-3 and particulates with half-lives greater than 8 days. This value is to be less than 1500 mRem/yr.

$P_{i\tau}$ = the dose parameter for organ τ, for radionuclide i, for the inhalation pathway, in mRem-m^3 per µCi-yr.

x/Q= the atmosphere dispersion coefficient in sec/m^3.

Q_{Pi} = release rate of nuclide i, in µCi/sec.

2.2.3 Calculation of Release Limits for H-3 and Particulates with Half-Lives Greater than 8 days

Since it is impractical to measure instantaneous release rates for radionuclides, the alarm setpoints for radionuclides are expressed in terms of total accumulated activity on sample media for a specified sampling time, ΔT, which is monitored as µCi by the stack effluent monitor.

Equation 2.11 is used to calculate the release rate limit for all H-3 and particulates with half-lives greater than 8 days. This equation is based on the dose rate to an infant due to inhalation of these radionuclides. In accordance with NUREG-0133, the infant will always receive the maximum dose rate. The atmospheric dispersion coefficients (x/Q) used are 6.05 E-5 sec/m^3 for the calculation of the FAST alarm setpoint and 3.9 E-6 sec/m^3 for the SLOW alarm setpoint.

2.2.4 Alarm Setpoint Calculations for H-3 and Particulates with Half-Lives Greater than 8 days

$$Q_{P\tau}=\frac{1500\ \text{mRem/yr}}{\sum_i (x/Q)(R_{Pi})P_{i\tau}(\text{inhalation})} \quad (2.11)$$

Where:

$Q_{P\tau}$ = the maximum allowed total release rate of a typical mixture of radionuclides in µCi/sec conservatively derived from the allowed annual average dose rate to organ τ, and very conservative x/Q.

R_{Pi} = the ratio of the activity of nuclide i, to the total activity of all nuclides in a typical mixture being released.

x/Q = the atmospheric dispersion coefficient as given above for FAST or SLOW alarm respectively, in sec/m^3.

Resolution of the $P_{i\tau}$ term in Equation 2.11 yields:

$$P_{i\tau}(\text{inhalation})=(10^6\ \text{pCi}/\mu\text{Ci})(BR)(DFA_{i\tau}) \quad (2.12)$$

Where:

$DFA_{i\tau}$ =the inhalation dose factor for an infant, for the ith radionuclide, for organ τ, in mRem/pCi.

BR = infant breathing rate, in m^3/yr.

To calculate the alarm setpoint in terms of total µCi deposited on filter sample media, the following equation is used:

$$Q_{sa}=\frac{\text{Lowest } Q_{P\tau}\times\Delta F}{F_s} \quad (2.13)$$

Where:

Q_{sa} = the activity in µCi (deposited on sample media in sample time ΔT) which initiates an appropriate alarm in the stack effluent monitor.

$Q_{P\tau}$ = µCi/sec

F_s = stack flow rate, cc/sec

ΔF = total flow through sample media (cc) in sample time ΔT, corrected to stack gas conditions. ΔT is normally 7 days.

The procedure outlined below is used to calculate the release limits for radionuclides. This will be done at least annually.

NOTE: This procedure is applicable for the determination of either FAST or SLOW alarms by utilizing the appropriate value for x/Q in the equation.

1) Start on Figure 2.2. Enter the date, the alarm setpoint being calculated, (FAST or SLOW) and the appropriate x/Q value to be used.

2) Enter the average release rate for the period, $Q_{P\tau}$, in μCi/sec, of each identified radionuclide. At the bottom of the form, compute and enter the sum ΣQ_{Pi}.

3) In the column labeled R_{Pi}, enter the ratio of the average period release rate of nuclide i, to the average total period release rate, ΣQ_{Pi}, for the period.

4) For each organ τ, as noted at the top of the form, calculate and enter the value of $(x/Q)(R_{Pi})P_{i\tau}$(inhalation) for each nuclide. $P_{i\tau}$(inhalation) values are found on Table 2.1. At the bottom of the column, for each organ, enter the value of $\Sigma(x/Q)(R_{Pi})(P_{i\tau})$ for that organ.

5) Go to Figure 2.3. Enter the date and the alarm setpoint being determined.

6) Using the equation at the top of Figure 2.3, calculate the release rate limits, $Q_{P\tau}$, for each organ τ.

7) Select the lowest value of $Q_{P\tau}$, enter at the bottom of Figure 2.3 under the appropriate blower operation. Multiply the $Q_{P\tau}$ number times the total sample flow through the sample media, cc, and divide this by the appropriate blower flow rate, cc/sec, to determine the Q_{sa}, in μCi, and use these as alarm setpoints.

FIGURE 2.2

H-3 AND PARTICULATE GASEOUS RELEASE MONITOR ALARM SETPOINT DETERMINATION

Date ____________________

Alarm being calculated (FAST or SLOW) ____________ x/Q ____________________sec/m³ *

Nuclide i	Q_{Pi}	R_{Pi}	$(x/Q)(R_{Pi})P_{ir}$(inhalation) **						
			Whole Body	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
H-3									
Co-60									
Sr-90									
Cs-134									
Cs-137									
Ce-144									
ΣQ_{Pi}=		$\Sigma(x/Q)(R_{Pi})(P_{ir})$=							

* For FAST alarm use x/Q of 6.05 E-5 sec/m^3; for SLOW alarm use x/Q of 3.90 E-6 sec/ m^3.

