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ODCM

OFFSITE DOSE CALCULATIONAL MANUAL

SALEM NUCLEAR GENERATING STATION
UNITS NO. 1 & 2

OPERATING LICENSE NOS.
DPR-70 AND DPR-

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OFFSITE DOSE
CALCULATION MANUAL
(ODCM)

UNITS 1 AND 2
OPERATING LICENSE NO. DPR-70
AND
OPERATING LICENSE NO. DPR-

SALEM NUCLEAR GENERATING STATION
PUBLIC SERVICE ELECTRIC AND GAS COMPANY

RETURN TO REACTOR DOCKET
FILES

P79 23 02

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1.0 INTRODUCTION

The offsite Dose Calculation Manual (ODCM) is required by the Radiological Effluent Technical Specification. The ODCM was prepared incorporating the guidance supplied by the USNRC Effluent Treatment Branch in their letter to all power reactors dated January 18, 1979.

It provides additional facts and administratives controls to be used at the Salem Nuclear Generating Station to incorporate the principals of 10CFR50 Appendix I. This document should be used in conjunction with other station procedures and documents which are reference herein. Surveillance and calibration methods and procedures are provided in greater detail in the station's technical specifications and in the station's test procedures 1PD-4,3001 through 1PD-4.30011. All setpoints provided are those currently installed and are subject to change.

In order to provide reasonable assurance that 10CFR50 Appendix I limits are not violated, initial dose estimates will assume that 8 curies of Carbon 14 is discharged annually. To assure doses remain within 10CFR50 Appendix I guidelines, the conversative un-assumption is to increase the dose calculated by 25%. Analysis performed to demonstrate compliance with 10CFR50 Appendix I indicates that this assumption should be conservative.

2.0 IMPLEMENTATION

This ODCM shall be maintained in accordance with radiological effluents technical specification 6.15. It shall be reviewed at least once a year by the Station Operation Review Committee or their designee. Temporary changes are permitted as long as Section 6.8.3 of the Technical Specifications are compiled with. Distribution of amendments will be by controlled copies.

3.0 RADIATION MONITORING INSTRUMENTATION

3.1 EFFLUENT MONITOR SETPOINTS

3.1.1 Gaseous Effluent Setpoint

Channel	- 1R14 Gas Decay Tank Monitor
Purpose	- Monitors the discharge from the waste gas holdup system and terminates discharge on high alarm.
Location	- Elevation 100, beneath the Number 11 and 12 fuel handling building fan intake ducts.
Detector	- Geiger-Mueller tube
Range	- 10 to 10^6 cpm
Interlocks	- Waste discharge valve 1WG41 is locked close.
Setpoint	- 20,000 cpm The basis for how this setpoint was derived is described in section 3.2.

3.0 RADIATION MONITORING INSTRUMENTATION

3.1.1 Gaseous Effluent Setpoints (Cont'd)

Channel	- 1R12A Containment/Plant Vent Noble Gas Monitor
Purpose	- May monitor the plant vent effluent <u>or</u> containment atmosphere for radioactivity after particulate and iodines are removed.
Location	- North penetration electrical side west wall, elevation 78.
Detector	- Beta-Gamma sensitive GM tube
Range	- 10 to 10^6 cpm
Interlocks	- All six containment ventilation isolation valves (1VC1 through 1VC6) are closed on high alarm. Pressure vacuum relief valves also isolates containment.
Setpoint	- 30,000 cpm The basis for how this setpoint was derived is described in section 3.2.

3.0 RADIATION MONITORING INSTRUMENTATION

3.1.1 Gaseous Effluent Setpoints (Cont'd)

Channel	- 1R16 Plant Vent Effluent
Purpose	- Monitors all effluent exiting the plant vent for radioactivity. Serves as a backup for channel 1R12A.
Location	- Elevation 194 of plant vent
Detector	- 4 GM tubes, beta-gamma sensitive
Range	- 10 to 10^6 cpm
Inerlocks	- None
Setpoint	- 500,000 cpm The description of how this setpoint was derived is in section 3.2.

3.1.2 Liquid Effluent Setpoints (Cont'd)

Channel	- 1R18 Liquid Waste Disposal Monitor
Purpose	- Monitors all liquid radioactive discharges
Location	- Inside Auxiliary Building on elevation 86 behind the Number 12 Waste Monitor Pump
Detector	- Sodium-iodide crystal with PM and preamplifier for gamma scintillator
Range	- 10 to 10^6 cpm
Interlocks	- Closes liquid waste discharge valve 1WL51.
Setpoint	- 800,000 cpm The basis for how this setpoint was derived is described in section 3.2.

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

Channel 1-R14 Waste Gas Effluent Monitor

Alarm: 20,000 cpm

Basis: The alarm will activate when the concentration reaches 37% of the Tech. Specs. instantaneous release rate limits for noble gases. FSAR Tables 11.1-6 and 11.1-7 are used to determine the fractional noble gas releases.

Calculations:

1. Instantaneous release rate limits for noble gases:

   A) $2.0 * (Q_{tv} * \overline{K}_v) \leq 1$

   where Q_{tv} = the total noble gas release rate from the plant vent in Ci/sec and K_v = the average total body dose factor due to gamma emission (rem/yr per Ci/sec).

   Assuming Xe-133 is the dominent gamma emitting isotope present then:

$$\overline{K}_V = 0.31 \frac{\text{rem/yr}}{\text{Ci/sec}}$$

$$Q_{TV} \leq \frac{1}{2(0.31)}$$

$$Q_{TV} \leq 1.6 \text{ Ci/sec}$$

   and

   B) $0.33 * Q_{tv} * (\overline{L}_v + 1.1\ \overline{N}_v) \leq 1$

   where Q_{tv} = the total noble gas release rate from the plant vent in Ci/sec.

1-R14 Waste Gas Effluent Monitor

L_v = the average skin dose factor due to beta emissions (rad/yr per Ci/sec), and

N_v = the average air dose factor to gamma emissions (rad/yr per Ci/sec).

