SALEM NUCLEAR GENERATING STATION

OFFSITE DOSE CALCULATION MANUAL

Revision 1 9/13/85

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Introduction

The Salem Offsite Dose Calculation Manual (ODCM) describes the methodology and parameters used in: 1) the calculation of radioactive liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints; and 2) the calculation of radioactive liquid and gaseous concentrations, dose rates and cumulative quarterly and yearly doses. The methodology stated in this manual is acceptable for use in demonstrating compliance with 10 CFR 20.106, 10 CFR 50, Appendix I and 40 CFR 190.

More conservative calculational methods and/or conditions (e.g., location and/or exposure pathways) expected to yield higher computed doses than appropriate for the maximally exposed person may be assumed in the dose evaluations.

The ODCM will be maintained at the station for use as a reference guide and training document of accepted methodologies and calculations. Changes will be made to the ODCM calculational methodologies and parameters as is deemed necessary to ensure reasonable conservatism in keeping with the principles of 10 CFR 50.36a and Appendix I for demonstrating radioactive effluents are ALARA.

NOTE: As used throughout this document, excluding acronyms, words appearing all capitalized denote the application of definitions as used in the Salem Technical Specifications.

1.0 Liquid Effluents

1.1 Radiation Monitoring Instrumentation and Controls

The liquid effluent monitoring instrumentation and controls at Salem for controlling and monitoring normal radioactive material releases in accordance with the Salem Radiological Effluent Technical Specifications are summarized as follows:

1) Alarm (and Automatic Termination) - 1-R18 (Unit 1) and 2-R18 (Unit 2) provide the alarm and automatic termination of liquid radioactive material releases as required by Technical Specification 3.3.3.8.

   1-R19 A, B, C, and D provide the alarm and isolation function for the Unit 1 steam generator blowdown lines. 2-R19 A, B, C and D provide this function for Unit 2.

2) Alarm (only) - The alarm functions for the Service Water System are provided by the radiation monitors on the Containment Fan Cooler discharges (1-R 13 A, B, C, D and E for Unit 1 and 2-R 13 A, B, and C for Unit 2).

   Releases from the secondary system are routed through the Chemical Waste Basin where the effluent is monitored (with an alarm function) by R37 prior to release to the environment.

Liquid radioactive waste flow diagrams with the applicable, associated radiation monitoring instrumentation and controls are presented as Figures 1-1 and 1-2 for Units 1 and 2, respectively.

1.2 Liquid Effluent Monitor Setpoint Determination

Per the requirements of Technical Specification 3.3.3.8, alarm setpoints shall be established for the liquid effluent monitoring instrumentation to ensure that the release concentration limits of Specification 3.11.1.1 are met (i.e., the concentration of radioactive material released in liquid effluents to UNRESTRICTED AREAS shall be limited to the concentrations specified in 10 CFR 20, Appendix B, Table II, Column 2, for radionuclides and 2.0E-04 uCi/ml for dissolved or entrained noble gases). The following equation* must be satisfied to meet the liquid effluent restrictions:

$$c \leq \frac{C\,(F+f)}{f} \qquad (1.1)$$

where:

- C = the effluent concentration limit of Technical Specification (3.11.1.1) implementing the 10 CFR 20 MPC for the site, in uCi/ml
- c = the setpoint, in uCi/ml, of the radioactivity monitor measuring the radioactivity concentration in the effluent line prior to dilution and subsequent release; the setpoint, which is inversely proportional to the volumetric flow of the effluent line and proportional to the volumetric flow of the dilution stream plus the effluent stream, represents a value which, if exceeded, would result in concentrations exceeding the limits of 10 CFR 20 in the UNRESTRICTED AREA
- f = the flow rate at the radiation monitor location, in volume per unit time, but in the same units as F, below
- F = the dilution water flow rate as measured prior to the release point, in volume per unit time

(Note that if no dilution is provided, $c \leq C$. Also, note that when (F) is large compared to (f), then $(F + f) \approx F$.)

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* Adapted from NUREG-0133

1.2.1 <u>Liquid Effluent Monitors (Radwaste, Steam Generator Blowdown, Chemical Waste Basin and Service Water)</u>. The setpoints for the liquid effluent monitors at the Salem Nuclear Generating Station are determined by the following equations:

$$SP \leq \frac{MPCe * SEN * CW}{RR} + bkg \qquad (1.2)$$

with:

$$MPCe = \frac{\sum Ci}{\sum\left(\frac{Ci}{MPCi}\right)} \qquad (1.3)$$

where:

SP = alarm setpoint corresponding to the maximum allowable release rate (cpm)
MPCe = an effective MPC value for the mixture of radionuclides in the effluent stream (uCi/ml)
Ci = the concentration of radionuclide i in the liquid effluent (uCi/ml)
MPCi = the MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (uCi/ml)
SEN = the sensitivity value to which the monitor is calibrated (cpm per uCi/ml)
CW = the circulating water flow rate (dilution water flow) at the time of release (gal/min)
RR = the liquid effluent release rate (gal/min)
bkg = the background of the monitor (cpm)

The radioactivity monitor setpoint equation (1.2) remains valid during outages when the circulating water dilution is potentially at its lowest value. Reduction of the waste stream flow (RR) may be necessary during these periods to meet the discharge criteria. However, in order to maximize the available plant discharge dilution and thereby minimize the potential offsite doses, releases from either Unit-1 or Unit-2 may be routed to either the Unit-1 or Unit-2 Circulating Water System discharge. This routing is possible via interconnections between the Service Water Systems (see Figures 1 and 2). Procedural restrictions prevent conducting simultaneous releases from either a single unit or both units into a single Circulating Water System discharge.

1.2.2 Conservative Default Values. Conservative alarm setpoints may be determined through the use of default parameters. Tables 1-1 and 1-2 summarize all current default values in use for Salem Unit-1 and Unit-2, respectively.

They are based upon the following:

a) substitution of the default effective MPC value of 1E-05 uCi/ml for radwaste releases (refer to Appendix A for justification);
b) for additional conservatism*, substitution of the I-131 MPC value of 3E-07 uCi/ml for the R19 Steam Generator blowdown monitors, R13 Service Water monitor and R37 Chemical Waste Basin monitor;
c) substitutions of the lowest operational circulating water flow, in gal/min; and,
d) substitutions of the highest allowed effluent release rate, in gal/min.

With pre-established alarm setpoints, it is possible to control the radwaste release rate (RR) to ensure the inequality of equation (1.2) is maintained under changing values for MPCe and for differing Circulating Water System dilutions.

1.3 Liquid Effluent Concentration Limits - 10 CFR 20

Technical Specification 3.11.1.1 limits the concentration of radioactive material in liquid effluents (after dilution in the Circulating Water System) to less than the concentrations as specified in 10 CFR 20, Appendix B, Table II, Column 2 for radionuclides other than noble gases. Noble gases are limited to a diluted concentration of 2.0E-04 uCi/ml. Release rates are controlled and

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* Use of the effective MPC value as derived in Appendix A may be non-conservative for the R19 Steam Generator blowdown monitors and R37 Chemical Waste Basin monitors where I-131 transfer during primary to secondary leakage may potentially be more controlling.

radiation monitor alarm setpoints are established as addressed above to ensure that these concentration limits are not exceeded. However, in the event any liquid release results in an alarm setpoint being exceeded, an evaluation of compliance with the concentration limits of Technical Specification 3.11.1.1 may be performed using the following equation:

$$\left[\sum\left(\frac{Ci}{MPCi}\right) * \left(\frac{RR}{CW + RR}\right)\right] \leq 1 \qquad (1.4)$$

where:

Ci = actual concentration of radionuclide i as measured in the undiluted liquid effluent (uCi/ml)

MPCi = the MPC value corresponding to radionuclide i from 10 CFR 20, Appendix B, Table II, Column 2 (uCi/ml)

= 2E-04 uCi/ml for dissolved or entrained noble gases

RR = the actual liquid effluent release rate (gal/min)

CW = the actual circulating water flow rate (dilution water flow) at the time of the release (gal/min)

1.4 Liquid Effluent Dose Calculation - 10 CFR 50

1.4.1 MEMBER OF THE PUBLIC Dose - Liquid Effluents. Technical Specification 3.11.1.2 limits the dose or dose commitment to MEMBERS OF THE PUBLIC from radioactive materials in liquid effluents from each unit of the Salem Nuclear Generating Station to:

- during any calendar quarter;
  ≤ 1.5 mrem to total body per unit
  ≤ 5.0 mrem to any organ per unit

- during any calendar year;
  ≤ 3.0 mrem to total body per unit
  ≤ 10.0 mrem to any organ per unit.

Per the surveillance requirements of Technical Specification 4.11.1.2, the following calculational methods may be used for determining the dose or dose commitment due to the liquid radioactive effluents from Salem.

$$Do = \frac{1.67E\text{-}02 * VOL}{CW} * \sum (Ci * Aio) \qquad (1.5)$$

where:

Do = dose or dose commitment to organ o, including total body (mrem)

Aio = site-related ingestion dose commitment factor to the total body or any organ o for radionuclide i (mrem/hr per uCi/ml)

Ci = average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (uCi/ml)

VOL = volume of liquid effluent released (gal)

CW = average circulating water discharge rate during release period (gal/min)

1.67E-02 = conversion factor (hr/min)

The site-related ingestion dose/dose commitment factors (A_{io}) are presented in Table 1-3 and have been derived in accordance with guidance of NUREG-0133 by the equation:

$$Aio = 1.14E\text{+}05\ [(UI * BIi) + (UF * BFi)]\ DFi \qquad (1.6)$$

where:

Aio = composite dose parameter for the total body or critical organ o of an adult for radionuclide i, for the fish and invertebrate ingestion pathways (mrem/hr per uCi/ml)

1.14E+05 = conversion factor (pCi/uCi * ml/kg ÷ hr/yr)

UI = adult invertebrate consumption (5 kg/yr)

BIi = bioaccumulation factor for radionuclide i in invertegrates from Table 1-4 (pCi/kg ÷ pCi/l)

UF = adult fish consumption (21 kg/yr)

BFi = bioaccumulation factor for radionuclide i in fish from Table 1-4 (pCi/kg per pCi/1)
DFi = dose conversion factor for nuclide i for adults in pre-selected organ, o, from Table E-11 of Regulatory Guide 1.109 (mrem/pCi)

The radionuclides included in the periodic dose assessment per the requirements of Technical Specification 3/4.11.1.2 are those as identified by gamma spectral analysis of the liquid waste samples collected and analyzed per the requirements of Technical Specification 3/4.11.1.1, Table 4.11-1.

Radionuclides requiring radiochemical analysis (e.g., Sr-89 and Sr-90) will be added to the dose analysis at a frequency consistent with the required minimum analysis frequency of Technical Specification Table 4.11-1.

1.4.2 Simplified_Liquid_Effluent_Dose_Calculation. In lieu of the individual radionuclide dose assessment as presented in Section 1.4.1, the following simplified dose calculational equation may be used for demonstrating compliance with the dose limits of Technical Specification 3.11.1.2. (Refer to Appendix B for the derivation and justification for this simplified method.)

Total_Body

$$Dtb = \frac{1.21E{+}03 * VOL}{CW} * \sum Ci \qquad (1.7)$$

Maximum_Organ

$$Dmax = \frac{2.52E{+}04 * VOL}{CW} * \sum Ci \qquad (1.8)$$

where:
Ci = average concentration of radionuclide i, in undiluted liquid effluent representative of the volume VOL (uCi/ml)
VOL = volume of liquid effluent released (gal)
CW = average circulating water discharge rate during release period (gal/min)
Dtb = conservatively evaluated total body dose (mrem)
Dmax = conservatively evaluated maximum organ dose (mrem)

1.21E+03 = conversion factor (hr/min) and the conservative total body dose conversion factor (Fe-59, total body -- 7.27E+04 mrem/hr per uCi/ml)

2.52E+04 = conversion factor (hr/min) and the conservative maximum organ dose conversion factor (Nb-95, GI-LLI -- 1.51E+06 mrem/hr per uCi/ml)

1.5 Secondary Side Radioactive Liquid Effluents and Dose Calculations During Primary to Secondary Leakage

During periods of primary to secondary leakage (i.e., steam generator tube leaks), radioactive material will be transmitted from the primary system to the secondary system. The potential exists for the release of radioactive material to the off-site environment (Delaware River) via secondary system discharges. Potentially significant radioactive material levels and potential releases are controlled/monitored by the Steam Generator blowdown monitors (R19) and the Chemical Waste Basin monitor (R37). However to ensure compliance with the regulatory limits on radioactive material releases, it may be desirable to account for potential releases from the secondary system during periods of primary to secondary leakage. Any potentially significant releases will be via the Chemical Waste Basin with the major source of activity being the Steam Generator blowdown.

With identified radioactive material levels in the secondary system, appropriate samples should be collected and analyzed for the principal gamma emitting radionuclides. Based on the identified radioactive material levels and the volume of water discharged, the resulting environmental doses may be calculated based on equation (1.5).

Because the release rate from the secondary system is indirect (e.g., SG blowdown is normally routed to condenser where the condensate clean-up system will remove much of the radioactive material), samples should be collected from the final release point (i.e., Chemical Waste Basin) for quantifying the radioactive material releases. However, for conservatism and ease of controlling and quantifying all potential release paths, it is prudent to sample the SG blowdown and to assume all radioactive material is released directly to the environment via the Chemical Waste Basin. This approach while not exact, is conservative and ensures timely analysis for regulatory compliance. Accounting for radioactive material retention of the condensate clean-up system ion exchange resins may be needed to more accurately account for actual releases.

1.6 Liquid Effluent Dose Projections

Technical Specification 3.11.1.3 requires that the liquid radioactive waste processing system be used to reduce the radioactive material levels in the liquid waste prior to release when the quarterly projected doses exceed:

- 0.375 mrem to the total body, or
- 1.25 mrem to any organ.

The applicable liquid waste processing system for maintaining radioactive material releases ALARA is the ion exchange system as delineated in Figure 1-3. Alternately, the waste evaporator as presented in the Salem FSAR has processing capabilities meeting the NRC ALARA design requirements and may be used in conjunction or in lieu of the ion exchange system for waste processing requirements in accordance with Technical Specification 3.11.1.3. These processing requirements are applicable to each unit individually. Exceeding the projected dose requiring processing prior to release for one unit does not in itself dictate processing requirements for the other unit.

Dose projections are made at least once per 31 days by the following equations:

$$Dtbp = Dtb\ (91 \div d) \quad (1.9)$$

$$Dmaxp = Dmax\ (91 \div d) \quad (1.10)$$

where:

- Dtbp = the total body dose projection for current calendar quarter (mrem)
- Dtb = the total body dose to date for current calendar quarter as determined by equation (1.5) or (1.7) (mrem)
- Dmaxp = the maximum organ dose projection for current calendar quarter (mrem)
- Dmax = the maximum organ dose to date for current calendar quarter as determined by equation (1.5) or (1.8) (mrem)
- d = the number of days to date for current calendar quarter
- 91 = the number of days in a calendar quarter

2.0 Gaseous Effluents

2.1 Radiation Monitoring Instrumentation and Controls

The gaseous effluent monitoring instrumentation and controls at Salem for controlling and monitoring normal radioactive material releases in accordance with the Radiological Effluent Technical Specifications are summarized as follows:

1) Waste Gas Holdup System - The vent header gases are collected by the waste gas holdup system. Gases may be recycled to provide cover gas for the CVCS hold-up tank or held in the waste gas tanks for decay prior to release. Waste gas decay tanks are batch released after sampling and analysis. The tanks are discharged via the Plant Vent. 1-R41C provides noble gas monitoring and automatic isolation of waste gas decay tank releases for Unit-1; this function is provided by 2-R41C for Unit-2.

2) Containment Purge and Pressure/Vacuum Relief - Containment purges and pressure/vacuum reliefs are released to the atmosphere via the respective unit Plant Vent. Noble gas monitoring and auto isolation function are provided by 1-R41C for Unit-1 and 2-R41C for Unit-2. Additionally, in accordance with Technical Specification 3.3.3.9, Table 3.3-13, 1-R12A and 2-R12A may be used to provide the containment monitoring and automatic isolation function during purge and pressure/vacuum reliefs.*

3) Plant Vent - The Plant Vent for each respective unit receives discharges from the waste gas hold-up system, condenser evacuation system, containment purge and pressure/vacuum reliefs, and the Auxiliary Building ventilation. Effluents are monitored by R41C, a flow through gross activity monitor (for noble gas monitoring). Additionally, in-line gross activity monitors (1-R16 and 2-R16) provide redundant back-up monitoring capabilities to the R41C monitors. Radioiodine and particulate sampling capabilities are provided by charcoal cartridge and filter medium samplers with redundant back-up sampling capabilities provided by R41B and R41A, respectively. Plant Vent flow rate is measured and as a back-up may be determined empirically as a function of fan operation (fan curves). Sampler flow rates are determined by flow rate instrumentation (e.g., venturi rotometer).

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* The R12A monitors also provide the safety function of containment isolation in the event of a fuel handling accident during refueling. During MODE 6 in accordance with Technical Specification 3/4.3.3, Table 3.3-6, the R12A alarm/trip setpoint shall be established at twice background, providing early indication and containment isolation accompanying unexpected increases in containment airborne radioactive material levels indicative of a fuel degradation.

A gaseous radioactive waste flow diagrams with the applicable, associated radiation monitoring instrumentation and controls are presented as Figures 2-1 and 2-2 for Units 1 and 2, respectively.

2.2 Gaseous_Effluent_Monitor_Setpoint_Determination

2.2.1 Containment_and_Plant_Vent_Monitor. Per the requirements of Technical Specification 3.3.3.11, alarm setpoints shall be established for the gaseous effluent monitoring instrumentation to ensure that the release rate of noble gases does not exceed the limits of Specification 3.11.2.1, which corresponds to a dose rate at the SITE BOUNDARY of 500 mrem/year to the total body or 3000 mrem/year to the skin. Based on a grab sample analysis of the applicable release (i.e., grab sample of the Containment atmosphere, waste gas decay tank, or Plant Vent), the radiation monitoring alarm setpoints may be established by the following calculational method. The measured radionuclide concentrations and release rate are used to calculate the fraction of the allowable release rate, as limited by Specification 3.11.2.1, by the equation:

$$FRAC = [4.72E+02 * X/Q * VF * \sum (Ci * Ki)] \div 500 \qquad (2.1)$$

$$FRAC = [4.72E+02 * X/Q * VF * \sum (Ci * (Li + 1.1\ Mi))] \div 3000 \qquad (2.2)$$

where:

FRAC = fraction of the allowable release rate based on the identified radionuclide concentrations and the release flow rate

X/Q = annual average meteorological dispersion to the controlling site boundary location (sec/m3)

VF = ventilation system flow rate for the applicable release point and monitor (ft3/min)

Ci = concentration of noble gas radionuclide i as determined by radioanalysis of grab sample (uCi/cm3)

Ki = total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m3, from Table 2-1)

Li = beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m3, from Table 2-1)

Mi = gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m3, from Table 2-1)

1.1 = mrem skin dose per mrad gamma air dose (mrem/mrad)
4.72E+02 = conversion factor (cm3/ft3 * min/sec)
500 = total body dose rate limit (mrem/yr)
3000 = skin dose rate limit (mrem/yr)

Based on the more limiting FRAC (i.e., higher value) as determined above, the alarm setpoints for the applicable monitors (R16, R41C, and/or R12A) may be calculated by the equation:

$$SP = [AF * \sum Ci * SEN \div FRAC] + bkg \qquad (2.3)$$

where:

SP = alarm setpoint corresponding to the maximum allowable release rate (cpm)
SEN = monitor sensitivity (cpm per uCi/cm3)
bkg = background of the monitor (cpm)
AF = administrative allocation factor for the specific monitor and type release, which corresponds to the fraction of the total allowable release rate that is administratively allocated to the release.

The allocation factor (AF) is an administrative control imposed to ensure that combined releases from Salem Units 1 and 2 and Hope Creek will not exceed the regulatory limits on release rate from the site (i.e., the release rate limits of Technical Specification 3.11.2.1). Normally, the combined AF value for Salem Units 1 and 2 is 0.5 (0.25 per unit), with the remainder 0.5 allocated to Hope Creek. Any increase in AF above 0.5 for the Salem Nuclear Generating Station will be coordinated with the Hope Creek Generating Station to ensure that the combined allocation factors for all units do not exceed 1.0.

2.2.2 Conservative Default Values. A conservative alarm setpoint can be established, in lieu of the individual radionuclide evaluation based on the grab sample analysis, to eliminate the potential of periodically having to adjust the setpoint to reflect minor changes in radionuclide distribution and variations in release flow rate. The alarm setpoint may be conservatively determined by the default values presented in Table 2-1 and 2-2 for Units 1 and 2, respectively.

These values are based upon:

- the maximum ventilation (or purge) flow rate;
- a radionuclide distribution* comprised of 95% Xe-133, 2% Xe-135, 1% Xe-133m, 1% Kr-88 and 1% Kr-85; and
- an administrative allocation factor of 0.25 to conservatively ensure that any simultaneous releases from Salem Units 1 and 2 do not exceed the maximum allowable release rate.