** P_{ir}(inhalation) values found in Table 2.1.

FIGURE 2.3

H-3 AND PARTICULATE GASEOUS RELEASE MONITOR ALARM SETPOINT SUMMARY

Alarm being calculated (FAST or SLOW) ______________ Date ___________________

$$Q_{P\tau} = \frac{1500 \text{ mRem/yr}}{\sum_i (x/Q)(R_{Pi})P_{i\tau}\,(\text{inhalation})}$$

$Q_{P\tau}$ = the maximum allowed total release rate of a typical mixture of radionuclides in µCi/sec conservatively derived from the allowed annual average dose rate to organ τ, and very conservative x/Q.

Organ τ	$\Sigma(x/Q)(R_{Pi})P_{i\tau}$(inhalation)*	$Q_{P\tau}$ (µCi/sec)
Whole Body		
Bone		
Liver		
Thyroid		
Kidney		
Lung		
GI-LLI		

* From Table 2.1

One-Blower Operation

$$Q_{sa} = \frac{\text{Lowest } Q_{P\tau} \times \Delta F}{1.650E+7}$$

$$Q_{sa} = \frac{\_\_\_\_\ \mu Ci/sec \times \_\_\_\_\ cc}{1.650\ E+7\ cc/sec}$$

Q_{sa} = ______________ µCi

Two-Blower Operation

$$Q_{sa} = \frac{\text{Lowest } Q_{P\tau} \times \Delta F}{3.304E+7}$$

$$Q_{sa} = \frac{\_\_\_\_\ \mu Ci/sec \times \_\_\_\_\ cc}{3.304\ E+7\ cc/sec}$$

Q_{sa} = ______________ µCi

Where:
ΔF = corrected total flow through sample media, cc.

TABLE 2.1

INFANT DOSE FACTORS P_{iT}(INHALATION) FOR H-3 AND PARTICULATE GASEOUS RELEASE MONITOR ALARM SETPOINT DETERMINATIONS

In Units of mRem-m^3/μCi-yr

Nuclide	Whole Body	Bone	Liver	Thyroid	Kidney	Lung	GI-LLI
H-3	6.47 E+2	*	6.47 E+2	6.47 E+2	6.47 E+2	6.47 E+2	6.47 E+2
C0-60	1.18 E+4	*	8.02 E+3	*	*	4.51 E+6	3.19 E+4
SR-90	2.59 E+6	4.09 E+7	*	*	*	1.12 E+7	1.31 E+5
CS-134	7.45 E+4	3.96 E+5	7.03 E+5	*	1.90 E+5	7.97 E+4	1.33 E+3
CS-137	4.55 E+4	5.49 E+5	6.12 E+5	*	1.72 E+5	7.13 E+4	1.33 E+3
CE-144	1.76 E+5	3.19 E+6	1.21 E+6	*	5.38 E+5	9.84 E+6	1.48 E+5

Values in this table are derived from Tables E-5 and E-10 in App. E of NRC Regulatory Guide 1.109, Revision 1, October 1977.

* No data available.

2.2.5 Calculation of Gamma and Beta Air Dose Commitments

In accordance with the RECP, the gamma and beta air dose commitments are to be calculated once per calendar quarter and yearly. Equations 2.14 and 2.15 are used to perform these calculations.

To demonstrate compliance with the limitations of Section 3.3.3.c, dose contributions are calculated for H-3, and particulates with half-lives greater than 8 days, identified in gaseous effluents released to unrestricted areas using the methodology presented in NRC Regulatory Guide 1.109, Rev. 1 October 1977. This methodology takes the form of the following general equation:

$$D_{\tau a}(r, \theta) = \sum_{Pi} \sum M^{P}_{i\tau a} W(r, \theta) Q_i \qquad (2.16)$$

Where:

$D_{\tau a}(r, \theta)$ = the dose commitment to organ τ, of an individual in age group a, at a distance r, in sector θ from the release point, due to the release to the atmosphere of radionuclides in mRem.

$W(r, \theta)$ = the average dispersion parameter for estimating the dose to an individual at the receptor location (r, θ), for the period of release, in sec/m^3 or m^{-2} as required by the characteristics of the exposure pathway.

Q_i = the total activity of each radionuclide i, in gaseous effluents for the release period of interest, in µCi.

$M^{P}_{i\tau a}$ = the dose conversion factor for exposure pathway P to organ τ, of an individual in age group a, for each identified radionuclide i. The units of $M^{P}_{i\tau a}$ are $(mRem\text{-}m^2)/\mu Ci$ or $(mRem\text{-}m^3)/\mu Ci\text{-}sec$ as required so that the product $M^{P}_{i\tau a}W(r, \theta)$ is mRem/µCi.

Equation 2.16 may be expanded to the following form where each term is the incremental dose received via one of the three major dose pathways.

$$D_{\tau a}(r, \theta) = \sum_i D^{G}_{i\tau a}(r, \theta) + D^{A}_{i\tau a}(r, \theta) + D^{D}_{i\tau a}(r, \theta) \qquad (2.17)$$

Where the first term on the right is the external dose from direct exposure to activity deposited on the ground plane, the second term is the dose from inhalation of radionuclides in air, and the third term is the dose from ingestion of foods contaminated by atmospheric releases of radionuclides.