Assuming Kr-85 is dominent for skin dose then $L_v = 1.6 \frac{rem/yr}{Ci/sec}$ and assuming Xe-133 is dominant for air dose, then $N_v = 1.3 \frac{rad/yr}{Ci/sec}$

therefore:

$$Q_{tv} \leq \frac{1}{0.33\ (1.6 + 1.1 \times 1.3)}$$

$$Q_{tv} \leq 1.0\ Ci/sec$$

which is a more restrictive limit,

2. Maximum waste gas release flow rate = 150 ft^3/min (PSE&G internal memorandum of 6-18-76).
3. Conversion factor = 2.8×10^4 cc/ft.^{3}.
4. Weighted sensitivty of 1-R14 for Kr-85 and Xe-133 = $5.4 \times 10^3 \frac{cpm}{uCi/cc}$
5. Fraction of total releases expected to come from gas decay tanks = 0.37 (Obtained from FSAR Tables 11.1-6 and 11.1-7).

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

1-R14 Waste Gas Effluent Monitor

6. Meter error factor = 0.75 assumes worst case for meter response error of ± 25% (Radiation Monitoring System Technical Manual).

7. Conversion factor = 10^6 uCi/Ci.

8. Conversion factor = 60 sec/min.

Setpoint:

$$\frac{(0.37)(1.0\ \text{Ci/sec})(10^6\ \text{uCi/Ci})(60\ \text{sec/min})(5.4 \times 10^3\ \text{cpm/uCi/cc})\ (0.75)}{150\ \text{ft}^3/\text{min} \times (2.8 \times 10^4\ \text{cc/ft}^3)} =$$

21,400 cpm

Therefore, choose the nearest major graduation on the meter face; 20,000 cpm.

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

1R12A Containment/Plant Vent Gas Effluent (Plant Vent Mode)

Alarm: 30,000 cpm

Basis: The alarm will activate when the concentration reaches the Tech. Specs. instantaneous release rate limits for noble gases (Salem Technical Specifications Section 3.11.2.1). FSAR Table 11.1-7 is used to determine the fractional noble gas releases.

Calculations:

1. Instantaneous release rate limits for noble gases:

A) $2.0 \; (Q_{tv} * \overline{K_v}) \leq 1$

where Q_{tv} = the total noble gas release rate from the plant vent in Ci/sec and K_v = the average total body dose factor due to gamma emission (rem/yr per Ci/sec).

Assuming the fractional releases (Q_t) from FSAR Table 11.1.-7 and the respective K_{iv} from Tech. Specs. then:

$$\overline{K}_v = 0.31 \; \frac{\text{rem/yr}}{\text{Ci/sec}}$$

$$Q_{tv} \leq \frac{1}{(2)(0.31)}$$

and

B) $0.33 * Q_{tv} (\overline{L}_v + 1.1 \overline{N}_v) \leq 1$

where Q_{tv} = the total noble gas release rate from the plant vent in Ci/sec.

$\overline{L}$ = the average skin dose factor due to beta emission (rem/yr per Ci/sec).

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

1R12A Containment/Plant Vent Gas Effluent (Plant Vent Mode)

and N_v = the average air dose factor due to gamma emissions (rad/yr per Ci/sec).

Assuming the fractional releases (Q_i) from FSAR Table 11.1-7 and the respective L_{i_v} and N_{i_v} from Tech. Specs, then:

$$\bar{L} = 0.82 \; \frac{\text{rem/yr}}{\text{Ci/sec}}$$

and

$$\bar{N} = 1.7 \; \frac{\text{rad/yr}}{\text{Ci/sec}}$$

therefore:

$$Q_{t_v} \leq 0.33 \frac{1}{(0.82 + 1.1 \times 1.7)}$$

$$Q_{t_v} \leq \underline{1.1 \text{ Ci/sec}}$$

which is the more restrictive limit.

2. Maximum plant vent flow rate = 1.2×10^5 ft^3/min (PSE&G internal memorandum of 6-18-76).

3. Conversion factor = 2.8×10^4 cc/ft^3

4. Sensitivity to Xe-133 = $2.1 \times 10^6 \frac{\text{cpm}}{\text{uCi/cc}}$ (Determined from initial radiological calibration using procedure 1PD 4.3.004).

5. Meter error factor = 0.75 assumes worst case for meter response error of $\pm$ 25% (Radiation Monitoring System Technical Manual).

6. Conversion Factor = 10^6 uCi/Ci.

3.2 Derivations of Setpoints (Cont'd)

7. Conversion factor = 60 sec/min.

Setpoint:

$$\frac{(1.1 \frac{Ci}{sec})(10^6 \frac{uCi}{Ci}) 60 \frac{sec}{min} (2.1 \times 10^6 \frac{cpm}{uCi/cc})(0.75)}{(1.25 \times 10^5 \ ft^3/min)(2.8 \times 10^4 \ cc/ft^3)} = 29,700 \text{ cpm}$$

Therefore choose the nearest major graduation on the meter face of 30,000 cpm

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

1R16 Plant Vent Effluent

Alarm: 500,000 cpm

Basis: The alarm will activate when the concentration reaches the Environmental Tech. Specs. instantaneous release rate limits for noble gases (Salem Environmental Technical Specifications Section 2.3.3.a.1). FSAR Table 11.1-7 is used to determine the fractional noble gas releases.

Calculations:

1. Instantaneous release rate limits for noble gases:

A) $2.0\ (Q_{T_V}\ \overline{K}_V) \leq 1$

where Q_{T_V} = the total noble gas release rate from the plant vent in Ci/sec and K = the average total body dose factor due to gamma emission (Rem/yr per Ci/sec).

Assuming the fractional releases (Q_i) from FSAR Table 11.1-7 and the respective K_{i_V} from Tech. Specs. then:

$$\overline{K}_V = 0.31\ \frac{\text{rem/yr}}{\text{Ci/sec}}$$

$$Q_{t_V} \leq \frac{1}{(2)\ (0.31)}$$

and

B) $0.33\ Q_{T_V}\ (\overline{L} + 1.1\ \overline{N}_V) \leq 1$

where Q_{t_V} = the total noble gas release rate from the plant vent in Ci/sec.

1-R16 Plant Vent Effluent

$\overline{L}_v$ = the average skin dose factor due to beta emissions (rad/yr per Ci/sec).

and $\overline{N}_v$ = the average air dose factor to gamma emissions (rad/yr per Ci/sec)

Assuming the fractional releases (Q_i) from FSAR Table 11.1-7 and the respective L_{iv} and N_{iv} from Tech. Specs then:

$$\overline{L}_v = 0.82 \frac{\text{rem/yr}}{\text{Ci/sec}}$$

and

$$\overline{N}_v = 1.7 \frac{\text{rad/yr}}{\text{Ci/sec}}$$

$$Q_{tv} \leq \frac{1}{0.33\ (0.82 + 1.1 \times 1.7)}$$

$Q_{tv} \leq 1.1$ Ci/sec

which is the more restrictive limit.

