OFFSITE DOSE CALCULATION MANUAL

LASALLE STATION
Units 1 and 2

1.0 INTRODUCTION - ODCM GENERAL INFORMATION

The Offsite Dose Calculation Manual (ODCM) presents a discussion of the following:

- The basic concepts applied in calculating offsite doses from plant effluents.
- The regulations and requirements for the ODCM and related programs.
- The methodology and parameters for the offsite dose calculations to assess impact on the environment and compliance with regulations.

The methodology detailed in this manual is intended for the calculation of radiation doses during routine (i.e., non-accident) conditions. The calculations are normally performed using a computer program. Manual calculations may be performed in lieu of the computer program.

The dose effects of airborne radioactivity releases predominately depend on meteorological conditions (wind speed, wind direction, and atmospheric stability). For airborne effluents, the dose calculations prescribed in this manual are based on historical average atmospheric conditions. This methodology is appropriate for estimating annual average dose effects and is stipulated in the Bases Section of the Radiological Effluents Controls (RECS).

1.1 Structure of the ODCM

Part I of the ODCM is considered to be the Radiological Effluents Controls (RECS), and contains the former Radiological Effluent Technical Specifications that have been removed from the Technical Specifications. Part I is organized as follows:

1- Definitions
2- Not Used
3- Controls
4- Surveillance Requirements
(Note: Sections 3 and 4 are presented together as 3/4)
   0. Control and Surveillance Requirements
   1. Radioactive Liquid Effluent Monitoring Instrumentation
   2. Radioactive Gaseous Effluent Monitoring Instrumentation
   3. Radioactive Liquid Effluents
   4. Radioactive Gaseous Effluents
   5. Total Dose
   6. Radiological Environmental Monitoring Program
   7. Land Use Census
   8. Inter-Laboratory Comparison Program
   9. Meteorological Monitoring Program
5- Bases
6- Administrative Requirements

Part II of the ODCM is considered to be the Offsite Dose Calculation Manual (ODCM), and contains methods, equations, assumptions, and parameters for calculation of radiation doses from plant effluents. Part II is organized as follows:

1- Introduction
2- Instrumentation and Systems
3- Liquid Effluents
4- Gaseous Effluents
5- Total Dose
6- Radiological and Environmental Monitoring Program

1.2 Regulations

This section serves to illustrate the regulations and requirements that define and are applicable to the ODCM. Any information provided in the ODCM concerning specific regulations are not a substitute for the regulations as found in the Code of Federal Regulations (CFR) or Technical Specifications.

1.2.1 Code of Federal Regulations

Various sections of the Code of Federal Regulations (CFR) require nuclear power stations to be designed and operated in a manner that limits the radiation exposure to members of the public. These sections specify limits on offsite radiation doses and on effluent radioactivity concentrations and they also require releases of radioactivity to be "As Low As Reasonably Achievable". These requirements are contained in 10CFR20, 10CFR50 and 40CFR190. In addition, 40CFR141 imposes limits on the concentration of radioactivity in drinking water provided by the operators of public water systems.

- <u>10CFR20, Standards for Protection Against Radiation</u>

  This revision of the ODCM addresses the requirements of 10CFR20. The 10CFR20 dose limits are summarized in Table 1 - 1.

- <u>Design Criteria (Appendix A of 10CFR50)</u>

  Section 50.36 of 10CFR50 requires that an application for an operating license include proposed Technical Specifications. Final Technical Specifications for each station are developed through negotiation between the applicant and the NRC. The Technical Specifications are then issued as a part of the operating license, and the licensee is required to operate the facility in accordance with them.

  Section 50.34 of 10CFR50 states that an application for a license must state the principal design criteria of the facility. Minimum requirements are contained in Appendix A of 10CFR50.

- ALARA Provisions (Appendix I of 10CFR50)

  Sections 50.34a and 50.36a of 10CFR50 require that the nuclear plant design and the station RECS have provisions to keep levels of radioactive materials in effluents to unrestricted areas "As Low As Reasonably Achievable" (ALARA). Although 10CFR50 does not impose specific limits on releases, Appendix I of 10CFR50 does provide numerical design objectives and suggested limiting conditions for operation. According to Section I of Appendix I of 10CFR50, design objectives and limiting conditions for operation, conforming to the guidelines of Appendix I "shall be deemed a conclusive showing of compliance with the "As Low As Reasonably Achievable" requirements of 10CFR50.34a and 50.36a."

  An applicant must use calculations to demonstrate conformance with the design objective dose limits of Appendix I. The calculations are to be based on models and data such that the actual radiation exposure of an individual is "unlikely to be substantially underestimated" (see 10CFR50 Appendix I, Section III.A.1).

  The guidelines in Appendix I call for an investigation, corrective action and a report to the NRC whenever the calculated dose due to the radioactivity released in a calendar quarter exceeds one-half of an annual design objective. The guidelines also require a surveillance program to monitor releases, monitor the environment and identify changes in land use.

- 40CFR190, Environmental Radiation Protection Standards for Nuclear Power Operations

  Under an agreement between the NRC and the EPA, the NRC stipulated to its licensees in Generic Letter 79-041 that "Compliance with Radiological Effluent Technical Specifications (RETS), NUREG-0473 (Rev.2) for BWR's, implements the LWR provisions to meet 40CFR190". (See Reference 103 and 49.)

  The regulations of 40CFR190 limit radiation doses received by members of the public as a result of operations that are part of the uranium fuel cycle. Operations must be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent to any member of the public due to radiation and to planned discharges of radioactive materials does not exceed the following limits:

  - 25 mrem to the total body
  - 75 mrem to the thyroid
  - 25 mrem to any other organ

An important difference between the design objectives of 10CFR50 and the limits of 40CFR190 is that 10CFR50 addresses only doses due to radioactive effluents. 40CFR190 limits doses due to effluents and to radiation sources maintained on site. See Section 1.2.4 for further discussion of the differences between the requirements of 10CFR50 Appendix I and 40CFR190.

- <u>40CFR141, National Primary Drinking Water Regulations</u>

  The following radioactivity limits for community water systems were established in the July, 1976 Edition of 40CFR141:

  - Combined Ra-226 and Ra-228: $\leq$ 5 pCi/L.
  - Gross alpha (particle activity including Ra-226 but excluding radon and uranium): $\leq$ 15 pCi/L.
  - The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 mrem/yr.

  The regulations specify procedures for determining the values of annual average radionuclide concentration that produce an annual dose equivalent of 4 mrem. Radiochemical analysis methods are also specified. The responsibility for monitoring radioactivity in a community water system falls on the supplier of the water. The LaSalle Station has requirements related to 40CFR141 in the RECS.

1.2.2 Radiological Effluent Technical Standards

The Radiological Effluent Technical Standards (RETS) were formerly a subset of the Technical Specifications. They implement provisions of the Code of Federal Regulations aimed at limiting offsite radiation dose. The NRC published Standard RETS for BWRs (Reference 3) as guidance to assist in the development of technical specifications. These documents have undergone frequent minor revisions to reflect changes in plant design and evolving regulatory concerns. The RETS have been removed from the Technical Specifications and placed in the ODCM as the RECS (see Reference 90). The RECS are similar but not identical to the guidance of the Standard Radiological Effluent Technical Specifications.

1.2.3 Offsite Dose Calculation Manual

The NRC in Generic Letter 89-01 defines the ODCM as follows (not verbatim) (see Reference 90):

> The Offsite Dose Calculation Manual (ODCM) shall contain the methodology and parameters used in the calculation of offsite doses resulting from radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring Alarm/Trip Setpoints, and in the conduct of the Radiological Environmental Monitoring Program. The ODCM shall also contain (1) the Radioactive Effluent Controls and Radiological Environmental Monitoring Programs and (2) descriptions of the Information that should be included in the Annual Radiological Environmental Operating and Annual Radioactive Effluent Release Reports.

Additional requirements for the content of the ODCM are contained throughout the text of the RECS.

1.2.4 Overlapping Requirements

In 10CFR20, 10CFR50 and 40CFR190, there are overlapping requirements regarding offsite radiation dose and dose commitment to the total body. In 10CFR20.1301, the total effective dose equivalent (TEDE) to a member of the public is limited to 100 mrem per calendar year. In addition, Appendix I to 10CFR50 establishes design objectives on annual total body dose or dose commitment of 3 mrem per reactor for liquid effluents and 5 mrem per reactor for gaseous effluents (see 10CFR50 Appendix I, Sections II.A and II.B.2(a)). Finally, 40CFR190 limits annual total body dose or dose commitment to a member of the public to 25 mrem due to all uranium fuel cycle operations.

While these dose limits/design objectives appear to overlap, they are different and each is addressed separately by the RETS. Calculations are made and reports are generated to demonstrate compliance to all regulations. Refer to Table 1 - 1 and Table 1 - 2 for additional information regarding instantaneous effluent limits, design objectives and regulatory compliance.

1.2.5 Dose Receiver Methodology

Table 1 - 2 lists the location of the dose recipient and occupancy factors, if applicable. Dose is assessed at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the maximum potential exposures. The dose calculation methodology is consistent with the methodology of Regulatory Guide 1.109 (Reference 6) and NUREG 0133 (Reference 14). Dose is therefore calculated to a maximum individual. The maximum individual is characterized as "maximum" with regard to food consumption, occupancy and other usage of the area in the vicinity of the plant site. Such a "maximum individual" represents reasonable deviation from the average for the population in general. In all physiological and metabolic respects, the maximum individual is assumed to have those characteristics that represent averages for their corresponding age group. Thus, the dose calculated is very conservative compared to the "average" (or typical) dose recipient who does not go out of the way to maximize radioactivity uptakes and exposure.

Table 1 - 1
Regulatory Dose Limit Matrix

REGULATION	DOSE TYPE	DOSE LIMIT(s)		ODCM Section
Airborne Releases:		(quarterly)	(annual)	
10CFR50 App. I[3]	Gamma Dose to Air due to Noble Gas Radionuclides (per reactor unit)	5 mrad	10 mrad	4.2.2.1
	Beta Dose to Air Due to Noble Gas Radionuclides (per reactor unit)	10 mrad	20 mrad	4.2.2.2
	Organ Dose Due to Specified Non-Noble Gas Radionuclides (per reactor unit)	7.5 mrem	15 mrem	4.2.3
	Total Body and Skin Dose (if air dose is exceeded): Total Body	2.5 mrem	5 mrem	4.2.2.3
	Total Body and Skin Dose (if air dose is exceeded): Skin	7.5 mrem	15 mrem	4.2.2.4
Technical Specifications	Total Body Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)	500 mrem/yr		4.2.1.1
	Skin Dose Rate Due to Noble Gas Radionuclides (instantaneous limit, per site)	3,000 mrem/yr		4.2.1.2
	Organ Dose Rate Due to Specified Non-Noble Gas Radionuclides (instantaneous limit, per site)	1,500 mrem/yr		4.2.1.3
Liquid Releases:		(quarterly)	(annual)	
10CFR50 App. I[3]	Whole (Total) Body Dose (per reactor unit)	1.5 mrem	3 mrem	3.4
	Organ Dose (per reactor unit)	5 mrem	10 mrem	3.4
Technical Specifications	The concentration of radioactivity in liquid effluents released to unrestricted areas	Ten times the values listed in 10CFR20 Appendix B; Table 2, Column 2, and in note 5 below for Noble Gases		3.2
Total Doses [1]:				
10 CFR 20.1301 (a)(1)	Total Effective Dose Equivalent [4]	100 mrem/yr		5.2
10CFR20.1301 (d) And 40CFR190	Total Body Dose	25 mrem/yr		5.2
	Thyroid Dose	75 mrem/yr		5.2
	Other Organ Dose	25 mrem/yr		5.2
Other Limits [2]:				
40CFR141	Total Body Dose Due to Drinking Water From Public Water Systems	4 mrem/yr		3.4
	Organ Dose Due to Drinking Water From Public Water Systems	4 mrem/yr		3.4

1 These doses are calculated considering all sources of radiation and radioactivity in effluents.

2 These limits are not directly applicable to nuclear power stations. They are applicable to the owners or operators of public water systems. However, the LaSalle RECS requires assessment of compliance with these limits.