For this radionuclide distribution, the alarm setpoint based on the total body dose rate is more restrictive than the corresponding setpoint based on the skin dose rate. The resulting conservative, default setpoints are presented in Tables 2-2 and 2-3.

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* Adopted from ANSI N237-1976/ANS-18.1, Source Term Specifications, Table 6

2.3 Gaseous Effluent Instantaneous Dose Rate Calculations - 10 CFR 20

2.3.1 Site Boundary Dose Rate - Noble Gases. Technical Specification 3.11.2.1a limits the dose rate at the SITE BOUNDARY due to noble gas releases to ≤500 mrem/yr, total body and ≤3000 mrem/yr, skin. Radiation monitor alarm setpoints are established to ensure that these release limits are not exceeded. In the event any gaseous releases from the station results in an alarm setpoint being exceeded, an evaluation of the SITE BOUNDARY dose rate resulting from the release may be performed using the following equations:

$$\dot{D}tb = X/Q * \sum (Ki * \dot{Q}i) \quad (2.4)$$

and

$$\dot{D}s = X/Q * \sum ((Li + 1.1Mi) * \dot{Q}i) \quad (2.5)$$

where:

$\dot{D}tb$	=	total body dose rate (mrem/yr)
$\dot{D}s$	=	skin dose rate (mrem/yr)
X/Q	=	atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m3)
$\dot{Q}i$	=	average release rate of radionuclide i over the release period under evaluation (uCi/sec)
Ki	=	total body dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m3, from Table 2-1)
Li	=	beta skin dose conversion factor for noble gas radionuclide i (mrem/yr per uCi/m3, from Table 2-1)
Mi	=	gamma air dose conversion factor for noble gas radionuclide i (mrad/yr per uCi/m3, from Table 2-1)
1.1	=	mrem skin dose per mrad gamma air dose (mrem/mrad)

As appropriate, simultaneous releases from Salem Units 1 and 2 and Hope Creek will be considered in evaluating compliance with the release rate limits of Specification 3.11.2.1a, following any release exceeding the above prescribed alarm setpoints. Monitor indications (readings) may be averaged over a time period not to exceed 15 minutes when determining noble gas release rate based on correlation of the monitor reading and monitor sensitivity. The 15 minute averaging is needed to allow for reasonable monitor response to potentially changing radioactive material concentrations and to exclude potential electronic spikes in monitor readings that may be unrelated to radioactive material releases. As identified, any electronic spiking monitor responses may be excluded from the analysis.

NOTE: For administrative purposes, more conservative alarm setpoints than those as prescribed above may be imposed. However, conditions exceeding these more limiting alarm setpoints do not necessarily indicate radioactive material release rates exceeding the limits of Technical Specification 3.11.2.1a. Provided actual releases do not result in radiation monitor indications exceeding alarm setpoint values based on the above criteria, no further analyses are required for demonstrating compliance with the limits of Specification 3.11.2.1a.

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table 2-4 may be used for evaluating the gaseous effluent dose rate.

2.3.2 Site Boundary Dose Rate - Radioiodine and Particulates. Technical Specification 3.11.2.1.b limits the dose rate to ≤1500 mrem/yr to any organ for I-131, tritium and particulates with half-lives greater than 8 days. To demonstrate compliance with this limit, an evaluation is performed at a frequency no greater than that corresponding to the sampling and analysis time period (e.g., nominally once per 7 days). The following equation may be used for the dose rate evaluation:

$$\dot{D}o = X/Q * \sum (Ri * \dot{Q}i) \qquad (2.6)$$

where:

$\dot{D}o$ = average organ dose rate over the sampling time period (mrem/yr)

X/Q = atmospheric dispersion to the controlling SITE BOUNDARY location for the inhalation pathway (sec/m3)

$\dot{R}i$ = dose parameter for radionuclide i, (mrem/yr per uCi/m3) for the child inhalation pathway from Table 2-5

$\dot{Q}i$ = average release rate over the appropriate sampling period and analysis frequency for radionuclide i -- I-131, I-133, tritium or other radionuclide in particulate form with half-life greater than 8 days (uCi/sec)

By substituting 1500 mrem/yr for $\dot{D}o$ and solving for $\dot{Q}$, an allowable release rate for I-131 can be determined. Based on the annual average meteorological dispersion (see Table 2-4) and the most limiting potential pathway, age group and organ (inhalation, child, thyroid -- Ri = 1.62E+07 mrem/yr per uCi/m3), the allowable release rate for I-131 is 42 uCi/sec. Reducing this release rate by a factor of 4 to account for potential dose contributions from other radioactive particulate material and other release points (e.g., Hope Creek), the corresponding release rate allocated to each of the Salem units is 10.5 uCi/sec. For a 7 day period, which is the nominal sampling and analysis frequency for I-131, the cumulative release is 6.3 Ci. Therefore, as long as the I-131 releases in any 7 day period do not exceed 6.3 Ci, no additional analyses are needed for verifying compliance with the Technical Specification 3.11.2.1.b limits on allowable release rate.

2.4 Noble Gas Effluent Dose Calculations - 10 CFR 50

2.4.1 UNRESTRICTED AREA Dose - Noble Gases. Technical Specification 3.11.2.2 requires a periodic assessment of releases of noble gases to evaluate compliance with the quarterly dose limits of ≤5 mrad, gamma-air and ≤10 mrad, beta-air and the calendar year limits ≤10 mrad, gamma-air and ≤20 mrad, beta-air. The limits are applicable separately to each unit and are not combined site limits. The following equations may be used to calculate the gamma-air and beta-air doses:

$$D_\gamma = 3.17E-08 * X/Q * \sum (Mi * Qi) \qquad (2.7)$$

and

$$D_\beta = 3.17E-08 * X/Q * \sum (Ni * Qi) \qquad (2.8)$$

where:

D_γ = air dose due to gamma emissions for noble gas radionuclides (mrad)

D_β = air dose due to beta emissions for noble gas radionuclides (mrad)

X/Q = atmospheric dispersion to the controlling SITE BOUNDARY location (sec/m3)

Qi = cumulative release of noble gas radionuclide i over the period of interest (uCi)
Mi = air dose factor due to gamma emissions from noble gas radionuclide i (mrad/yr per uCi/m3, from Table 2-1)
Ni = air dose factor due to beta emissions from noble gas radionuclide i (mrad/yr per uCi/m3, Table 2-1)
3.17E-08 = conversion factor (yr/sec)

2.4.2 Simplified Dose Calculation for Noble Gases. In lieu of the individual noble gas radionuclide dose assessment as presented above, the following simplified dose calculational equations may be used for verifying compliance with the dose limits of Technical Specification 3.11.2.2. (Refer to Appendix C for the derivation and justification for this simplified method.)

$$D_{\gamma} = \frac{3.17E-08}{0.50} * X/Q * Meff * \sum Qi \qquad (2.9)$$

and

$$D_{\beta} = \frac{3.17E-08}{0.50} * X/Q * Neff * \sum Qi \qquad (2.10)$$

where:
Meff = 5.3E+02, effective gamma-air dose factor (mrad/yr per uCi/m3)
Neff = 1.1E+03, effective beta-air dose factor (mrad/yr per uCi/m3)
0.50 = conservatism factor to account for potential variability in the radionuclide distribution

Actual meteorological conditions concurrent with the release period or the default, annual average dispersion parameters as presented in Table 2-4, may be used for the evaluation of the gamma-air and beta-air doses.

2.5 Radioiodine and Particulate Dose Calculations - 10 CFR 50

2.5.1 UNRESTRICTED AREA Dose - Radioiodine and Particulates. In accordance with requirements of Technical Specification 3.11.2.3, a periodic assessment shall be performed to evaluate compliance with the quarterly dose limit of ≤7.5 mrem and calendar year limit ≤15 mrem to any organ. The following equation may be used to evaluate the maximum organ dose due to releases of I-131, tritium and particulates with half-lives greater than 8 days:

$$Daop = 3.17E{-}08 * W * SFp * \sum (Ri * Qi) \qquad (2.11)$$

where:

Daop = dose or dose commitment via controlling pathway p and age group a (as identified in Table 2-4) to organ o, including the total body (mrem)

W = atmospheric dispersion parameter to the controlling location(s) as identified in Table 2-4

- X/Q = atmospheric dispersion for inhalation pathway and H-3 dose contribution via other pathways (sec/m3)
- D/Q = atmospheric deposition for vegetation, milk and ground plane exposure pathways (m-2)

Ri = dose factor for radionuclide i, (mrem/yr per uCi/m3) or (m2 - mrem/yr per uCi/sec) from Table 2-5 for each age group a and the applicable pathway p as identified in Table 2-4. Values for Ri were derived in accordance with the methods described in NUREG-0133.

Qi = cumulative release over the period of interest for radionuclide i -- I-131 or radioactive material in particulate form with half-life greater than 8 days (uCi).

SFp = annual seasonal correction factor to account for the fraction of the year that the applicable exposure pathway does not exist.

1) For milk and vegetation exposure pathways:
   = A six month fresh vegetation and grazing season (May through October)
   = 0.5
2) For inhalation and ground plane exposure pathways:
   = 1.0

For evaluating the maximum exposed individual, the infant age group is controlling for the milk pathway and the child age group is controlling for the vegetation pathway. Only the controlling age group and pathway as identified in Table 2-4 need be evaluated for compliance with Technical Specification 3.11.2.3.

2.5.2 <u>Simplified Dose Calculation for Radioiodines and Particulates</u>. In lieu of the individual radionuclide (I-131 and particulates) dose assessment as presented above, the following simplified dose calculational equation may be used for verifying compliance with the dose limits of Technical Specification 3.11.2.3.

$$Dmax = 3.17E-08 * W * SFp * RI-131 * \sum Qi \qquad (2.12)$$

where:

Dmax = maximum organ dose (mrem)

RI-131 = I-131 dose parameter for the thyroid for the identified controlling pathway

= 1.05E+12, infant thyroid dose parameter with the cow-milk pathway controlling (m2 - mrem/yr per uCi/sec)

The ground plane exposure and inhalation pathways need not be considered when the above simplified calculational method is used because of the overall negligible contribution of these pathways to the total thyroid dose. It is recognized that for some particulate radionuclides (e.g., Co-60 and Cs-137), the ground exposure pathway may represent a higher dose contribution than either the vegetation or milk pathway. However, use of the I-131 thyroid dose parameter for all radionuclides will maximize the organ dose calculation, especially considering that no other radionuclide has a higher dose parameter for any organ via any pathway than I-131 for the thyroid via the milk pathway.

The location of exposure pathways and the maximum organ dose calculation may be based on the available pathways in the surrounding environment of Salem as identified by the annual land-use census (Technical Specification 3.12.2). Otherwise, the dose will be evaluated based on the predetermined controlling pathways as identified in Table 2-4.

2.6 Secondary Side Radioactive Gaseous Effluents and Dose Calculations

During periods of primary to secondary leakage, minor levels of radioactive material may be released via the secondary system to the atmosphere. Non-condensables (e.g., noble gases) will be predominately released via the condenser evacuation system and will be monitored and quantified by the routine plant vent monitoring and sampling system and procedures (e.g., R15 on condenser evacuation, R41C on plant vent, and the plant vent particulate and charcoal samplers).

However, if the Steam Generator blowdown is routed directly to the Chemical Waste Basin (via the SG blowdown flash tank) instead of being recycled through the condenser, it may be desirable to account for the potential atmospheric releases of radioiodines and particulates from the flash tank vent (i.e., releases due to moisture carry over). Since this pathway is not sampled or monitored, it is necessary to calculate potential releases.

Based on the guidance in NRC NUREG-0133, the releases of the radioiodines and particulates may be calculated by the equation:

$$\dot{Q}i = Ci * Rsgb * Fft * (1-SQftv) \tag{2.13}$$

where:

$\dot{Q}i$ = the release rate of radionuclide, i, from the steam generator flash tank vent (uCi/sec)

Ci = the concentration of radionuclide, i, in the secondary coolant water averaged over not more than one week (uCi/ml)

Rsgb = the steam generator blowdown rate to the flash tank (ml/sec)

Fft = the fraction of blowdown flashed in the tank determined from a heat balance taken around the flash tank at the applicable reactor power level

SQftv = the measured steam quality in the flash tank vent; or an assumed value of 0.85, based on NUREG-0017.

Tritium releases via the steam flashing may also be quantified using the above equation with the assumption of a steam quality (SQftv) equal to 0. Since the H-3 will be associated with the water molecules, it is not necessary to account for the moisture carryover which is the transport media for the radioiodines and particulates.

Based on the design and operating conditions at Salem, the fraction of blowdown converted to steam (Fft) is approximately 0.48. The equation simplifies to the following:

$$\dot{Q}i = 0.072\ Ci\ \ Rsgb \qquad (2.14)$$

For H-3, the simplified equation is:

$$\dot{Q}i = 0.48\ Ci\ \ Rsgb \qquad (2.15)$$

Also during reactor shutdown operations with a radioactively contaminated secondary system, radioactive material may be released to the atmosphere via the atmospheric reliefs (PORV) and the safety reliefs on the main steam lines and via the steam driven auxiliary feed pump exhaust. The evaluation of the radioactive material concentration in the steam relative to that in the steam generator water is based on the guidance of NUREG-0017, Revision 1. The partitioning factors for the radioiodines is 0.01 and is 0.001 for all other particulate radioactive material. The resulting equation for quantifying releases via the atmospheric steam releases is:

$$\dot{Q}ij = 0.13 * \sum_{j} (Cij * SFj) * PF \qquad (2.16)$$

where:

Qij = release rate of radionuclide i via pathway j (uCi/sec)
SFj = steam flow for release pathway j
= 450,000 lb/hr per PORV
= 800,000 lb/hr per safety relief valve
= 50,000 lb/hr for auxiliary feed pump exhaust
PF = partitioning factor, ratio of concentration in steam to that in the water in the steam generator
= 0.01 for radioiodines
= 0.005 for all other particulates
= 1.0 for H-3

Any significant releases of noble gases via the atmospheric steam releases can be quantified in accordance with the calculational methods of the Salem Emergency Plan EP IV-III.

Alternately, the quantification of the release rate and cumulative releases may be based on actual samples of main steam collected at the R46 sample locations. The measured radionuclide concentration in the steam may be used for quantifying the noble gases, radioiodine and particulate releases.

Note: The expected mode of operation would be to isolate the effected steam generator, thereby reducing the potential releases during the shutdown/cooldown process. Use of the above calculational methods should consider actual operating conditions and release mechanisms.

The calculated quantities of radioactive materials may be used as inputs to the equation (2.11) or (2.12) to calculate offsite doses for demonstrating compliance with the Radiological Effluent Technical Specifications.

2.7 Gaseous Effluent Dose Projection

Technical Specification 3.11.2.4 requires that the GASEOUS RADWASTE TREATMENT SYSTEM and VENTILATION EXHAUST TREATMENT SYSTEM be used to reduce radioactive material levels prior to discharge when projected doses exceed one-half the annual design objective rate in any calendar quarter, i.e., exceeding:

- 0.625 mrad/quarter, gamma air;
- 1.25 mrad/quarter, beta air; or
- 1.875 mrem/quarter, maximum organ.

The applicable gaseous processing systems for maintaining radioactive material releases ALARA are the Auxiliary Building normal ventilation system (filtration systems # 1,2 and 3) and the Waste Gas Decay Tanks as delineated in Figures 2-3 and 2-4.

Dose projections are performed at least once per 31 days by the following equations:

$$D\ p = D * (91 \div d) \qquad (2.17)$$

$$D\ p = D * (91 \div d) \qquad (2.18)$$

$$Dmaxp = Dmax * (91 \div d) \qquad (2.19)$$

where:

D p	=	gamma air dose projection for current calendar quarter (mrad)
D	=	gamma air dose to date for current calendar quarter as determined by equation (2.7) or (2.9) (mrad)
D p	=	beta air dose projection for current calendar quarter (mrad)
D	=	beta air dose to date for current calendar quarter as determined by equation (2.8) or (2.10) (mrad)
Dmaxp	=	maximum organ dose projection for current calendar quarter (mrem)
Dmax	=	maximum organ dose to date for current calendar quarter as determined by equation (2.11) or (2.12) (mrem)
d	=	number of days to date in current calendar quarter
91	=	number of days in a calendar quarter

3.0 Special Dose Analyses

3.1 Doses Due To Activities Inside the SITE BOUNDARY

In accordance with Technical Specification 6.9.1.11, the Radioactive Effluent Release Report (RERR) submitted within 60 days after January 1 of each year shall include an assessment of radiation doses from radioactive liquid and gaseous effluents to MEMBERS OF THE PUBLIC due to their activities inside the SITE BOUNDARY.

There is one location on Artificial Island that is accessible to MEMBERS OF THE PUBLIC for activities unrelated to PSE&G operational and support activities. This location is the Second Sun (visitor's center) located near the main gate for the Salem Nuclear Generating Station. Ball fields located near the intersection of the access roads for the Salem and Hope Creek sites are recreational sites available only to PSE&G employees and site contractor employees: they are not available for use by others.

Because of occupancy times, the ball fields represent a more controlling recreationally accessible area than does the Second Sun and shall also be evaluated for determining the maximum potential dose to a MEMBER OF THE PUBLIC.

However, the Second Sun represents the location for Technical Specification evaluation. The following conservative assumptions may be made concerning locations, exposure times, and exposure pathways:

	Second Sun	Ball Fields
Distance/Direction	0.21 mile / SE	0.71 mile / E
Exposure Time:	4 hours/yr (2 hours per visit 2 visits per year)	210 hr/yr (4 hours twice per week over a 6 month ball season)
Exposure Pathways:	direct exposure (Noble gases)	direct exposure (Noble gases)
	inhalation (H-3, I-131, particulates)	inhalation (H-3, I-131, particulates)
Meteorological Dispersion*:	annual average (as determined for year being evaluated)	annual average (as determined for year being evaluated)
	1.0E-05 sec/m3 (default value)	1.2E-06 sec/m3 (default value)

The calculational methods as presented in Sections 2.4 and 2.5 may be used for determining the maximum potential dose to a MEMBER OF THE PUBLIC based on the above assumptions.

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* The conservative default values have been derived from the meteorological dispersion data as presented in the HCGS FSAR, Section 2.3. These values may be used if current year meteorology is unavailable at the time of NRC reporting; however a follow-up evaluation shall be performed when the data becomes available.

3.2 Doses to MEMBERS OF THE PUBLIC - 40 CFR 190

The Radioactive Effluent Release Report (RERR) submitted within 60 days after January 1 of each year shall also include an assessment of the radiation dose to the likely most exposed MEMBER OF THE PUBLIC for reactor releases and other nearby uranium fuel cycle sources (including dose contributions from effluents and direct radiation from on-site sources). For the likely most exposed MEMBER OF THE PUBLIC in the vicinity of Artificial Island, the sources of exposure need only consider the Salem Nuclear Generating Station and the Hope Creek Nuclear Generating Station: No other fuel cycle facilities contribute to the MEMBER OF THE PUBLIC dose for the Artificial Island vicinity.

The dose contribution from the operation of Hope Creek Nuclear Generating Station will be estimated based on the methods as presented in the Hope Creek Offsite Dose Calculation Manual (HCGS ODCM).

As appropriate for demonstrating/evaluating compliance with the limits of Technical Specification 3.11.4 (40 CFR 190), the results of the environmental monitoring program may be used for providing data on actual measured levels of radioactive material in the actual pathways of exposure.

3.2.1 Effluent Dose Calculations. For purposes of implementing the surveillance requirements of Technical Specification 3/4.11.4 and the reporting requirements of 6.9.1.11 (RERR), dose calculations for the Salem Nuclear Generating Station may be performed using the calculational methods contained within this ODCM; the conservative controlling pathways and locations of Table 2-4 or the actual pathways and locations as identified by the land use census (Technical Specification 3/4.12.2) may be used. Average annual meteorological dispersion parameters or meteorological conditions concurrent with the release period under evaluation may be used.