Applying the methodology of NRC Regulatory Guide 1.109 Rev. 1, equation 2.17 is expanded as follows:

$$D_{\tau a}(r,\theta)=\sum_i M^{G}_{i\tau a}\,Q_i(D/Q)(r,\theta)+\sum_i M^{A}_{i\tau a}\,Q_i(x/Q)(r,\theta)$$

$$+\sum_i M^{DV}_{i\tau a}Q_i(D/Q)(r,\theta)+(M^{DV}_{14\tau a}Q_{14}+M^{DV}_{T\tau a}Q_T)(x/Q)(r,\theta)$$

$$+\sum_i M^{Dm}_{i\tau a}Q_i(D/Q)(r,\theta)+(M^{Dm}_{14\tau a}Q_{14}+M^{Dm}_{T\tau a}Q_T)(x/Q)(r,\theta)$$

$$+\sum_i M^{DM}_{i\tau a}Q_i(D/Q)(r,\theta)+(M^{DM}_{14\tau a}Q_{14}+M^{DM}_{T\tau a}Q_T)(x/Q)(r,\theta)$$

$$+\sum_i M^{DL}_{i\tau a}Q_i(D/Q)(r,\theta)+(M^{DL}_{14\tau a}Q_{14}+M^{DL}_{T\tau a}Q_T)(x/Q)(r,\theta) \quad (2.18)$$

Where:

$(x/Q)(r, \theta)$ = the annual average atmospheric dispersion factor for a receptor at the distance r, in sector θ, from the release point, in sec/m^3. For LACBWR, the value for this term is conservatively taken to be the largest historical (1983-1987) undecayed/undepleted x/Q for a real receptor and is 1.82 E-6 sec/m^3.

$(D/Q)(r, \theta)$ = 1.82 E-9 m^{-2}. This is based on the relationship $D/Q = V_d x/Q$ where V_d = the deposition velocity in m/sec. V_d is generally $\leq$ 1 E-3 m/sec for dry deposition of submicron aerosols which may be released from the LACBWR facility during SAFSTOR (Ref. Whicker, F. W., and Schultz, V., Radioecology: Nuclear Energy and the Environment, Vol. II, CRC Press, Inc., Boca Raton, Florida, 1982.

$M^{G}_{i\tau a}$ = $1.06\ S_F\ DFG_{i\tau}\ (1-\exp(-\lambda_i t_b))/\lambda_i$ and according to R.G. 1.109 the dose to all internal organs (τ) for all age groups (a) is taken to be the same as the total body dose.

$M^{A}_{i\tau a}$ = $3.17\ E\text{-}2\ BR_a\ DFA_{i\tau a}$

for the ingestion pathway (DV) for produce (non-leafy-vegetables, fruits, and grains):

$M^{DV}_{i\tau a}$ = $1.1\ E2\ DFI_{i\tau a}\ U^{v}_{a}\ f_g \exp(-\lambda_i t_h)(r(1-\exp(-\lambda_{Ei} t_e))/Y_v\lambda_{Ei}$

$+ B_{iv}\ (1-\exp(-\lambda_i t_b))/\ P\lambda_i)$

for all radionuclides except C-14 and H-3.

$M^{DV}_{14\tau a}$ = $22\ DFI_{14\tau a}\ U^{v}_{a}\ f_g\ p$ for C-14

$M^{DV}_{T\tau a}$ = $12\ DFI_{T\tau a}\ U^{v}_{a}\ f_g/H$ for tritium for the ingestion pathway (Dm) for milk:

$M^{Dm}_{iTa} =$ $1.1\ E2\ DFI_{iTa}\ U^{m}_{a}\ F_{mi}\ Q_F \exp(-\lambda_i t_f)(f_p f_s(1 - \exp(-\lambda_i t_h)) + \exp(-\lambda_i t_h))$

$x\ (r(1 - \exp(-\lambda_{Ei} t_e))/Y_v \lambda_{Ei} + B_{iv} (1 - \exp(-\lambda_i t_b))/P\lambda_i)$

for all radionuclides except C-14 and H-3.

$M^{Dm}_{14Ta} =$ $22\ DFI_{14Ta}\ U^{m}_{a}\ F_{mi}\ Q_F\ p(\exp(-\lambda_{14} t_f))$ for C-14

$M^{Dm}_{TTa} =$ $12\ DFI_{TTa}\ U^{m}_{a}\ F_{mi}\ Q_F \exp(-\lambda_T t_f)/H$ for tritium

for the ingestion pathway (DM) for meat:

$M^{DM}_{iTa} =$ $1.1\ E2\ DFI_{iTa}\ U^{M}_{a}\ F_{fi}\ Q_F \exp(-\lambda_i t_s)(f_p f_s(1 - \exp(-\lambda_i t_h)) + \exp(-\lambda_i t_h))$

$x\ (r(1 - \exp(-\lambda_{Ei} t_e))/Y_v \lambda_{Ei} + B_{iv} (1 - \exp(-\lambda_i t_b))/P\lambda_i)$

for all radionuclides except C-14 and H-3.

$M^{DM}_{14Ta} =$ $22\ DFI_{14Ta}\ U^{M}_{a}\ F_{f14}\ Q_F\ p(\exp(-\lambda_{14} t_s))$ for C-14

$M^{DM}_{TTa} =$ $12\ DFI_{TTa}\ U^{M}_{a}\ F_{fT}\ Q_F \exp(-\lambda_T t_s)/H$ for tritium

for the ingestion pathway (DL) for leafy vegetables:

$M^{DL}_{iTa} =$ $1.1\ E2\ DFI_{iTa}\ U^{L}_{a}\ f_e \exp(-\lambda_i t_h)(r(1 - \exp(-\lambda_{Ei} t_e))/Y_v \lambda_{Ei}$

$+B_{iv}(1 - \exp(-\lambda_i t_b))/P\lambda i)$

for all radionuclides except C-14 and H-3.

$M^{DL}_{14Ta} =$ $22\ DFI_{14Ta}\ U^{L}_{a}\ f_e p$ for C-14

$M^{DL}_{TTa} =$ $12\ DFI_{TTa}\ U^{L}_{a}\ f_e/H$ for tritium

The values used for the various parameters in the above equations are those recommended in NRC Regulatory Guide 1.109, Rev. 1, for the maximum exposed individual.