2. Maximum plant vent flow rate = 1.25×10^5 ft^3/min (PSE&G internal memorandum of 6-18-76).

3. Conversion factor = 2.8×10^4 cc/ft^3

4. Sensitivity to Xe-133 = $3.6 \times 10^7 \frac{\text{cpm}}{\text{uCi/cc}}$ (Determined from initial radiological calibration by using procedure 1PD 4.3.008).

5. Meter error factor - 0.75 assumes worst case for meter response error of ± 25% (Radiation Monitoring System Technical Manual).

6. Conversion factor 10^6 uCi/Ci.

7. Conversion factor = 60 sec/min.

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

1R16 Plant Vent Effluent

Setpoint:

$$\frac{(1.1\ \frac{Ci}{sec})\ (10^6\ \frac{uCi}{Ci})\ (60\ \frac{sec}{min})\ (3.6x10^7\ \frac{cpm}{uCi/cc})\ (0.75)}{(1.25x10^5\ ft^3/min)\ (2.8x10^4\ cc/ft^3)} = 509{,}000\ cpm$$

Therefore choose the nearest major graduation on the meter face of 500,000 cpm

3.2 Derivations of Setpoints (Cont'd)

1-R18 Liquid Waste Disposal Monitor

Alarm: 800,000 CPM is permissible if and only if MPC_w is greater than 2.5×10^{-5} uCi/cc.

Basis: This device monitors a liquid waste stream before it is diluted by the circulating water and released to the environment. Section 3.11.1.1 of the Tech. Specs. requires that the MPC not be exceeded. The alarm will activate when the concentration through the monitor reaches a value where the resultant concentration in the dilution water will exceed the MPC_w for an historical mixture will be used as an example.

Calculation:

1. MPC_w = weighted MPC where 2.5×10^{-5} uCi/cc is the worst case historical data in Porter Gertz Consultants Technical Report #150 (PGC TR #150).
2. Sensitivity of monitor is $2.9 \times 10^{7} \frac{\text{CPM}}{\text{uCi/cc}}$ as calculated and documented in the original calibration of the R18 detector based on 1PD4.3.001.
3. Flow rate through the liquid radwaste discharge line of 80 GPM.
4. Meter error factor = 0.75 assumes worst case for meter response of ±25% (Radiation monitoring system technical manual).
5. Flow rate of 185,000 GPM assuming operation of one circulating water pump @ full flow. If a procedure is written to assure both circulating water pumps are operating a value of 370,000 GPM may be used (two pumps discharge to a single discharge line).
6. Throttling factor of 2 should be used is the flow rate through the sampler is less than 40 GPM.

Calculate the setpoint as follows:

Setpoint:

$$= MPC_w \frac{\text{(R18 sensitivity)(\#circulators)(circulator flow rate)(meter error)}}{\text{(Pump speed) (throttle error (if any))}}$$

1-R-18 Liquid Waste Disposal Monitor (Cont'd)

Example

$$\frac{(2.5 \times 10^{-5} \frac{uCi}{cc} * (2.9E7 \frac{CPM}{uCi/cc} * (1) * (185,00 \frac{gal}{min}) * .75 + 1.01E6 \text{ CPM}}{80 \frac{gal}{min} * (2)}$$

Select the closest value other than ful scale or 800,000 CPM where MPC_w is calculated as:

$$MPC_w = \frac{1}{\frac{\% A}{MPC_A} + \frac{\% B}{MPC_B} \text{ ....etc.}}$$

Therefore, choose the nearest graduation on the meter face less than the full scale.

3.2 Derivations of Setpoints (Cont'd)

CHANNEL 2R41C Plant Vent (Noble Gas)
INSTRUMENT NO. RA-1.0155-2
LOCATION Elec. Penetration Area Elevation 100, columns C19A C20A
DETECTOR Photomultiplier Tube, Beta Scintillator
INTERLOCKS CONTROLLED Close 2WG41 Valve
LOOP NO. 2

INSTRUMENT RECOMMENDED SETTINGS

CONF = 0.90E0 DDBND = 2.71E2
CTTIM = 3.00E1 FAIL = 0.00E0

HIGH VOLTAGE ADJUSTMENT

Set H.V. (test pt.) to 7.9 volts actual value is 1180 volts or adjust H.V. to obtain either of the following values:

a) 3.2E5 cpm from Co60 source number 237D
b) 1.1E5 cpm from Sr90 source number 237P
c) 1.1E5 cpm from Sr90 source number 2370

ALARM 4.89E05 CPM
WARNING 1.10E04 CPM

ALARM SETPOINT
BASIS: The alarm will activate when the concentration reaches the instantaneous release rate limits for noble gases

The detector utilized is a beta scintillator and is, therefore, more sensitive for beta rays then it is for gamma rays. However, the predominate gaseous isotope is Xe-133 which is a beta and gamma emitter. The dose expression is solved and the most restrictive curie limit discharge limit is selected as the radiation setpoint.

ASSUMPTIONS AND CALCULATIONS

1. The ODCM limits the instaneous release rate for noble gases:

A. The Whole body dose must be less than 0.5 rem as follows:

$$K_V * \quad X/Q * Q_V < 500 \text{ mrem/yr}$$

where Q_V = the total noble gas release rate from the plant vent in Ci/sec and K_V = the average total body dose factor due to gamma emission (mrem/yr per Ci/sec).

$$K_V = 2.94 \text{ E}_{02} \qquad \frac{\text{mrem/yr}}{\text{uCi/m}^3}$$

ASSUMPTIONS AND CALCULATIONS: (Cont'd) 2R41C

then:

Q_v < 0.77 Ci/sec

and

B. The Skin dose must be less than 3 rem as follows:

$$[L \; +1.1 \; M] \; X/Q < 3000 \text{ mrem/yr}$$

L_v = the average skin dose factor due to beta emissions (mrad/yr) per uCi/m^3

and M_v = the average air dose factor to gamma emissions (mrad/yr per uCi/m^3)

For Xe-133 the dose factors are as follows:

$$L_v = 3.06E02 \; \frac{mrem/yr}{uCi/m^3}$$

and

$$M_v = 3.53E02 \; \frac{mrad/yr}{uCi/m^3}$$

$$Qv < \frac{3000}{[3.06E02 + (1.1)\;(3.53E02)]^*\;[2.2E-6]}$$

therefore:

Qv < 1.96 Ci/sec

0.77 Ci/sec is more restrictive limit than the 1.96 Ci/sec.

2. Maximum plant vent flow rate = 1.25×10^5 ft^3/min (PSE&G internal memorandum of 6-18-76)

3. Conversion factor = 2.8×10^4 cc/ft^3

4. Sensitivity to ^{133}Xe = 3.75×10^7 $\frac{cpm}{uCi/cc}$ (Determined from initial radiological calibration by using Victoreen procedure AT-65 on 12/12/78 with 3.39×10^{-2} uCi/cc of Xe-133.)