3 Note that 10CFR50 provides design objectives, not limits.

4 Compliance with 10CFR20.1301(a)(1) is demonstrated by compliance with 40CFR190. Note that it may be necessary to address dose from on-site activity by members of the public as well.

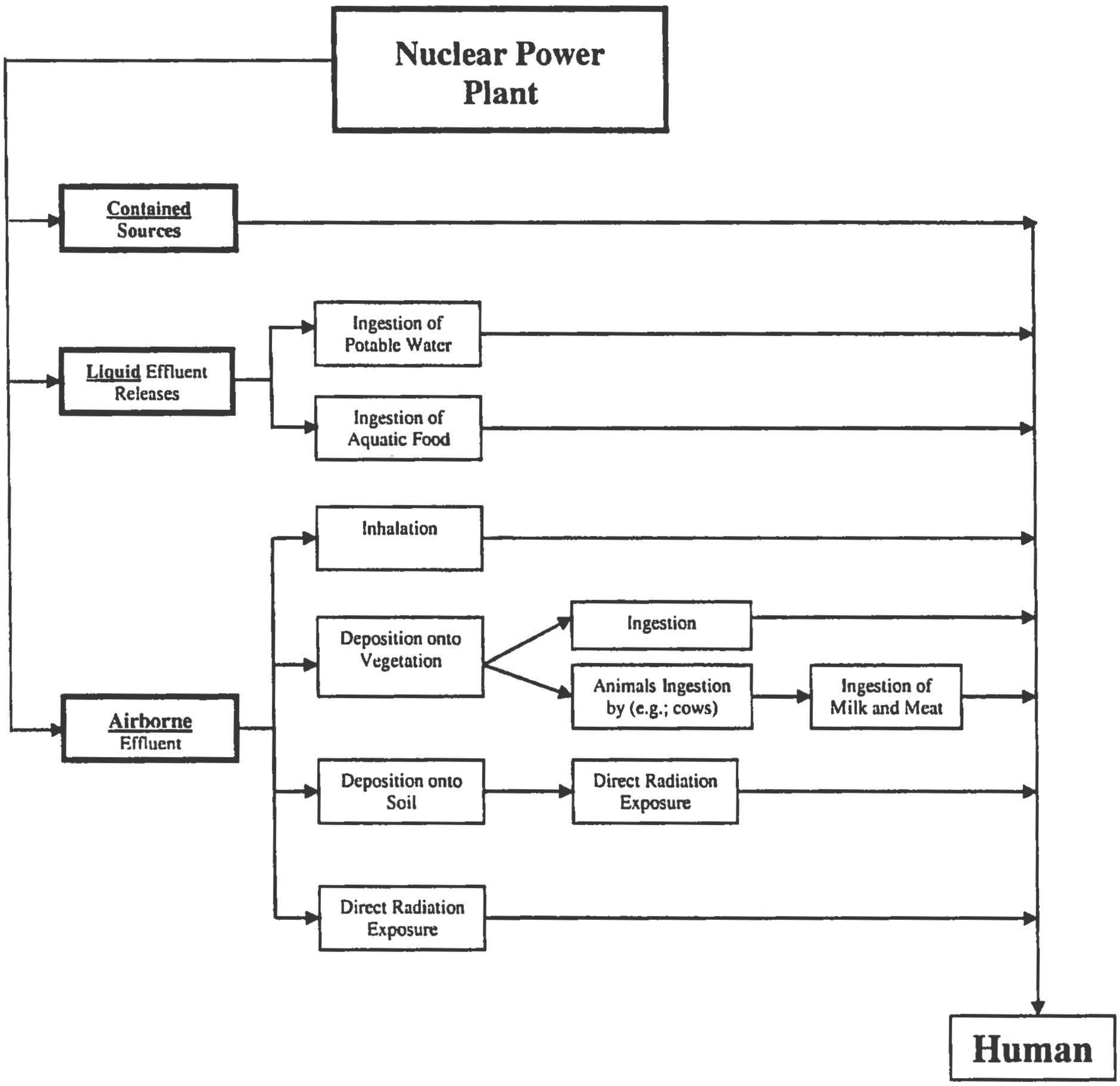
5 Kr-85m, Kr-85, Kr-87, Kr-88, Ar-41, Xe-131m, Xe-133m, Xe-133, Xe-135m and Xe-135 allowable concentration is 2E-4, 5E-4, 4E-5, 9E-5, 7E-5, 7E-4, 5E-4, 6E-4, 2E-4 and 2E-4 μCi/ml, respectively, computed from Equation 17 of ICRP Publication 2 adjusted for infinite cloud submersion in water, and R = 0.01 rem/wk, ρ_w = 1.0 g/cm3, and P_w/P_t = 1.0.

Table 1 - 2
Dose Assessment Receivers

Dose Component or Pathway	Location; Occupancy if Different than 100%
"Instantaneous" dose rates from airborne radioactivity	Unrestricted area boundary location that results in the maximum dose rate
"Instantaneous" concentration limits in liquid effluents	Point where liquid effluents enter the unrestricted area
Annual average concentration limits for liquid effluents	Point where liquid effluents enter the unrestricted area
Direct dose from contained sources	Receiver spends part of this time in the controlled area and the remainder at his residence or fishing nearby; occupancy factor is considered and is site-specific.
Direct dose from airborne plume	Receiver is at the unrestricted area boundary location that results in the maximum dose.
Dose due to radioiodines, tritium and particulates with half-lives greater than 8 days for inhalation, ingestion of vegetation, milk and meat, and ground plane exposure pathways.	Receiver is at the location in the unrestricted area where the combination of existing pathways and receptor age groups indicates the highest potential exposures.
Ingestion dose from drinking water	The drinking water pathway is considered as an additive dose component in this assessment only if the public water supply serves the community immediately adjacent to the plant.
Ingestion dose from eating fish	The receiver eats fish from the receiving body of water
Total Organ Doses	Summation of ingestion/inhalation doses
Total Dose	Summation of above data (Note it may also be necessary to address dose from on-site activity by members of the public.)

Figure 1 - 1 illustrates some of the potential radiation exposure pathways to humans due to routine operation of a nuclear power station.

Figure 1 - 1
Radiation Exposure Pathways to Humans



1.3 Offsite Dose Calculation Parameters

This section contains offsite dose calculation parameter factors, or values not specific only to one of the gas, liquid, or total dose chapters. Additional parameters are provided in the Sections 2, 4 and 5 of the ODCM.

10CFR50 Dose Commitment Factors

With the exception of H-3, the dose commitment factors for 10CFR50 related calculations are exactly those provided in Regulatory Guide 1.109 (Reference 6). The following table lists the parameters and the corresponding data tables in the RG 1.109:

PATHWAY	ADULT	TEENAGER	CHILD	INFANT
Inhalation	RG 1.109: Table E-7	RG 1.109: Table E-8	RG 1.109: Table E-9	RG 1.109: Table E-10
Ingestion	RG 1.109: Table E-11	RG 1.109: Table E-12	RG 1.109: Table E-13	RG 1.109: Table E-14

These tables are contained in Regulatory Guide 1.109 (Reference 6). Each table (E-7 through E-14) provides dose factors for seven organs for each of 73 radionuclides, and Table E-5 lists Miscellaneous Dose Assessment Factors - Consumption Parameters. For radionuclides not found in these tables, dose factors will be derived from ICRP 2 (Reference 50) or NUREG-0172 (Reference 51). The values for H-3 are taken from NUREG-4013 (Reference 107).

1.4 References

The references listed below were transferred from the previous ODCM revision that was common to all former Commonwealth Edison nuclear stations. The references not applicable to LaSalle Station have been deleted, however the numbering has been preserved for ease of reference management throughout the ODCM document; therefore, reference numbering is not sequential.

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Table 1 - 3
Miscellaneous Dose Assessment Factors: Environmental Parameters

Parameter	Value	Comment	Equation	Basis[a]
f_g	0.76		4-11, 4-12	A
f_L	1.0	Fraction of annual intake of fresh, leafy vegetation grown locally	4-11, 4-12	A
f_p	1.0	Fraction of year animals on pasture	4-13, 4-15	A
f_s	1.0	Fraction of feed from pasture when on pasture	4-13, 4-15	A
t_b	262,800 hrs or 9.46E8 sec	30 years. Period of buildup of activity in soil	4-9	C
t_f	48 hrs or 1.73E5 sec	Cow Milk Pathway	4-13	A
	480 hrs or 1.73E6	Cow Meat Pathway	4-15	A
t_h	1440 hrs or 5.18E6 sec	Delay time for ingestion of vegetation by man 60 days for produce	4-11	A
	2160 hrs or 7.78E6 sec	Delay time for ingestion of stored feed by animals	4-13, 4-15	A
t_L	24 hrs or 8.64E4 sec	Delay time for ingestion of leafy vegetable by man	4-11	A
Q_F	50 Kg/day	Cow Feed Consumption Rate	4-13, 4-14, 4-15, 4-16	B
r	1.0	For Iodines Fraction of deposited particulates retained on vegetation	4-11, 4-13, 4-15	A
	0.2	For Particulates	4-11, 4-13, 4-15	A
Y_p	0.7 Kg/m^2	Grass Yield	4-13, 4-15	A
Y_s	2.0 Kg/m^2	Stored Feed Yield	4-13, 4-15	A
Y_v	2.0 Kg/m^2	Vegetarian Area Density	4-11	A
λ_w	0.0021 hr^{-1} or 5.73 E-7 sec^{-1}	Weathering decay constant	4-11, 4-13, 4-15	A
H	8 gm/m^3	Absolute Atmospheric Humidity	4-12, 4-14, 4-16	D
D_W	1.0	Dilution Factor at point of withdrawal of drinking water	3-3	

Table 1 – 3
Miscellaneous Dose Assessment Factors: Environmental Parameters

Parameter	Value	Comment	Equation	Basis[a]
BR		Breathing Rate (m^3 / yr)		E
	1400 m^3/yr	Infant		
	3700 m^3/yr	Child		
	8000 m^3/yr	Teen		
	8000 m^3/yr	Adult		E
U^L		Leafy Vegetation Consumption Rate (kg/yr)		
	0 kg/yr	Infant		
	26 Kg/yr	Child		
	42 kg/yr	Teen		
	64 kg/yr	Adult		
U^V		Stored Vegetation Consumption (kg/yr)		E
	0 kg/yr	Infant		
	520 kg/yr	Child		
	630 kg/yr	Teen		
	520 kg/yr	Adult		
U^C		Cow Milk Consumption Rate (L/yr)		E
	330 L/yr	Infant		
	330 L/yr	Child		
	400 L/yr	Teen		
	310 L/yr	Adult		
U^M		Meat Consumption Rate (kg/yr)		E
	0 kg/yr	Infant		
	41 kg/yr	Child		
	65 kg/yr	Teen		
	110 kg/yr	Adult		
U^F		Fish Consumption Rate (kg/yr)		E
	0 kg/yr	Infant		
	6.9 kg/yr	Child		
	16 kg/yr	Teen		
	21 kg/yr	Adult		
U^D		Drinking Water Consumption Rate (L/yr)		E
	330 L/yr	Infant		
	510 L/yr	Child		
	510 L/yr	Teen		
	730 L/yr	Adult		

