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INDIAN POINT 3

OFFSITE DOSE CALCULATION MANUAL

Revision 3, February 1986

ODCM

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1.0 INSTRUMENTATION AND SYSTEM

1.1 Effluent Monitoring System Description

Effluent monitor information is provided in Table 1-1, including an indication of which monitors use effluent set points. Figures 5-1 and 5-2 show a schematic of the possible radioactive release points with monitor locations for gaseous and liquid pathways respectively.

1.2 Setpoints

This section provides equations and methodology used for each alarm and trip set point on each effluent release point according to Specifications 2.1 and 2.2.

1.2.1 Set Points for Gaseous Effluent Monitors

Set points for gaseous monitors are based on the permissible discharge rate as calculated in section 3.4 of this ODCM. The most restrictive set points (based on annual average dose limit) should be used if practical. If not practical and with the concurrence of the Shift Supervisor and/or Superintendent of Power, as appropriate, points man be used. (per Reference 10, AP-11). All but the computer-generated set points are based on the following permissible discharge rates:

Permissible Discharge Rate (Ci/sec)

Basis of Limit	Iodine/ Particulate*	Noble Gases
Annual Average*	3.3E-8	5.06E-4
Quarterly Average **	6.5E-8	1.01E-3
Instantaneous (Tech Spec 2.4.1)	2.2E-6	1.63E-2

3

* Half-lives greater than 8 days.

** These limits are not part of the Tech Spec requirement 2.4.1, but are included for information, as these limits are used for operational control of releases.

The noble gas limits are based on an isotopic mix as described in Table 3.10.

The generic equation for determining an alarm set point is as follows:

$$S = \frac{(D)}{(E)\ (F)\ (4.72\ E\text{-}4)}$$

Where: S = Alarm set point (cpm)
D = permissible discharge rate (Ci/sec)
E = Monitor Calibration Factor $\frac{(uCi/cc)}{cpm}$
F = Vent duct flow rate (ft^3/min)
4.72×10^{-4} = conversion factor to convert from $\frac{uCi}{cc}$ $\frac{Ft^3}{min.}$ to Ci/sec

The computer-generated set points are determined by calculating the instantaneous dose rates based on the actual nuclide mix. During normal operation without a primary to secondary leak, the only release point is the Unit 3 main plant vent. However, in the event of a leak, the blowdown flash tank and the condenser air ejector would also be release points. In that case, the total discharge rate for all release points must remain less than the permissible discharge rate. Alarm set points would be reduced accordingly, depending on the fraction of the permissible discharge rate allowed to be released from each release point.

1.2.2 Set Points for Liquid Effluent Monitors

Liquid Effluent Monitors R18 and R19 have set points based on limiting the concentrations in the discharge canal to the levels listed in 10 CFR 20 Appendix B, Table 2, Column 2. The set points are calculated based on the following equation:

$$S = \frac{(MPCw) \quad (F)}{E \times f}$$

S = Set points on monitor (cpm)

MPCw = Maximum Permissible Concentration (uCi/cc) for isotopic mixture being released per 10 CFR 20, Appendix B, Table 2, Column 2. This will be calculated for each release.

F = Available Dilution Flow in Discharge Canal (gpm)

f = Release Discharge Rate (gpm)