5. Conversion factor = 10^6 uCi/Ci.

6. Conversion factor = 60 sec/min

7. X/Q = 2.2E-6 sec/m^3 which is the historical highest calculated annual average relative concentration. (USNRC, SER SNGS - Unit 2)

8. In sampler background = 20 cpm (Victoreen procedure AT-65).

Setpoint: Alarm

$$\frac{(0.77\ \frac{Ci}{sec})\ (10^6\ \frac{uCi}{Ci})\ (60\ \frac{sec}{min})\ (3.75x10^7)}{(1.25x10^5\ ft^3/min)\ (2.832x10x^4\ cc/ft^3)} = 489,407\ cpm$$

Therefore, dial in a septoint of 4.89E05 cpm

WARNING SETPOINT

BASIS: The alarm will activate when the concentration reaches a fraction of the Technical Specifications quarterly release rate limits for noble gases. The alarm/trip setpoint will be set to prevent the air dose from gaseous effluents form exceeding 5 mrad due to gamma emitters and 10 mrad from beta emitters during any calendar quarter from each reactor at the site.

$$(1/3.15E7) * M * \frac{X}{Q} * Q < 5\frac{mrad}{quarter}\ (\text{equivalent to } 10\frac{mrad}{yr})$$

$$(1/3.15E7) * N * \frac{X}{Q} * Q < 10\underline{mrad}\ (\text{equivalent to } 40\frac{mrad}{yr})$$

where M, N, $\frac{X}{Q}$ and Q are defined in the ODCM

By solving for Q and dividing by the number of seconds in a calendar quarter it may be proven that the average release rate of Xe-133 must be less than 1.73E-2 Ci/sec for each reactor at the site.

Setpoint: Warning

$$\frac{(1.73x\ 10^{-2}Ci/sec)\ 10^6\ uCi/Ci)\ (60\ sec/min)\ 3.75x10^7\ \frac{cpm}{uCi/cc}}{(1.25x10^5\ ft\ ^3/min)\ (2.832x10^4\ cc/ft^3)} = 10,996\ cpm$$

Therefore, dial in a setpoint of 1.10E04 cpm

3.2 Derivations of Setpoints (Cont'd)

CHANNEL 2R16 Plant Vent (Gross)
INSTRUMENT NO. RA-8346-2
LOCATION Plant Vent Elevation 195
DETECTOR Photomultiplier Tube, Beta Scintillator
INTERLOCKS CONTROLLED None
LOOP NO. 4

INSTRUMENT RECOMMENDED SETTINGS

CONF = 0.90E0 DDBND = 1.41E3
CTTIM = 3.00E1 FAIL = 0.00E0

HIGH VOLTAGE ADJUSTMENT

Set H.V. (test pt.) to 9.7 volts or adjust H.V. to obtain either of the following values:

a) 3.2E5 cpm from Co60 source number 237D
b) 1.1E5 cpm from Sr90 source number 237P
c) 1.1E5 cpm from Sr90 source number 237O

ALARM 4.57E05 CPM
WARNING 1.03E04 CPM

ALARM SETPOINT
BASIS: The alarm will activate when the concentration reaches the instantaneous release rate limits for noble gases

The detector utilized is a beta scintillator and is, therefore, more sensitive for beta rays then it is for gamma rays. However, the predominate gaseous isotope is Xe-133 which is a beta and gamma emitter. The dose expression is solved and the most restrictive curie limit discharge limit is selected as the radiation setpoint.

ASSUMPTIONS AND CALCULATIONS

1. The ODCM limits the instaneous release rate for noble gases:

   A. The whole body dose must be less than 0.5 rem as follows:

   $$Kv * X/Q * Qv < 500 \text{ mrem/yr}$$

   where Q_v = the total noble gas release rate from the plant vent in Ci/sec and K_v = the average total body dose factor due to gamma emission (mrem/yr per Ci/sec).

   $$K_v = 2.94 \text{ E}_{02} \; \frac{\text{mrem/yr}}{\text{uCi/m}^3}$$

then:

$Q_V < 0.77$ ci/sec

and

B. The skin dose must be less than 3 rem as follows:
[L +1.1 M] X/Q < 3000 mrem/yr

L_V = the average skin dose factor due to beta emissions (mrad/yr) per uCi/m^3

and M_V = the average air dose factor to gamma emissions (mrad/yr per uCi/m^3

For Xe-133 the dose factors are as follows:

$$L_V = 3.06E02 \quad \frac{\text{mrem/yr}}{\text{uCI/sec/m}^3}$$

and

$$M^V = 3.53E02 \frac{\text{mrad/yr}}{\text{uCi/m}^3}$$

$$Qv < \frac{3000}{[3.06E02 + (1.1)\ (3.53E02)]*[2.2E-6]}$$

therefore:

$$Qv < \underline{1.96\ \text{Ci/sec}}$$

0.77 Ci/sec is a more restrictive limit than the 1.96 Ci/sec.

2. Maximum plant vent flow rate = 1.25×10^5 ft^3/min (PSE&G internal memorandum of 6-18-76)

3. Conversion factor = 2.8×10^4 cc/ft^3

4. Sensitivity to $^{133}Xe = 3.50 \times 10^7 \frac{\text{cpm}}{\text{uCi/cc}}$
(Determined from initial radiological calibation by using Victoreen procedure AT-65 on 12/12/78 with 3.39×10^{-2} uCi/cc of Xe-133.)