[a]Basis key:

A: Reference 6, Table E-15.
B: Reference 6, Table E-3.
C: The parameter t_b is taken as the midpoint of plant operating life (based upon an assumed 60 year plant operating lifetime).
D: Reference 14, Section 5.3.1.3.
E: Reference 6, Table E-5

Table 1 - 4
Stable Element Transfer Data

Element	F_f Meat (d/kg)	F_M(Cow) Milk (d/L)	Reference
H	1.2E-02	1.0E-02	6
Be	1.5E-03	3.2E-03	Footnote 1
C	3.1E-02	1.2E-02	6
F	2.9E-03	1.4E-02	Footnote 2
Na	3.0E-02	4.0E-02	6
Mg	1.5E-03	3.2E-03	Footnote 1
Al	1.5E-02	1.3E-03	Footnote 3
P	4.6E-02	2.5E-02	6
Cl	2.9E-03	1.4E-02	Footnote 2
Ar	NA	NA	NA
K	1.8E-02	7.2E-03	16
Ca	1.6E-03	1.1E-02	16
Sc	2.4E-03	7.5E-06	Footnote 4
Ti	3.4E-02	5.0E-06	Footnote 5
V	2.8E-01	1.3E-03	Footnote 6
Cr	2.4E-03	2.2E-03	6
Mn	8.0E-04	2.5E-04	6
Fe	4.0E-02	1.2E-03	6
Co	1.3E-02	1.0E-03	6
Ni	5.3E-02	6.7E-03	6
Cu	8.0E-03	1.4E-02	6
Zn	3.0E-02	3.9E-02	6
Ga	1.5E-02	1.3E-03	Footnote 3
Ge	9.1E-04	9.9E-05	Footnote 7
As	1.7E-02	5.0E-04	Footnote 8
Se	7.7E-02	1.0E-03	Footnote 9
Br	2.9E-03	2.2E-02	F_f Footnote 2;F_M from Ref. 16
Kr	NA	NA	NA
Rb	3.1E-02	3.0E-02	6
Sr	6.0E-04	8.0E-04	6
Y	4.6E-03	1.0E-05	6
Zr	3.4E-02	5.0E-06	6
Nb	2.8E-01	2.5E-03	6
Mo	8.0E-03	7.5E-03	6
Tc	4.0E-01	2.5E-02	6
Ru	4.0E-01	1.0E-06	6
Rh	1.5E-03	1.0E-02	6
Pd	5.3E-02	6.7E-03	Footnote 10
Cd	3.0E-02	2.0E-02	Footnote 11
In	1.5E-02	1.3E-03	Footnote 3
Sn	9.1E-04	9.9E-05	Footnote 7
Sb	5.0E-03	2.0E-05	98
Ag	1.7E-02	5.0E-02	6
Te	7.7E-02	1.0E-03	6
I	2.9E-03	6.0E-03	6
Xe	NA	NA	NA
Cs	4.0E-03	1.2E-02	6
Ba	3.2E-03	4.0E-04	6
La	2.0E-04	5.0E-06	6
Ce	1.2E-03	1.0E-04	6
Pr	4.7E-03	5.0E-06	6
Nd	3.3E-03	5.0E-06	6

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Table 1 - (Cont'd)
Stable Element Transfer Data

Element	F_f Meat (d/kg)	F_M (Cow) Milk (d/L)	Reference
Pm	2.9E-04	2.0E-05	16
Sm	2.9E-04	2.0E-05	16
Eu	2.9E-04	2.0E-05	16
Gd	2.9E-04	2.0E-05	16
Dy	2.9E-04	2.0E-05	16
Er	2.9E-04	2.0E-05	16
Tm	2.9E-04	2.0E-05	16
Yb	2.9E-04	2.0E-05	16
Lu	2.9E-04	2.0E-05	16
Hf	3.4E-02	5.0E-06	Footnote 5
Ta	2.8E-01	1.3E-03	F_M - Ref.16; F_f -Footnote 6
W	1.3E-03	5.0E-04	6
Re	1.0E-01	1.3E-03	F_M - Ref.16; F_f -Footnote 12
Os	2.2E-01	6.0E-04	Footnote 13
Ir	7.3E-03	5.5E-03	Footnote 14
Pt	5.3E-02	6.7E-03	Footnote 10
Au	1.3E-02	3.2E-02	Footnote 15
Hg	3.0E-02	9.7E-06	F_M - Ref.16; F_f -Footnote 11
Tl	1.5E-02	1.3E-03	F_M - Ref.16; F_f -Footnote 3
Pb	9.1E-04	9.9E-05	98
Bi	1.7E-02	5.0E-04	98
Ra	5.5E-04	5.9E-04	98
Th	1.6E-06	5.0E-06	98
U	1.6E-06	1.2E-04	98
Np	2.0E-04	5.0E-06	6
Am	1.6E-06	2.0E-05	98

Notes:
1. NA = It is assumed that noble gases are not deposited on the ground.
2. Elements listed are those considered for 10CFR20 assessment and compliance.

Footnotes:

There are numerous F_f and F_M values that were not found in published literature. In these cases, the periodic table was used in conjunction with published values. The periodic table was used based on a general assumption that elements have similar characteristics when in the same column of the periodic table. The values of elements in the same column of the periodic table, excluding atomic numbers 58-71 and 90-103, were averaged then assigned to elements missing values located in the same column of the periodic table. This method was used for all columns where there were missing values except column 3A, where there was no data, hence, the average of column 2B and 4A were used.

1. Values obtained by averaging Reference 6 values of Ca, Sr, Ba and Ra.
2. F_f value obtained by assigning the Reference 6 value for I. F_M value obtained by averaging I (Ref. 6) and Br (Ref.16).
3. F_f values obtained by averaging Zn (Ref.6) and Pb (Ref. 98); there were no values for elements in the same column; an average is taken between values of columns 2B and 4A on the periodic table. F_M values obtained by using the value for Tl from Reference 16.
4. Values obtained by averaging Reference 6 values of Y and La.
5. Values obtained by assigning the Reference 6 value for Zr.
6. F_f values obtained from Ref. 6 value for Nb. F_M values obtained by averaging values for Nb (Ref.6) and Ta (Ref. 16).
7. Values obtained from the Reference 6 values for Pb.
8. Values obtained from the Reference 6 values for Bi.
9. Values obtained from the Reference 6 values for Te.
10. Values obtained from the Reference 6 values for Ni.
11. F_f values obtained from Ref. 6 values for Zn. F_M values obtained by averaging the Reference 6 values for Zn and Hg.
12. Values obtained by averaging Reference 6 values for Mn, Tc, Nd and Reference 98 value for U.
13. Values obtained by averaging Reference 6 values from Fe and Ru.
14. Values obtained by averaging Reference 6 values from Co and Rh.
15. Values obtained by averaging Reference 6 values from Cu and Ag.

Figure 1 – 2
Unrestricted Area Boundary

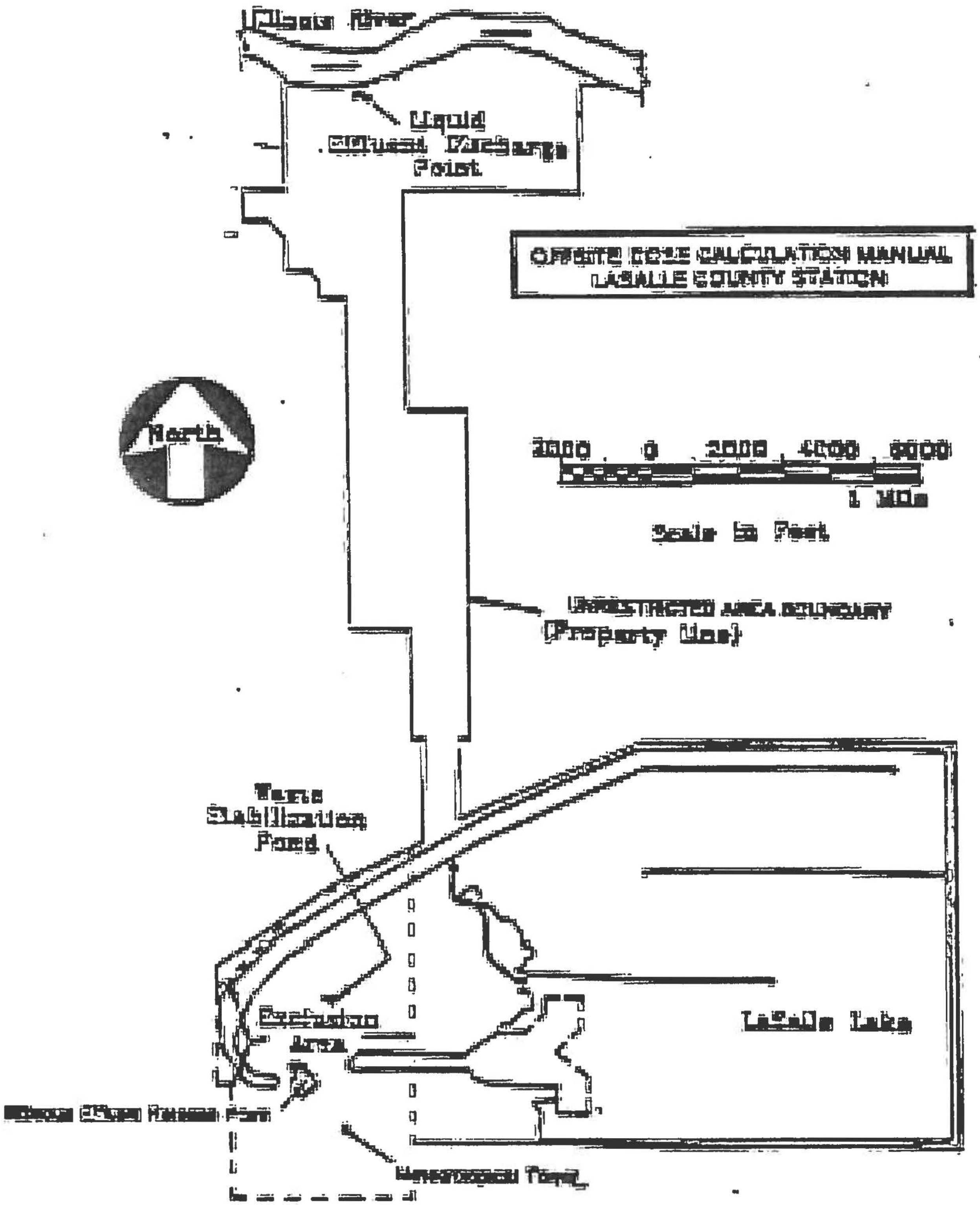
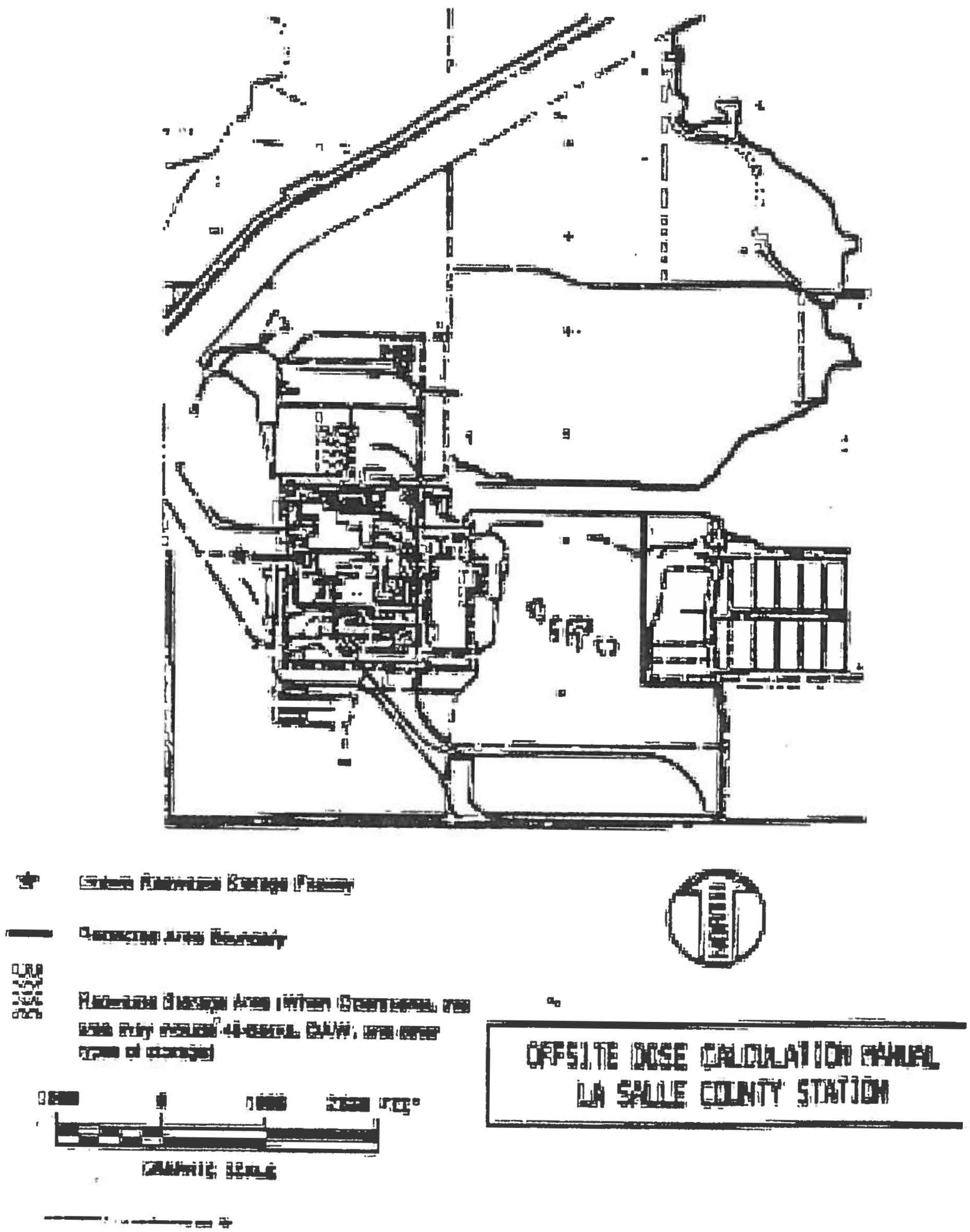