E = Calibration Factor of monitor $\frac{(uCi/cc)}{cpm}$

TABLE 1-1

EFFLUENT MONITORING SYSTEM DATA

CHANNEL	MONITOR DESCRIPTION	SAMPLING LOCATIONS	RANGE	CONTROL FUNCTIONS	ALARM SET POINT USED *
R-12 G	Containment Gas Monitor	Samples drawn from Containment Fan Coolers #'s 32 and 35	$0-10^6$ cpm	Containment Ventilation Isolation	Yes
R-14 G	Plant Vent Radiogas Monitor	In-plant vent at approximately 105' elevation	$0-10^6$ cpm $0-10^{-3}$ (uCi/cc) (typical)	Secures waste gas tank release.	Yes
R-27** G	Plant Vent Wide-Range Monitor	In-plant vent	$10^{-7}-10^{+5}$ (uCi/cc)	None	Yes
R-15 G	Condenser Air Ejector Monitor	In-line detector on the air ejector exhaust header	$0-10^6$ cpm	On alarm diverts air ejector flow to VC, flash evaporator shut down, steam to condense priming ejector flow stopped.	No
R-20 G	Waste Gas Disposal System Monitor	15' PAB - Waste Gas Tank	$0-10^5$ mR/hr.	None	No
R-46 G	Administration Building Vent Radiogas Monitor	4th Floor Administration Building Monitor Exhaust Plenum for Controlled Areas	$0-10^6$ cpm	None	Yes
R-59 G	RAMS Building Vent Radiogas Monitor	55' RAMS Building Monitor Exhaust Plenum	$0-10^6$ cpm	None	Yes
R-16 or R-23 L	Fan Cooler Service Water Activity	Service Water chase across from Mini-Containment	$10-10^6$ cpm	None	Yes
R-17A or R-17B L	Component Cooling Water Activity	41' PAB in component cooling water header	$10-10^6$ cpm	Isolates Surge Tank Vents from atmosphere.	No
R-18 L	Waste Disposal Liquid Effluent Monitor	55' PAB Waste Condensate Room monitors liquid waste discharge	$0-10^6$ cpm	Stops release on alarm.	Yes
R-19 L	S/G Samples Blowdown Monitor	PAB blowdown room monitors steam generator blowdown	$0-10^6$ cpm	Closes blowdown isolation valve.	Yes

3

* Alarm setpoint used for effluent considerations.

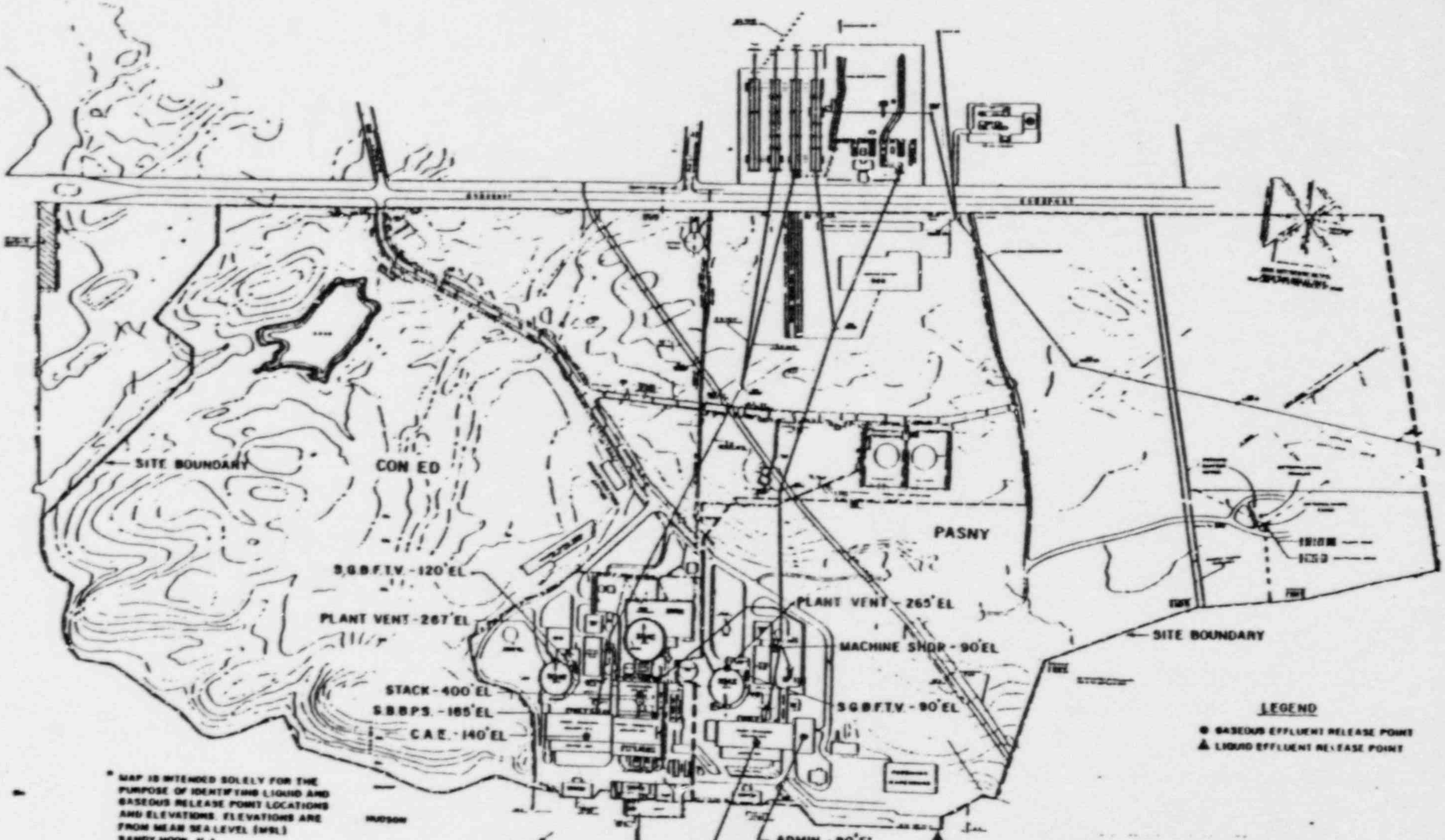
** If available, (R-14 or R-27 must be operating).