Parameter		Dimensions	Description/Source
1.0 E6		pCi/μCi	
DFG_{iT}		mRem-m²/pCi-hr	from table E-6 in R.G.
DFA_{iTa}		mRem/pCi inhaled	from table E-7 thru E-10 in R.G.
DFA_{14Ta}		mRem/pCi inhaled	from table E-7 thru E-10 in R.G.
DFA_{TTa}		mRem/pCi inhaled	from table E-7 thru E-10 in R.G.
DFI_{iTa}		mRem/pCi ingested	from tables E-11 thru E-14 in R.G.
DFI_{14Ta}		mRem/pCi ingested	from tables E-11 thru E-14 in R.G.
DFI_{TTa}		mRem/pCi ingested	from tables E-11 thru E-14 in R.G.
S_F	= 0.7	dimensionless	attenuation factor accounting for shielding by residential structures
λ_i		hr^{-1}	radiological decay constant for nuclide i.
t_b	$= 1.31 \times 10^5$	Hr	period of long-term buildup for activity in soil (nominally 15 yrs)
3.17×10^{-2}		pCi-yr/μCi-sec	
BR_a		m^3/yr	inhalation rate for age group a. Table E-5 in R.G.
1.1×10^2		pCi-yr/μCi-hr	
U^v_a		kg/yr	consumption rate of produce for individual in age group a. Table E-5 of R.G.
f_g	= 0.76	Dimensionless	fraction of produce ingested that is grown in garden of interest.
t_h		hr	time delay between harvest of vegetation or crops and ingestion.
	= 0		for pasture grass by animals
	= 2160		for stored feed by animals
	= 24		for leafy vegetables by man
	= 1440		for produce by man
r	= 0.2	dimensionless	fraction of deposited activity retained on crops, leafy vegetables, or pasture grass.
λ_{Ei}	$= \lambda_i + \lambda_W$	hr^{-1}	effective removal rate constant for radionuclide i from crops.
λ_W	= .0021	hr^{-1}	removal rate constant for activity on plant or leaf surfaces by weathering (≈ to 14 day half-life)
t_e		hr	period of crop, leafy vegetable, or pasture grass exposure during growing season.

Parameter		Dimensions	Description/Source
	= 720		for grass-cow-milk-man pathway
	= 1440		for crop/vegetation-man pathway
Y_v		kg/m^2	agricultural productivity (measured in wet weight)
	= 0.7		for grass-cow-milk-man pathway
	= 2.0		for produce or leafy vegetables ingested by man
B_{iv}		dimensionless	pCi/kg in vegetation per pCi/kg in soil for nuclide i. Table E-1 in R.G.
P	= 240	kg/m^2	effective surface density of soil (dry weight)
22		pCi-yr-m^3/μCi-kg-sec	
p		dimensionless	ratio of the total annual release time for C-14 to the total annual time during which photosynthesis occurs with the condition that $p \leq 1.0$
	= 1.0		for continuous C-14 releases.
12		pCi-g-yr/μCi-kg-sec	
H	= 8.0	g/m^3	average absolute humidity of the atmosphere at location (r, θ)
$U^m{}_a$		liters/yr	consumption rate of milk for individual in age group a. Table E-5 of R.G.
F_{mi}		day/l	factor for estimation of activity of nuclide i in milk from that in animal feed (pCi/l in milk per pCi/d ingested by the animal) Table E-1 in R.G.
Q_F	= 50	kg/day	feed or forage consumption rate (wet weight) by milk cow or beef cattle
t_f	= 48	hr	transport time from animal feed-milk-man.
f_p	= 0.5	dimensionless	fraction of the year that animals graze on pasture.
f_s	= 1.0	dimensionless	fraction of daily feed that is pasture when the animal is on pasture
$U^M{}_a$		kg/yr	consumption rate of meat & poultry for individual in age group a. Table E-5 of R.G.
F_{fi}		day/kg	factor for estimation of activity of nuclide i in meat from that in animal feed (pCi/kg in meat per pCi/day ingested by the animal) Table E-1 in R.G.
t_s	= 480	hr	average time from slaughter of meat animal to consumption of meat
$U^L{}_a$		kg/yr	consumption rate of leafy vegetables for individual in age group a. Table E-5 in R.G.
f_e	= 1.0	dimensionless	fraction of leafy vegetables grown in garden of interest.

2.2.6 Calculations of Dose Commitments due to Gaseous Release

In accordance with the RECP, the maximum commitment to a MEMBER OF THE PUBLIC from H-3 and all radionuclides in particulate form with half-lives greater than 8 days shall be determined at least quarterly.

To perform this calculation Equation 2.18 has been formatted on a computer-based spreadsheet. The quantity in curies of each nuclide (i) released to the atmosphere from the LACBWR facility during the calendar quarter is entered in the appropriate cell of the spreadsheet. The spreadsheet program calculates and displays the total quarterly dose in mRem to the total body and each organ of an individual in each of four age groups and the cumulative calendar year dose to the total body and each organ. It also determines the maximum exposed organ (and its dose) for each age group each quarter and the dose to the maximum exposed organ in all age groups. The quarterly and cumulative calendar year doses to the maximum exposed organ are compared to the limits and the relation in terms of percent of the limit is displayed. The maximum incremental organ dose received through each of the three major pathways is also determined for each age group each quarter.

3.0 RADIOACTIVE EFFLUENT CONTROL PROGRAM

3.1 Program Requirements

The Radioactive Effluent Control Program (RECP) shall conform to the guidance of 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. This program shall establish the requirements for monitoring, sampling, and analysis of radioactive gaseous and liquid 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. It shall provide 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.