Figure 1 – 3
Restricted Area Boundary



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2.0 INSTRUMENTATION AND SYSTEMS

2.1 Liquid Releases

A simplified liquid radwaste and liquid effluent flow diagram are provided in Figures 2-2 and 2-3.

The liquid radwaste treatment system is designed and installed to reduce radioactive liquid effluents by collecting the liquids, providing for retention or holdup, and providing for treatment by filter or demineralizer for the purpose of reducing the total radioactivity prior to release to the environment. The system is described in Section 11.2.2 of the LaSalle UFSAR.

The Station has identified a potential pathway for low levels of tritium to enter the LaSalle Cooling lake via the Waste Water Treatment Facility (WWTF) through efforts associated with the Station's on-going tritium monitoring program utilizing environmental LLDs. During periods of low inputs into the station fire sumps via the turbine lube oil conditioners, tritium tends to concentrate to measureable levels when analyzed to environmental LLDs. This has resulted in the periodic presence of low levels of H3 at the WWTF, also measured to environmental levels. However, measured values at the plants permitted outfall, the cooling pond Blowdown to the Illinois River, has remained undetectable as counted to effluent LLDs. This potential pathway has been assessed and determined not to be a significant contributor to the total dose of a member of the public in accordance with the regulatory position provided in RG 1.109.

2.1.1 Radwaste Discharge Tanks

There are two discharge tanks (1(2)WF05T, 25,000 gallons each) which receive water for discharge to the Illinois River via the cooling lake blowdown.

2.1.2 Cooling Pond Blowdown

Cooling Pond Blowdown is the liquid discharge line to the Illinois River. The Cooling Pond Blowdown has a compositor to meet the sampling requirements of Part I RECS Table R12.3.1-2. Blowdown flow is determined by Blowdown Flow Control Valve position, in accordance with site implementing procedures.

2.2 Radiation Monitors

2.2.1 Liquid Radwaste Effluent Monitor

Monitor 0D18-K907 monitors all releases from the release tanks. On hi-hi alarm the monitor automatically initiates closure of valve 0WL067 and trips the radwaste discharge pump to terminate the release.

Pertinent information on the monitor and associated control devices is provided in LaSalle UFSAR Section 11.5.2.3.3.

2.2.2 Service Water Effluent Monitors

Monitors 1(2)D18-K912 continuously monitor the service water effluent. On high alarm service water discharge may be terminated manually. No control device is initiated by these monitors. | JAN 2015

Pertinent information on these monitors is provided in LaSalle UFSAR

2.2.3 RHR Heat Exchanger Cooling Water Effluent Monitors

Instrument channels 1(2)D18-N906/8 continuously monitor the RHR heat exchanger cooling water effluent. On high alarm the operating loop may be terminated manually and the redundant loop brought on line. No control device is initiated by these monitors. |

Pertinent information on these monitors is provided in LaSalle UFSAR Section 11.5.2.3.4.

2.3 Liquid Radiation Effluent Monitors Alarm and Trip Setpoints

Alarm and trip setpoints of liquid effluent monitors at the principal release points are established to ensure that the limits of RECS are not exceeded in the unrestricted area.

2.3.1 Liquid Radwaste Effluent Monitor

The monitor setpoint is found by solving equation (2-1) for the total isotopic activity.

$$P \le K \times [\Sigma C_i^T / \Sigma (C_i^T / 10 \times DWC_i)] \times [(F^d + F^r max)/F^r max] \qquad (2-1)$$

P Release Setpoint [cpm]

K	$[\Sigma (K_i \times C_i \times W_i) / \Sigma C_i^T]$	[cpm/μCi/ml]
K_i	Counting efficiency for radionuclide I	[cpm/μCi/ml]
W_i	Weighting Factor	
C_i^T	Concentration of radionuclide i in the release tank.	[μCi/ml]
F^r_{max}	Maximum Release Tank Discharge Flow Rate The maximum flow rate is 45 gpm.	[gpm]
DWC	Derived Water Concentration of radionuclide i The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-2402.	[μCi/ml]
10	Multiplier associated with the limits specified in Part I RECS 12.3.1.	
F^d	Dilution Flow	[gpm]

2.3.2 Service Water Effluent Monitors

The monitor setpoint is established at two times the background count rate (not to exceed 10000 cpm).

2.3.3 RHR Heat Exchanger Cooling Water Effluent Monitors

The monitor setpoint is established at two times the background count rate (not to exceed 10000 cpm).

2.3.4 Discharge Flow Rates

2.3.4.1 Release Tank Discharge Flow Rate

Prior to each batch release, a grab sample is obtained.

The results of the analysis of the sample determine the discharge rate of each batch as follows:

$$F^r max = 0.1 \times [F^d / \Sigma (C_i / 10xDWC_i)] \quad (2\text{-}2)$$

The summation is over radionuclides i.

0.1 Reduction factor for conservatism.

F^r_{max} Maximum Permitted Discharge Flow Rate [gpm]

The maxiumum permited flow rate from the radwaste discharge tank.

F^d Dilution Flow [gpm]

C_i Concentration of Radionuclide i in the Release Tank [µCi/mL]

The concentration of radioactivity in the radwaste discharge tank based on measurements of a sample drawn from the tank.

DWC_i Maximum Permissible Concentration of Radionuclide i[µCi/ml]

The concentration of radionuclide i given in Appendix B, Table 2, Column 2 to 10CFR20.1001-2402.

10 Multiplier associated with the limits specified in Part I RECS 12.3.1.

MF Multiplication Factor

$F^r_{max} < 0.5$; MF = 3

$0.5 < F^r_{max} < 5$; < MF = 5

$5 < F^r_{max}$; MF = 7.5

Recommended Release Tank Flow Rate.

$$F_{r\,rec} = F_r \max X \, MF \tag{2-3}$$

F_{rrec}	recommended discharge flow rate	(gpm)
$F_{r\,max}$	maximum permitted discharge flow rate	(gpm)
MF	multiplication factor.	

2.3.4.2 Release Limits

Release limits are determined from RECS. Calculated maximum permissible discharge rates are divided by 10 for conservatism and to ensure that release concentrations are well below applicable derived water concentrations (DWC).

2.3.4.3 Release Mixture

For the liquid radwaste effluent monitor the release mixture used for the setpoint determination is the radionuclide mix identified in the grab sample isotopic analysis plus four additional radionuclides. The additional radionuclides are H-3, Fe-59, Sr-89, and Sr-90. The quantities to be added are obtained from the most current analysis for these four radionuclides.

For all other liquid effluent monitors no release mixture is used because the setpoint is established at "two times background."

2.3.4.4 Liquid Dilution Flow Rates

A conservative maximum blowdown flowrate of 20,000 gpm is used for all radwaste discharge calculations unless actual blowdown flow is determined to be less.

2.3.4.5 Conversion Factors

The readout for the liquid radwaste effluent monitor is in CPM. The calibration constant is based on the detector sensitivity to Cs-137/Ba-137 and an energy response curve.

2.3.5 Allocation of Effluents from Common Release Points

Based on common release point, liquid releases from the Station will be allocated to Unit 1. Other potential pathways (i.e., RHR) are allocated to their respective unit.

2.3.6 Projected Doses for Releases

Doses are not calculated prior to release. Dose contributions from liquid effluents are determined in accordance with the RECS and station procedures.

2.3.7 Solidification of Waste/Process Control Program

The process control program (PCP) contains the sampling, analysis, and formulation determination by which solidification of radioactive wastes from liquid systems is ensured.

Figure 2-4 is a simplified diagram of solid radwaste processing.

2.4 Airborne Release

A simplified gaseous radwaste and gaseous effluent flow diagram are provided in Figure 2-1.

The airborne release point for radioactive effluents is the ventilation stack, which is classified as a stack in accordance with the definitions in Section 4.1.4.

In addition, the standby gas treatment system effluent is released through a separate stack inside the ventilation stack. This release point has the same location and classification as the ventilation stack.

Exfiltration to the environment from the Turbine Building has been identified at times of positive pressure in the Turbine Building. Within 20 hours of the turbine building being at positive pressure continuous air sampling shall be in place in the south Turbine Building trackway to monitor releases through this pathway. The releases through the trackway door and other potential release paths contain insignificant levels of contamination when compared to the Station Vent Stack which has a 1,000,000 cfm typical stack flow compared to the Trackway flow rate of 40,000 scfm and conservatively estimated as a total of 80,000 scfm to account for pathways other than the trackway. In addition, typical releases from LaSalle Station have not exceeded 0.02% of the 10CFR50 Appendix I dose limits. Any identified release via this pathway is a ground level release and should be considered in dose calculations. See Figure 2-1 for further information.