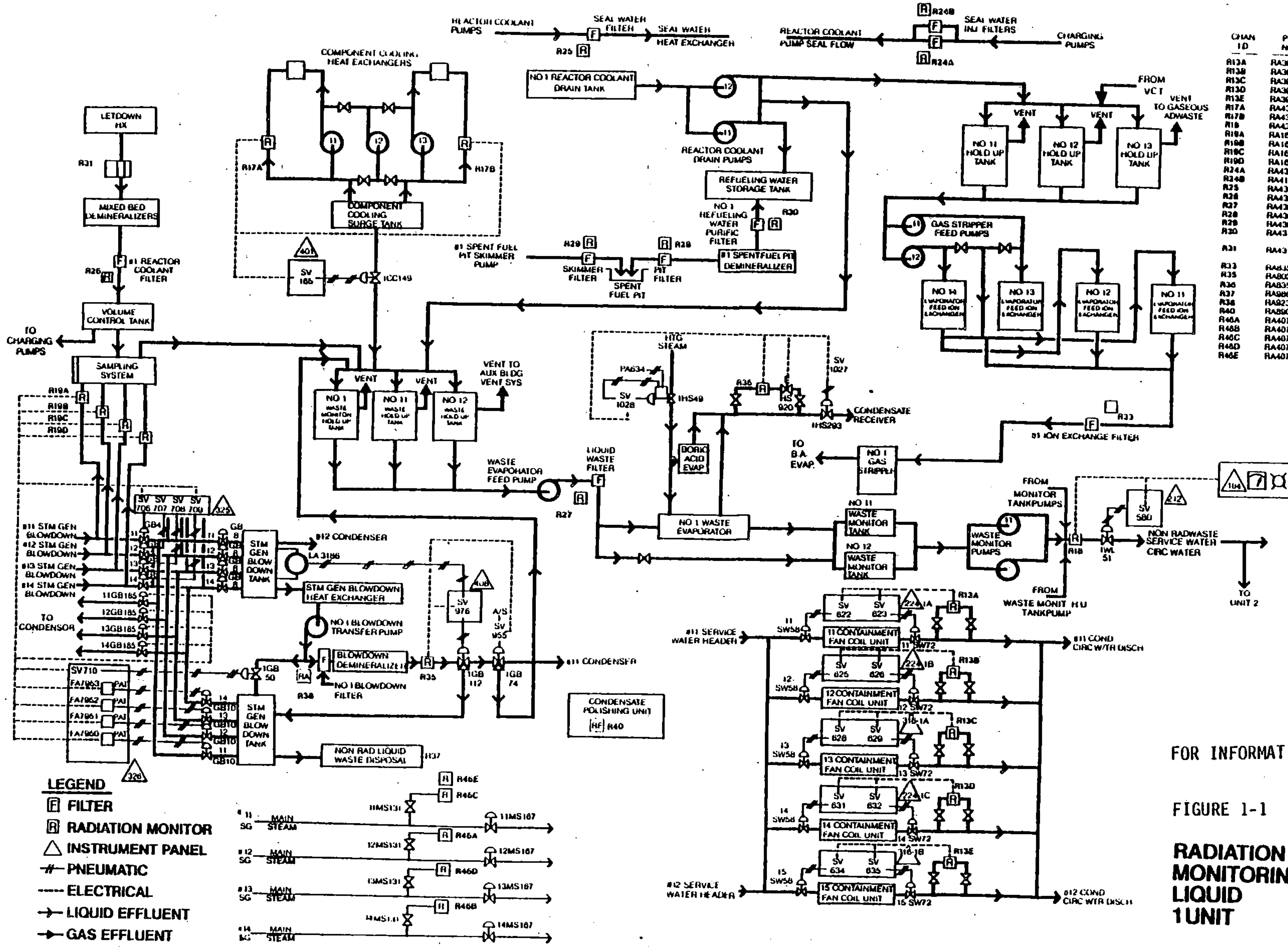
3.2.2 Direct Exposure Dose Determination. Any potentially significant direct exposure contribution to off-site individual doses may be evaluated based on the results of the environmental measurements (e.g., TLD, ion chamber measurements) and/or by the use of a radiation transport and shielding calculational method. Only during atypical conditions will there exist any potential for significant on-site sources at Salem that would yield potentially significant off-site doses (i.e., in excess of 1 mrem per year to a MEMBER OF THE PUBLIC), that would require detailed evaluation for demonstrating compliance with 40 CFR 190. However, should a situation exist whereby the direct exposure contribution is potentially significant, on-site measurements, off-site measurements and/or calculational techniques will be used for determination of dose for assessing 40 CFR 190 compliance.

4.0 Radiological Environmental Monitoring Program

The operational phase of the Radiological Environmental Monitoring Program (REMR) is conducted in accordance with the requirements of Appendix A Technical Specification 3.12. The objectives of the program are:

- To determine whether any significant increases occur in the concentration of radionuclides in the critical pathways of exposure in the vicinity of Artificial Island;
- To determine if the operation of the Salem Nuclear Generating Stations has resulted in any increase in the inventory of long lived radionuclides in the environment;
- To detect any changes in the ambient gamma radiation levels; and
- To verify that SNGS operations have no detrimental effects on the health and safety of the public or on the environment.

The sampling requirements (type of samples, collection frequency and analysis) and sample locations are presented in Appendix D.



CHAN ID	PS NO	COMP ID
R13A	RA3907	R0023A
R13B	RA3908	R0024A
R13C	RA3909	R0025A
R13D	RA3910	R0026A
R13E	RA3911	R0027A
R17A	RA4333	R0016A
R17B	RA4334	R0017A
R18	RA4335	R0018A
R19A	RA1626	R0019A
R19B	RA1627	R0020A
R19C	RA1628	R0021A
R19D	RA1629	R0022A
R24A	RA4304	R0029A
R24B	RA4111	R0030A
R25	RA4305	R0031A
R26	RA4306	R0032A
R27	RA4307	R0033A
R28	RA4308	R0034A
R29	RA4309	R0035A
R30	RA4310	R0036A
R31	RA4316	R0044A
R33	RA8352	R0053A
R35	RA8029	
R36	RA8354	
R37	RA9864	
R38	RA9234	
R40	RA8902	
R46A	RA4072	
R46B	RA4073	
R46C	RA4074	
R46D	RA4075	
R46E	RA4076	

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FIGURE 1-1

RADIATION MONITORING LIQUID 1 UNIT

Table 1-1
Parameters for Liquid Alarm Setpoint Determinations
Unit 1

Parameter	Actual Value	Default Value	Units	Comments
MPCe	calculated	1E-05 *	uCi/ml	calculate for each batch to be released
MPCI-131	3E-07	N/A	uCi/ml	I-131 MPC conservatively used for SG blow-down and Service Water monitor setpoints
Ci	measured	N/A	uCi/ml	taken from gamma spectral analysis of liquid effluent
MPCi	as determined	N/A	uCi/ml	taken from 10 CFR 20, Appendix B, Table II, Col. 2.
SEN 1-R18	as determined	2.9E+07	cpm per uCi/ml	radwaste effluent (Cs-137)
1-R19 (A,B,C,D)		2.9E+07		Steam Generator blowdown (Cs-137)
1-R13 (A,B,C,D,E)		1.2E+08		Service Water - Containment fan cooling (Cs-137)
CW	as determined	1.85E+05	gpm	Circulating Water System, single CW pump
RR 1-R18	as determined	120	gpm	determined prior to release; release rate can be adjusted for Technical Specification compliance
1-R19		80		Steam Generator blowdown rate per generator
1-R13		2500		Service Water flow rate for Containment fan coolers
SP 1-R18	calculated	4.4E+05(+bkg)	cpm	Default alarm setpoints; more conservative values may be used as deemed appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA.
1-R19**	calculated	2.0E+04(+bkg)		
1-R13**	calculated	2.6E+03(+bkg)		

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* Refer to Appendix A for derivation

** The MPC values of I-131 (3E-07 uCi/ml) has been used for derivation of the R19 Steam Generator blowdown and R13 Service Water monitor setpoints as discussed in Section 1.2.2.

Table 1-2
Parameters for Liquid Alarm Setpoint Determinations
Unit 2

Parameter	Actual Value	Default Value	Units	Comments
MPCe	calculated	1E-05 *	uCi/ml	calculate for each batch to be released
MPCI-131	3E-07	N/A	uCi/ml	I-131 MPC conservatively used for SG blowdown, Service Water and Chemical Waste Basin monitor setpoints
Ci	measured	N/A	uCi/ml	taken from gamma spectral analysis of liquid effluent
MPCi	as determined	N/A	uCi/ml	taken from 10 CFR 20, Appendix B, Table II, Col. 2.
SEN** 2-R18	as determined	8.8E+07	cpm per uCi/ml	radwaste effluent (Cs-137)
2-R19 (A,B,C & D)		8.8E+07		Steam Generator blowdown (Cs-137)
2-R13 (A,B,& C)		8.8E+07		Service Water - Containment fan cooling (Cs-137)
R37		8.8E+07		Chemical Waste Basin (Cs-137)
CW	as determined	1.85E+05	gpm	Circulating Water System, single CW pump
RR 2-R18	as determined	120	gpm	determined prior to release; release rate can be adjusted for Technical Specification compliance
2-R19		80		Steam Generator blowdown rate per generator
2-R13		2500		Service Water flow rate for Containment fan coolers
R37		300		Chemical Waste Basin discharge
SP 2-R18	calculated	8.0E+05(+bkg)***	cpm	Default alarm setpoints; more conservative values may be used as deem appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA.
2-R19****	calculated	6.1E+04(+bkg)		
2-R13	calculated	1.9E+03(+bkg)		
R37****	calculated	1.6E+04(+bkg)		

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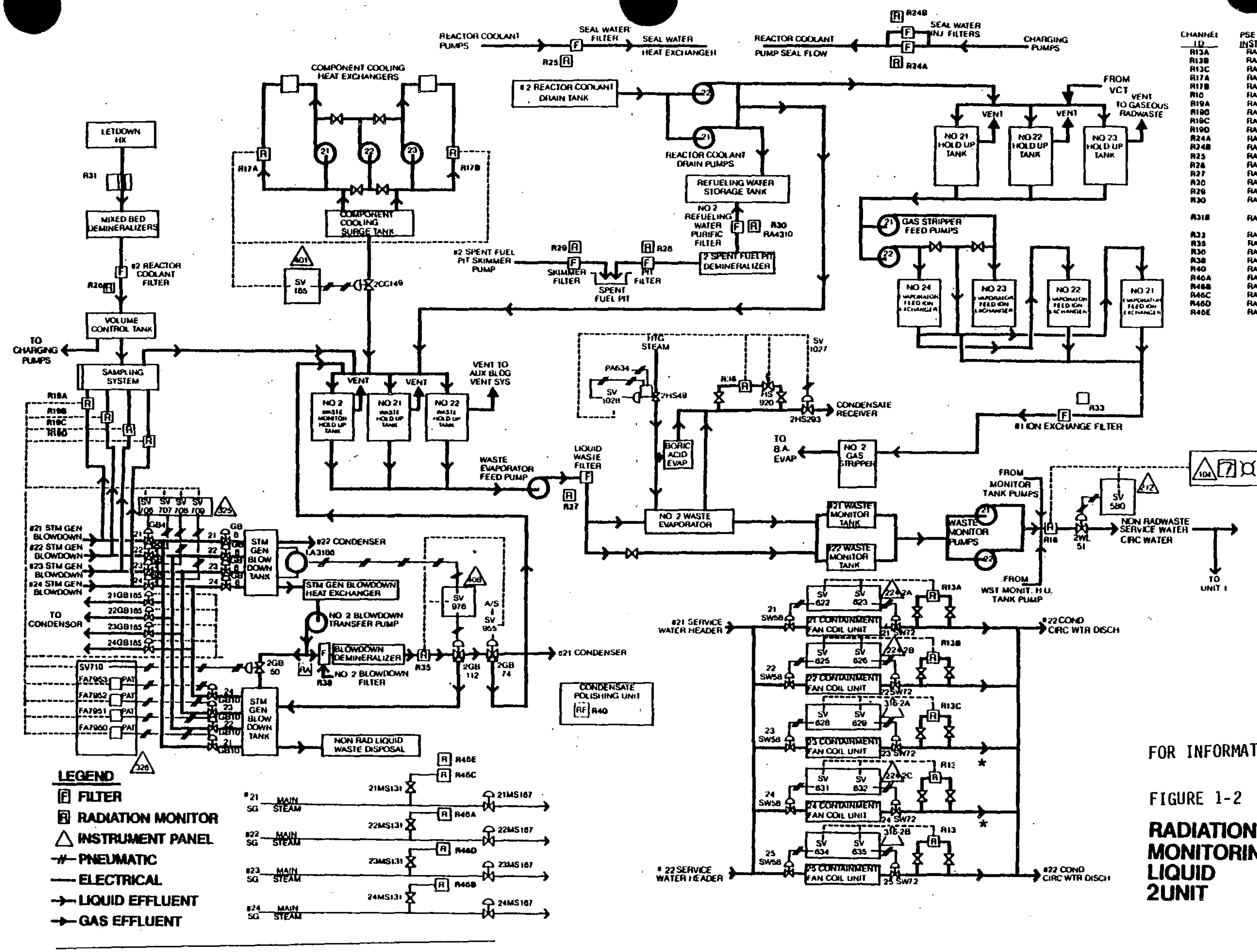
* Refer to Appendix A for derivation

** Based on Cs-137 response

*** Actual calculated setpoint for 2-R18 (1.3E+06) is greater than the full scale monitor indicator, therefore, for conservatism the recommended setpoint has been reduced to 8.0E+05 cpm.

**** The MPC value of I-131 (3E-07 uCi/ml) has been used for derivation of the R19 Steam generator blowdown R13 Service Water and the R37 Chemical Waste Basin monitor setpoints as discussed in Section 1.2.2.



CHANNEL ID	PSE&GCO INSTR NO
R13A	RA3907
R13B	RA3908
R13C	RA3909
R17A	RA4333
R17B	RA4334
R18	RA4335
R19A	RA1626
R19B	RA1627
R19C	RA1628
R19D	RA1629
R24A	RA4304
R24B	RA4111
R25	RA4305
R26	RA4306
R27	RA4307
R28	RA4308
R29	RA4309
R30	RA4310
R31B	RA4316
R33	RA8352
R35	RA8029
R36	RA8354
R38	RA9234
R40	RA8902
R46A	RA4072
R46B	RA4073
R46C	RA4074
R46D	RA4075
R46E	RA4076

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FIGURE 1-2

RADIATION MONITORING LIQUID 2UNIT

* Monitoring for the #24 and #25 containment fan coil units is provided by the R13A, B or C monitors through interconnects.

Table 1-3

Site Related Ingestion Dose Commitment Factors, A_{io}
(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.82e-1	2.82e-1	2.82e-1	2.82e-1	2.82e-1	2.82e-1
C-14	1.45e 4	2.90e 3	2.90e 3	2.90e 3	2.90e 3	2.90e 3	2.90e 3
Na-24	4.57e-1	4.57e-1	4.57e-1	4.57e-1	4.57e-1	4.57e-1	4.57e-1
P-32	4.69e 6	2.91e 5	1.81e 5	-	-	-	5.27e 5
Cr-51	-	-	5.58e 0	3.34e 0	1.23e 0	7.40e 0	1.40e 3
Mn-54	-	7.06e 3	1.35e 3	-	2.10e 3	-	2.16e 4
Mn-56	-	1.78e 2	3.15e 1	-	2.26e 2	-	5.67e 3
Fe-55	5.11e 4	3.53e 4	8.23e 3	-	-	1.97e 4	2.03e 4
Fe-59	8.06e 4	1.90e 5	7.27e 4	-	-	5.30e 4	6.32e 5
Co-58	-	6.03e 2	1.35e 3	-	-	-	1.22e 4
Co-60	-	1.73e 3	3.82e 3	-	-	-	3.25e 4
Ni-63	4.96e 4	3.44e 3	1.67e 3	-	-	-	7.18e 2
Ni-65	2.02e 2	2.62e 1	1.20e 1	-	-	-	6.65e 2
Cu-64	-	2.14e 2	1.01e 2	-	5.40e 2	-	1.83e 4
Zn-65	1.61e 5	5.13e 5	2.32e 5	-	3.43e 5	-	3.23e 5
Zn-69	3.43e 2	6.56e 2	4.56e 1	-	4.26e 2	-	9.85e 1
Br-83	-	-	7.25e-2	-	-	-	1.04e-1
Br-84	-	-	9.39e-2	-	-	-	7.37e-7
Br-85	-	-	3.86e-3	-	-	-	-
Rb-86	-	6.24e 2	2.91e 2	-	-	-	1.23e 2
Rb-88	-	1.79e 0	9.49e-1	-	-	-	2.47e-11
Rb-89	-	1.19e 0	8.34e-1	-	-	-	6.89e-14
Sr-89	4.99e 3	-	1.43e 2	-	-	-	8.00e 2
Sr-90	1.23e 5	-	3.01e 4	-	-	-	3.55e 3
Sr-91	9.18e 1	-	3.71e 0	-	-	-	4.37e 2
Sr-92	3.48e 1	-	1.51e 0	-	-	-	6.90e 2
Y-90	6.06e 0	-	1.62e-1	-	-	-	6.42e 4
Y-91m	5.72e-2	-	2.22e-3	-	-	-	1.68e-1
Y-91	8.88e 1	-	2.37e 0	-	-	-	4.89e 4
Y-92	5.32e-1	-	1.56e-2	-	-	-	9.32e 3
Y-93	1.69e 0	-	4.66e-2	-	-	-	5.35e 4
Zr-95	1.59e 1	5.11e 0	3.46e 0	-	8.02e 0	-	1.62e 4
Zr-97	8.81e-1	1.78e-1	8.12e-2	-	2.68e-1	-	5.51e 4
Nb-95	4.47e 2	2.49e 2	1.34e 2	-	2.46e 2	-	1.51e 6
Mo-99	-	1.28e 2	2.43e 1	-	2.89e 2	-	2.96e 2
Tc-99m	1.29e-2	3.66e-2	4.66e-1	-	5.56e-1	1.79e-2	2.17e 1
Tc-101	1.33e-2	1.92e-2	1.88e-1	-	3.46e-1	9.81e-3	5.77e-14
Ru-103	1.07e 2	-	4.60e 1	-	4.07e 2	-	1.25e 4
Ru-105	8.89e 0	-	3.51e 0	-	1.15e 2	-	5.44e 3
Ru-106	1.59e 3	-	2.01e 2	-	3.06e 3	-	1.03e 5

Table 1-3 (con't)

Site Related Ingestion Dose Commitment Factors, Aio
(mrem/hr per uCi/ml)

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
Ag-110m	1.56e 3	1.45e 3	8.60e 2	-	2.85e 3	-	5.91e 5
Te-125m	2.17e 2	7.86e 1	2.91e 1	6.52e 1	8.82e 2	-	8.66e 2
Te-127m	5.48e 2	1.96e 2	6.68e 1	1.40e 2	2.23e 3	-	1.84e 3
Te-127	8.90e 0	3.20e 0	1.93e 0	6.60e 0	3.63e 1	-	7.03e 2
Te-129m	9.31e 2	3.47e 2	1.47e 2	3.20e 2	3.89e 3	-	4.69e 3
Te-129	2.54e 0	9.55e-1	6.19e-1	1.95e 0	1.07e 1	-	1.92e 0
Te-131m	1.40e 2	6.85e 1	5.71e 1	1.08e 2	6.94e 2	-	6.80e 3
Te-131	1.59e 0	6.66e-1	5.03e-1	1.31e 0	6.99e 0	-	2.26e-1
Te-132	2.04e 2	1.32e 2	1.24e 2	1.46e 2	1.27e 3	-	6.24e 3
I-130	3.96e 1	1.17e 2	4.61e 1	9.91e 3	1.82e 2	-	1.01e 2
I-131	2.18e 2	3.12e 2	1.79e 2	1.02e 5	5.35e 2	-	8.23e 1
I-132	1.06e 1	2.85e 1	9.96e 0	9.96e 2	4.54e 1	-	5.35e 0
I-133	7.45e 1	1.30e 2	3.95e 1	1.90e 4	2.26e 2	-	1.16e 2
I-134	5.56e 0	1.51e 1	5.40e 0	2.62e 2	2.40e 1	-	1.32e-2
I-135	2.32e 1	6.08e 1	2.24e 1	4.01e 3	9.75e 1	-	6.87e 1
Cs-134	6.84e 3	1.63e 4	1.33e 4	-	5.27e 3	1.75e 3	2.85e 2
Cs-136	7.16e 2	2.83e 3	2.04e 3	-	1.57e 3	2.16e 2	3.21e 2
Cs-137	8.77e 3	1.20e 4	7.85e 3	-	4.07e 3	1.35e 3	2.32e 2
Cs-138	6.07e 0	1.20e 1	5.94e 0	-	8.81e 0	8.70e-1	5.11e-5
Ba-139	7.85e 0	5.59e-3	2.30e-1	-	5.23e-3	3.17e-3	1.39e 1
Ba-140	1.61e 3	2.06e 0	1.08e 2	-	7.02e-1	1.18e 0	3.38e 3
Ba-141	3.81e 0	2.88e-3	1.29e-1	-	2.68e-3	1.63e-3	1.80e-9
Ba-142	1.72e 0	1.77e-3	1.08e-1	-	1.50e-3	1.00e-3	2.43e-18
La-140	1.57e 0	7.94e-1	2.10e-1	-	-	-	5.83e 4
La-142	8.06e-2	3.67e-2	9.13e-3	-	-	-	2.68e2
Ce-141	3.43e 0	2.32e 0	2.63e-1	-	1.08e 0	-	8.86e 3
Ce-143	6.04e-1	4.46e 2	4.94e-2	-	1.96e-1	-	1.67e 4
Ce-144	1.79e 2	7.47e 1	9.59e 0	-	4.43e 1	-	6.04e 4
Pr-143	5.79e 0	2.32e 0	2.87e-1	-	1.34e 0	-	2.54e 4
Pr-144	1.90e-2	7.87e-3	9.64e-4	-	4.44e-3	-	2.73e-9
Nd-147	3.96e 0	4.58e 0	2.74e-1	-	2.68e 0	-	2.20e 4
W-187	9.16e 0	7.66e 0	2.68e 0	-	-	-	2.51e 3
Np-239	3.53e-2	3.47e-3	1.91e-3	-	1.08e-2	-	7.11e 2

Table 1-4
Bioaccumulation Factors (BFi)
(pCi/kg per pCi/liter)*

Element	Saltwater Fish	Saltwater Invertebrate
H	9.0E-01	9.3E-01
C	1.8E+03	1.4E+03
Na	6.7E-02	1.9E-01
P	3.0E+03	3.0E+04
Cr	4.0E+02	2.0E+03
Mn	5.5E+02	4.0E+02
Fe	3.0E+03	2.0E+04
Co	1.0E+02	1.0E+03
Ni	1.0E+02	2.5E+02
Cu	6.7E+02	1.7E+03
Zn	2.0E+03	5.0E+04
Br	1.5E-02	3.1E+00
Rb	8.3E+00	1.7E+01
Sr	2.0E+00	2.0E+01
Y	2.5E+01	1.0E+03
Zr	2.0E+02	8.0E+01
Nb	3.0E+04	1.0E+02
Mo	1.0E+01	1.0E+01
Tc	1.0E+01	5.0E+01
Ru	3.0E+00	1.0E+03
Rh	1.0E+01	2.0E+03
Ag	3.3E+03	3.3E+03
Sb	4.0E+01	5.4E+00
Te	1.0E+01	1.0E+02
I	1.0E+01	5.0E+01
Cs	4.0E+01	2.5E+01
Ba	1.0E+01	1.0E+02
La	2.5E+01	1.0E+03
Ce	1.0E+01	6.0E+02
Pr	2.5E+01	1.0E+03
Nd	2.5E+01	1.0E+03
W	3.0E+01	3.0E+01
Np	1.0E+01	1.0E+01

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* Values in this Table are taken from Regulatory Guide 1.109 except for phosphorus (fish) which is adapted from NUREG/CR-1336 and silver and antimony which are taken from UCRL 50564, Rev. 1, October 1972.