5. Conversion factor = 10^6 uCi/Ci.

6. Conversion factor = 60 sec/min

7. X/Q = 2.2E-6 sec/m^3 which is the historical highest calculated annual average relative concentration.

8. In sampler background = 22 cpm (Victoreen Procedure AT-65).

ASSUMPTIONS AND CALCULATIONS: (Cont'd) 2R16

Setpoint: Alarm

$$\frac{(0.77\ \frac{Ci}{sec})(10^6\ \frac{uCi}{Ci})(60\ \frac{sec}{min})(3.50x10^7)}{(1.25x10^5\ ft^3/min)\ (2.832x10^4\ cc/ft^3)} = 773,915\ cpm$$

Therefore, dial in a setpoint of 4.57E05 cpm

WARNING SETPOINT
BASIS: The alarm will activate when the concentration reaches a fraction of the Technical Specifications quarterly release rate limits for noble gases. The alarm/trip setpoint will be set to prevent the air dose from gaseous effluents from exceeding 5 mrad due to gamma emitters and 10 mrad from beta emitters during any calendar quarter from each reactor at the site.

$$(1/3.15E7) * M * \frac{X}{Q} * Q < 5\frac{mrad}{quarter}\ \text{(equivalent to } 10\frac{mrad}{yr})$$

$$(1/3.15\#7) * N * \frac{X}{Q} * Q < 10\underline{mrad}\ \text{(equivalent to } 40\frac{mrad}{yr})$$

where M, N, $\frac{X}{Q}$ and Q are defined in the ODCM

By solving for Q and dividing by the number of seconds in a calendar quarter, it may be proven that the average release rate of Xe-133 must be less than 1.73E-2 Ci/sec for each reactor at the site.

Setpoint: Warning

$$\frac{(1.7x10^{-2} Ci/sec)\ (10^6\ uCi/Ci\ \ (60\ sec/min)\ 3.50x10^7\ \frac{cpm}{uCi/cc}}{(1.25x10^5\ ft\ 3/min)\ (2.832x10^4\ cc/ft^3)} = 17,388$$

Therefore dial in a setpoint of 1.03E04 cpm

3.0 RADIATION MONITORING INSTRUMENTATION

3.2 Derivations of Setpoints (Cont'd)

CHANNEL 2R18 Liquid Waste Disposal
INSTRUMENT NO. RA-4335-2
LOCATION Auxiliary Building 86, 14.8/TT
DETECTOR Photomultiplier Tube, Gamma Scintillator
INTERLOCKS CONTROLLED Close valve 2WL41
Loop No. 5

INSTRUMENT RECOMMENDED SETTINGS

CONF =	0.90E0	DNBND =	3.69E2
CTTM =	3.00E1	FAIL =	0.00E0

HIGH VOLTAGE ADJUSTMENT

Set H.V. (test pt) to 6.2 volts or adjust H.V. to obtain any of the following values:

a) 1.9E5 cpm from Ba 133 source number 237J
b) 1.6E5 cpm from Cs 137 source number 237L
c) 1.6E5 cpm from Cs 137 source number 237M

ALARM 4.08E04 cpm
WARNING 2.05E04 cpm

Alarm Basis: This device monitors liquid waste streams before they are diluted by the circulating water and released to the environment. The ODCM requires that the MPCw not be exceeded. The alarm will activate when the concentration through the monitor reaches a value where the resultant concentration in the dilution water will exceed the MPCw. The MPCw for an unidentified mixture will be used for conservatism.

Assumptions and Calculation:

1. MPCw = $1x10^{7}$ uCi/cc for unidentified isotopes (10 CFR 20, Appendix B, Table 2).

2. Sensitivity to Co60 = $1.69x10^{8}$ cpm/uCi/cc
   Sensitivity to Cs-137 = $8.83x10^{7}$ cpm uCi/cc (determined from initial radiological calibration by using Victoreen Procedure AT-64 on 12/4/78 with 1.07 x 10^{-2} uCi/cc of each isotope.

3. Maximum (present) flow rate through pathway = 80 GPM (PSE&G internal memorandum of 6/18/76).

4. Flow rate of dilution water = 370,000 GPM (Page Q-11.3-1 of the FSAR states there will be a dilution flow of 740,000 GPM. As a conservative assumption, only half of the dilution flow was considered).

2R18 (Cont'd)

a) Conversion factor = 3.8×10^3 cc/gal
b) Conversion factor = 1.31×10^5 min/quarter
c) Conversion factor = 10^6 Ci/uCI

6. Sampler background = 60 cpm (C_b) Initial background as determined by Victoreen Instrument Corporation in channel 2R35, subsequent backgrounds may be higher as the sampler becomes contaminated.

Setpoint: Alarm

$$\frac{(1\times10^{-7}\ \text{uCi/cc})\ (8.83\times10^{7}\ \frac{\text{cpm}}{\text{uCi/cc}})\ (370{,}000\ \text{GPM})}{80\ \text{GPM}} + C_b = 40{,}839\ \text{cpm} + C_b$$

Therefore dial in a setpoint of 4.08E04 cpm

Warning
Basis: Warning will activate when the liquid activity concentration exceeds 1/2 the MPC of an unidentified liquid.

Setpoint: Warning

$$\frac{(1/2)\ (1\times10^{-7}\ \text{uCi/cc}\ 8.8^{3}\times10^{7}\ \frac{\text{cpm}}{\text{uCi/cc}})\ (3.70\times10^{5}\ \text{GPM})}{80\ \text{gpm}} + C_b =$$

Therefore, dial in a setpoint of 2.05E04 cpm

NOTE: 1) If the MPC is known to be higher than 1×10^7 then the alarm trip setpoint may be raised higher by a factor of $\frac{\text{MPC(actual)}}{1\times10^{-7}\text{uCi/cc}}$

2) If the flow rate through the pathway is 200 GPM then the setpoint should be diminished by a factor of $\frac{80\ \text{GPM}}{200\ \text{GPM}}$

4.0 LIQUID EFFLUENTS

5.1 Limits or Restrictions

The dose to air at the site boundary should be limited in accordance with 10CFR20, 10CFR50 Appendix I and 40 CFR190 such that:

4.1.1 During any instant release activities must be maintainedd below the concentrations of 10CFR20.106.

4.1.2 During any calendar quarter (Jan.-Mar., April-June, July-Sept., Oct.-Dec.) the dose delivered shall be less than 1.5 mrem to the whole body and less than 5 mrem to any organ from each reactor.

4.1.3 During any calendar year (Jan. 1-Dec. 31) the dose delivered shall be less than 3 mrem to the whole body and less than 10 mrem to any organ from each reactor.

The values above are to be treated as limits. However, if the calculatd dose from the release of radioactve materials in noble gaseous effluents exceeds the limits described above, prepare and submit a Special Report (not an LER) to the Commission pursuant to Specification 6.9.2 of the SNGS-TS and limit the subsequent releases such that the dose or dose commitment to a real individual from all uranium fuel cycle sources is $\leq$ 25 mrem (except to the thyroid, which is limited to $\leq$ 75 mrem) over 12 consecutive months from all reactors.