The limitations of operability of gaseous and liquid monitoring instrumentation, including surveillance test and setpoint determination in accordance with Section 2.0, Offsite Dose Calculations, will be included in this program.

Requirements for the Reactor Building Ventilation System, including filtration and elevated stack release of exhausted air is included in Section 3.3.1.

In accordance with provisions of 40 CFR 190, the restrictions and surveillance requirements for total dose to any MEMBER OF THE PUBLIC from all LACBWR related sources and dose pathways are presented in Section 3.4.

3.2 Liquid Effluents

3.2.1 Sampling and Analysis

All liquid effluent releases at LACBWR will be in batch form. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analysis, each batch shall be isolated and then thoroughly mixed, to assure representative sampling. The radioactive content of each batch of radioactive liquid waste to be discharged shall be determined in accordance with Table 3.1.

The results of pre-release analyses shall be 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 RECP.

TABLE 3.1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS REQUIREMENTS FOR BATCH RELEASES

	Type of Activity Analysis[c]	Sampling Frequency	Minimum Analysis Frequency
1	Principal Gamma emitters[b]	Prior to discharge	Each discharge – prior to discharge
2	Gross Alpha	Prior to discharge	Each discharge – prior to discharge
3	Tritium	Prior to discharge	Each discharge
4	Sr-90 and Fe-55 Beta emitters	Prior to discharge	Quarterly Composite[a]

NOTES:

(a) 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.

(b) The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Co-60, Cs-134, and Cs-137. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported.

(c) Methods of calculating the Lower Limits of Detection (LLD) shall be contained in approved procedures and are calculated in accordance with criteria of NUREG-0473, Rev. 2.

3.2.2 Liquid Effluent Release Limitation

a) Concentration – the concentration of radioactive material released in liquid effluents at any time to areas beyond the EFFLUENT RELEASE BOUNDARY shall be limited to concentrations specified in 10 CFR Part 20, Appendix B, Table 2, Column 2.

If the concentration of radioactive material released beyond the EFFLUENT RELEASE BOUNDARY exceeds the above limits, restore the concentration to within the above limits without delay.

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

b) Dose – 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 shall be 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

The cumulative dose contribution from liquid effluent shall be determined at least once per calendar quarter in accordance with Section 2.0, Offsite Dose Calculations. If this calculated dose exceeds the above limits, prepare and submit to the Commission, within 30 days, 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 shall be in compliance with the above limits.

This limit is provided to implement the requirements of Sections II.A, III.A, IV.A and Annex of Appendix I, 10 CFR Part 50. The dose calculations in Section 2.0 implement the requirement in Section III.A of Appendix I that conformance with the guides of Appendix I be 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.

3.2.3 Liquid Effluent Instrumentation

The following radioactive liquid effluent monitoring instrumentation channels shall be OPERABLE, with their alarm setpoints set to ensure that the limits of Section 3.2.2a, are not exceeded, at all times when releasing liquid radioactive effluents.

- Liquid Radwaste Effluent Line Monitor

  and;

- Liquid Radwaste Effluent Line Flow Meter

The alarm setpoints for this monitor will be determined and adjusted using methodology in Section 2.0, Offsite Dose Calculations.

The radioactive liquid effluent instrumentation is provided to monitor the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents with the alarm setpoints set to ensure that the alarm will occur prior to exceeding the limits of 10 CFR Part 20.

a) Surveillance Requirements – each radioactive liquid effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL FUNCTIONAL TEST, and CHANNEL CALIBRATION operations at the frequencies shown in Table 3.2.

b) Corrective Action

1) With the Liquid Radwaste Effluent Line Monitor channel alarm/trip-point setpoint less conservative than that required by Section 3.2.2a, immediately suspend the release or change the setpoint so that it is acceptably conservative.

2) With the Liquid Radwaste Effluent Line Monitor NOT OPERABLE, or if its alarm setpoint is found to be less conservative than required, suspend release of liquid radioactive effluent without delay. Effluent releases may be resumed without the Liquid Radwaste Effluent Line Monitor OPERABLE, provided that at least two independent samples are analyzed and that at least two technically qualified members of the staff independently verify the release rate calculations. If the monitor is not operable for more than 30 continuous days, explain in the next annual Radioactive Effluent Release Report.

3) With the flow meter NOT OPERABLE, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases.

TABLE 3.2

RADIOACTIVE LIQUID EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument	Channel Check	Source Checks	Channel Functional Test	Channel Calibration
Liquid Radwaste Effluent Line Monitor	Prior to discharge	Prior to discharge *(See Note 4)*	Quarterly *(See Note 1)*	At least once per 18 months *(See Note 3)*
Liquid Radwaste Effluent Line Flow Meter	*(See Note 2)*	N/A	N/A	At least once per 18 months *(See Note 5)*

NOTES:

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that an alarm indication occurs if any of the following conditions exist:

- Instrument indicates measured levels at the alarm setpoint.
- Instrument indicates a downscale (circuit failure) failure.

(2) The CHANNEL CHECK shall consist of verifying indication of flow during periods of release. CHANNEL CHECK shall be made at least once per 24 hours on days in which continuous, periodic, or batch releases are made.

(3) The CHANNEL CALIBRATION shall include the use of a known liquid radioactive source positioned in a reproducible geometry with respect to the sensor. The source will have the gamma emitting radionuclide mixture and activity concentration which would normally be measured by the channel during batch discharges.

(4) Background radiation may be used for the source check.