Exfiltration to the environment from the North Service Building may occur due to changes in the ventilation system. Within 20 hrs of the turbine building being at positive pressure, air sampling shall be performed at times when the ventilation systems are aligned to support unit 2 egress. This air sampling is designed to ensure evaluation of releases emanating from the Turbine Building in accordance with Section 2.5.5.

The station vent stack is equipped with three access hatches at elevations 853', 888' and 1055'. Nominal leakage from these access hatches is expected at an approximated value of up to 1000 SCFM. Resultant doses due to this nominal leakage are negligible when compared to the SVS flow of 1.00 E6 SCFM and have been calculated as such. Doses due to this nominal leakage are therefore accounted for in the gaseous effluent stream and do not require further calculation.

During maintenance activities in which the hatch(es) would be opened, however, the lower elevation hatches (elevations 853' and 888') are classified as vent or "mixed mode" release pathways. These release pathways should be monitored during the maintenance activity period, with resultant releases calculated as mixed mode. Monitoring may be accomplished by determining flow at the point of release and conservatively utilizing the normal effluent release activity levels (at the SVS WRGM sample location). Flow via this pathway should be determined by measurement or engineering calculation. Release activities can be determined from the normal effluent sample point, assuming isokinetic flow at the release pathway. Alternately, grab sampling may be used to ensure representative sampling at the point of release.

The higher elevation hatch at 1050' remains as a stack (elevated) release pathway and can be monitored via the SVS instrumentation and methodology.

Airborne releases to the environment may result if a fire occurs in a contaminated material warehouse. In the event of a fire in a contaminated material warehouse this pathway would be considered a ground level release and should be quantified and considered in dose calculations.

Tritium contributions to gaseous effluents resulting from drum evaporation activities have been assessed at LaSalle Station. A bounding calculation using conservative source term assumptions demonstrated that expected drum evaporation activities would amount to <1% of station releases. In situ sampling of drum evaporation activities yielded analysis results well below the conservative estimates. Drum evaporation activities do not pose a significant contribution to effluent releases at LaSalle Station.

2.4.1 Condenser Offgas Treatment System

The condenser offgas treatment system is designed and installed to reduce radioactive gaseous effluents by collecting non-condensable off-gases from the condenser and providing for holdup to reduce the total radioactivity by radiodecay prior to release to the environment. The daughter products are retained by charcoal and HEPA filters. The system is described in Section 11.3.2.1 of the LaSalle UFSAR. | JAN 2015

2.4.2 Ventilation Exhaust Treatment System

Ventilation exhaust treatment systems are designed and installed to reduce gaseous radioiodine or radioactive material in particulate form in selected effluent streams by passing ventilation or vent exhaust gases through charcoal adsorbers and/or HEPA filters prior to release to the environment. Such a system is not considered to have any effect on noble gas effluents. The ventilation exhaust treatment systems are shown in Figure 2-1.

Engineered safety features atmospheric cleanup systems are not considered to be ventilation exhaust treatment system components.

2.5 Gaseous Effluent Radiation Monitors

2.5.1 Station Vent Stack Effluent Monitor

Monitor 0PLD5J (Wide Range Noble Gas Monitor) continuously monitors the final effluent from the station vent stack. JAN 2015

The monitor system has isokinetic sampling, gaseous grab sampling, iodine and particulate sampling, tritium sampling, and post-accident sampling capability.

In normal operation the low-range noble gas channel is on line and active. The midrange channel replaces the low-range channel at a concentration of 0.01 μCi/cc png* and the high-range channel replaces the mid-range channel at a concentration of 10 uCi/cc png.

The low-range and mid/high-range iodine and particulate samplers operate in a similar manner. In normal operation the low-range samplers are on line. At a concentration of 0.001 μCi/cc png the mid/high-range samplers are brought on line, and at a concentration of 0.1 μCi/cc png the low-range sample pump is turned off.

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* To facilitate use of the wide range gas monitors on the Station Vent Stack and Standby Gas Treatment System Stack in post-accident dose assessment, the output of each is expressed in units of pseudo noble gas (png) activity. Pseudo noble gas is a fictitious radionuclide defined to have emission characteristics representative of a post-accident noble gas mix. Upon decay, a pseudo noble gas nuclide emits one gamma ray with energy 0.8 MeV and one beta particle with endpoint energy 1.68 MeV and average energy 0.56 MeV.

No automatic isolation or control functions are performed by this monitor. Pertinent information on this monitor is provided in the LaSalle UFSAR Section 11.5.2.2.1.

2.5.2 Standby Gas Treatment System Effluent Monitor

Monitor 0PLD2J (Wide Range Noble Gas Monitor) continuously monitors the final effluent from the standby gas treatment system (SGTS) stack.

The SGTS stack monitor has isokinetic sampling, gaseous grab sampling, particulate and iodine sampling, and post accident sampling capability.

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In normal operation the low range noble gas channel is on line and active. The midrange channel replaces the low-range channel at a concentration of 0.01 µCi/cc png and the high-range channel replaces the mid-range channel at a concentration of 10 µCi/cc png.

The low-range and mid/high-range iodine and particulate samples operate in a similar manner. In normal operation, the low-range samples are on-line. At a concentration of 0.001 µCi/cc png the mid/high-range samplers are brought on-line, and at a concentration of 0.1 µCi/cc png the low-range sample pump is turned off.

No automatic isolation or control functions are performed by this monitor.

Pertinent information on this monitor is provided in the LaSalle UFSAR Section 11.5.2.2.2.

2.5.3 Reactor Building Ventilation Monitors

Monitors 1(2)D18-N009 continuously monitor the effluent from the Unit 1(2) reactor building. On high alarm, the monitors automatically initiate the following actions:

A. Shutdown and isolation of the reactor building vent system

B. Startup of the standby gas treatment system

C. Isolation of primary containment purge and vent lines

Pertinent information on these monitors is provided in LaSalle UFSAR Section 11.5.2.1.1.

2.5.4 Condenser Air Ejector Monitors

Monitors 1(2)D18-N002/N012 (pre-treatment) and 1(2)D18-N903A/B (post-treatment) continuously monitor gross gamma activity downstream of the steam jet air ejector and prior to release to the main stack.

On "high-high-high" alarm monitor 1(2)D18-N903A/B automatically initiates closure of valve 1(2)N62-F057 thus terminating the release.

Pertinent information on these monitors is found in LaSalle UFSAR Sections 11.5.2.1.2 and 11.5.2.1.3.

2.5.5 Turbine Building Trackway and North Service building

In order to quantify releases via either the (1) Turbine Building Trackway or (2) North Service Building (when the ventilation systems are aligned to support the unit 2 egress) at times of positive pressure in the Turbine Building, airborne sampling shall be continuously collected using an air sampler appropriately located. The air sampler collecting shall begin within 20 hours of the turbine building being at positive pressure, and then continuously for as long as the turbine building remains at positive pressure. The samples collected should be counted on a weekly basis. Air sampling to identify noble gas, iodine and particulate monitoring (either as a grab sampler or continuous sampling) is designed to ensure evaluation of releases emanating from the Turbine Building.

The curie content of any contaminated material warehouse is maintained current by site administrative procedures. If a fire were to occur, the actual curie content of the warehouse would be used in determining the ground level release.

2.6 Gaseous Radiation Effluent Alarm and Trip Setpoints

2.6.1 Reactor Building Vent Effluent Monitor

The setpoint for the reactor building vent effluent monitor is established at 10 mR/hr.

2.6.2 Condenser Air Ejector Monitors

Pre-Treatment Monitor

The high trip setpoint is established at 1.5 times the normal full power background rate, including nitrogen-16 (N-16) to help ensure that effluents are maintained ALARA.

The high-high trip setpoint is established at < 100 µCi/sec per MW-th (3.4E+05 µCi/sec per Technical Specification 3.7.6). JAN 2015

Post-Treatment Monitor

The off-gas isolation setpoint is conservatively set at or below one-half the release limit calculated using the more conservative value obtained from equations (2-5) and (2-6) below.

The off gas isolation setpoint is converted into the monitor units of counts per second (cps) as follows:

$$P \leq Q_{SVS} \times E \times [R_{png} / R_{OG}] + F_{OG} \qquad (2\text{-}4)$$

P Off-gas Post-treatment Monitor Isolation Setpoint. [cps]

The off-gas post-treatment monitor setpoint which initiates isolation of flow of offgas to the station vent stack.

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Q_{SVS} Actual Station Vent Stack High Alarm Setpoint [μCi/sec of png]
The actual high alarm setpoint of the Station Vent Stack wide range gas monitor in units of μCi/sec of png (pseudo noble gas). This is determined by using Equations (2-5) and (2-6) and then converting the result to units of μCi/sec of png.

E Efficiency of the Off-Gas Post Treatment Monitor [cps/(μCi/sec of off gas mix)]

R_{png} Response of the Station Vent Stack WRGM to Pseudo Noble Gas [cpm per μCi/cc of pseudo noble gas]

R_{OG} Response of the Station Vent Stack WRGM to Off Gas [cpm per μCi/cc of off gas]

F_{OG} Maximum Off-Gas Flow Rate [cc/sec]

2.6.3 Station Vent Stack Effluent Monitor

The high alarm setpoint for the station vent stack effluent monitor is conservatively set at or below one-half the calculated release limit calculated using the more conservative value obtained from equations (2-5) and (2-6) below. These equations yield the release limit in units of μCi/sec of the mix specified in Table 2-1. For consistency with the monitor readout, this calculated release limit is converted to units of μCi/sec of pseudo noble gas before being entered into the monitor data base.

2.6.4 Standby Gas Treatment Stack Monitor

The high alarm setpoint for the standby gas treatment system effluent monitor is conservatively set at or below one-half the release limit calculated using the more conservative value obtained from equations (2-5) and (2-6) below. These equations yield the release limit in units of μCi/sec of the mix specified in Table 2-1. For consistency with the monitor readout, this calculated release limit is converted to units of μCi/sec of pseudo noble gas before being entered into the monitor data base.

2.6.5 Release Limits

Alarm and trip setpoints of gaseous effluent monitors are established to ensure that the release rate limits of RECS are not exceeded. The release limit Q_{ts} is found by solving Equations (2-5) and (2-6).

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$$(1.11)\ Q_{ts} \Sigma \{F_i S_i\} \leq 500 \text{ mrem/yr} \qquad (2\text{-}5)$$

$$Q_{ts}\ \Sigma\{\overline{L}_i\ f_i\ (X/Q)_s \exp(-\lambda_i\ R/3600\,U_s)\dagger + (1.11)(f_i)S_i\} < 3000\, mrem/yr \qquad (2\text{-}6)$$

The summations are over noble gas radionuclides i.

f_i Fractional Radionuclide Composition:

The release rate of noble gas radionuclide i divided by the total release rate of all noble gas radionuclides.

Q_{ts} Total Allowed Release Rate, Stack Release [µCi/sec of ODCM mix]

The total allowed release rate of all noble gas radionuclides released as stack releases in units of µCi/sec of the mix specified in section 2.6.6.

† exp ($-\lambda_i R/3600\ U_s$) is conservatively set equal to 1.0 for purposes of determining setpoints.