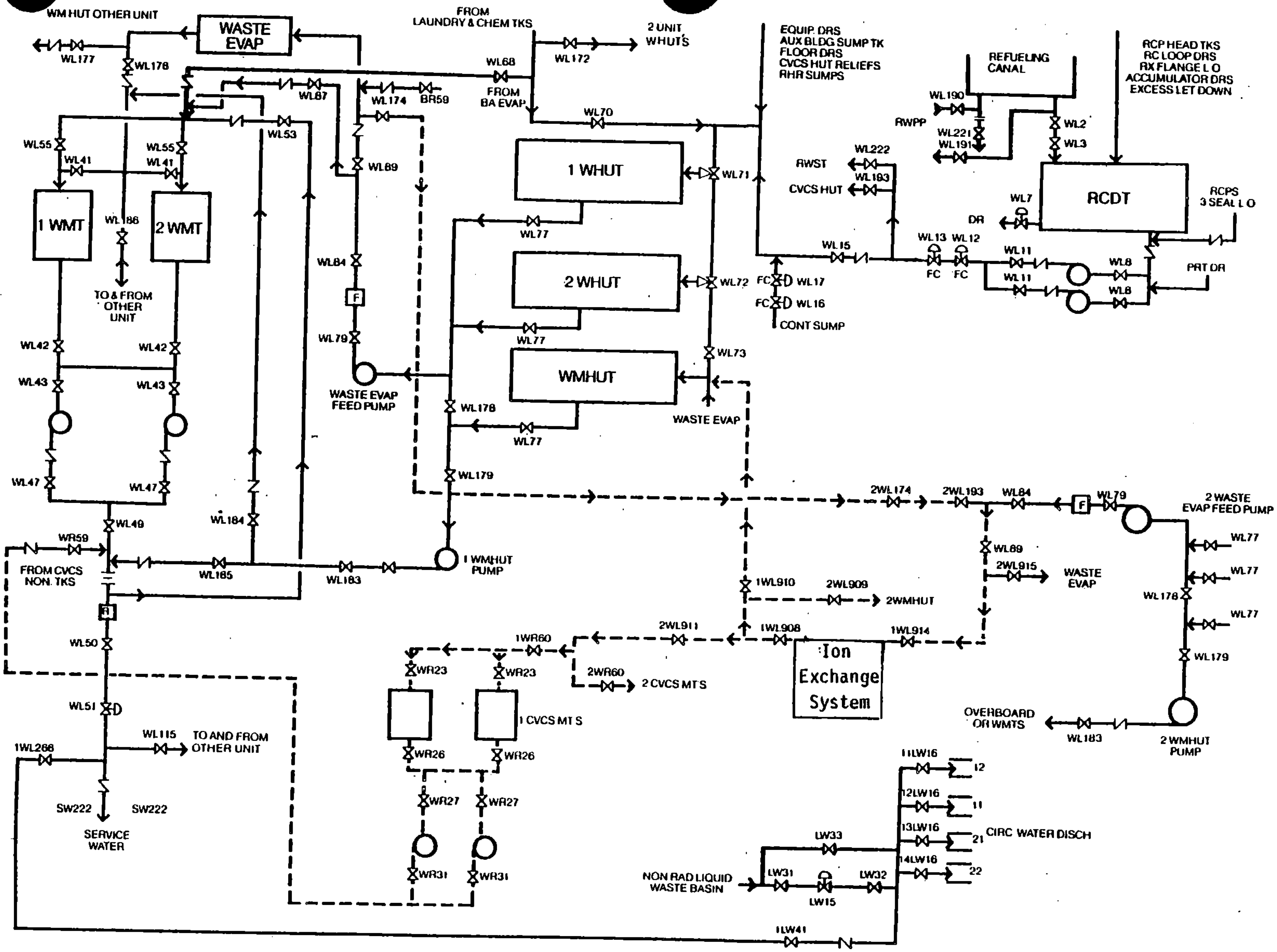

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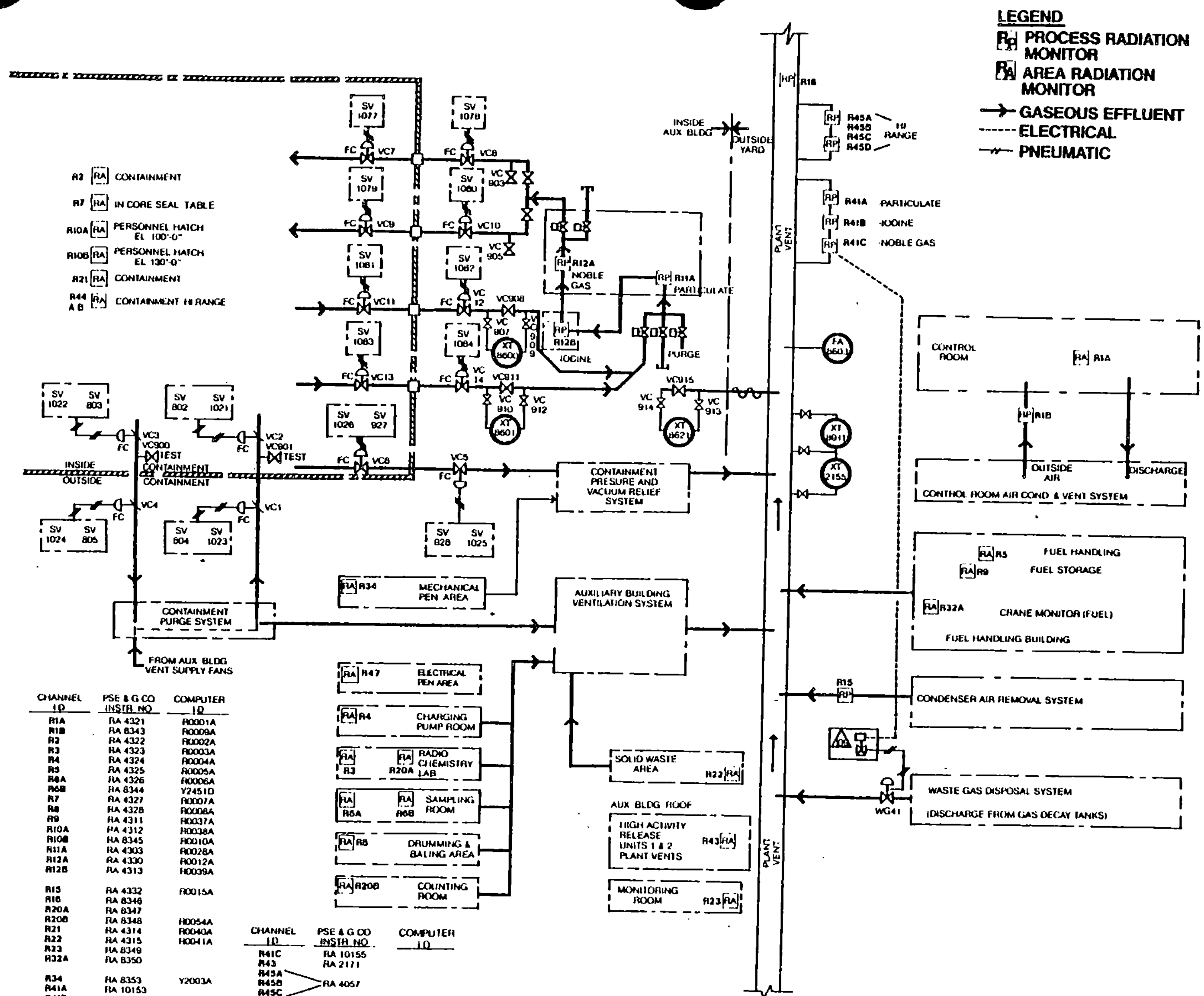
FIGURE 1-3

LIQUID WASTE



CHANNEL ID	PSE & G CO INSTR NO	COMPUTER ID
R1A	RA 4321	R0001A
R1B	RA 8343	R0009A
R2	RA 4322	R0002A
R3	RA 4323	R0003A
R4	RA 4324	R0004A
R5	RA 4325	R0005A
R6A	RA 4326	R0006A
R6B	RA 8344	Y2451D
R7	RA 4327	R0007A
R8	RA 4328	R0008A
R9	RA 4311	R0037A
R10A	RA 4312	R0038A
R10B	RA 8345	R0010A
R11A	RA 4303	R0028A
R12A	RA 4330	R0012A
R12B	RA 4313	R0039A
R15	RA 4332	R0015A
R16	RA 8346	
R20A	RA 8347	
R20B	RA 8348	R0054A
R21	RA 4314	R0040A
R22	RA 4315	R0041A
R23	RA 8349	
R32A	RA 8350	
R34	RA 8353	Y2003A
R41A	RA 10153	
R41B	RA 10154	

CHANNEL ID	PSE & G CO INSTR NO	COMPUTER ID
R41C	RA 10155	
R43	RA 2171	
R45A, R45B, R45C	RA 4057	
R45D	RA 4058	
R44A	RA 2584	
R44B	RA 2586	
R47	RA 4171	

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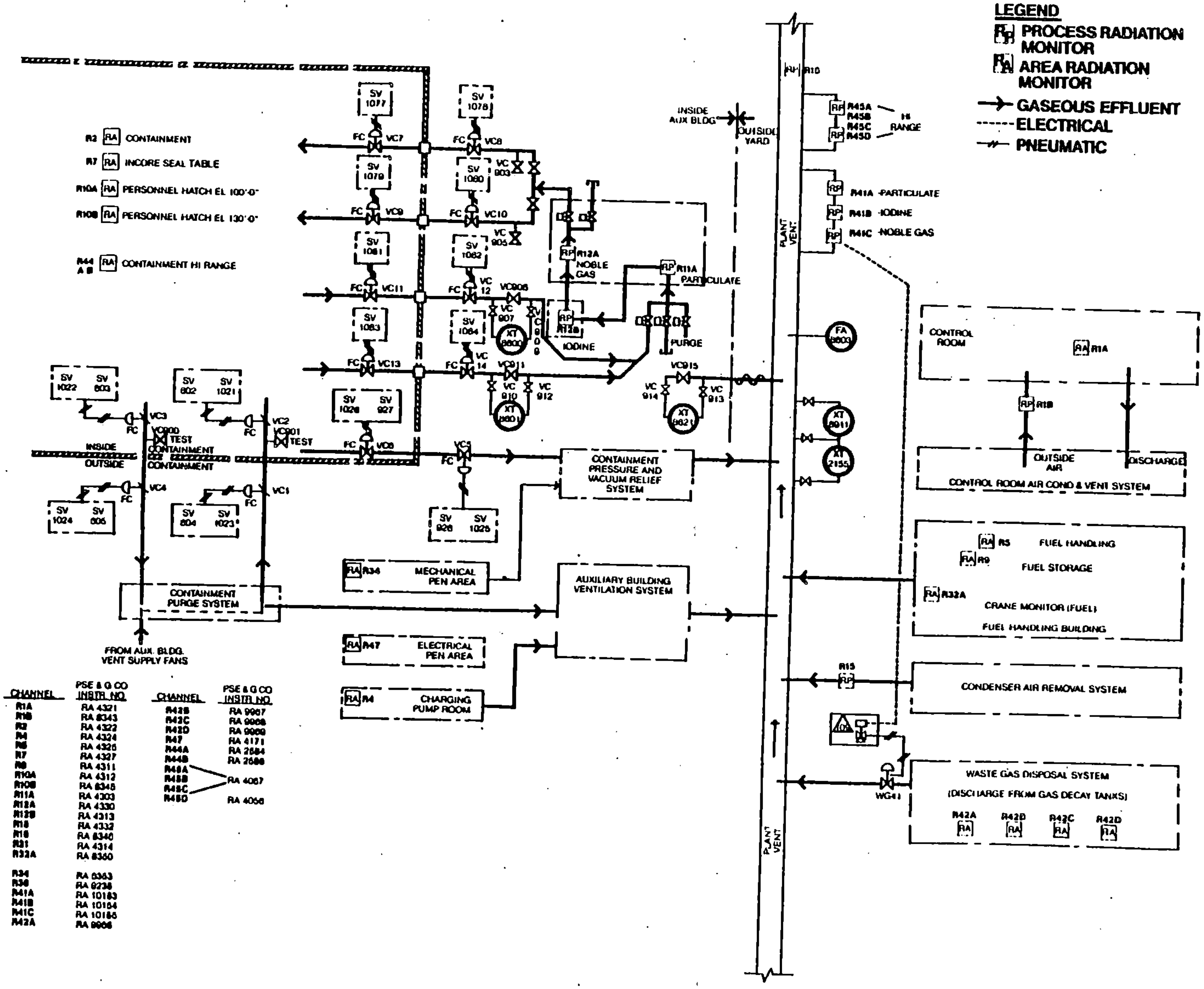
FIGURE 2-1

RADIATION MONITORING GASEOUS 1 UNIT



CHANNEL	PSE & G CO INSTR. NO
R1A	RA 4321
R1B	RA 8343
R2	RA 4322
R4	RA 4324
R5	RA 4326
R7	RA 4327
R8	RA 4311
R10A	RA 4312
R10B	RA 8348
R11A	RA 4303
R12A	RA 4330
R12B	RA 4313
R15	RA 4332
R16	RA 8340
R31	RA 4314
R32A	RA 8360
R34	RA 8363
R36	RA 9238
R41A	RA 10183
R41B	RA 10184
R41C	RA 10185
R42A	RA 9966

CHANNEL	PSE & G CO INSTR. NO
R42B	RA 9967
R42C	RA 9968
R42D	RA 9969
R47	RA 4171
R44A	RA 2584
R44B	RA 2586
R45A, R45B, R45C	RA 4067
R45D	RA 4056

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FIGURE 2-2

RADIATION MONITORING GASEOUS 2UNIT

Table 2-1
Dose Factors for Noble Gases

Radionuclide	Total Body Dose Factor Ki (mrem/yr per uCi/m3)	Skin Dose Factor Li (mrem/yr per uCi/m3)	Gamma Air Dose Factor Mi (mrad/yr per uCi/m3)	Beta Air Dose Factor Ni (mrad/yr per uCi/m3)
Kr-83m	7.56E-02	------	1.93E+01	2.88E+02
Kr-85m	1.17E+03	1.46E+03	1.23E+03	1.97E+03
Kr-85	1.61E+01	1.34E+03	1.72E+01	1.95E+03
Kr-87	5.92E+03	9.73E+03	6.17E+03	1.03E+04
Kr-88	1.47E+04	2.37E+03	1.52E+04	2.93E+03
Kr-89	1.66E+04	1.01E+04	1.73E+04	1.06E+04
Kr-90	1.56E+04	7.29E+03	1.63E+04	7.83E+03
Xe-131m	9.15E+01	4.76E+02	1.56E+02	1.11E+03
Xe-133m	2.51E+02	9.94E+02	3.27E+02	1.48E+03
Xe-133	2.94E+02	3.06E+02	3.53E+02	1.05E+03
Xe-135m	3.12E+03	7.11E+02	3.36E+03	7.39E+02
Xe-135	1.81E+03	1.86E+03	1.92E+03	2.46E+03
Xe-137	1.42E+03	1.22E+04	1.51E+03	1.27E+04
Xe-138	8.83E+03	4.13E+03	9.21E+03	4.75E+03
Ar-41	8.84E+03	2.69E+03	9.30E+03	3.28E+03

Table 2-2
Parameters for Gaseous Alarm Setpoint Determinations
Unit-1

Parameter	Actual Value	Default Value	Units	Comments
X/Q	calculated	2.2E-06	sec/m^3	USNRC Salem Safety Evaluation, Sup. 3
VF (Plant Vent)	as measured or fan curves	1.25E+05	ft^3/min	Plant Vent - normal operation
VF (Cont. Purge)	as measured or fan curves	3.5E+04	ft^3/min	Containment purge
AF	coordinated with HCGS	0.25	unitless	Administrative allocation factor to ensure combined releases do not exceed release rate limit for site.
C_i	measured	N/A	uCi/cm^3	
K_i	nuclide specific	N/A	$mrem/yr$ per uCi/m^3	Values from Table 2-1
L_i	nuclide specific	N/A	$mrem/yr$ per uCi/m^3	Values from Table 2-1
M_i	nuclide specific	N/A	$mrad/yr$ per uCi/m^3	Values from Table 2-1
SEN 1-R41C*	as determined	1.6E+07	cpm per uCi/cm^3	Plant Vent
1-R16		3.6E+07		Plant Vent (redundant)
1-R12A		2.1E+06		Containment
SP 1-R41C	calculated	3.3E+04(+bkg)	cpm	Default alarm setpoints; more conservative values may be used as deemed appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA.
1-R16	calculated	7.4E+04(+bkg)		
1-R12A**	calculated	1.5E+04(+bkg)		

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* Based on mean for calibration with mixture of radionuclides

** Applicable during MODES 1 through 5. During MODE 6 (refueling), monitor setpoint shall be reduced to 2X background in accordance with Tech Spec Table 3.3-6.

Table 2-3
Parameters for Gaseous Alarm Setpoint Determinations
Unit-2

Parameter	Actual Value	Default Value	Units	Comments
X/Q	calculated	2.2E-06	sec/m^3	licensing technical specification value
VF (Plant Vent)	as measured or fan curves	1.25E+05	ft^3/min	Plant Vent - normal operation
VF (Cont. Purge)	as measured or fan curves	3.5E+04	ft^3/min	Containment purge
AF	coordinated with HCGS	0.25	unitless	Administrative allocation factor to ensure combined releases do not exceed release rate limit for site.
C_i	measured	N/A	uCi/cm^3	
K_i	nuclide specific	N/A	$mrem/yr$ per uCi/m^3	Values from Table 2-1
L_i	nuclide specific	N/A	$mrem/yr$ per uCi/m^3	Values from Table 2-1
M_i	nuclide specific	N/A	$mrad/yr$ per uCi/m^3	Values from Table 2-1
SEN 2-R41C*	as determined	1.6E+07	cpm per uCi/cm^3	Plant Vent
2-R16		3.5E+07		Plant Vent (redundant)
2-R12A		3.3E+07		Containment
SP 2-R41C	calculated	3.3E+04(+bkg)	cpm	Default alarm setpoints; more conservative values may be used as deemed appropriate and desirable for ensuring regulatory compliance and for maintaining releases ALARA.
2-R16	calculated	7.2E+04(+bkg)		
2-R12A**	calculated	2.4E+05(+bkg)		

* Based on mean for calibration with mixture of radionuclides

** Applicable during MODES 1 through 5. During MODE 6 (refueling), monitor setpoints shall be reduced to 2X background in accordance with Tech Spec Table 3.3-6.

Table 2-4
Controlling Locations, Pathways and
Atmospheric Dispersion for Dose Calculations ‡

Technical Specification	Location	Pathway(s)	Controlling Age Group	Atmospheric Dispersion X/Q (sec/m3)	Atmospheric Dispersion D/Q (1/m2)
3.11.2.1a	site boundary (0.83 mile, N)	noble gases direct exposure	N/A	2.2E-06	N/A
3.11.2.1b	site boundary (0.83 mile, N)	inhalation	child	2.2E-06	N/A
3.11.2.2	site boundary (0.83 mile, N)	gamma-air beta-air	N/A	2.2E-06	N/A
3.11.2.3	residence/dairy (4.8 miles, NNE)	milk and ground plane	infant	5.4E-08	2.1E-10

‡ The identified controlling locations, pathways and atmospheric dispersion are from the Safety Evaluation Report, Supplement No. 3 for the Salem Nuclear Generating Station, Unit 2 (NUREG-0517, December 1978).