G = Gaseous

NOTE ON RANGE OF MONITORS:
Maximum release rate that can be detected onscale by the detector (Ci/sec.) is based on the maximum readout range of the detector, the calibration factor and the volume flow rate of the discharge.

Ci/sec. (max) = (max cpm) x (uCi/cc/cpm) x (cfm) x (4.72 E-04)

FIGURE 1-1



MAP DEFINING UNRESTRICTED AREAS FOR RADIOACTIVE GASEOUS AND LIQUID EFFLUENTS*

FIGURE 1-1

* MAP IS INTENDED SOLELY FOR THE PURPOSE OF IDENTIFYING LIQUID AND GASEOUS RELEASE POINT LOCATIONS AND ELEVATIONS. ELEVATIONS ARE FROM MEAN SEA LEVEL (MSL) SANDY HOOK, N.J.

2.0 LIQUID EFFLUENTS

2.1 Liquid Effluent Releases - General Information

2.1.1 The surveillance and lower limit of detection requirements for liquid radioactive effluents are contained in Section 3.3.1 of the Technical Specifications. For any and all discharges, a minimum dilution flow should be available for IP3NPP to ensure compliance with time average liquid release limits.

2.1.2 A completed and properly authorized Liquid Radioactive Waste Permit shall be issued prior to the release of any radioactive waste from an isolated tank to the discharge canal. A permit is required for each tank to be discharged and must be retained for the life of the plant.

2.1.3 All activity determinations for liquid radioactive effluents will be performed in such a manner as to be representative of the activity released to the river.

2.1.4 The radioactivity in liquid waste shall be continuously monitored during release. If the flowmeter is inoperable, the flow shall be estimated every four hours by difference in tank level or by discharge pump curves.

2.1.5 Prior to discharge, the tank contents shall be recirculated for two tank volumes. After this recirculation, and prior to discharge, a sample shall be taken and analyzed for activity with a portion of the sample set aside for composite analysis. The measured activity shall be used for calculating permissible discharge rate and the alarm set point for the liquid waste discharge monitor.

2.1.6 Radioactive releases that are continuous such as steam generator blowdown during primary-secondary leaks when released to the river shall be documented on Liquid Radioactive Waste Release Permits using data supplied by the Chemistry technician.

2.1.7 Assurance that combined liquid released from units 2 and 3 do not exceed section 2.3. Limits for the site are provided by administrative controls agreed to in the Memorandum of Understanding (#15) between Con Edison and the Power Authority concerning liquid discharge and the requirements of this document.