The remaining parameters in Equation (2-5) have the same definitions as in Equation 4- 9 of Section 4.2.3.1. The remaining parameters in Equation (2-6) have the same definition as in Equation 4-10 of Section 4.2.3.2.

Equation (2-5) is based on Equation 4-9 of Section 4.2.3.1 and the RECS restriction on whole body dose rate (500 mrem/yr) due to noble gases released in gaseous effluents (see Section 4.2.1.1). Equation (2-6) is based on Equation 4-10 of Section 4.2.3.2 and the RECS restriction on skin dose rate (3000 mrem/yr) due to noble gases released in gaseous effluents (see Section 4.2.1.2).

The more conservative solution from Equations (2-5) and (2-6) is used as the limiting noble gas release rate.

Calibration methods and surveillance frequency for the monitors will be conducted as specified in the RECS.

2.6.6 Release Mixture

In the determination of alarm and trip set points, the radioactivity mixture in the exhaust air is assumed to have the radionuclide composition in Table 2-1, taken from Table 3-3 of GE NEDO-10871, March 1973.

2.6.7 Conversion Factors

The conversion factors used to establish gaseous effluent monitor setpoints are obtained as follows.

Station vent stack effluent monitor.

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Calibrations compare the response of station detectors to that of a reference detector using NIST traceable sources. Conversion factors for the station detectors are obtained from the response to noble gas or solid sources.

Condenser air ejector monitor.

Pretreatment Monitor

The value is determined using noble gas radionuclides identified in a representative sample, the offgas release rate and monitor response at the time the sample is taken.

Post-treatment Monitor

The value is determined using noble gas radionuclides identified in a representative sample, the offgas concentration and monitor response at the time the sample is taken.

Standby gas treatment system monitor.

Calibrations compare the response of station detectors to that of a reference detector using NIST traceable sources. Conversion factors for the station detectors are obtained from the response to noble gas or solid sources.

2.6.8 HVAC Flow Rates

The main stack flow rate is obtained from either the process computer or Monitor RM-23.

The SGTS flow rate is obtained from either the process computer or chart recorders in the main control room.

2.6.9 Allocation of Effluents from Common Release Points

Radioactive gaseous effluents released from the main chimney are comprised of contributions from both units. Under normal operating conditions, it is difficult to allocate the radioactivity between units due to fuel performance, in-plant leakage, power history, and other variables. Consequently, no allocation is normally made between the units. Instead, the entire release is treated as a single source.

2.6.10 Dose Projections

Because the gaseous releases are continuous, the doses are routinely calculated in accordance with the RECS.

Table 2-1

Assumed Composition of the LaSalle Station Noble Gas Effluent
(From GE NEDO – 10871 Table 3.3)

Nuclide	T1/2	uCi/s @ T=0	Contribution	% Contribution
Kr83m	1.86h	3.40E+03	4.50E-03	0.45%
Kr85m	4.4h	6.10E+03	8.08E-03	0.81%
Kr85	10.74h	2.00E+01	2.65E-05	0.00%
Kr87	76m	2.00E+04	2.65E-02	2.65%
Kr88	2.79h	2.00E+04	2.65E-02	2.65%
Kr89	3.18m	1.30E+05	1.72E-01	17.22%
Kr90	32.3s	2.80E+05	3.71E-01	37.08%
Xe131m	11.96d	1.50E+01	1.99E-05	0.00%
Xe133m	2.26d	2.90E+02	3.84E-04	0.04%
Xe133	5.27d	8.20E+03	1.09E-02	1.09%
Xe135m	15.7m	2.60E+04	3.44E-02	3.44%
Xe135	9.16h	2.20E+04	2.91E-02	2.91%
Xe137	3.82m	1.50E+05	1.99E-01	19.87%
Xe138	14.2m	8.90E+04	1.18E-01	11.79%
Total		7.55E+05	1.00E+00	100.00%

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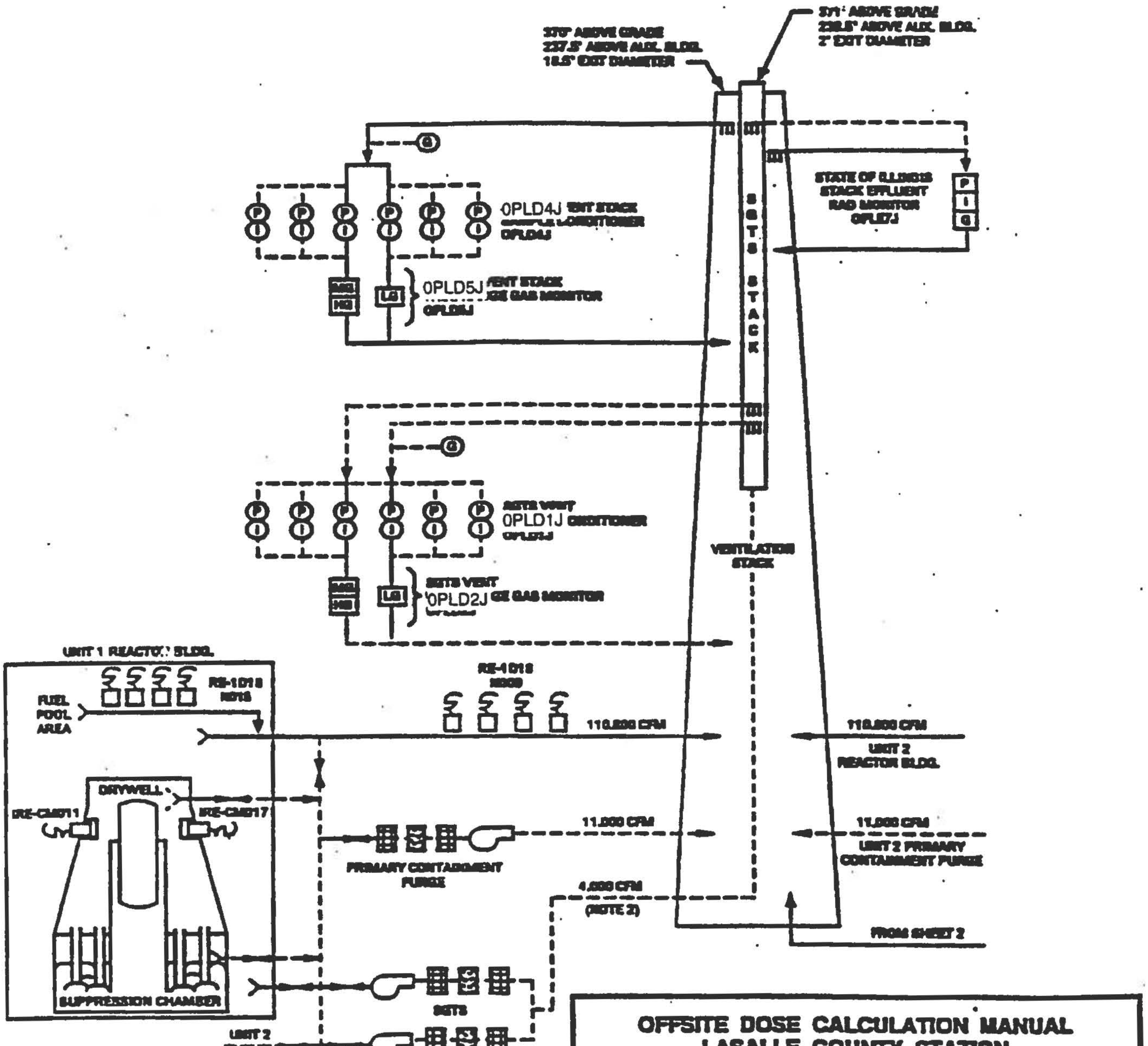

**OFFSITE DOSE CALCULATION MANUAL
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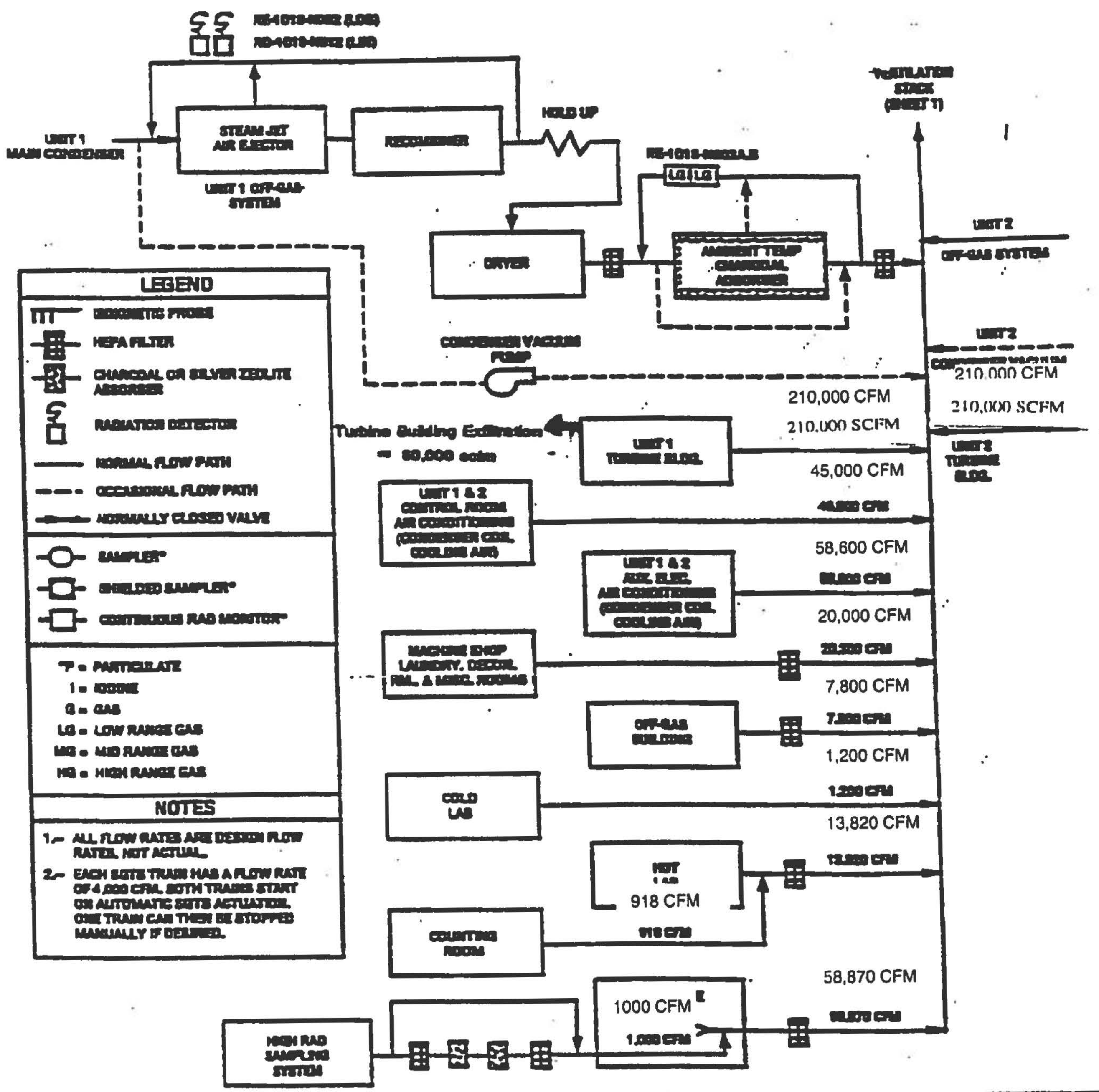
FIGURE 2-1