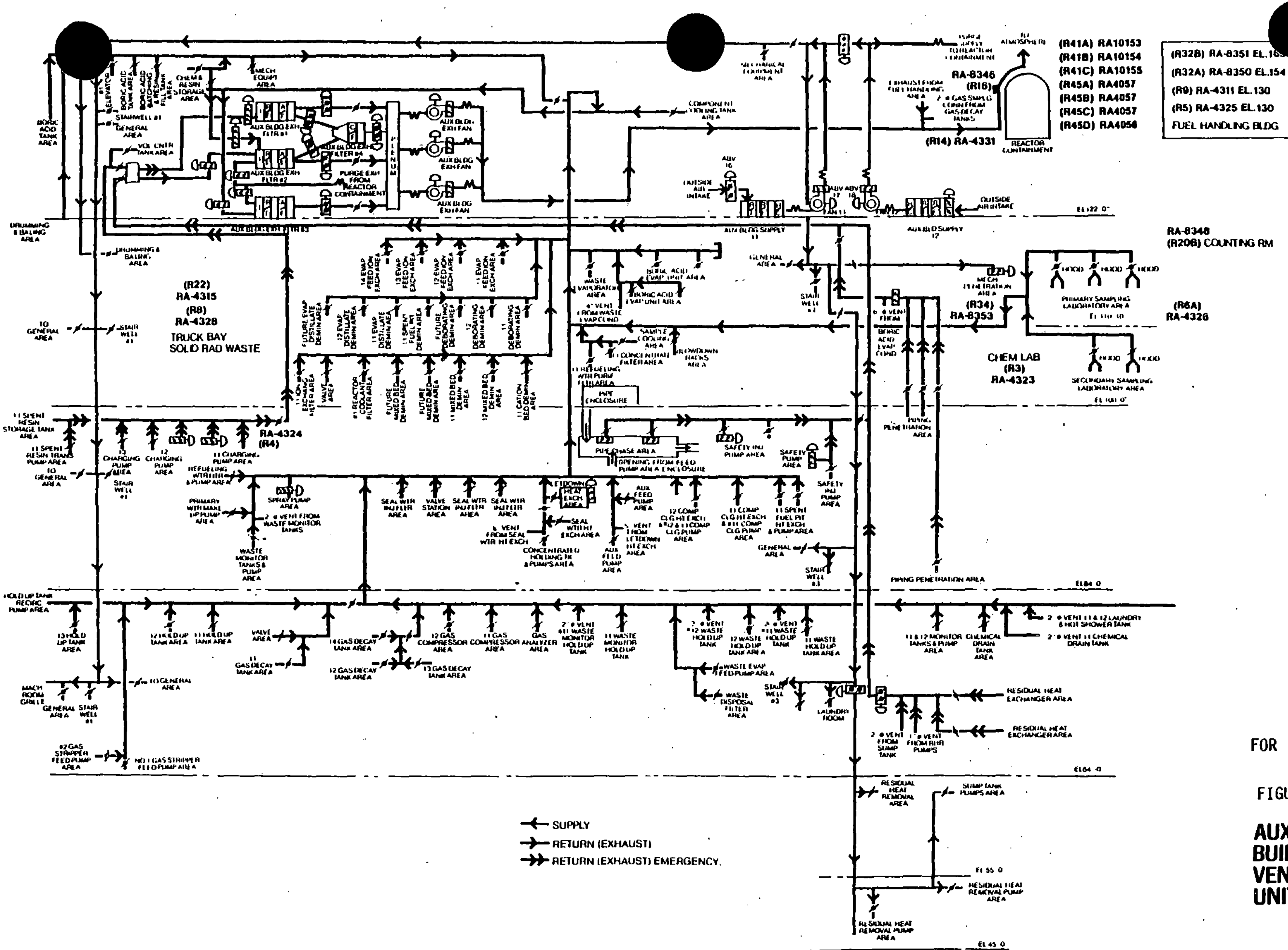

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FIGURE 2-3

AUXILIARY BUILDING VENTILATION UNIT 1

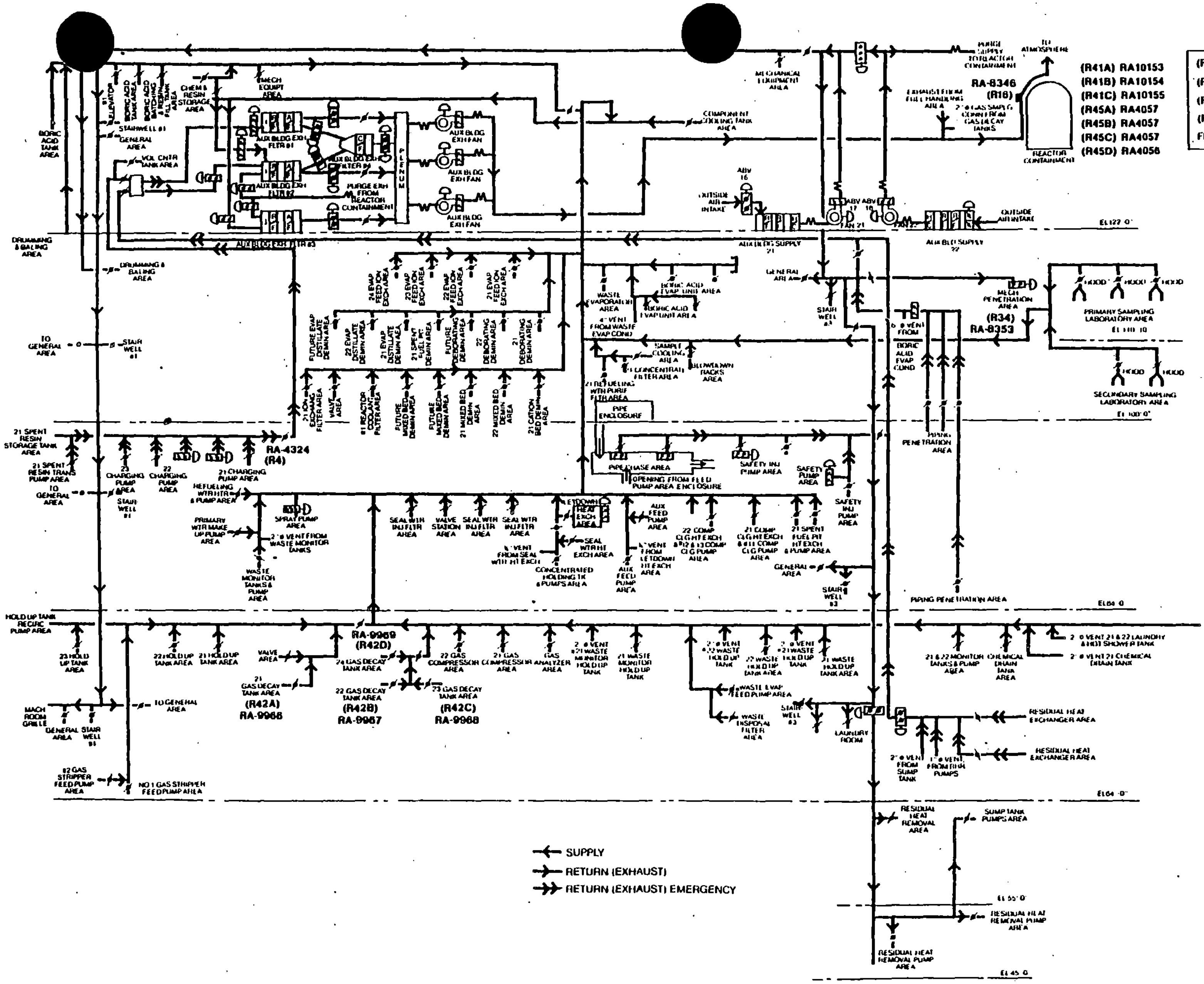

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FIGURE 2-4

AUXILIARY BUILDING VENTILATION UNIT 2

Table 2-5
Pathway Dose Factors - Atmospheric Releases

R(io) Inhalation Pathway Factors - ADULT

(mrem/yr per uCi/m3)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.26e 3	1.26e 3	1.26e 3	1.26e 3	1.26e 3	1.26e 3
C-14	1.82e 4	3.41e 3	3.41e 3	3.41e 3	3.41e 3	3.41e 3	3.41e 3
P-32	1.32e 6	7.71e 4	5.01e 4	-	-	-	8.64e 4
Cr-51	-	-	1.00e 2	5.95e 1	2.28e 1	1.44e 4	3.32e 3
Mn-54	-	3.96e 4	6.30e 3	-	9.84e 3	1.40e 6	7.74e 4
Fe-55	2.46e 4	1.70e 4	3.94e 3	-	-	7.21e 4	6.03e 3
Fe-59	1.18e 4	2.78e 4	1.06e 4	-	-	1.02e 6	1.88e 5
Co-58	-	1.58e 3	2.07e 3	-	-	9.28e 5	1.06e 5
Co-60	-	1.15e 4	1.48e 4	-	-	5.97e 6	2.85e 5
Ni-63	4.32e 5	3.14e 4	1.45e 4	-	-	1.78e 5	1.34e 4
Zn-65	3.24e 4	1.03e 5	4.66e 4	-	6.90e 4	8.64e 5	5.34e 4
Rb-86	-	1.35e 5	5.90e 4	-	-	-	1.66e 4
Rb-88	-	3.87e 2	1.93e 2	-	-	-	3.34e-9
Sr-89	3.04e 5	-	8.72e 3	-	-	1.40e 6	3.50e 5
Sr-90	9.92e 7	-	6.10e 6	-	-	9.60e 6	7.22e 5
Y-91	4.62e 5	-	1.24e 4	-	-	1.70e 6	3.85e 5
Zr-95	1.07e 5	3.44e 4	2.33e 4	-	5.42e 4	1.77e 6	1.50e 5
Nb-95	1.41e 4	7.82e 3	4.21e 3	-	7.74e 3	5.05e 5	1.04e 5
Ru-103	1.53e 3	-	6.58e 2	-	5.83e 3	5.05e 5	1.10e 5
Ru-106	6.91e 4	-	8.72e 3	-	1.34e 5	9.36e 6	9.12e 5
Ag-110m	1.08e 4	1.00e 4	5.94e 3	-	1.97e 4	4.63e 6	3.02e 5
Te-125m	3.42e 3	1.58e 3	4.67e 2	1.05e 3	1.24e 4	3.14e 5	7.06e 4
Te-127m	1.26e 4	5.77e 3	1.57e 3	3.29e 3	4.58e 4	9.60e 5	1.50e 5
Te-129m	9.76e 3	4.67e 3	1.58e 3	3.44e 3	3.66e 4	1.16e 6	3.83e 5
I-131	2.52e 4	3.58e 4	2.05e 4	1.19e 7	6.13e 4	-	6.28e 3
Cs-134	3.73e 5	8.48e 5	7.28e 5	-	2.87e 5	9.76e 4	1.04e 4
Cs-136	3.90e 4	1.46e 5	1.10e 5	-	8.56e 4	1.20e 4	1.17e 4
Cs-137	4.78e 5	6.21e 5	4.28e 5	-	2.22e 5	7.52e 4	8.40e 3
Ba-140	3.90e 4	4.90e 1	2.68e 3	-	1.67e 1	1.27e 6	2.18e 5
Ce-141	1.99e 4	1.35e 4	1.53e 3	-	6.26e 3	3.62e 5	1.20e 5
Ce-144	3.43e 6	1.43e 6	1.84e 5	-	8.48e 5	7.78e 6	8.16e 5
Pr-143	9.36e 3	3.75e 3	4.64e 2	-	2.16e 3	2.81e 5	2.00e 5
Nd-147	5.27e 3	6.10e 3	3.65e 2	-	3.56e 3	2.21e 5	1.73e 5

Table 2-5 (con't)

R(io) Inhalation Pathway Factors - TEENAGER

(mrem/yr per uCi/m3)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.27E 3	1.27E 3	1.27E 3	1.27E 3	1.27E 3	1.27E 3
C-14	2.60E 4	4.87E 3	4.87E 3	4.87E 3	4.87E 3	4.87E 3	4.87E 3
P-32	1.89E 6	1.10E 5	7.16E 4	-	-	-	9.28E 4
Cr-51	-	-	1.35E 2	7.50E 1	3.07E 1	2.10E 4	3.00E 3
Mn-54	-	5.11E 4	8.40E 3	-	1.27E 4	1.98E 6	6.68E 4
Fe-55	3.34E 4	2.38E 4	5.54E 3	-	-	1.24E 5	6.39E 3
Fe-59	1.59E 4	3.70E 4	1.43E 4	-	-	1.53E 6	1.78E 5
Co-58	-	2.07E 3	2.78E 3	-	-	1.34E 6	9.52E 4
Co-60	-	1.51E 4	1.98E 4	-	-	8.72E 6	2.59E 5
Ni-63	5.80E 5	4.34E 4	1.98E 4	-	-	3.07E 5	1.42E 4
Zn-65	3.86E 4	1.34E 5	6.24E 4	-	8.64E 4	1.24E 6	4.66E 4
Rb-86	-	1.90E 5	8.40E 4	-	-	-	1.77E 4
Rb-88	-	5.46E 2	2.72E 2	-	-	-	2.92E-5
Sr-89	4.34E 5	-	1.25E 4	-	-	2.42E 6	3.71E 5
Sr-90	1.08E 8	-	6.68E 6	-	-	1.65E 7	7.65E 5
Y-91	6.61E 5	-	1.77E 4	-	-	2.94E 6	4.09E 5
Zr-95	1.46E 5	4.58E 4	3.15E 4	-	6.74E 4	2.69E 6	1.49E 5
Nb-95	1.86E 4	1.03E 4	5.66E 3	-	1.00E 4	7.51E 5	9.68E 4
Ru-103	2.10E 3	-	8.96E 2	-	7.43E 3	7.83E 5	1.09E 5
Ru-106	9.84E 4	-	1.24E 4	-	1.90E 5	1.61E 7	9.60E 5
Ag-110m	1.38E 4	1.31E 4	7.99E 3	-	2.50E 4	6.75E 6	2.73E 5
Te-125m	4.88E 3	2.24E 3	6.67E 2	1.40E 3	-	5.36E 5	7.50E 4
Te-127m	1.80E 4	8.16E 3	2.18E 3	4.38E 3	6.54E 4	1.66E 6	1.59E 5
Te-129m	1.39E 4	6.58E 3	2.25E 3	4.58E 3	5.19E 4	1.98E 6	4.05E 5
I-131	3.54E 4	4.91E 4	2.64E 4	1.46E 7	8.40E 4	-	6.49E 3
Cs-134	5.02E 5	1.13E 6	5.49E 5	-	3.75E 5	1.46E 5	9.76E 3
Cs-136	5.15E 4	1.94E 5	1.37E 5	-	1.10E 5	1.78E 4	1.09E 4
Cs-137	6.70E 5	8.48E 5	3.11E 5	-	3.04E 5	1.21E 5	8.48E 3
Ba-140	5.47E 4	6.70E 1	3.52E 3	-	2.28E 1	2.03E 6	2.29E 5
Ce-141	2.84E 4	1.90E 4	2.17E 3	-	8.88E 3	6.14E 5	1.26E 5
Ce-144	4.89E 6	2.02E 6	2.62E 5	-	1.21E 6	1.34E 7	8.64E 5
Pr-143	1.34E 4	5.31E 3	6.62E 2	-	3.09E 3	4.83E 5	2.14E 5
Nd-147	7.86E 3	8.56E 3	5.13E 2	-	5.02E 3	3.72E 5	1.82E 5

Table 2-5 (con't)

R(io) Inhalation Pathway Factors - CHILD

(mrem/yr per uCi/m3)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.12E 3	1.12E 3	1.12E 3	1.12E 3	1.12E 3	1.12E 3
C-14	3.59E 4	6.73E 3	6.73E 3	6.73E 3	6.73E 3	6.73E 3	6.73E 3
P-32	2.60E	1.14E 5	9 88E 4	-	-	-	4.22E 4
Cr-51	-	-	1.54E 2	8.55E 1	2.43E 1	1.70E 4	1.08E 3
Mn-54	-	4.29E 4	9.51E 3	-	1.00E 4	1.58E 6	2.29E 4
Fe-55	4.74E 4	2.52E 4	7.77E 3	-	-	1.11E 5	2.87E 3
Fe-59	2.07E 4	3.34E 4	1.67E 4	-	-	1.27E 6	7.07E 4
Co-58	-	1.77E 3	3.16E 3	-	-	1.11E 6	3.44E 4
Co-60	-	1.31E 4	2.26E 4	-	-	7.07E 6	9.62E 4
Ni-63	8.21E 5	4.62E 4	2.80E 4	-	-	2.75E 5	6.33E 3
Zn-65	4.25E 4	1.13E 5	7.03E 4	-	7.14E 4	9.95E 5	1.63E 4
Rb-86	-	1.98E 5	1.14E 5	-	-	-	7.99E 3
Rb-88	-	5.62E 2	3.66E 2	-	-	-	1.72E 1
Sr-89	5.99E 5	-	1.72E 4	-	-	2.16E 6	1.67E 5
Sr-90	1.01E 8	-	6.44E 6	-	-	1.48E 7	3.43E 5
Y-91	9.14E 5	-	2.44E 4	-	-	2.63E 6	1.84E 5
Zr-95	1.90E 5	4.18E 4	3.70E 4	-	5.96E 4	2.23E 6	6.10E 4
Nb-95	2.35E 4	9.18E 3	6.55E 3	-	8.62E 3	6.14E 5	3.70E 4
Ru-103	2.79E 3	-	1.07E 3	-	7.03E 3	6.62E 5	4.48E 4
Ru-106	1.36E 5	-	1.69E 4	-	1.84E 5	1.43E 7	4.29E 5
Ag-110m	1.69E 4	1.14E 4	9.14E 3	-	2.12E 4	5.48E 6	1.00E 5
Te-125m	6.73E 3	2.33E 3	9.14E 2	1.92E 3	-	4.77E 5	3.38E 4
Te-127m	2.49E 4	8.55E 3	3.02E 3	6.07E 3	6.36E 4	1.48E 6	7.14E 4
Te-129m	1.92E 4	6.84E 3	3.04E 3	6.33E 3	5.03E 4	1.76E 6	1.82E 5
I-131	4.81E 4	4.81E 4	2.73E 4	1.62E 7	7.88E 4	-	2.84E 3
Cs-134	6.51E 5	1.01E 6	2.25E 5	-	3.30E 5	1.21E 5	3.85E 3
Cs-136	6.51E 4	1.71E 5	1.16E 5	-	9.55E 4	1.45E 4	4.18E 3
Cs-137	9.06E 5	8.25E 5	1.28E 5	-	2.82E 5	1.04E 5	3.62E 3
Ba-140	7.40E 4	6.47E 1	4.33E 3	-	2.11E 1	1.74E 6	1.02E 5
Ce-141	3.92E 4	1.95E 4	2.90E 3	-	8.55E 3	5.44E 5	5.66E 4
Ce-144	6.77E 6	2.12E 6	3.61E 5	-	1.17E 6	1.20E 7	3.88E 5
Pr-143	1.85E 4	5.55E 3	9.14E 2	-	3.00E 3	4.33E 5	9.73E 4
Nd-147	1.08E 4	8.73E 3	6.81E 2	-	4.81E 3	3.28E 5	8.21E 4

Table 2-5 (con't)

R(io) Inhalation Pathway Factors - INFANT

(mrem/yr per uCi/m3)