Table 4.1.1
Summary of Limits

Dose to	Calendar Quarter	Calendar Year	12 Consecutive Months*
Whole Body	1.5 mrem	3 mrem	25 mrem
Organ	5.0 mrem	10 mrem	75 mrem

*The EPA 12 month values includes liquids, gases and direct radiation and apply to all reactors at the site. All other values apply to each nuclear unit.

4.0 LIQUID EFFLUENTS (Cont'd)

4.2 Dose Calculations

4.2.1 The dose from liquids shall be estimated at least once every 31 days for each unit while releases are being made.

4.2.2 The dose shall include liquid radioactive discharges from the station and shall be classified as either a batch or continuous releases. This does not include isotopes below MDL or isotopes identified in composites analysis or isotopes with very short decay times.

4.2.2.1 Batch Release includes:

i) Waste Monitoring Tanks

ii) Laundry and Hot Shower Tanks

iii) Chemical Drain Tanks

iv) Chemical Volume Control CVC CVC Tanks

v) Waste Hold-up (monitor) Tank

vi) Waste Hold-up Tanks

vii) Abnormal Releases

4.2.2.2 Continuous Releases include:

i) Intermittent Steam Generator Blowdown

4.2.3 The dose contribution for each radionuclides identified in liquid effluents released to unrestricted areas will be calculated using equations which follow for the purpose of demonstration compliance with the Technical Specifications. For submitting 6 month effluent release reports, additional pathways will be included and minor differences in the calculated doses may arise due to the inclusion of these additional dose contributors and the inclusion of isotopes which are only available several weeks after the individual releases have taken place.

4.0 LIQUID EFFLUENTS (Cont'd)

4.3 Dose Equation

eq 1) D = A * t * C * (DU)

where

D = is the total dose (to the body or to any organ.

A = a total dose conversion factor (See eq. 2 (mrem/hr per uCi/cc)

t = the time over which the C and F terms are averaged (hours)

C = the average concentration at the point of discharge isotope (uCi/cc see instruction 4.3.3 on Pg. 4.4.

DU = dose uncertainty factor = 1.25 (see instruction 6)

The composite dose coversion factor actually consists of the impact of each isotope to an individual due to the fish consumption and the consumption of crabs, oysters, and clams. The equation for the dose conversion factor (A) may be written as:

eq 2) A = 1.14E5 (21 BF + BI) DF

where

BF = the bioaccumulation factor for a nuclide in the fish as taken from Reg. Guide 1.109 (salt water) (pCi/kg per pCi/l)

BI = the bioaccumulation factor for a nuclide in invertebrates as taken from Reg. Guide 1.109 (salt water - pCi/kg per pCi/l)

21 = the # of kilograms of fish which an adult may consume in a year.

5 = the # of kilograms of clams, oysters and invertebrates which an adult may consume in a year.

The A factor is supplied for isotopes and is listed as Table. 4.1. The BF, BI and DF factors to calculate the A factor was taken from Reg. Guide 1.109. Our site is nota fresh water site, therefore, the Uw or Dw terms were not necessary.

INSTRUCTIONS FOR CALCULATING RADIATION DOSE FROM LIQUID EFFLUENTS

4.3.1 Determine the isotopes released. The station technical specifications describe which isotopes must be monitored and also describe detection limits which are used for dose calculations. Post-release isotopic analyses are used for dose calculations. Post-release isotopic analyses such as strontium analyses will not be included.

4.3.2 Locate the dose conversion factor (A) for each isotope using Table 4.1.

4.3.3 Determine the average concentration of the release (C) at the discharge point by taking into account all dilution. An average concentration is merely equal to the total number of microcuries discharged over the total amount of fluid discharged.

4.3.4 Multiply the A, C, and the duration of the release(t).

4.3.5 The value obtained is the official estimate of the total dose received by a member of the public who consumes these aquatic foods at the rate specified.

4.3.6 For purpose of complying with 10CFR50 Appendix I yearly dose limits and, since post-release analyses may cause the dose estimated in step 5 to be non-conservative, a dose uncertainty factor of 25% is added. Doses are, therefore, multiplied by a factor of 1.25.

4.4 Operation of Radwaste Equipment

If during any calendar quarter the whole body or organ dose exceeds 0.375 mrem or 1.25 mrem respectfully, then the liquid radwaste system will be operated.

TABLE 4.1

LIQUID EFFLUENT INGESTION DOSE FACTORS*

Radionuclide	A_i Dose or Dose Commitment Factors (mrem-ml per hr-uCi) Total Body	Critical Organs
H-3	2.8E-1	2.8E-1
P-32	6.4E+5	1.9E+6
Cr-51	5.6E+0	1.4E+3
Mn-54	1.4E+3	2.2E+4
Fe-55	8.2E+3	5.11E+4
Fe-59	7.3E+4	6.3E+5
Co-58	1.4E+3	1.2E+4
Co-60	3.8E+3	3.3E+4
Zn-65	2.3E+5	5.1E+5
Rb-86	2.9E+2	6.2E+2
Sr-89	1.4E+2	5.0E+3
Sr-90	3.0E+4	1.2E+5
Y-91	2.4E+0	4.9E+4
Zr-95	3.5E0	1.6E+4
Zr-97	8.1E-2	5.5E+4
Nb-95	1.3E+2	1.5E+6
Mo-99	2.4E+1	3.0E+2
Ru-103	4.6E+1	1.2E+4
Ru-106	2.0E+2	1.0E+5
Ag-110m	N/A	N/A
Sb-124	N/A	N/A
Sb-125	N/A	N/A
Te-125m	2.9E+1	8.8E+2
Te-127m	6.7E+1	2.2E+3
Te-129m	1.5E+2	4.7E+3
Te-131m	5.7E+1	6.8E+3
Te-132	1.2E+2	6.2E+3
I-131	1.8E+2	1.0E+5
I-133	3.9E+1	1.9E+4
Cs-134	1.3E+4	1.6E+4
Cs-136	2.0E+3	2.8E+3
Cs-137	7.9E+3	1.2E+4
Ba-140	1.1E+2	3.4E+3
La-140	2.1E-1	5.8E+4
Ce-141	2.6E-1	8.9E+3
Ce-143	4.9E-2	1.7E+4
Ce-144	9.6E0	6.0E+4
Np-239	1.9E-3	7.1E+2

*The listed dose factors are for radionuclides that may be detected in liquid effluents.