SIMPLIFIED GASEOUS RADWASTE AND GASEOUS EFFLUENT FLOW DIAGRAM (SHEET 1 OF 2)



OFFSITE DOSE CALCULATION MANUAL
LASALLE COUNTY STATION

FIGURE 2-1
SIMPLIFIED GASEOUS RADWASTE AND GASEOUS EFFLUENT FLOW DIAGRAM
(SHEET 2 OF 2)

JAN 2015

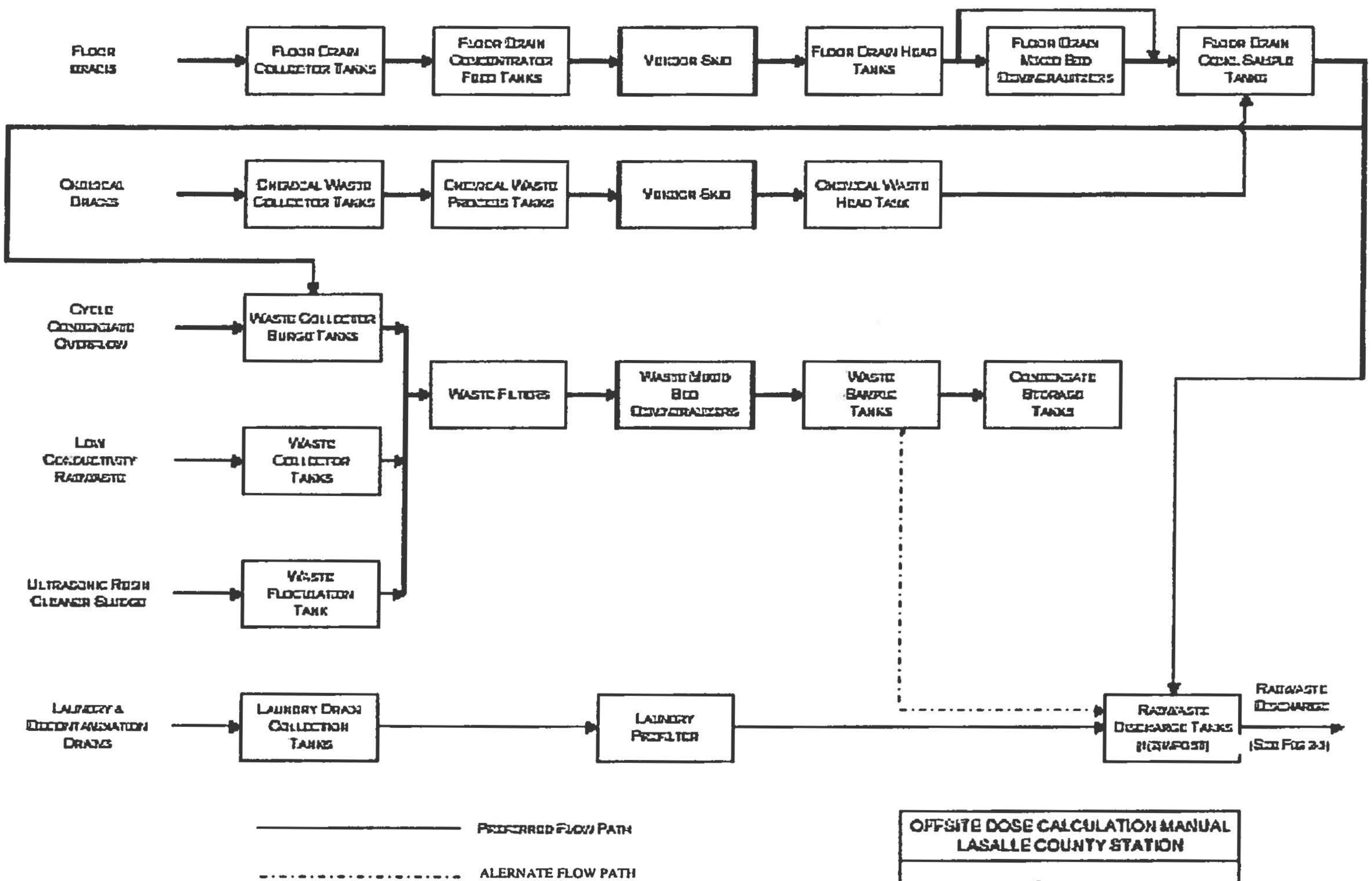


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FIGURE 2-2

SIMPLIFIED LIQUID RADWASTE PROCESSING DIAGRAM

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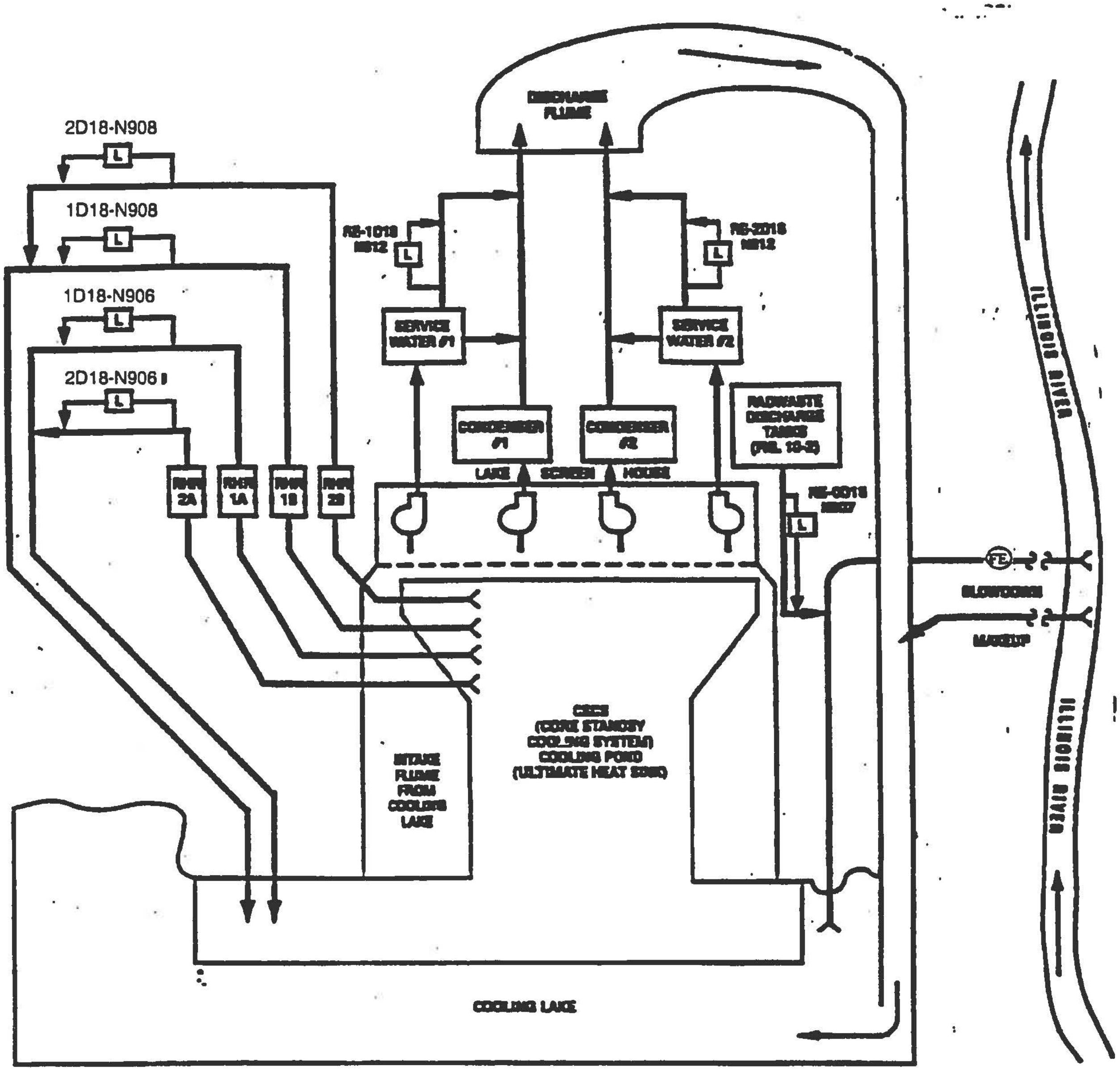

LEGEND AND NOTES	
L	LIQUID RADIATION MONITOR
FE	FLOW ELEMENT

OFFSITE DOSE CALCULATION MANUAL
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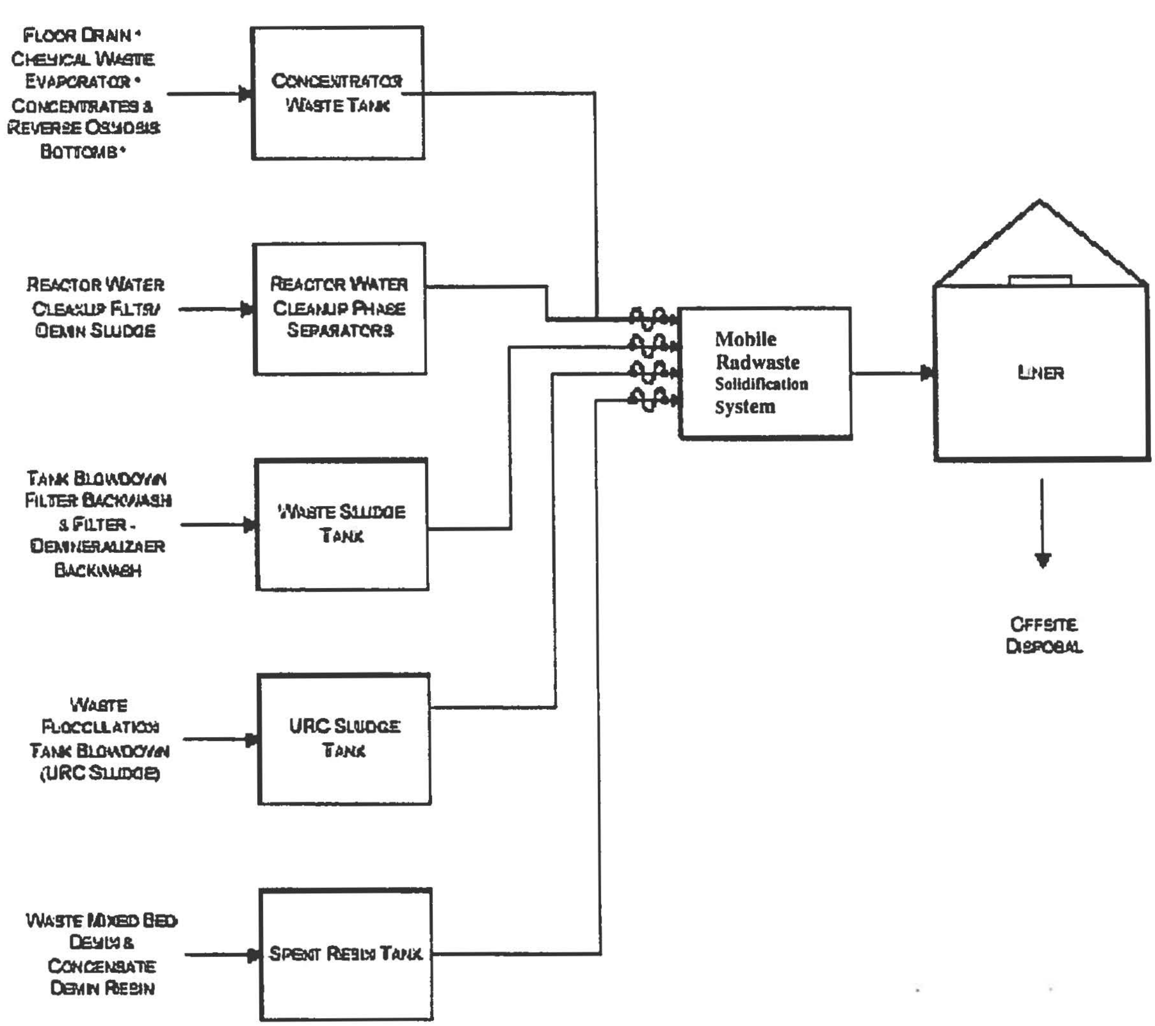
FIGURE 2-3

SIMPLIFIED LIQUID EFFLUENT FLOW DIAGRAM



Legend and Notes

Flexible Hose

URC = Ultrasonic Resin Cleaner

* = Abandoned in Place

OFFSITE DOSE CALCULATION MANUAL
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FIGURE 2-4

SIMPLIFIED SOLID RADWASTE
PROCESSING DIAGRAM

3.0 LIQUID EFFLUENTS

3.1 Liquid Effluent Releases – General Information

3.1.1 The design objectives of 10CFR50, Appendix I and RECS provide the following limits on the dose to a member of the public from radioactive materials in liquid effluents released from each reactor unit to restricted area boundaries:

- During any calendar quarter, less than or equal to 1.5 mrem to the total body and less than or equal to 5 mrem to any organ.
- During any calendar year, less than or equal to 3 mrem to the total body and less than or equal to 10 mrem to any organ.