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	6.47E 2	6.47E 2	6.47E 2	6.47E 2	6.47E 2	6.47E 2
C-14	2.65E 4	5.31E 3	5.31E 3	5.31E 3	5.31E 3	5.31E 3	5.31E 3
P-32	2.03E 6	1.12E 5	7.74E 4	-	-	-	1.61E 4
Cr-51	-	-	8.95E 1	5.75E 1	1.32E 1	1.28E 4	3.57E 2
Mn-54	-	2.53E 4	4.98E 3	-	4.98E 3	1.00E 6	7.06E 3
Fe-55	1.97E 4	1.17E 4	3.33E 3	-	-	8.69E 4	1.09E 3
Fe-59	1.36E 4	2.35E 4	9.48E 3	-	-	1.01E 6	2.48E 4
Co-58	-	1.22E 3	1.82E 3	-	-	7.77E 5	1.11E 4
Co-60	-	8.02E 3	1.18E 4	-	-	4.51E 6	3.19E 4
Ni-63	3.39E 5	2.04E 4	1.16E 4	-	-	2.09E 5	2.42E 3
Zn-65	1.93E 4	6.26E 4	3.11E 4	-	3.25E 4	6.47E 5	5.14E 4
Rb-86	-	1.90E 5	8.82E 4	-	-	-	3.04E 3
Rb-88	-	5.57E 2	2.87E 2	-	-	-	3.39E 2
Sr-89	3.98E 5	-	1.14E 4	-	-	2.03E 6	6.40E 4
Sr-90	4.98E 7	-	2.59E 6	-	-	1.12E 7	1.31E 5
Y-91	5.88E 5	-	1.57E 4	-	-	2.45E 6	7.03E 4
Zr-95	1.15E 5	2.79E 4	2.03E 4	-	3.11E 4	1.75E 6	2.17E 4
Nb-95	1.57E 4	6.43E 3	3.78E 3	-	4.72E 3	4.79E 5	1.27E 4
Ru-103	2.02E 3	-	6.79E 2	-	4.24E 3	5.52E 5	1.61E 4
Ru-106	8.68E 4	-	1.09E 4	-	1.07E 5	1.16E 7	1.64E 5
Ag-110m	9.98E 3	7.22E 3	5.00E 3	-	1.09E 4	3.67E 6	3.30E 4
Te-125m	4.76E 3	1.99E 3	6.58E 2	1.62E 3	-	4.47E 5	1.29E 4
Te-127m	1.67E 4	6.90E 3	2.07E 3	4.87E 3	3.75E 4	1.31E 6	2.73E 4
Te-129m	1.41E 4	6.09E 3	2.23E 3	5.47E 3	3.18E 4	1.68E 6	6.90E 4
I-131	3.79E 4	4.44E 4	1.96E 4	1.48E 7	5.18E 4	-	1.06E 3
Cs-134	3.96E 5	7.03E 5	7.45E 4	-	1.90E 5	7.97E 4	1.33E 3
Cs-136	4.83E 4	1.35E 5	5.29E 4	-	5.64E 4	1.18E 4	1.43E 3
Cs-137	5.49E 5	6.12E 5	4.55E 4	-	1.72E 5	7.13E 4	1.33E 3
Ba-140	5.60E 4	5.60E 1	2.90E 3	-	1.34E 1	1.60E 6	3.84E 4
Ce-141	2.77E 4	1.67E 4	1.99E 3	-	5.25E 3	5.17E 5	2.16E 4
Ce-144	3.19E 6	1.21E 6	1.76E 5	-	5.38E 5	9.84E 6	1.48E 5
Pr-143	1.40E 4	5.24E 3	6.99E 2	-	1.97E 3	4.33E 5	3.72E 4
Nd-147	7.94E 3	8.13E 3	5.00E 2	-	3.15E 3	3.22E 5	3.12E 4

Table 2-5 (con't)

R(io) Grass-Cow-Milk Pathway Factor - ADULT

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	7.63E 2	7.63E 2	7.63E 2	7.63E 2	7.63E 2	7.63E 2
C-14	2.63E 8	5.27E 7	5.27E 7	5.27E 7	5.27E 7	5.27E 7	5.27E 7
P-32	1.71E10	1.06E 9	6.60E 8	-	-	-	1.92E 9
Cr-51	-	-	2.86E 4	1.71E 4	6.30E 3	3.80E 4	7.20E 6
Mn-54	-	8.40E 6	1.60E 6	-	2.50E 6	-	2.57E 7
Fe-55	2.51E 7	1.73E 7	4.04E 6	-	-	9.67E 6	9.95E 6
Fe-59	2.98E 7	7.00E 7	2.68E 7	-	-	1.95E 7	2.33E 8
Co-58	-	4.72E 6	1.06E 7	-	-	-	9.57E 7
Co-60	-	1.64E 7	3.62E 7	-	-	-	3.08E 8
Ni-63	6.73E 9	4.66E 8	2.26E 8	-	-	-	9.73E 7
Zn-65	1.37E 9	4.36E 9	1.97E 9	-	2.92E 9	-	2.75E 9
Rb-86	-	2.59E 9	1.21E 9	-	-	-	5.11E 8
Rb-88	-	1.25E 7	6.61E 6	-	-	-	1.72E-4
Sr-89	1.45E 9	-	4.16E 7	-	-	-	2.33E 8
Sr-90	4.68E10	-	1.15E10	-	-	-	1.35E 9
Y-91	8.60E 3	-	2.30E 2	-	-	-	4.73E 6
Zr-95	9.46E 2	3.03E 2	2.05E 2	-	4.76E 2	-	9.62E 5
Nb-95	8.25E 4	4.59E 4	2.47E 4	-	4.54E 4	-	2.79E 8
Ru-103	1.02E 3	-	4.39E 2	-	3.89E 3	-	1.19E 5
Ru-106	2.04E 4	-	2.58E 3	-	3.94E 4	-	1.32E 6
Ag-110m	5.83E 7	5.39E 7	3.20E 7	-	1.06E 8	-	2.20E10
Te-125m	1.63E 7	5.90E 6	2.18E 6	4.90E 6	6.63E 7	-	6.50E 7
Te-127m	4.58E 7	1.64E 7	5.58E 6	1.17E 7	1.86E 8	-	1.54E 8
Te-129m	6.04E 7	2.25E 7	9.57E 6	2.08E 7	2.52E 8	-	3.04E 8
I-131	2.96E 8	4.24E 8	2.43E 8	1.39E11	7.27E 8	-	1.12E 8
Cs-134	5.65E 9	1.34E10	1.10E10	-	4.35E 9	1.44E 9	2.35E 8
Cs-136	2.61E 8	1.03E 9	7.42E 8	-	5.74E 8	7.87E 7	1.17E 8
Cs-137	7.38E 9	1.01E10	6.61E 9	-	3.43E 9	1.14E 9	1.95E 8
Ba-140	2.69E 7	3.38E 4	1.76E 6	-	1.15E 4	1.93E 4	5.54E 7
Ce-141	4.84E 3	3.27E 3	3.71E 2	-	1.52E 3	-	1.25E 7
Ce-144	3.58E 5	1.50E 5	1.92E 4	-	8.87E 4	-	1.21E 8
Pr-143	1.59E 2	6.37E 1	7.88E 0	-	3.68E 1	-	6.96E 5
Nd-147	9.42E 1	1.09E 2	6.52E 0	-	6.37E 1	-	5.23E 5

Table 2-5 (con't)

R(io) Grass-Cow-Milk Pathway Factor - TEENAGER

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	9.94E 2	9.94E 2	9.94E 2	9.94E 2	9.94E 2	9.94E 2
C-14	4.86E 8	9.72E 7	9.72E 7	9.72E 7	9.72E 7	9.72E 7	9.72E 7
P-32	3.15E10	1.95E 9	1.22E 9	-	-	-	2.65E 9
Cr-51	-	-	5.00E 4	2.78E 4	1.10E 4	7.13E 4	8.40E 6
Mn-54	-	1.40E 7	2.78E 6	-	4.17E 6	-	2.87E 7
Fe-55	4.45E 7	3.16E 7	7.36E 6	-	-	2.00E 7	1.37E 7
Fe-59	5.20E 7	1.21E 8	4.68E 7	-	-	3.82E 7	2.87E 8
Co-58	-	7.95E 6	1.83E 7	-	-	-	1.10E 8
Co-60	-	2.78E 7	6.26E 7	-	-	-	3.62E 8
Ni-63	1.18E10	8.35E 8	4.01E 8	-	-	-	1.33E 8
Zn-65	2.11E 9	7.31E 9	3.41E 9	-	4.68E 9	-	3.10E 9
Rb-86	-	4.73E 9	2.22E 9	-	-	-	7.00E 8
Rb-88	-	2.26E 7	1.21E 7	-	-	-	1.94E 0
Sr-89	2.67E 9	-	7.66E 7	-	-	-	3.18E 8
Sr-90	6.61E10	-	1.63E10	-	-	-	1.86E 9
Y-91	1.58E 4	-	4.24E 2	-	-	-	6.48E 6
Zr-95	1.65E 3	5.22E 2	3.59E 2	-	7.67E 2	-	1.20E 6
Nb-95	1.41E 5	7.80E 4	4.30E 4	-	7.57E 4	-	3.34E 8
Ru-103	1.81E 3	-	7.75E 2	-	6.40E 3	-	1.52E 5
Ru-106	3.75E 4	-	4.73E 3	-	7.23E 4	-	1.80E 6
Ag-110m	9.63E 7	9.11E 7	5.54E 7	-	1.74E 8	-	2.56E10
Te-125m	3.00E 7	1.08E 7	4.02E 6	8.39E 6	-	-	8.86E 7
Te-127m	8.44E 7	2.99E 7	1.00E 7	2.01E 7	3.42E 8	-	2.10E 8
Te-129m	1.11E 8	4.10E 7	1.75E 7	3.57E 7	4.62E 8	-	4.15E 8
I-131	5.38E 8	7.53E 8	4.04E 8	2.18E11	1.30E 9	-	1.49E 8
Cs-134	9.81E 9	2.31E10	1.07E10	-	7.34E 9	2.80E 9	2.87E 8
Cs-136	4.45E 8	1.75E 9	1.18E 9	-	9.53E 8	1.50E 8	1.41E 8
Cs-137	1.34E10	1.78E10	6.20E 9	-	6.06E 9	2.35E 9	2.53E 8
Ba-140	4.85E 7	5.95E 4	3.13E 6	-	2.02E 4	4.00E 4	7.49E 7
Ce-141	8.87E 3	5.92E 3	6.81E 2	-	2.79E 3	-	1.69E 7
Ce-144	6.58E 5	2.72E 5	3.54E 4	-	1.63E 5	-	1.66E 8
Pr-143	2.92E 2	1.17E 2	1.45E 1	-	6.77E 1	-	9.61E 5
Nd-147	1.81E 2	1.97E 2	1.18E 1	-	1.16E 2	-	7.11E 5

Table 2-5 (con't)

R(io) Grass-Cow-Milk Pathway Factor - CHILD

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.57E 3	1.57E 3	1.57E 3	1.57E 3	1.57E 3	1.57E 3
C-14	1.19E 9	2.39E 8	2.39E 8	2.39E 8	2.39E 8	2.39E 8	2.39E 8
P-32	7.77E10	3.64E 9	3.00E 9	-	-	-	2.15E 9
Cr-51	-	-	1.02E 5	5.66E 4	1.55E 4	1.03E 5	5.41E 6
Mn-54	-	2.09E 7	5.58E 6	-	5.87E 6	-	1.76E 7
Fe-55	1.12E 8	5.93E 7	1.84E 7	-	-	3.35E 7	1.10E 7
Fe-59	1.20E 8	1.95E 8	9.71E 7	-	-	5.65E 7	2.03E 8
Co-58	-	1.21E 7	3.72E 7	-	-	-	7.08E 7
Co-60	-	4.32E 7	1.27E 8	-	-	-	2.39E 8
Ni-63	2.96E10	1.59E 9	1.01E 9	-	-	-	1.07E 8
Zn-65	4.13E 9	1.10E10	6.85E 9	-	6.94E 9	-	1.93E 9
Rb-86	-	8.77E 9	5.39E 9	-	-	-	5.64E 8
Rb-88	-	4.17E 7	2.89E 7	-	-	-	2.04E 6
Sr-89	6.62E 9	-	1.89E 8	-	-	-	2.56E 8
Sr-90	1.12E11	-	2.83E10	-	-	-	1.50E 9
Y-91	3.91E 4	-	1.04E 3	-	-	-	5.21E 6
Zr-95	3.84E 3	8.45E 2	7.52E 2	-	1.21E 3	-	8.81E 5
Nb-95	3.18E 5	1.24E 5	8.84E 4	-	1.16E 5	-	2.29E 8
Ru-103	4.29E 3	-	1.65E 3	-	1.08E 4	-	1.11E 5
Ru-106	9.24E 4	-	1.15E 4	-	1.25E 5	-	1.44E 6
Ag-110m	2.09E 8	1.41E 8	1.13E 8	-	2.63E 8	-	1.68E10
Te-125m	7.38E 7	2.00E 7	9.84E 6	2.07E 7	-	-	7.12E 7
Te-127m	2.08E 8	5.60E 7	2.47E 7	4.97E 7	5.93E 8	-	1.68E 8
Te-129m	2.72E 8	7.61E 7	4.23E 7	8.78E 7	8.00E 8	-	3.32E 8
I-131	1.30E 9	1.31E 9	7.46E 8	4.34E11	2.15E 9	-	1.17E 8
Cs-134	2.26E10	3.71E10	7.83E 9	-	1.15E10	4.13E 9	2.00E 8
Cs-136	1.00E 9	2.76E 9	1.79E 9	-	1.47E 9	2.19E 8	9.70E 7
Cs-137	3.22E10	3.09E10	4.55E 9	-	1.00E10	3.62E 9	1.93E 8
Ba-140	1.17E 8	1.03E 5	6.84E 6	-	3.34E 4	6.12E 4	5.94E 7
Ce-141	2.19E 4	1.09E 4	1.62E 3	-	4.78E 3	-	1.36E 7
Ce-144	1.62E 6	5.09E 5	8.66E 4	-	2.82E 5	-	1.33E 8
Pr-143	7.23E 2	2.17E 2	3.59E 1	-	1.17E 2	-	7.80E 5
Nd-147	4.45E 2	3.60E 2	2.79E 1	-	1.98E 2	-	5.71E 5

Table 2-5 (con't)

R(io) Grass-Cow-Milk Pathway Factor - INFANT

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T.Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	1.57E 3	1.57E 3	1.57E 3	1.57E 3	1.57E 3	1.57E 3
C-14	2.34E 9	5.00E 8	5.00E 8	5.00E 8	5.00E 8	5.00E 8	5.00E 8
P-32	1.60E11	9.42E 9	6.21E 9	-	-	-	2.17E 9
Cr-51	-	-	1.61E 5	1.05E 5	2.30E 4	2.05E 5	4.71E 6
Mn-54	-	3.90E 7	8.83E 6	-	8.63E 6	-	1.43E 7
Fe-55	1.35E 8	8.72E 7	2.33E 7	-	-	4.26E 7	1.11E 7
Fe-59	2.25E 8	3.93E 8	1.55E 8	-	-	1.16E 8	1.88E 8
Co-58	-	2.43E 7	6.06E 7	-	-	-	6.05E 7
Co-60	-	8.81E 7	2.08E 8	-	-	-	2.10E 8
Ni-63	3.49E10	2.16E 9	1.21E 9	-	-	-	1.07E 8
Zn-65	5.55E 9	1.90E10	8.78E 9	-	9.23E 9	-	1.61E10
Rb-86	-	2.22E10	1.10E10	-	-	-	5.69E 8
Rb-88	-	1.09E 8	5.99E 7	-	-	-	1.06E 8
Sr-89	1.26E10	-	3.61E 8	-	-	-	2.59E 8
Sr-90	1.22E11	-	3.09E10	-	-	-	1.52E 9
Y-91	7.33E 4	-	1.95E 3	-	-	-	5.26E 6
Zr-95	6.83E 3	1.66E 3	1.18E 3	-	1.79E 3	-	8.28E 5
Nb-95	5.93E 5	2.44E 5	1.41E 5	-	1.75E 5	-	2.06E 8
Ru-103	8.69E 3	-	2.91E 3	-	1.81E 4	-	1.06E 5
Ru-106	1.90E 5	-	2.38E 4	-	2.25E 5	-	1.44E 6
Ag-110m	3.86E 8	2.82E 8	1.86E 8	-	4.03E 8	-	1.46E10
Te-125m	1.51E 8	5.04E 7	2.04E 7	5.07E 7	-	-	7.18E 7
Te-127m	4.21E 8	1.40E 8	5.10E 7	1.22E 8	1.04E 9	-	1.70E 8
Te-129m	5.59E 8	1.92E 8	8.62E 7	2.15E 8	1.40E 9	-	3.34E 8
I-131	2.72E 9	3.21E 9	1.41E 9	1.05E12	3.75E 9	-	1.15E 8
Cs-134	3.65E10	6.80E10	6.87E 9	-	1.75E10	7.18E 9	1.85E 8
Cs-136	1.96E 9	5.77E 9	2.15E 9	-	2.30E 9	4.70E 8	8.76E 7
Cs-137	5.15E10	6.02E10	4.27E 9	-	1.62E10	6.55E 9	1.88E 8
Ba-140	2.41E 8	2.41E 5	1.24E 7	-	5.73E 4	1.48E 5	5.92E 7
Ce-141	4.33E 4	2.64E 4	3.11E 3	-	8.15E 3	-	1.36E 7
Ce-144	2.33E 6	9.52E 5	1.30E 5	-	3.85E 5	-	1.33E 8
Pr-143	1.49E 3	5.59E 2	7.41E 1	-	2.08E 2	-	7.89E 5
Nd-147	8.82E 2	9.06E 2	5.55E 1	-	3.49E 2	-	5.74E 5

Table 2-5 (con't)

R(io) Vegetation Pathway Factor - ADULT

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.26E 3	2.26E 3	2.26E 3	2.26E 3	2.26E 3	2.26E 3
C-14	2.28E 8	4.55E 7	4.55E 7	4.55E 7	4.55E 7	4.55E 7	4.55E 7
P-32	1.40E 9	8.73E 7	5.42E 7	-	-	-	1.58E 8
Cr-51	-	-	4.66E 4	2.79E 4	1.03E 4	6.19E 4	1.17E 7
Mn-54	-	3.11E 8	5.94E 7	-	9.27E 7	-	9.54E 8
Fe-55	2.09E 8	1.45E 8	3.37E 7	-	-	8.06E 7	8.29E 7
Fe-59	1.27E 8	2.99E 8	1.14E 8	-	-	8.35E 7	9.96E 8
Co-58	-	3.09E 7	6.92E 7	-	-	-	6.26E 8
Co-60	-	1.67E 8	3.69E 8	-	-	-	3.14E 9
Ni-63	1.04E10	7.21E 8	3.49E 8	-	-	-	1.50E 8
Zn-65	3.17E 8	1.01E 9	4.56E 8	-	6.75E 8	-	6.36E 8
Rb-86	-	2.19E 8	1.02E 8	-	-	-	4.32E 7
Rb-88	-	3.29E 6	1.74E 6	-	-	-	4.54E-5
Sr-89	9.96E 9	-	2.86E 8	-	-	-	1.60E 9
Sr-90	6.04E11	-	1.48E11	-	-	-	1.75E10
Y-91	5.13E 6	-	1.37E 5	-	-	-	2.82E 9
Zr-95	1.19E 6	3.81E 5	2.58E 5	-	5.97E 5	-	1.21E 9
Nb-95	1.42E 5	7.91E 4	4.25E 4	-	7.81E 4	-	4.80E 8
Ru-103	4.80E 6	-	2.07E 6	-	1.83E 7	-	5.61E 8
Ru-106	1.93E 8	-	2.44E 7	-	3.72E 8	-	1.25E10
Ag-110m	1.06E 7	9.76E 6	5.80E 6	-	1.92E 7	-	3.98E 9
Te-125m	9.66E 7	3.50E 7	1.29E 7	2.90E 7	3.93E 8	-	3.86E 8
Te-127m	3.49E 8	1.25E 8	4.26E 7	8.92E 7	1.42E 9	-	1.17E 9
Te-129m	2.55E 8	9.50E 7	4.03E 7	8.75E 7	1.06E 9	-	1.28E 9
I-131	8.09E 7	1.16E 8	6.63E 7	3.79E10	1.98E 8	-	3.05E 7
Cs-134	4.66E 9	1.11E10	9.07E 9	-	3.59E 9	1.19E 9	1.94E 8
Cs-136	4.20E 7	1.66E 8	1.19E 8	-	9.24E 7	1.27E 7	1.89E 7
Cs-137	6.36E 9	8.70E 9	5.70E 9	-	2.95E 9	9.81E 8	1.68E 8
Ba-140	1.29E 8	1.62E 5	8.43E 6	-	5.49E 4	9.25E 4	2.65E 8
Ce-141	1.96E 5	1.33E 5	1.51E 4	-	6.17E 4	-	5.08E 8
Ce-144	3.29E 7	1.37E 7	1.77E 6	-	8.16E 6	-	1.11E10
Pr-143	6.34E 4	2.54E 4	3.14E 3	-	1.47E 4	-	2.78E 8
Nd-147	3.34E 4	3.86E 4	2.31E 3	-	2.25E 4	-	1.85E 8

Table 2-5 (con't)