(5) The CHANNEL CALIBRATION will be in accordance with approved procedures.

3.3 Gaseous Effluents

3.3.1 Reactor Building Ventilation

Normal air discharge from LACBWR is made as an elevated stack release. Air is swept through the Turbine and Reactor Building and then discharged out the stack where the particulate activity is monitored prior to release.

If at any time a verified FAST alarm condition occurs on either of the stack particulate effluent monitors, filtration of the Reactor Building Ventilation System exhaust SHALL COMMENCE as soon as practicable through a set of HEPA particulate filters to reduce the amount of radioactive particulates being released to the environment.

With Reactor Building Ventilation System exhaust being discharged without filtration during periods of a verified FAST alarm condition on either of the stack particulate effluent monitors, prepare and submit to the Commission within 30 days a Special Report which discusses the circumstances and what action will be taken to prevent a recurrence.

3.3.2 Stack Effluent Sampling and Analyses

The radioactive gaseous discharge from LACBWR will be sampled and analyzed in accordance with Table 3.3.

TABLE 3.3

RADIOACTIVE GASEOUS WASTE SAMPLING AND ANALYSIS

Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis(d)
Stack Effluent	Continuous(b)	Weekly(a) Particulate Sample	Principal Gamma Emitters(c)
	Continuous(b)	Quarterly Particulate Sample Composite	Sr-90
	Continuous(b)	Weekly(a) Particulate Sample	Gross Alpha
	Monthly	Monthly	H-3

NOTES:

(a) The filter sample shall be changed at least weekly, and filter analyses shall be completed within seven (7) days.

(b) The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation.

(c) The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn-54, Co-60, Zn-65, Cs-134, Cs-137, and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be considered. Other gamma peaks that are identifiable and measurable, together with those of the above nuclides, shall also be analyzed and reported in the annual Radioactive Effluent Release Report.

(d) Lower Limits of Detection (LLD) are determined in accordance with approved procedures and are calculated in accordance with criteria of NUREG-0473, Revision 2.

3.3.3 <u>Stack Effluent Release Limitation</u>

a) <u>Instantaneous Dose Rate</u> – the dose rate due to radioactive materials released in gaseous stack effluents to areas beyond the EFFLUENT RELEASE BOUNDARY shall be limited to:

- The dose rate limit for H-3 and for all radionuclides in particulate form with half-lives greater than 8 days shall be ≤ 1500 mRem/year to any organ.

The dose rate due to H-3 and for all radioactive materials in particulate form with half-lives > 8 days in gaseous stack effluents shall be determined to be within the above limits in accordance with Section 2.0, Offsite Dose Calculations, by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 3.3.

If the dose rate(s) exceeds the above limits, without delay decrease the release rate to within the above limit(s).

This instantaneous dose rate limit is provided to ensure that the dose rate at any time at the EFFLUENT RELEASE BOUNDARY from gaseous effluents from LACBWR will be within the annual dose limits of 10 CFR Part 20 for unrestricted areas. The annual dose limits are the doses associated with the concentrations of 10 CFR Part 20, Appendix B, Table 2, Column 1. These limits provide reasonable assurance that radioactive material discharged in gaseous effluents will not result in the exposure of an individual in an unrestricted area, outside the EFFLUENT RELEASE BOUNDARY to annual average concentrations exceeding the limits specified in Appendix B, Table 2 of 10 CFR Part 20. For individuals who may at times be within the EFFLUENT RELEASE BOUNDARY, the occupancy of the individual will be sufficiently low to compensate for any increase in the atmospheric diffusion factor above that for the EFFLUENT RELEASE BOUNDARY. The specified release rate limits restrict, at all times, the corresponding gamma and beta dose rates above background to an individual at or beyond the EFFLUENT RELEASE BOUNDARY to ≤ 500 mRem/year to the total body or to ≤ 3000 mRem/year to the skin. These release rate limits also restrict, at all times, the corresponding organ dose rate above background to an individual via the inhalation pathway to ≤ 1500 mRem/year.

b) <u>Dose from Radionuclides</u> – the dose to a MEMBER OF THE PUBLIC from H-3, and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents released to areas beyond the EFFLUENT RELEASE BOUNDARY shall be limited to:

<u>Calendar Quarter</u>	<u>Calendar Year</u>
≤ 7.5 mRem to any organ	≤ 15 mRem to any organ

The cumulative dose contributions shall be determined at least once per calendar quarter in accordance with Section 2.0, Offsite Dose Calculations.

With the calculated dose from the release of H-3 and all radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days a Special Report which identifies the cause(s) for exceeding the limit and defines the corrective actions which have been taken or will be taken to reduce these releases in gaseous effluents during remaining quarters so that the cumulative dose during each subsequent quarter and during the calendar year will be within the above limits.

This limit is provided to implement the requirements of Sections II.C, III.A, IV.A and Annex of Appendix I, 10 CFR Part 50. The ODCM calculational methods specified in the surveillance requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be 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.

3.3.4 Instrumentation

The radioactive gaseous effluent monitoring instrumentation channels shown in Table 3.4 shall be OPERABLE with their alarm setpoints set to ensure that the limits of Section 3.3.3a are not exceeded.

a) Gaseous Effluent Instrumentation Surveillance Requirements – Each radioactive gaseous effluent monitoring instrumentation channel shall be demonstrated OPERABLE by performance of the CHANNEL CHECK, SOURCE CHECK, CHANNEL FUNCTIONAL TEST, and CHANNEL CALIBRATION operations at the frequencies shown in Table 3.5.

b) Corrective Action

1) With a radioactive gaseous effluent monitoring instrumentation channel alarm setpoint less conservative than that required, declare the channel inoperable or change the setpoint so that it is acceptably conservative.