3.1.2 The organ doses due to radioactivity in liquid effluents are also used as part of the 40CFR190 compliance and are included in the combination of doses to determine the total dose used to demonstrate 10CFR20 compliance. (See Section 5.0, Total Dose)

3.1.3 Dose assessments for 10CFR20 and 40CFR190 compliance are made for an adult using Federal Guidance Report No. 11 (Reference 93) dose conversion factors. Dose assessments for 10CFR50 Appendix I compliance are made for four age groups (adult/teenager/child/infant) using Regulatory Guide 1.109 (Reference 6) dose conversion factors.

3.1.4 To limit the consequences of tank overflow, the RECS/Technical Specifications may limit the quantity of radioactivity that may be stored in unprotected outdoor tanks. Unprotected tanks are tanks that are not surrounded by liners, dikes, or walls capable of holding the tank contents and that do not have tank overflows and surrounding area drains connected to the liquid radwaste treatment system. The specific objective is to provide assurance that in the event of an uncontrolled release of a tank's contents, the resulting radioactivity concentrations beyond the unrestricted area boundary, at the nearest potable water supply and at the nearest surface water supply, will be less than the limits of 10CFR20 Appendix B, Table 2; Column 2.

The Technical Specifications and RECS may contain a somewhat similar provision. For most nuclear power stations, specific numerical limits are specified on the number of curies allowed in affected tanks.

3.1.5 Cases in which normally non-radioactive liquid streams (such as the Service Water) are found to contain radioactive material are non-routine will be treated on a case specific basis if and when this occurs. Since the station has sufficient capacity to delay a liquid release for reasonable periods of time, it is expected that planned releases will not take place under these circumstances. Therefore, the liquid release setpoint calculations need not and do not contain provisions for treating multiple simultaneous release pathways.

3.2 Liquid Effluent Concentrations

3.2.1 One method of demonstrating compliance to the requirements of 10CFR20.1301 is to demonstrate that the annual average concentrations of radioactive material released in gaseous and liquid effluents do not exceed the values specified in 10CFR20 Appendix B, Table 2, Column 2. (See 10CFR 20.1302(b)(2).) However, as noted in Section 5.5, this mode of 10CFR20.1301 compliance has not been elected.

As a means of assuring that annual concentration limits will not be exceeded, and as a matter of policy assuring that doses by the liquid pathway will be ALARA; RECS provides the following restriction:

> "The concentration of radioactive material released in liquid effluents to unrestricted areas shall be limited to ten times the concentration values in Appendix B, Table 2, Column 2 to 10CFR20.1001-20.2402."

This also meets the requirement of Station Technical Specifications and RECS.

3.2.2 According to the footnotes to 10CFR20 Appendix B, Table 2, Column 2, if a radionuclide mix of known composition is released, the concentrations must be such that

$$\sum_i \left(\frac{C_i}{10\,ECL_i} \right) \leq 1 \qquad (3\text{-}1)$$

where the summation is over radionuclide **i**.

C_i Radioactivity Concentration in Liquid Effluents to the Unrestricted Area [μCi/ml]

Concentration of radionuclide **i** in liquid released to the unrestricted area.

ECL_i Effluent Concentration Limit in Liquid Effluents Released to the Unrestricted Area [μCi/ml]

The allowable annual average concentration of radionuclide **i** in liquid effluents released to the unrestricted area. This concentration is specified in 10CFR20 Appendix B, Table 2, Column 2. Concentrations for noble gases are different and are specified in the stations' Technical Specifications/RECS.

10 Multiplier to meet the requirements of Technical Specifications.

If either the identity or concentration of any radionuclide in the mixture is not known, special rules apply. These are given in the footnotes in 10CFR20 Appendix B, Table 2, Column 2.

3.2.3 When radioactivity is released to the unrestricted area with liquid discharge from a tank (e.g., a radwaste discharge tank), the concentration of a radionuclide in the effluent is calculated as follows:

$$C_i = (C_i^t)\,(F^r)/(F^d + F^r) \qquad (3\text{-}2)$$

C_i Concentration in Liquid effluent to the unrestricted area. [μCi/ml]

Concentration of radionuclide 'i' in liquid released to the unrestricted area.

C_i^t Concentration in the Discharge Tank [μCi/ml]

Measured concentration of radionuclide **i** in the discharge tank.

F^r Flow Rate, Tank Discharge [cfs]

Measured flow rate of liquid from the discharge tank to the initial dilution stream.

F^d Flow Rate, Initial Dilution Stream [cfs]

Measured flow rate of the initial dilution stream that carries the radionuclides to the unrestricted area boundary (e.g. circulating cooling water or blowdown from a cooling tower or lake).

The RECS and Technical Specifications require a specified sampling and analysis program to assure that liquid radioactivity concentrations at the point of release are maintained within the required limits. To comply with this provision, samples are analyzed in accordance with the radioactive liquid waste (or effluent) sampling and analysis program in Section 12.3 of Part I, RECS. Radioactivity concentrations in tank effluents are determined in accordance with Equation 3-2. Comparison with the Effluent Concentration Limit is made using Equation 3-1.

3.3 Liquid Effluent Dose Calculation Requirements

3.3.1 RECS require determination of cumulative and projected dose contributions from liquid effluents for the current calendar quarter and the current calendar year at least once per 31 days.

For a release attributable to a processing or effluent system shared by more than one reactor unit, the dose due to an individual unit is obtained by proportioning the effluents among the units sharing the system.

3.3.2 Operability and Use of the Liquid Radwaste Treatment System

The design objectives of 10CFR50, Appendix I and RECS/Technical Specifications require that the liquid radwaste treatment system be operable and that appropriate portions be used to reduce releases of radioactivity when projected doses due to the liquid effluent from each reactor unit to restricted area boundaries exceed either of the following (see Section 12.3.3 of Part I, RECS);

- 0.06 mrem to the total body in a 31-day period.
- 0.2 mrem to any organ in a 31-day period.

3.4 Dose Methodology

3.4.1 Liquid Effluent Dose Method: General

The dose from radioactive materials in liquid effluents considers the contributions for consumption of fish and potable water. All of these pathways are considered in the dose assessment unless demonstrated not to be present. While the adult is normally considered the maximum individual, the methodology provides for dose to be calculated for all four age groups. The dose to each organ (and to the total body) is calculated by the following expressions:

3.4.1.1 NUREG – 0133 Methodology

$$D_\tau = \frac{\sum_i \left[A_{i\tau} \sum_{\ell=1}^{m} \Delta t_\ell \, C_{i_\ell} \, F_\ell \right]}{D_w} \quad (3\text{-}3)$$

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where:

D_τ = The cumulative dose commitment to the total body or any organ, τ, from liquid effluents for the total time period $\sum_{\ell=1}^{m} \Delta t_\ell$, (mrem).

Δt_ℓ = The length of the ℓ th time period over which C_{i_ℓ} and F_ℓ are averaged for the liquid release, (hours).

C_{i_ℓ} = The average concentration of radionuclide, *i*, in undiluted liquid effluent during time period Δt_ℓ, from any liquid release, (uCi/ml).

F_ℓ = The near field average dilution factor for C_{i_ℓ} during any liquid effluent release. Defined as the ratio of the maximum undiluted liquid waste flow during the release to the average flow through the discharge pathway

$$F_\ell = \frac{(\text{tank volume(gallons)})}{(\text{tank volume(gallons)}) + (\text{Blowdown Dilution (gallons)})}$$

D_w = The dilution factor at point of exposure or at point of withdrawal of drinking water (dimensionless).

$A_{i\tau}$ = The site specific ingestion dose commitment factor to the total body or organ, τ, for each radionuclide and pathway

3.4.2 Potable Water Pathway

3.4.2.1 NUREG – 0133 Methodology

$$A_{i\tau} = k_0 * U_w * D_{aipj} * e^{(-\lambda_i t_p^D)} \qquad (3\text{-}4)$$

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k_0 = 114155, units conversion factor (1.0 E6 pCi/uCi * 1000 ml/L/ 8760 hr/yr). Note for fish units are g/kg.

U = usage factor per pathway.

D_{aipj} = dose conversion factor for nuclide, *i*, for total body or any organ, τ, (mrem/pCi).

λ_i = radioactive decay constant of nuclide 'i' (hr-1) .

t_p^D = delay time for water pathway in hours to allow for nuclide decay during transport through the water purification plant and the water distribution system.

3.4.3 Fish Ingestion Pathway

3.4.3.1 NUREG -0133 Methodology

Freshwater Fish

$$A_{i\tau} = k_0 * U_F * BF_i * D_{aipj} \quad * e^{\left(-\lambda_i t_p^F\right)} \qquad (3\text{-}5)$$

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k_0 = 114155, units conversion factor (1.0 E6 pCi/uCi * 1000 ml/L/ 8760 hr/yr). Note for fish units are g/kg.

U = usage factor per pathway.

D_{aipj} = dose conversion factor for nuclide, *i*, for total body or any organ, τ, (mrem/pCi).

BF_i = bioaccumulation factor for nuclide, *i*, in fresh water fish (pCi/kg per pCi/L).

λ_i = radioactive decay constant of nuclide 'i' (hr-1).

t_p^F = delay time for fish pathway to allow for nuclide decay during transport through the food chain, as well as during food preparation.

3.4.4 Offsite Doses

Offsite doses due to projected releases of radioactive materials in liquid effluents are calculated using the equation in 3.4.1.1. Projected radionuclide release concentrations are used in place of measured concentrations, C_i.

3.4.5 Drinking Water

LaSalle Station has requirements for calculation of drinking water dose that are related to 40CFR141, the Environmental Protection Agency National Primary Drinking Water Regulations. These are discussed in Section 1.2.1.

3.5 Bioaccumulation Factors

3.5.1 There are no public potable water intakes on the Illinois River for 97 miles downstream of the station at Peoria, IL.

3.5.2 There is no irrigation occurring on the Illinois River downstream of the station.

3.5.3 Recreation includes one or more of the following: boating, water-skiing, swimming, and sport fishing.