2.1.8 The dilution flow from Unit No. 3 should be used for calculating discharge canal concentrations. However, by agreement with Con Edison's IP3NPP Watch Supervisor, and the Power Authority's IP3NPP Watch Supervisor one party can reduce or eliminate radioactive liquid waste discharge for a period of time to allow the other party to use the full site dilution flow, or a specified portion thereof, for a discharge when necessary.

2.1.9 Steam generator blowdown activity is determined by samples taken three times per week. This frequency is required by Table 4.1-2 item 6 of Appendix A of the stations operating license. These "grab" samples of the steam generators are collected in a manner to be proportional to the rate of flow of the total steam generator blowdown. These samples are then analysed for the various radionuclides at the frequencies specified in Table 3.3-1B (further flow proportional composites are made where appropriate). (REF NUREG 0472 - REV 3 DRAFT 6 TABLE 4.11-1)

2.1.10 The Discharge Canal flow rate is determined by the use of pump flow characteristics curves. The normal flow for condenser cooling pumps is 140,000 gpm when operating at maximum frequency. During the cold weather months the condenser cooling pumps are operating at reduced frequency this reduced flow is nominally 71,000 gpm (Ref: NUREG 0472-REV. 3 DRAFT 6 3.3-12) 3

2.1.11 Radioactivity content in outdoor tanks is to be limited to less than ten curies. Compliance with this requirement is demonstrated by limiting the radioactive concentration in these tanks to the value which results in ten curies when the tank is at full liquid capacity except as modified below. The radioactive concentrations for these tanks are:

RWST

$$\frac{10 \text{ curies} \times 10^6 \text{ uCi/curie}}{358,500 \text{ gals} \times 3785 \text{ ml/gal}} = 7.3 \times 10^{-3} \text{ uCi/ml}$$

PWST

$$\frac{10 \text{ curies} \times 10^6 \text{ uCi/curie}}{165,000 \text{ gals} \times 3785 \text{ ml/gal}} = 1.6 \times 10^{-2} \text{ uCi/ml}$$

31 & 32 mt

$$\frac{10 \text{ curies} \times 10^6 \text{ uCi/curie}}{11,750 \text{ gals.} \times 3785 \text{ ml/gal}} = 2.2 \times 10^{-1} \text{ uCi/ml}$$

Outside Temporary Tanks

$$\frac{10 \text{ curies} \times 10^6 \text{ uCi/curie}}{\text{Volume in gals.} \times 3785 \text{ ml/gal.}} = \text{uCi/ml}$$

The refueling water storage tank has the potential to be filled from the reactor cavity with liquid which exceeds the limits stated. Therefore prior to filling the RSWT from the reactor cavity after refueling operations, the reactor cavity (or residual heat removal system) must be sampled for radioactivity and action taken to ensure that the total activity in the tank does not exceed 10 curies. 3

Outside temporary tanks should not be filled with liquid which could exceed the concentration limit calculated. Therefore prior to transfer to outside tanks the source of liquid shall be sampled for radioactivity if it exceeds the concentration limit calculated. (REF NUREG 0472 REV 3 DRAFT 6, 3.11.1.4)

2.1.12 There are no continuous composite samples for steam generator blowdown. The method of determining release concentrations is shown below:

Blowdown flowrate (by flowmeter or by flow curves) multiplied by sample blowdown concentration equals composite activity being released. In addition, R-19 monitors the composite steam generator blowdown released. (REF NUREG 0472 REV 3 DRAFT 6 TABLE 3.3-12)

2.1.13 The service water radioactivity monitor listed in Table 3.3-12 is defined as the process radiation monitors which monitor components which discharge into or are cooled by the service water system. These process radiation monitors are component cooling radiation monitor (R-17 A/B), Liquid Waste Release Monitor (R-18) Steam Generator Blowdown Monitor (R-19), Vapor Containment Fan Coolers, and Vapor Containment FCU Motor Coolers (R-23).