R(io) Vegetation Pathway Factor - TEENAGER

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	2.28E 3	2.28E 3	2.28E 3	2.28E 3	2.28E 3	2.28E 3
C-14	3.69E 8	7.38E 7	7.38E 7	7.38E 7	7.38E 7	7.38E 7	7.38E 7
P-32	1.61E 9	9.96E 7	6.23E 7	-	-	-	1.35E 8
Cr-51	-	-	6.20E 4	3.44E 4	1.36E 4	8.85E 4	1.04E 7
Mn-54	-	4.52E 8	8.97E 7	-	1.35E 8	-	9.28E 8
Fe-55	3.25E 8	2.31E 8	5.38E 7	-	-	1.46E 8	9.98E 7
Fe-59	1.81E 8	4.22E 8	1.63E 8	-	-	1.33E 8	9.98E 8
Co-58	-	4.38E 7	1.01E 8	-	-	-	6.04E 8
Co-60	-	2.49E 8	5.60E 8	-	-	-	3.24E 9
Ni-63	1.61E10	1.13E 9	5.45E 8	-	-	-	1.81E 8
Zn-65	4.24E 8	1.47E 9	6.86E 8	-	9.41E 8	-	6.23E 8
Rb-86	-	2.73E 8	1.28E 8	-	-	-	4.05E 7
Rb-88	-	5.13E 6	2.74E 6	-	-	-	4.40E-1
Sr-89	1.51E10	-	4.33E 8	-	-	-	1.80E 9
Sr-90	7.51E11	-	1.85E11	-	-	-	2.11E10
Y-91	7.87E 6	-	2.11E 5	-	-	-	3.23E 9
Zr-95	1.74E 6	5.49E 5	3.78E 5	-	8.07E 5	-	1.27E 9
Nb-95	1.92E 5	1.06E 5	5.86E 4	-	1.03E 5	-	4.55E 8
Ru-103	6.87E 6	-	2.94E 6	-	2.42E 7	-	5.74E 8
Ru-106	3.09E 8	-	3.90E 7	-	5.97E 8	-	1.48E10
Ag-110m	1.52E 7	1.44E 7	8.74E 6	-	2.74E 7	-	4.04E 9
Te-125m	1.48E 8	5.34E 7	1.98E 7	4.14E 7	-	-	4.37E 8
Te-127m	5.51E 8	1.96E 8	6.56E 7	1.31E 8	2.24E 9	-	1.37E 9
Te-129m	3.67E 8	1.36E 8	5.81E 7	1.18E 8	1.54E 9	-	1.38E 9
I-131	7.70E 7	1.08E 8	5.79E 7	3.14E10	1.85E 8	-	2.13E 7
Cs-134	7.09E 9	1.67E10	7.74E 9	-	5.30E 9	2.02E 9	2.08E 8
Cs-136	4.29E 7	1.69E 8	1.13E 8	-	9.19E 7	1.45E 7	1.35E 7
Cs-137	1.01E10	1.35E10	4.69E 9	-	4.59E 9	1.78E 9	1.92E 8
Ba-140	1.38E 8	1.69E 5	8.91E 6	-	5.75E 4	1.14E 5	2.13E 8
Ce-141	2.82E 5	1.88E 5	2.16E 4	-	8.86E 4	-	5.38E 8
Ce-144	5.27E 7	2.18E 7	2.83E 6	-	1.30E 7	-	1.33E10
Pr-143	7.12E 4	2.84E 4	3.55E 3	-	1.65E 4	-	2.34E 8
Nd-147	3.63E 4	3.94E 4	2.36E 3	-	2.32E 4	-	1.42E 8

Table 2-5 (con't)

R(io) Vegetation Pathway Factor - CHILD

(mrem/yr per uCi/m3) for H-3 and C-14
(m2 * mrem/yr per uCi/sec) for others

Nuclide	Bone	Liver	T. Body	Thyroid	Kidney	Lung	GI-LLI
H-3	-	4.37E 3	4.37E 3	4.37E 3	4.37E 3	4.37E 3	4.37E 3
C-14	8.89E 8	1.78E 8	1.78E 8	1.78E 8	1.78E 8	1.78E 8	1.78E 8
P-32	3.37E 9	1.58E 8	1.30E 8	-	-	-	9.30E 7
Cr-51	-	-	1.18E 5	6.54E 4	1.79E 4	1.19E 5	6.25E 6
Mn-54	-	6.61E 8	1.76E 8	-	1.85E 8	-	5.55E 8
Fe-55	8.00E 8	4.24E 8	1.31E 8	-	-	2.40E 8	7.86E 7
Fe-59	4.01E 8	6.49E 8	3.23E 8	-	-	1.88E 8	6.76E 8
Co-58	-	6.47E 7	1.98E 8	-	-	-	3.77E 8
Co-60	-	3.78E 8	1.12E 9	-	-	-	2.10E 9
Ni-63	3.95E10	2.11E 9	1.34E 9	-	-	-	1.42E 8
Zn-65	8.12E 8	2.16E 9	1.35E 9	-	1.36E 9	-	3.80E 8
Rb-86	-	4.52E 8	2.78E 8	-	-	-	2.91E 7
Rb-88	-	9.19E 6	6.39E 6	-	-	-	4.51E 5
Sr-89	3.59E10	-	1.03E 9	-	-	-	1.39E 9
Sr-90	1.24E12	-	3.15E11	-	-	-	1.67E10
Y-91	1.87E 7	-	5.01E 5	-	-	-	2.49E 9
Zr-95	3.90E 6	8.58E 5	7.64E 5	-	1.23E 6	-	8.95E 8
Nb-95	4.10E 5	1.59E 5	1.14E 5	-	1.50E 5	-	2.95E 8
Ru-103	1.55E 7	-	5.94E 6	-	3.89E 7	-	3.99E 8
Ru-106	7.45E 8	-	9.30E 7	-	1.01E 9	-	1.16E10
Ag-110m	3.22E 7	2.18E 7	1.74E 7	-	4.05E 7	-	2.58E 9
Te-125m	3.51E 8	9.50E 7	4.67E 7	9.84E 7	-	-	3.38E 8
Te-127m	1.32E 9	3.56E 8	1.57E 8	3.16E 8	3.77E 9	-	1.07E 9
Te-129m	8.54E 8	2.39E 8	1.33E 8	2.75E 8	2.51E 9	-	1.04E 9
I-131	1.43E 8	1.44E 8	8.18E 7	4.76E10	2.36E 8	-	1.28E 7
Cs-134	1.60E10	2.63E10	5.54E 9	-	8.14E 9	2.92E 9	1.42E 8
Cs-136	8.06E 7	2.22E 8	1.43E 8	-	1.18E 8	1.76E 7	7.79E 6
Cs-137	2.39E10	2.29E10	3.38E 9	-	7.46E 9	2.68E 9	1.43E 8
Ba-140	2.77E 8	2.43E 5	1.62E 7	-	7.90E 4	1.45E 5	1.40E 8
Ce-141	6.53E 5	3.26E 5	4.84E 4	-	1.43E 5	-	4.07E 8
Ce-144	1.27E 8	3.98E 7	6.78E 6	-	2.21E 7	-	1.04E10
Pr-143	1.48E 5	4.46E 4	7.37E 3	-	2.41E 4	-	1.60E 8
Nd-147	7.16E 4	5.80E 4	4.49E 3	-	3.18E 4	-	9.18E 7

Table 2-5 (con't)

R(io) Ground Plane Pathway Factor

(m2 * mrem/yr per uCi/sec)

Nuclide	Any Organ
H-3	-
C-14	-
P-32	-
Cr-51	4.68E 6
Mn-54	1.34E 9
Fe-55	-
Fe-59	2.75E 8
Co-58	3.82E 8
Co-60	2.15E10
Ni-63	-
Zn-65	7.45E 8
Rb-86	8.98E 6
Rb-88	3.32E 8
Sr-89	2.16E 4
Sr-90	-
Y-91	1.09E 6
Zr-95	2.48E 8
Nb-95	1.36E 8
Ru-103	1.09E 8
Ru-106	4.21E 8
Ag-110m	3.47E 9
Te-125m	1.55E 6
Te-127m	9.17E 4
Te-129m	2.00E 7
I-131	1.72E 7
Cs-134	6.75E 9
Cs-136	1.49E 8
Cs-137	1.03E10
Ba-140	2.05E 7
Ce-141	1.36E 7
Ce-144	6.95E 7
Pr-143	-
Nd-147	8.40E 6

APPENDIX A

Evaluation of Default MPC Value

for Liquid Effluents

Appendix A
Evaluation of Default MPC Value for Liquid Effluents

In accordance with the requirements of Technical Specification (3.3.3.10) the radioactive liquid effluent monitors shall be operable with alarm setpoints established to ensure that the concentration of radioactive material at the discharge point does not exceed the MPC value of 10 CFR 20, Appendix B, Table II, Column 2. The determination of allowable radionuclide concentration and corresponding alarm setpoint is a function of the individual radionuclide distribution and corresponding MPC values.

In order to limit the need for routinely having to reestablish the alarm setpoints as a function of changing radionuclide distributions, a default alarm setpoint can be established. This default setpoint can be based on an evaluation of the radionuclide distribution of the liquid effluents from Salem and the effective MPC value for this distribution.

The effective MPC value for a radionuclide distribution is calculated by the equation:

$$MPCe = \frac{\sum Ci}{\sum \left(\frac{Ci}{MPCi} \right)} \qquad (A.1)$$

where:

- MPCe = an effective MPC value for a mixture of radionuclide (uCi/ml)
- Ci = concentration of radionuclide i in the mixture
- MPCi = the 10 CFR 20, Appendix B, Table II, Column 2 MPC value for radionuclide i (uCi/ml)

Based on the above equation and the radionuclide distribution in the effluents for past years from Salem, an effective MPC value can be determined. Results are presented in Tables A-1 and A-2 for Unit 1 and Unit 2, respectively.

Considering the average effective MPC values for the years 1981 through 1984, it is reasonable to select an MPC_e value of 1E-05 uCi/ml as typical of liquid radwaste discharges. Using this value to calculate the default R18 alarm setpoint value, results in a setpoint that:

1) Will not require frequent re-adjustment due to minor variations in the nuclide distribution which are typical of routine plant operations, and

2) Will provide for a liquid radwaste discharge rate (as evaluated for each batch release) that is compatible with plant operations (refer to Tables 1-1 and 1-2).

Table A-1

Calculation of Effective MPC

Salem Unit 1

Nuclide	MPC* (uCi/ml)	Activity Released (Ci) 1981	1982	1983	1984
Na-24	3E-05	2.4E-02	1.9E-03	5.3E-03	5.6E-03
Cr-51	2E-03	5.9E-02	1.4E-01	6.2E-02	5.3E-02
Mn-54	1E-04	7.4E-02	2.1E-01	1.6E-01	1.9E-01
Fe-59	5E-05	3.8E-03	8.6E-03	4.2E-02	5.8E-03
Co-58	9E-05	4.5E-01	1.7	1.8	1.6
Co-60	3E-05	3.2E-01	9.1E-01	7.1E-01	1.2
Zr-95	6E-05	1.0E-02	1.1E-02	8.0E-03	1.8E-03
Nb-95	1E-04	1.8E-02	4.8E-02	2.2E-02	1.7E-02
Nb-97	9E-04	N/D**	9.5E-03	3.6E-04	2.0E-02
Tc-99m	3E-03	N/D	N/D	N/D	1.6E-03
Sr-89	3E-06	N/D	N/D	1.2E-03	4.2E-04
Sr-90	3E-07	N/D	N/D	N/D	2.2E-05
Mo-99	4E-05	2.5E-04	1.0E-03	1.6E-03	1.9E-03
Ag-110m	3E-05	N/D	4.7E-03	N/D	N/D
Sn-113	8E-05	8.9E-04	2.2E-04	3.8E-04	9.4E-04
Sb-124	2E-05	6.2E-04	8.0E-03	1.4E-02	1.7E-02
Sb-125	1E-04	3.0E-01	6.8E-03	4.4E-02	4.9E-03
I-131	3E-07	1.1E-01	6.5E-02	2.4E-02	4.5E-02
I-133	1E-06	8.8E-02	5.5E-03	3.3E-02	2.5E-02
I-135	4E-06	N/D	3.5E-04	1.6E-03	1.2E-03
Cs-134	9E-06	6.0E-02	4.0E-02	1.8E-02	5.1E-02
Cs-137	2E-05	7.6E-02	5.9E-02	3.0E-02	5.8E-02
Ba-140	2E-05	N/D	N/D	1.3E-02	2.1E-03
La-140	2E-05	N/D	7.5E-03	1.3E-02	1.6E-02
Total Ci		1.59	3.24	3.00	3.32
$\sum \frac{Ci}{MPCi}$		4.86E+05	2.83E+05	1.66E+05	2.46E+05
MPCe (uCi/ml)		3.3E-06	1.14E-05	1.80E-05	1.35E-05

* MPC value for unrestricted area from 10 CFR 20, Appendix B, Table II, Column 2.
** N/D - not detected

Table A-2
Calculation of Effective MPC
Salem Unit 2

Nuclide	MPC* (uCi/ml)	Activity Released (Ci) 1981	1982	1983	1984
Na-24	3E-05	2.0E-01	1.2E-03	9.2E-03	4.4E-03
Cr-51	2E-03	9.5E-02	1.1E-01	4.6E-02	3.6E-02
Mn-54	1E-04	4.4E-02	2.0E-01	1.4E-01	1.6E-01
Fe-59	5E-05	5.8E-03	5.6E-03	3.1E-02	7.6E-03
Co-58	9E-05	8.1E-01	1.7	1.7	1.3
Co-60	3E-05	2.6E-01	8.6E-01	5.7E-01	9.8E-01
Zr-95	6E-05	1.0E-02	9.7E-03	5.2E-03	1.2E-03
Nb-95	1E-04	1.5E-02	2.3E-02	1.6E-02	1.4E-02
Nb-97	9E-04	N/D**	1.1E-02	1.1E-02	2.1E-02
Tc-99m	3E-03	N/D	N/D	N/D	1.4E-03
Sr-89	3E-06	N/D	N/D	3.2E-04	3.2E-04
Sr-90	3E-07	N/D	N/D	N/D	4.1E-05
Mo-99	4E-05	7.4E-05	1.7E-04	3.0E-03	1.4E-03
Ag-110m	3E-05	N/D	3.9E-03	N/D	N/D
Sn-113	8E-05	2.6E-04	1.6E-04	5.9E-04	1.2E-03
Sb-124	2E-05	9.1E-04	1.0E-02	2.0E-02	3.0E-02
Sb-125	1E-04	8.4E-03	1.0E-02	9.6E-02	3.6E-03
I-131	3E-07	2.6E-02	1.3E-01	3.6E-02	4.2E-02
I-133	1E-06	6.0E-04	6.0E-03	5.4E-02	2.6E-02
I-135	4E-06	N/D	N/D	1.6E-03	4.4E-04
Cs-134	9E-06	1.8E-02	5.1E-02	2.0E-02	2.6E-02
Cs-137	2E-05	2.9E-02	7.6E-02	3.6E-02	4.8E-02
Ba-140	2E-05	N/D	N/D	9.8E-03	6.6E-03
La-140	2E-05	N/D	6.7E-03	8.1E-02	3.0E-02
Total Ci		1.52	3.21	2.89	2.74
$\sum \frac{Ci}{MPCi}$		1.16E+05	5.00E+05	2.26E+05	2.24E+05
MPCe (uCi/ml)		1.31E-05	6.42E-06	1.28E-05	1.22E-05

* MPC value for unrestricted area from 10 CFR 20, Appendix B, Table II, Column 2.
** N/D - not detected

APPENDIX B

Technical Basis for Effective Dose Factors

Liquid Radioactive Effluent

APPENDIX B

Technical Basis for Effective Dose Factors - Liquid Effluent Releases

The radioactive liquid effluents for the years 1984, 1983 and 1982 were evaluated to determine the dose contribution of the radionuclide distribution. This analysis was performed to evaluate the use of a limited dose analysis for determining environmental doses, providing a simplified method of determining compliance with the dose limits of Technical Specification 3.11.1.2. For the radionuclide distribution of effluents from Salem, the controlling organ is the GI-LLI. The calculated GI-LLI dose is predominately a function of the Fe-59, CO-58, CO-60 and Nb-95 releases. The radionuclides, Co-58 and CO-60 contribute the large majority of the calculated total body dose. The results of this evaluation are presented in Table B-1 and Table B-2.

For purposes of simplifying the details of the dose calculational process, it is conservative to identify a controlling, dose significant radionuclide and limit the calculational process to the use of the dose conversion factor for this nuclide. Multiplication of the total release (i.e., cumulative activity for all radionuclides) by this dose conversion factor provides for a dose calculational method that is simplified while also being conservative.

For the evaluation of the maximum organ dose, it is conservative to use the Nb-95 dose conversion factor (1.51 E+06 mrem/hr per uCi/ml, GI-LLI). By this approach, the maximum organ dose will be overestimated since this nuclide has the highest organ dose factor of all the radionuclides evaluated. For the total body calculation, the Fe-59 dose factor (7.27 E+04 mrem/hr per uCi/ml, total body) is the highest among the identified dominant nuclides.

For evaluating compliance with the dose limits of Technical Specification 3.11.1.2, the following simplified equations may be used:

Total_Body

$$Dtb = \frac{1.67E-02 * VOL}{CW} * A_{Fe-59,TB} * \sum Ci \qquad (B.1)$$

where:

Dtb = dose to the total body (mrem)
A Fe-59,TB = 7.27E+04, total body ingestion dose conversion factor for Fe-59 (mrem/hr per uCi/ml)
VOL = volume of liquid effluent released (gal)
$\sum C_i$ = total concentration of all radionuclides (uCi/ml)
CW = average circulating water discharge rate during release period (gal/min)
1.67E-02 = conversion factor (hr/min)

Substituting the value for the Fe-59 total body dose conversion factor, the equation simplified to:

$$Dtb = \frac{1.21E+03 * VOL}{CW} * \sum Ci \qquad (B.2)$$

Maximum_Organ

$$Dmax = \frac{1.67E-02 * VOL * A_{Nb-95,GI-LLI}}{CW} * \sum Ci \qquad (B.3)$$

where:

Dmax = maximum organ dose (mrem)
A Nb-95,GI-LLI = 1.51E+06, Gi-LLI ingestion dose conversion factor for Mn-54 (mrem/hr per uCi/ml)

Substituting the value for $A_{Nb-95,GI-LLI}$ the equation simplifies to:

$$Dmax = \frac{2.52E+04 * VOL}{CW} * \sum Ci \qquad (B.4)$$

Tritium is not included in the limited analysis dose assessment for liquid releases, because the potential dose resulting from normal reactor releases is relatively negligible. The average annual tritium release from each Salem Unit is approximately 350 curies. The calculated total body dose from such a release is 2.4E-03 mrem/yr via the fish and invertebrate ingestion pathways. This amounts to 0.08% of the design objective dose of 3 mrem/yr. Furthermore, the release of tritium is a function of operating time and power level and is essentially unrelated to radwaste system operation.

Table B-1
Adult Dose Contributions
Fish and Invertebrate Pathways
Unit 1

	1984				1983				1982			
Radio-nuclide	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.
Fe-59	5.83E-03	0.05	0.04	0.18	4.21E-02	0.34	0.30	0.66	8.57E-03	0.08	0.05	0.23
Co-58	1.58	0.25	0.21	0.02	1.82	0.27	0.03	0.09	1.70	0.30	0.20	0.15
Co-60	1.20	0.54	0.42	0.34	7.06E-01	0.30	0.26	0.10	9.09E-01	0.45	0.28	0.22
Ag-110m	N/D	*	*	*	N/D	*	*	*	4.70E-03	*	0.03	*
Mn-54	1.93E-01	0.03	0.05	0.22	1.63E-01	0.02	0.04	0.09	2.06E-01	0.04	0.04	0.21
Nb-95	1.74E-02	*	0.28	*	2.17E-02	*	0.37	*	2.83E-02	*	0.40	*
Cs-137	5.84E-02	0.05	*	0.11	3.04E-02	0.04	*	0.03	5.89E-02	0.06	*	0.10
Cs-134	5.06E-02	0.08	*	0.13	1.83E-02	0.03	*	0.02	3.95E-02	0.07	*	0.09
Cr-51	5.30E-02	*	*	*	6.15E-02	*	*	*	1.38E-01	*	*	*
Total	3.33E+00				3.03E+00				3.21E+00			

* less than 0.01
N/D = not detected

Table B-2
Adult Dose Contributions
Fish and Invertebrate Pathways
Unit 2

	1984				1983				1982			
Radio-nuclide	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.	Release (Ci)	TB Dose Frac.	GI-LLI Dose Frac.	Liver Dose Frac.
Fe-59	7.56E-03	0.08	0.06	0.24	3.12E-02	0.31	0.23	0.61	5.61E-03	0.05	0.04	0.16
Co-58	1.30	0.25	0.21	0.13	1.66	0.30	0.24	0.10	1.70	0.30	0.22	0.15
Co-60	9.79E-01	0.53	0.41	0.28	5.72E-01	0.29	0.22	0.10	8.61E-01	0.44	0.30	0.22
Ag-110m	N/D	*	*	*	N/D	*	*	*	3.92E-03	*	0.02	*
Mn-54	1.61E-01	0.03	0.05	0.18	1.36E-01	0.02	0.03	0.10	2.02E-01	0.04	0.05	0.21
Nb-95	1.36E-02	*	0.27	*	1.59E-02	*	0.28	*	2.28E-02	*	0.37	*
Cs-137	4.81E-02	0.05	*	0.10	3.58E-02	0.04	*	0.04	7.64E-02	0.08	*	0.14
Cs-134	2.63E-02	0.05	*	0.07	1.98E-02	0.04	*	0.03	5.06E-02	0.09	*	0.12
Cr-51	3.64E-02	*	*	*	4.58E-02	*	*	*	1.07E-01	*	*	*
Total	2.75E+00				2.85E+00				3.22E+00			

* less than 0.01
N/D = not detected

APPENDIX C

Technical Bases for Effective Dose Factors

Gaseous Radioactive Effluent

APPENDIX C
Technical Bases for Effective Dose Factors - Gaseous Radioactive Effluents

Overview

The evaluation of doses due to releases of radioactive material to the atmosphere can be simplified by the use of effective dose transfer factors instead of using dose factors which are radionuclide specific. These effective factors, which can be based on typical radionuclide distributions of releases, can be applied to the total radioactivity released to approximate the dose in the environment (i.e., instead of having to perform individual radionuclide dose analyses only a single multiplication (Keff, Meff or Neff) times the total quantity of radioactive material released would be needed). This approach provides a reasonable estimate of the actual dose while eliminating the need for a detailed calculational technique.