2) With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels OPERABLE, take the ACTION required by Table 3.4. Exert best efforts to return the instruments to OPERABLE status within 30 days and, if unsuccessful, explain in the next annual Radioactive Effluent Release Report why the inoperability was not corrected in a timely manner.

TABLE 3.4

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION

Instrument	Minimum Channels Operable	Applicable Conditions	Action
1. Stack Monitor System			
a. Particulate Activity Monitor	1	**	B
b. Sampler Flow Rate Measuring Device	1	**	A

** At all times, unless alternate monitoring is available

ACTIONS:

A. With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 24 hours.

B. With the number of channels OPERABLE less than required by the Minimum Channels OPERABLE requirement, effluent releases via this pathway may continue provided continuous collection of samples with auxiliary sampling equipment is initiated within 12 hours.

TABLE 3.5

RADIOACTIVE GASEOUS EFFLUENT MONITORING INSTRUMENTATION SURVEILLANCE REQUIREMENTS

Instrument	Channel Check	Source Check	Channel Functional Test	Channel Calibration[3]
1. Stack Monitor System				
a. Particulate Activity Monitor	DAILY	N/A	QUARTERLY[1]	AT LEAST ONCE PER 18 MONTHS
b. Sampler Flow Rate Measuring Device	DAILY	N/A	QUARTERLY[2]	AT LEAST ONCE PER 18 MONTHS

NOTES:

(1) The CHANNEL FUNCTIONAL TEST shall also demonstrate that an alarm indication occurs if any of the following conditions exist:

a. Instrument indicates measured level above the alarm setpoint on one channel.

b. Instrument indicates a failure by a Low Flow and Low Count Rate signal.

(2) The CHANNEL FUNCTIONAL TEST shall also demonstrate that the alarm occurs if the flow instrument indicates measured levels below the minimum and/or above the maximum alarm setpoint.

(3) The CHANNEL CALIBRATION shall be conducted in accordance with approved procedures.

3.4 Total Dose to a Member of the Public

The dose equivalent to any MEMBER OF THE PUBLIC due to release of radioactivity and radiation, shall be limited to $\leq$ 25 mRem to the total body or any organ (except the thyroid, which is limited to $\leq$ 75 mRem) over a period of one calendar year.

With the calculated doses from the release of radioactive materials in liquid or gaseous effluents exceeding twice the calendar year dose limits specified in Sections 3.2.2b, 3.3.3b, or 3.3.3c, a determination should be made, including direct radiation from Reactor Building and radioactive waste storage tanks to determine if the above limits have been exceeded. If these limits have been exceeded, prepare and submit a Special Report (including an analysis which estimates the radiation exposure to a MEMBER OF THE PUBLIC for the calendar year) to the Director, Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, DC 20555, within 30 days, which defines the corrective action to be taken to reduce subsequent releases to prevent recurrence of exceeding these limits. If the release condition resulting in the excess 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.

Cumulative dose contributions from liquid and gaseous effluents shall be determined quarterly and annually in accordance with Section 2.0, Offsite Dose Calculations.

Cumulative dose contributions from direct radiation from the reactor containment or radioactive waste storage tanks shall be determined once per year in accordance with Section 4.0, Radiological Environmental Monitoring Program.

This requirement is provided to meet the dose limitations of 40 CFR 190. Whenever the calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I, 10 CFR Part 50, a Special Report will be submitted which describes a course of action which should result in the limitation of dose to a real individual for 12 consecutive months to within the 40 CFR 190 limits.

For conservatism, for compliance with this limit, the maximum total dose to any MEMBER OF THE PUBLIC will be assumed to be the sum of the maximums from each dose pathway even though the actual maximally exposed individual for each of the pathways could not be the same person.

The maximum potential dose to a MEMBER OF THE PUBLIC from direct radiation from the Reactor Building and radioactive waste storage tanks is determined by TLD dosimeters located at various locations around the perimeter of the LACBWR access controlled area and the EFFLUENT RELEASE BOUNDARY for the environmental monitoring program. For compliance with this limit, the actual maximum possible exposure to an actual MEMBER OF THE PUBLIC from direct radiation may be determined from maximum possible exposure times relative to the continuous exposure dose measured by the TLDs. Conservative maximum possible exposure times will be determined by actual observation of the areas of interest by LACBWR management and/or security personnel.

3.5 Radioactive Effluent Control Reporting Requirements

3.5.1 Radioactive Effluent Release Report

Paragraph (a)(2) of 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors," requires that a report be made to the Commission 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, the information submitted shall be in accordance with Appendix B of Regulatory Guide 1.21 (Revision 1) dated June 1974 with data summarized on at least a quarterly basis. The Radioactive Effluent Release Report shall be submitted by March 1 of each year.

This same report shall include an assessment, performed in accordance with the ODCM, of radiation doses to members of the public from radioactive liquid and gaseous effluents released beyond the effluent release boundary. This report shall contain any changes made to the ODCM during the previous twelve months.

3.5.2 RECP Non-Conformance Reporting

1) With the Radiological Effluent Control Program not being conducted as specified in Sections 3.2.2b, 3.3.1, 3.3.3b, and 3.4; prepare and submit to the Commission, within 30 days, 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 shall be in compliance with the stated limits.

   Refer to Sections 3.2.2b, 3.3.1, 3.3.3b, and 3.4 for specific information.