If any of these monitors are taken out of service and the removal of that monitor from service is not specifically addressed in the Radiological Environmental Technical Specification samples shall be taken every 12 hours or releases may not continue via this pathway. Samples may be taken on the affected monitored stream or on the service water system. (REF NUREG 0472 REV 3 DRAFT 6 TABLE 3.3-12)

2.1.14 Liquid Effluent Concentrations are limited to 10CFR20 limits, as calculated under 20,106a. This permits averaging of effluent concentrations over one year. This is appropriate since doses from the liquid pathway are the result of total curies released and are not greatly influenced by instantaneous concentrations. In any case, the total dose per quarter and per year must be within the limitations of 2.3.2 of the RETS. (REF NUREG 0472 REV 3 DRAFT 6 3.11.1.1)

2.1.15 There are no drinking water intakes within 3 miles of the site on the Hudson River. (REF NUREG 0472 REV 3 DRAFT 6 3.11.1.2)

2.1.16 A turbine hall drain system which would collect leakage of contaminated secondary plant waters during operation does not exist at IP3. The sumps which are present in the turbine hall five foot elevation receive drains from areas containing secondary plant components at sub atmospheric pressures, these sumps would not meet the intent of the NUREG-0472.

The activity released to the environment via this pathway is negligible when steam generator blowdown activity is less than 3×10^{-5} uCi/cc. Activity released via this pathway when steam generator activity exceeds 3×10^{-5} uCi/cc is determined by the following method:

$$\text{Turbine Hall Drain Effluent Activity} = \left\{\begin{array}{c}\text{Feedwater}\\ \text{Specific}\\ \text{Activity}\end{array}\right\} \times \left\{\begin{array}{c}\text{Steam}\\ \text{Plant}\\ \text{Makeup}\\ \text{Rate}\end{array}\right\} - \left\{\begin{array}{c}\text{Steam}\\ \text{Generator}\\ \text{Blowdown}\end{array}\right\}$$

(REF NUREG 0472 REV 3 DRAFT 6 TABLE 3.3-12)

2.2 Liquid Effluent Concentrations

2.2.1 This section provides a description of the means that will be used to demonstrate compliance with Technical Specification 2.3.1.

2.2.2 Compliance with the instantaneous limits of 10CFR20 is achieved by observance of discharge limits and monitor set points. Normally, only dilution water from Unit 3 circulators is taken credit for, except as allowed by the memorandum of understanding between NYPA and Con Edison. A monthly report is issued which summarizes the radioactive releases from the site for the preceding month. This report provides information necessary to comply with quarterly and annual average limitations on discharge.

2.2.3 Each isolated liquid waste tank must be recirculated for two tank volumes prior to sampling in order to obtain a representative sample.

2.2.4 The concentration in liquid effluents prior to dilution in the discharge canal is determined by sampling prior to release, for batch releases. For continuous releases, the concentration is determined by grab sampling or by the following equation:

$$C = E \times R$$

C = concentration of liquid effluent (uCi/cc) prior to dilution

E = Calibration factor of monitor $\frac{(\text{uCi/cc})}{\text{cpm}}$

R = count rate of monitor (cpm)

2.2.5 The concentration in liquid effluents after dilution in the discharge canal is determined by the following equation:

$$C_D = \frac{C \times f}{F}$$

C_D = Diluted concentration of liquid effluent (uCi/cc)

f = Release Discharge Rate (gpm)

F = Dilution Flow in Discharge Canal, Unit 3 circulators only (gpm)

2.3 Liquid Effluent Dose Calculation Requirements

2.3.1 Section 2.3.2 of the Technical Specification requires that the dose or dose committment above background to an individual in an unrestricted area from radioactive materials in liquid effluents released from each reactor unit shall be limited:

a) During any calendar quarter less than or equal to 1.5 mrem to the total body and to less than or equal to 5 mrem to any organ.

b) During any calendar year to less than or equal to 3 mrem to the total body and to less than or equal to 10 mrem to any organ.

Note: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech Spec 2.6.B.

2.3.2 Section 2.3.3 of the Technical Specifications requires that appropriate portions of the radwaste treatment system be used to reduce the radioactive material in liquid waste prior to their discharge when the projected dose due to liquid effluent from each reactor unit when averaged over 31 days, would exceed 0.06 mrem to the total body or 0.2 mrem to any organ. Doses due to liquid release shall be projected at least once per 31 days.