Determination of Effective Dose Factors

Effective dose transfer factors are calculated by the following equations:

$$Keff = \sum (Ki * fi) \qquad (C.1)$$

where:

Keff = the effective total body dose factor due to gamma emissions from all noble gases released

Ki = the total body dose factor due to gamma emissions from each noble gas radionuclide i released

fi = the fractional abundance of noble gas radionuclide i relative to the total noble gas activity

$$(L + 1.1\ M)eff = \sum ((Li + 1.1\ Mi) * fi) \qquad (C.2)$$

where:

(L + 1.1 M)eff = the effective skin dose factor due to beta and gamma emissions from all noble gases released

(Li + 1.1 Mi) = the skin dose factor due to beta and gamma emissions from each noble gas radionuclide i released

$$M_{eff} = \sum (M_i * f_i) \quad (C.3)$$

where:

M_{eff} = the effective air dose factor due to gamma emissions from all noble gases released

M_i = the air dose factor due to gamma emissions from each noble gas radionuclide i released

$$N_{eff} = \sum (N_i * f_i) \quad (C.4)$$

where:

N_{eff} = the effective air dose factor due to beta emissions from all noble gases released

N_i = the air dose factor due to beta emissions from each noble gas radionuclide i released

Normally, it would be expected that past radioactive effluent data would be used for the determination of the effective dose factors. However, the noble gas releases from Salem have been maintained to such negligible quantities that the inherent variability in the data makes any meaningful evaluations difficult. For the past three years, the total noble gas releases have been limited to 1400 Ci for 1982, 900 Ci for 1983, and 2,000 Ci for 1984. Therefore, in order to provide a reasonable basis for the derivation of the effective noble gas dose factors, the primary coolant source term from ANSI N237-1976/ANS-18.1, "Source Term Specifications," has been used as representing a typical distribution. The effective dose factors as derived are presented in Table C-1.

Application

To provide an additional degree of conservatism, a factor of 0.50 is introduced into the dose calculational process when the effective dose transfer factor is used. This conservatism provides additional assurance that the evaluation of doses by the use of a single effective factor will not significantly underestimate any actual doses in the environment.

For evaluating compliance with the dose limits of Technical Specification

3.11.2.2, the following simplified equations may be used:

$$D_\gamma = \frac{3.17E-08}{0.50} * X/Q * Meff * \sum Qi \qquad (C.5)$$

and

$$D_\beta = \frac{3.17E-08}{0.50} * X/Q * Neff * \sum Qi \qquad (C.6)$$

where:

D_γ	=	air dose due to gamma emissions for the cumulative release of all noble gases (mrad)
D_β	=	air dose due to beta emissions for the cumulative release of all noble gases (mrad)
X/Q	=	atmospheric dispersion to the controlling site boundary (sec/m3)
Meff	=	5.3E+02, effective gamma-air dose factor (mrad/yr per uCi/m3)
Neff	=	1.1E+03, effective beta-air dose factor (mrad/yr per uCi/m3)
$\sum$ Qi	=	cumulative release for all noble gas radionuclides (uCi)
3.17E-08	=	conversion factor (yr/sec)
0.50	=	conservatism factor to account for the variability in the effluent data

Combining the constants, the dose calculational equations simplify to:

$$D_\gamma = 3.5E-05 * X/Q * \sum Qi \qquad (C.7)$$

and

$$D_\beta = 7.0E-05 * X/Q * \sum Qi \qquad (C.8)$$

The effective dose factors are used on a very limited basis for the purpose of facilitating the timely assessment of radioactive effluent releases, particularly during periods of computer malfunction where a detailed dose assessment may be unavailable.

Table C-1
Effective Dose Factors

Noble Gases - Total Body and Skin

Radionuclide	fi*	Total Body Effective Dose Factor Keff (mrem/yr per uCi/m3)	Skin Effective Dose Factor (L+ 1.1 M)eff (mrem/yr per uCi/m3)
Kr-85	0.01	--	1.4E+01
Kr-88	0.01	1.5E+02	1.9E+02
Xe-133m	0.01	2.5E+00	1.4E+01
Xe-133	0.95	3.0E+02	6.6E+02
Xe-135	0.02	3.6E+01	7.9E+01
Total		4.8E+02	9.6E+02

Noble Gases - Air

Radionuclide	fi*	Gamma Air Effective Dose Factor Meff (mrad/yr per uCi/m3)	Beta Air Effective Dose Factor Neff (mrad/yr per uCi/m3)
Kr-85	0.01	--	2.0E+01
Kr-88	0.01	1.5E+02	2.9E+01
Xe-133m	0.01	3.3E+00	1.5E+01
Xe-133	0.95	3.4E+02	1.0E+03
Xe-135	0.02	3.8E+01	4.9E+01
Total		5.3E+02	1.1E+03

* Based on Noble gas distribution from ANSI N237-1976/ANSI-18.1, "Source Term Specifications."

Appendix D

Radiological Environmental Monitoring Program

Sample Type, Location and Analysis

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	TYPE AND FREQUENCY OF ANALYSES
I. AIRBOURNE				
(a) PARTICULATES	10D1	3.9 mi SSW of vent	Continuous low volume air sampler. Sample collected every week along with filter change	Gross beta analysis on each weekly sample*
	2S2	0.4 mi NNE of vent		
	1F1	5.8 mi N of vent		Gross B- analysis done >24 hr. after sampling to allow for Rn and Thoron daughter decay
	2F2	8.7 mi NNE of vent		
	3H3#	110 mi NE of Station		Gamma isotopic analysis on quarterly composite
	16E1	4.1 mi NNW of vent		

Control Station

* Gamma spectrometry shall be performed if gross beta exceeds ten times the yearly mean of control station value.

Table D-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

EXPOSURE PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	TYPE AND FREQUENCY OF ANALYSES
1. AIRBOURNE				
	10D1	3.9 mi SSW of vent		
(b) IODINE				
	16E1	4.1 mi NNW of vent	A TEDA impregnated charcoal flow-through cartridge is connected to air particulate air sampler and is collected weekly	
	2F2	8.7 mi NNE of vent		
	2S2	0.4 mi NNE of vent		Iodine 131 analyses are performed weekly
	3H3#	110 mi NE of vent		

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
II. SOIL				
	10D1	3.9 mi SSW of vent		
	16E1	4.1 mi NNW of vent	10 soil plugs to a depth of 6" over an area of 25 ft² are composited and sealed in a plastic bag at each location** A sample will be collected from each location once every 3 years	
	3G1 #	16.6 miles NE of vent		
	3H3 #	110 mi NE of station		
	1F1	5.8 mi N of vent		
	2F2	8.7 mi NNE of vent		Gamma spectrometry performed on collection
	5D1	3.5 mi E of vent		
	2F1	5 mi NNE of vent		Sr-90 analyses on one sample from each location on collection
	2E1	4.4 mi NNE of vent		
	2S2	0.4 mi NNE of vent		

**Soil samples are taken in general with procedures outlined in HASL-300 (Rev. 5/73). If a suitable sample cannot be obtained at a location, a sample shall be obtained from a new location. The NRC shall be notified in writing of the new sample location.

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
III. DIRECT				
	2S2	0.4 mi NNE of vent	2 TLD's will be collected from each location quarterly	Gamma dose quarterly
	5S1	1.0 mi E of vent		
	6S2	0.2 mi ESE of vent		
	7S1	0.12 mi SE of vent		
	10S1	0.14 mi SSW of vent		
	11S1	0.09 mi SW of vent		
	5D1	3.5 mi E of vent		
	10D1	3.9 mi SSW of vent		
	14D1	3.4 mi WNW of vent		
	2E1	4.4 mi NNE of vent		
	3E1	4.1 mi NE of vent		
	13E1	4.2 mi NE of vent		
	16E1	4.1 mi NNW of vent		
	1F1	5.8 mi N of vent		
	2F2	8.7 mi NNE of vent		
	5F1	8.0 mi E of vent		
	6F1	6.4 mi ESE of vent		
	7F2	9.1 mi SE of vent		
	11F1	5.2 mi SW of vent		
	13F1	9.8 mi W of vent		
	3G1 #	16.6 mi NE of vent		
	2H1 #	34 mi NNE of vent		
	3H1 #	32 mi NE of vent		
	3H3 #	110 mi NE of vent		

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
III. DIRECT (Cont'd)			Collected quarterly	Gamma-dose quarterly
	4D2	3.7 miles ENE of vent		
	9E1	4.2 miles S of vent		
	11E2	5.0 mi SW of vent		
	12E1	4.4 miles WSW of vent		
	2-B	7.4 miles NNE of vent		
	3F2	5.1 miles NE of ven		
	3F3	8.6 miles NE of vent		
	10F2	5.8 miles SSW of vent		
	12F1	9.4 miles WSW of vent		
	13F2	6.5 miles W of vent		
	13F3	9.3 miles W of vent		
	14I2	6.6 miles WNW of vent		
	15F3	5.4 miles NW of vent		
	16F2	8.1 miles NNW of vent		
	16G1 #	14.8 miles NNW of vent		
	1G3 #	18.5 miles N of vent		
	10G1 #	11.6 miles SSW of vent		

Control Station

Table D-1
RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
IV. WATER				
(a) SURFACE	11A1	Approximately 650 ft SW of vent	Two gallon sample to be collected monthly providing winter icing conditions allow sample collection	Gamma isotopic analysis monthly H-3 on quarterly composites
	12C1 #	2.5 mi WSW of vent		
	16F1	6.9 mi NNW of vent C&D canal		
	7E1	1 mi W of Mad Horse Creek; 4.5 mi SE of vent		
(b) GROUND	2S3	on site	Two gallon grab sample is collected monthly.	Gamma isotopic analysis on quarterly composite H-3 analysis are done monthly.
	3E1 #	4.1 mi NE of vent		
(c) DRINKING	2F3 (raw)	Salem Water Co.; 8 mi NNE of vent	50 ml aliquot is taken daily and composited to a monthly sample of two gallons	Gross beta monthly Gamma isotopic analyis on quarterly composite H-3 on quarterly composite

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
V. AQUATIC				
BENTHOS	7E1	1 mi N of Mad Horse Creek; 4.5 mi SE of vent	A benthos sample consisting of benthic organisms and associated sediment is taken semiannually	Gamma isotopic analysis - semiannually; Sr-90 semiannually on sediment
	12C1 #	2.5 mi WSW of vent		
	11A1	Outfall area; 650' SW of vent		
VI. INGESTION				
(a) MILK	15F1	5.2 mi NW of vent	Four gallon grab sample of fresh milk is collected from each farm semimonthly.	Gamma isotopic analysis I-131 - semimonthly
	2F4	6.3 mi NNE of vent		
	5F2	7.0 mi E of vent		
	14F1	5.5 mi WNW of vent		
	3G1 #	16.6 miles NE of vent		
(b) FISH	11A1	Outfall area; 650' SW of vent	Two key samples of fish are sealed in plastic bag or jar and frozen semiannually or when in season	Gamma isotopic analysis of edible portionon collection
	12C1 #	2.5 mi WSW of vent		

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
VI. INGESTION				
(c) CRAB	11A1	Outfall area; 650' SW of vent	Two keys samples of crab are sealed in a plastic bag or jar and frozen semiannually or when in season	Gamma isotopic analysis of edible portion on collection
	12C1 #	West. Bank opposite Artificial Island 2.5 mi SWS of vent		
(d) FRUITS OR VEGETATION	1G1 #	10.2 miles N of vent	Samples are collected during the normal harvest season, sealed in plastic, and frozen if perishable. Sufficient sample is collected to yield 500 grams of dry weight	Radioiodine determination of green leafy vegetables on collection Gamma isotopic analysis on collection
	2E1	4.4 mi NNE of vent		
	2F1	5.0 mi NNE of vent		

Control Station

PATHWAY	STATION CODE	LOCATION	COLLECTION METHOD	ANALYSES
VI. INGESTION				
(e) GAME	XXX	Station vicinity east side of estuary	Muskrats are skinned and frozen semiannually	Gamma isotopic analysis on edible portion only on collection
	XXX #	West side of estuary, 3-5 mi from vent		
	XXX	Within 10 mi of Station	Beef portion of cow is*** sampled and frozen semiannually	

XXX = location given at time of collection

*** = This sample is subject to availability of slaughtered cow

Control Station

Figure D -1
ONSITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND

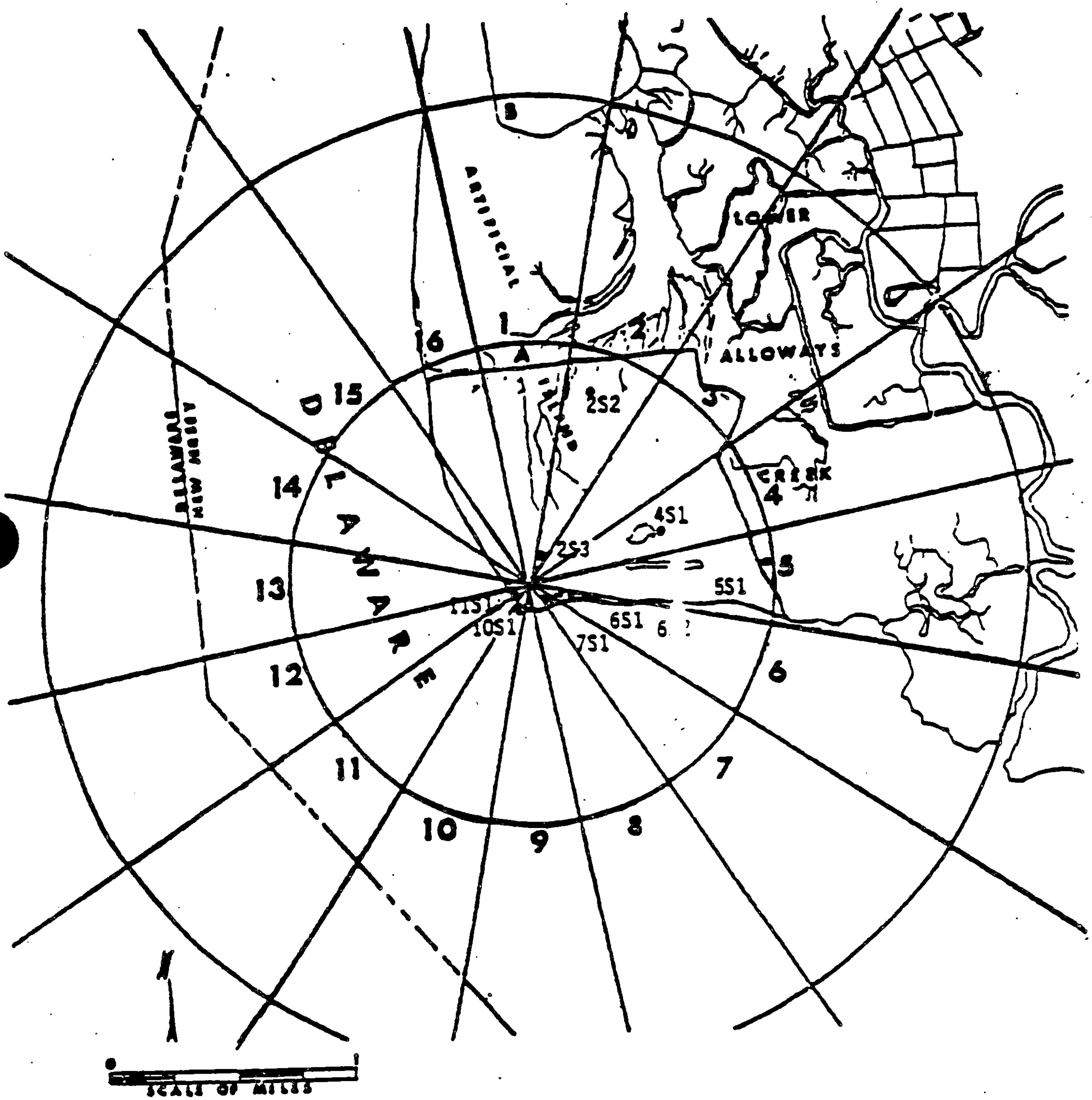
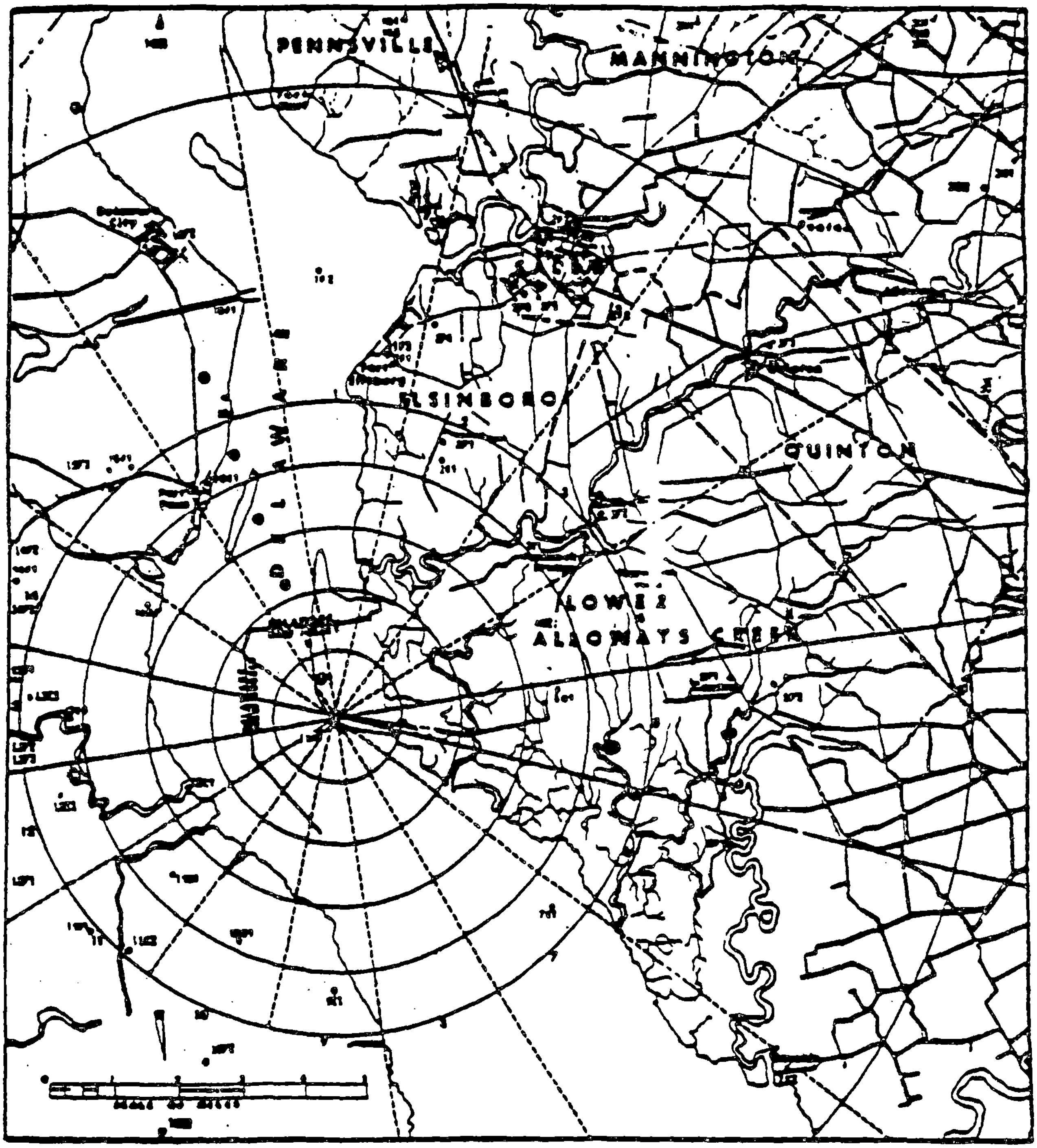


Figure D -2
OFFSITE SAMPLING LOCATIONS
ARTIFICIAL ISLAND



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EFFLUENT RELEASE REPORT
RERR-19

SALEM GENERATING STATION
SALEM UNIT NOS. 1 & 2

UNIT 1 DOCKET NO. 50-272
UNIT 2 DOCKET NO. 50-311
OPERATING LICENSE NO. DPR-70
OPERATING LICENSE NO. DPR-75

MARCH 1986