5.0 GASEOUS EFFLUENTS (NOBLE GASES)

5.1 Limits or Restrictions

The dose to air at the site boundary should be limited in accordance with 10CFR20, 10CFR50 Appendix I and 40 CFR190 such that:

5.1.1 During any instant release activities must be maintained below the concentrations of 10CFR20.106.

5.1.2 During any calendar quarter (Jan.-Mar., April-June, July-Sept., Oct.-Dec.) the dose delivered to air shall be less than 5 mrads and 10 mrads from gamma and beta radiation respectively from each reactor.

5.1.3 During any calendar year (Jan. 1-Dec. 31) the dose delivered shall be less than 10 mrads and 20 mrads from gamma and beta radiatin respectively from each reactor.

The values above are to be treated as limits. However, if the calculatd dose from the release of radioactve materials in noble gaseous effluents exceeds the limits described above, prepare and submit a Special Report (not an LER) to the Commission pursuant to Specification 6.9.2 of the SNGS-TS.

Table 5.1.1

Summary Air Dose Limits

Air Dose From	Calendar Quarter	Calendar Year
Gamma Rays	5 mrads	10 mrads
Beta Rays	10 mrads	20 mrads

5.0 GASEOUS EFFLUENTS - NOBLE GASES (CONT'D)

5.2 General Guidance on Dose Calculations

5.2.1 The dose from gases shall be estimated at least once every 31 days for each unit while releases are being made.

5.2.2 The dose shall include all gaseous radioactive discharges from the station. Isotopes identified as MDL or LLD are treated as numerically equal to zero.

5.2.2.1 Release Points includes but are not limited to the following locations:

i) Waste Gas Decay Tanks

ii) Containment Purges

5.2.3 The dose contribution for each radionuclides identified in gaseous effluents released to unrestricted areas will be calculated using equations which follow for the purpose of demonstration compliance with the Technical Specifications. For submitting 6 month effluent release reports, additional pathways will be included and minor differences in the calculated doses may arise due to the inclusion of these additional dose contributors and the inclusion of isotopes which are only available several weeks after the individual releases have taken place.

5.3 Dose Equations

5.3.1 In order to calculate the dose from Gamma Rays of noble gases, use the following equation:

$$D_G = 3.17E-8 * M_i * \frac{X}{Q} * Q_i * DU$$

5.3.2 In order to calculate the dose from beta rays of noble gases, use the following equation:

$$D_B = 3.17E-8 * N_i * \frac{X}{Q} * Q_i * DU$$

5.3.3 In order to further protect the public from exposure to noble gases, the release rate must be restricted as provided in specification 3.11.2.1.

Table 5.3.1)

Summary Release Rate Limits

To Protect	Limit Dose Rate To
Whole Body	500 mrem/yr
Skin	3,000 mrem/yr

5.3.4 The equations to use are as follows:

$$K_i * \left(\frac{X}{Q}\right) * \dot{Q} < 3000 \text{ mrem/yr}$$

$$(L_i + 1.1M_i) * \left(\frac{X}{Q}\right) * \dot{Q}_i < 3000 \text{ mrem/yr}$$

where $\dot{Q}_i$ = curies per second

Therefore, don't release a gas decay tank containing noble gases so rapid that it causes a release rate in excess of the values above.

Note:

The factors K_i, L_i, M_i, and N_i relate the radionuclide airborne concentrations to various dose rates assuming a semi-infinite cloud. These factors may be taken directly from Table B-1, of the Regulatory Guide 1.109 (Ref. 6), if the values therein are multiplied by 10^6 to convert piocuries to microcuries as used in the above equations.

5.0 GASEOUS EFFLUENTS - NOBLE GASES (CONT'D)

5.4 Instructions For Demonstrating Noble Gases Releases are Within Limits

A recommended scheme for determining compliance or airborne releases is presented below. The use of a digital computer will greatly simplify this determination.

1) Determining isotopic composition of noble gases discharged in uCi/cc or equivalent. Using equations in 5.3.4 determine the release rate requirements.

2) Using Table 5.0 which lists the dose conversion factors locate the K, L, M, and N terms for each individual isotope of interest. In addition, let the DU Term equal a dose uncertainty factor of 1.25.

3) Use the "Chi over Q (X /Q) term of 2.2E-6 sec/m^3 which is the historical highest calculated annual average relative concentration according to Supplement 3 USNRC Salem Nuclear Generating Station Safety Evaluation Report.

4) Determine the total number of microcuries (Q_i).

5) Substitute the L, K, M, N, and Q terms into the equations provided.

6.0 IODINES, PARTICULATES AND NON-NOBLE GAS AEROSOLS

6.1. Limits or Restrictions

In order to protect the public from exposure to radioactive aerosols, radioiodines, particulates and other non-noble gases with half-lives greater than 8 days, releases should be limited in accordance with 10CFR20, 10CFR50 Appendix I and 40CFR190 such that:

6.1.1 During any instant release activities must be maintained below the concentrations of 10CFR20.106.

6.1.2 During any calendar quarter (Jan.-Mar., April-June, July-Sept., Oct.-Dec.) the dose delivered shall be less than 7.5 mrem to any organ from each reactor.

6.1.3 During any calendar year (Jan. 1-Dec. 31) the dose delivered shall be less than 15 mrem to any organ from each reactor.

The values above are to be treated as limits. However, if the calculated dose from the release of radioactive materials in liquid effluents exceeds the limits described above, prepare and submit a Special Report (not an LER) to the Commission pursuant to Specification 6.9.2 of the SNGS-TS and limit the subsequent releases such that the dose or dose commitment to a real individual from all uranium fuel cycle sources is $\leq$ 25 mrem (except to the thyroid, which is limited to $\leq$ 75 mrem) over 12 consecutive months from all reactors.

6.0 IODINES, PARTICULATES AND NON-NOBLE GAS AEROSOLS (Cont'd)

The release limitations are summarized below.

Table 6.1.1
Summary Airborne Iodines, Non-Noble Gases
and Particulate Limits

Dose To	Calendar Quarter	Calendar Quarter	12 Consecutive Months
Any Organ	7.5 mrem	15 mrem	75 mrem

NOTES:

a) The EPA 12 month values apply to all reactors at the site. All other values apply to each nuclear unit. The EPA limits include liquids and gases.