4.0 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

4.1 Program Requirements

The Radiological Environmental Monitoring Program (REMP) shall conform to the guidance of Appendix I to 10 CFR Part 50. The REMP shall provide the requirements for monitoring, sampling, analyzing, and reporting radiation and radionuclides in the environment resulting from the LACBWR facility and/or its effluents. These requirements have been established to ensure the measurements of radiation and of radioactive material in potential exposure pathways to MEMBERS OF THE PUBLIC are performed. Various environmental samples will be taken within the area surrounding LACBWR and in selected controlled or background locations. An Interlaboratory Comparison Program shall be 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.

The radiological monitoring program required by this specification provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides, which lead to the highest potential radiation exposures of individuals resulting from plant effluents. This monitoring program theory supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways.

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.

4.2 REMP Description

Radiological environmental monitoring samples will be collected and analyzed in accordance with Table 4.1. The specific sample locations are listed in HSP-03.01. Section 3 of the Health and Safety Procedures (HSPs) shall contain procedures to provide specific guidance to the HP technicians in the collection and analysis of each environmental sample.

TABLE 4.1

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

	Exposure Pathway and/or Sample	Number of Samples[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
1.	AIRBORNE PARTICULATES	Three (3)	Continuous operation of sampler with sample collection as required by dust loading, but at least weekly.	1) Analyze each filter for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the control sample (La Crosse). 2) A composite of particulate filters from each location will be gamma analyzed at least once per quarter.
2.	DIRECT RADIATION	Eight (8)	At least semiannually	1) Gamma dose – at least semi-annually.
3.	WATERBORNE (River Water)	Two (2)	Monthly	1) Gamma isotopic analysis monthly on each sample. 2) Tritium analysis on composite sample from each location quarterly.
4.	RIVER SEDIMENT	Two (2)	Semi-annually	1) Gamma isotopic analysis on each sample.
5.	INGESTION			
	a. Fish	One (1) sample of two (2) different species in area important as a recreational or commercial species.	At least semi-annually	1) Gamma isotopic analysis of the edible portions of each sample.
	b. Milk	As Determined	Obtain sample if abnormal stack particulate release occurs.	1) Gamma isotopic analysis on each sample.
	c. Vegetation	As Determined	Obtain sample if abnormal stack particulate release occurs.	1) Gamma isotopic analysis of the edible portion of each composite sample.

NOTE: (a) Exact sample locations are listed in HSP-03.01.

4.3 REMP Lower Limits of Detection (LLD)

The sampling techniques and counting equipment used for the analysis of samples collected as requirements of the REMP will meet LLDs calculated in accordance with criteria of NUREG-0473, Rev. 2. LACBWR's LLDs are calculated as follows and are essentially the same as those found in NUREG-0473, Rev. 2. Table 4.2 lists these values.

4.3.1 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.

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

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

Where:

LLD = priori lower limit of detection as defined above (as picocurie per unit mass or volume).

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

E = counting efficiency (as counts per gamma).

V = sample size (in units of mass or volume).

2.22 = number of transformations per minute per picocurie.

Y = gamma abundance for isotope of interest.

λ = radioactive decay constant for the particular radionuclide.

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

TABLE 4.2

ENVIRONMENTAL SAMPLE ANALYSES LOWER LIMITS OF DETECTION (LLD) VALUES

Analysis	Sample Type				
	Water pCi/l	Airborne Particulate or Radioiodine (pCi/m^3)	Fish (pCi/Kg, Wet)	Milk (pCi/l)	Sediment (pCi/Kg Dry)
Gross Beta	6	1 E-2			
H-3	3500(2000)[a]				
Mn-54	15		130		
Co-60	15		130		
Zn-65	30		260		
Cs-134	15	5 E-2	130	15	150
Cs-137	18	6 E-2	150	18	180

NOTE: (a) For drinking water.

4.4 Interlaboratory Comparison Program

An Interlaboratory Comparison Program will be established to ensure that the analyses being performed to comply with the REMP is accurate. A suitable offsite laboratory will be used to supply NIST traceable or equivalent standard spiked sample media for analysis. The offsite laboratory will supply a report to DPC of the comparison results. The Interlaboratory Comparison Program will be conducted annually. The results of this comparison will be included in the Radiological Environmental Monitoring Report.

4.5 Radiological Environmental Monitoring Reporting Requirements

4.5.1 Radiological Environmental Monitoring Report

The Radiological Environmental Monitoring Report shall be submitted annually to the Administrator of the Regional Office of the NRC. This report shall include summarized and tabulated results, including interpretations and analysis of data trends, of environmental samples taken during the previous calendar year. 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.

The report shall also include 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. The Radiological Environmental Monitoring Report shall be submitted by March 1 of each year.

4.5.2 REMP Non-Conformance Reporting

1) With the Radiological Environmental Monitoring Program not being conducted as specified in Table 4.1, prepare and submit to the Commission, 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.

2) With the Interlaboratory Comparisons not being performed, report the corrective actions taken to prevent a recurrence to the Commission in the Radiological Environmental Monitoring Report.

3) With radiological environmental sample analysis in excess of the reporting levels listed in Table 4.3, when averaged over any calendar quarter, prepare and submit to the Commission a Special Report within 30 days, with a description of the reasons for exceeding these reporting levels.

TABLE 4.3

REPORTING LEVELS FOR RADIOACTIVITY CONCENTRATIONS IN ENVIRONMENTAL SAMPLES

Analysis	Water pCi/l	Airborne Particulate pCi/m^3	Fish pCi/kg (wet)	Milk pCi/l
H-3	20,000	--	--	--
Mn-54	1,000	--	30,000	--
Co-60	300	--	10,000	
Zn-65	300	--	20,000	--
Cs-134	30	10	1,000	60
Cs-137	50	20	2,000	70