6.2 General Guidance on Dose Calculations

6.2.2 The dose shall be calculated for all gaseous release points. The guidance supplied in Section 5.2 also applies to section 6.2

6.0 IODINES, PARTICULATES AND NON-NOBLE GAS AEROSOLS (Cont'd)

6.3 Dose Equations

6.3.1 The dose to the public from radioiodine, particulates and non-noble gases with half-lives greater than 8 days shall be determined to be the sum of the terms which follows. This analysis assumes that the public drinks milk from the closest dairy farm and also breathes the air at this same location.

$$D_T = 3.17 \times 10^{-8} * Ri*(W_H + W_G)*Qi*DU$$

Where Du is the dose uncertainty factor of 1.25. If operating experience indicates that the Du factor is not conservative, then it will be changed.

6.3.2 For the direction sectors with existing pathways within 5 miles from the unit, use the values R_i for those pathways. If no real pathway exists within 5 miles from the center of the building complex, use the cow-milk R_i assuming that this pathway exists at the 4.5 to 5.0 mile distance in the worst sector. If the R_i for an existing pathway within 5 miles is less than a cow-milk R_i at 4.5 to 5.0 miles, then use the value of the cow-milk R_i at 4.5. to 5.0 miles. The pathway values used for calculating dose contributions shall be consistent with the results of the land use census performed pursuant to Specification 3.12.2. The controlling value of R_i for each radionuclide is determined and provided in tabular form in this ODCM as Table 5.1. The parameters W corresponds to the applicable pathway location and are subject to change. The Licensing and Environment Department will determine if the values of W need to be altered.

6.0 IODINES, PARTICULATES AND NON-NOBLE GAS AEROSOLS (Cont'd)

6.3.3 The release rate of radioactive iodines and particulates must be restricted as provided in Specification 3.11.2.1

Table 6.3.1
Summary Dose Rate Limits

To Protect	Limit Dose Rate To
Any organ or thyroid	1,500 mrem

6.3.4 The equation to use is as follows:

$R_i \, W \, \dot{Q} < 1500$ mrem/yr

assuming all I 131 then $\dot{Q} = 6.5$ uCi/sec

Therefore don't release a gas decay tank such that the resulting dose rates exceed the values above. This is achieved by keeping $\dot{Q}$ under 6.5 uCi/sec

6.4 Instructions for Demonstrating Iodines, Particulates and Non-noble Gases are Within Limits

6.4.1 Determining isotopic composition of the various iodines particulates and other non noble gases discharged with half lives > 8 days (uCi/cc or equivalent).

6.4.2 Using Table 5.1 which lists the conversion factors locate the "Ri" term for each individual isotope of interest.

6.4.3 For the "W_H" and "W_G" terms use 5.4E-8 sec/m^3 and 2.1E-10/m^2 which is the historical X/Q and D/Q relative concentration in the NNE sector according to Supplement 3 to the Safety Evaluation Report of the SNGS.

6.4.4 Determine the total microcuries discharged over the reporting period.

6.4.5 Substitute the R, W, and Q terms into the equations provided.

6.5 Operating of Radwaste Equipment

6.5.1 If the calculated dose exceeds 1.25 mrad for gamma radiation and 2.5 mrad for beta radiation during any calendar quarter, then the gaseous radwaste treatment system shall be operated.

6.5.2 To account for the isotopes which may not be identified until after the release has been made, a dose uncertainty factor of 25% of the applicable limit has been added. If operating experience indicates that the 25% factor is not conservative, then the dose uncertainty factor will be changed.

6.5.3 The following are gaseous radioactive waste management systems for which credit may be taken:

i) Waste hold-up for decay

ii) Iodine and particulate filtration

The following are not gaseous radwaste management systems:

i) Engineering Safety features such as internal atmosphere

ii) Elevated vents

TABLE 5.0

DOSE FACTORS FOR NOBLE GASES AND DAUGHTERS*

Radionuclide	Total Body Dose Factor K_i (mrem/yr per μCi/m^3)	Skin Dose Factor L_i (mrem/yr per μCi/m^3)	Gamma Air Dose Factor M_i (mrad/yr per μCi/m^3)	Beta Air Dose Factor N_i (mrad/yr per μCi/m^3)
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

*The listed dose factors are for radionuclides that may be detected in gaseous effluents.
**7.56E-02 = 7.56×10^{-2}.

TABLE 5.1

DOSE PARAMETERS FOR RADIOIODINES AND RADIOACTIVE PARTICULATE, GASEOUS EFFLUENTS*

Radionuclide	P_i Inhalation Pathway (mrem/yr per µCi/m^3)	R_i Milk & Ground Pathways (m^2. mrem/yr per uCi/sec)	Radionuclide	P_i Inhalation Pathway (mrem/yr per µCi/m^3)	R_i Milk & Ground Pathways (m^2. mrem/yr per uCi/sec)
H-3	6.5E+02	2.4E+03	Cd-115m	7.0E+04	4.8E+07
P-32	2.0E+06	1.5E+11	Sn-123	2.9E+05	3.4E+09
Mn-54	2.5E+04	1.1E+09	Sn-126	1.2E+06	1.1E+09
Fe-59	2.4E+04	7.0E+08	Sb-124	5.9E+04	1.1E+09
Co-58	1.1E+04	5.7E+08	Sb-125	1.5E+04	1.1E+09
Co-60	3.2E+04	4.6E+09	Te-127m	3.8E+04	7.4E+10
Zn-65	6.3E+04	1.7E+10	Te-129m	3.2E+04	1.3E+09
Rb-86	1.9E+05	1.6E+10	Cs-134	7.0E+05	5.3E+10
Sr-89	4.0E+05	1.0E+10	Cs-136	1.3E+05	5.4E+09
Sr-90	4.1E+07	9.5E+10	Cs-137	6.1E+05	4.7E+10
Y-91	7.0E+04	1.9E+09	Ba-140	5.6E+04	2.4E+08
Zr-95	2.2E+04	3.5E+08	Ce-141	2.2E+04	8.7E+07
Nb-95	1.3E+04	3.6E+08	Ce-144	1.5E+05	6.5E+08
Ru-103	1.6E+04	3.4E+10	I-131	1.5E+07	1.1E+12
Ru-106	1.6E+05	4.4E+11	I-133	3.6E+06	9.6E+09
Ag-110m	3.3E+04	1.5E+10			

*The listed dose parameters are for radionuclides that may be detected in gaseous effluents.