These doses are projected based on the dose methodology in Section 2.4 or 2.5. The average of previous months' doses is used to project future dose.

2.3.3 Section 2.3.1 of Technical Specifications require that the concentration of radioactive material released from the site shall be limited to the concentrations specified in 10 CFR Part 20, Appendix B, Table II, Column 2 for radionuclides other than dissolved or entrained noble gases (averaged over a calendar quarter). For dissolved or entrained noble gases the concentration shall be limited to 2×10^{-4} uCi/ml total activity.

2.3.4 Calculation of Maximum Permissible Concentrations in Liquid Effluents

2.3.4.1 This section describes the methodology used to meet the requirements of section 2.3.3. The total discharge canal concentration of discharge from all reactor units, both continuous and intermittent, must be maintained at less than the effective maximum permissible concentration for the respective radionuclide mixture exclusive of dissolved noble gases when averaged per 10CFR20.106a. The dissolved noble gas limit is contained in Section 2.3.4.

2.3.4.2 The following methodology is utilized to meet the requirements of section 2.3.4.

a. Record tank identification, time of isolation, volume to be discharged; start tank recirculation, recording rate, start time, and end time (later calculated in 2 below).

b. Assure that at least two tank volumes have been recirculated as follows:

$$T = \frac{2V}{G}$$

where:

T = minimum recirculation time (minutes)

V = Volume in tank (gallon)

G = recirculation rate (gpm) end time equal to T plus start time.

c. After recirculation, have the tank sampled and determine the radioactive concentration and MPC_w for the sample. Record this and the total dilution flow from this unit.

d. Determine if other liquid radioactive discharges are being made from this unit and obtain the radioactive concentration and discharge rate. If another release is occurring, the available dilution flow must be adjusted. This may be performed by allocation or by calculation. The adjusted dilution flow is calculated as follows:

$$\frac{Dr \quad (A)}{MPC_{wA}} = E$$

where:

Dr = Current release discharge rate (gpm)

E = Required dilution flow for current release (gpm)

A = Concentration of radioactivity in current release (uCi/cc)

MPC_{wA} = Maximum permissible concentration for current release (uCi/cc)

Adjusted Dilution Flow = Available dilution flow- E.

e. Calculate the permissible radioactive discharge rate for the isolated tank as follows:

$$D = \frac{(MPC_{wT}) * (B)}{C}$$

where:

D = Maximum permissible discharge rate (gpm)

MPC_{wT} = Maximum permissible concentration for tank release (uCi/cc)

B = Adjusted dilution flow available from unit (gpm)

C = Radioactive concentration in tank for discharge (uCi/ml).

2.4 Dose Methodology (Computer Calculation)

2.4.1 NUREG 0133 (Ref. 1, Section 4.3, Pg. 14) states that cumulative dose contributions should consider the dose contribution from the maximum exposed individual's consumption of fish, invertebrates and potable water as appropriate. The river at IP3NPP is considered to be fresh water when in reality it is a tidal estuary and never completely fresh. Observed average chlorosity at IP3NPP has ranged as high as 2.5 g/l or about 13% sea water and 87% fresh water. Hence, use of the Hudson River for water supply purposes is precluded south of Chelsea (mile point 65) which is the nearest point of potable water supply. Radionuclide concentration in the nearest water supply have been calculated (Ref.2) to be a factor of at least 500 lower than the river water in the Indian Point area. Exposures from ingestion of the drinking water is therefore negligible.

Based on these factors, potable water consumption is not considered to be a pathway at IP3NPP. Thus, at IP3NPP, the cumulative dose considers only the dose contributions from the maximum exposed individuals consumption of fish and invertebrates. Also, IP3NPP takes the position that the adult is the maximum exposed individual, as recommended by NUREG 0133 (Ref. 1, Section 4.3, Pg. 14). Subsequently, tables of dose factors for the adult case were developed in Section 2.4.3.

2.4.2 The relationships and methods that form the calculational base for dose accounting for the liquid effluent pathway are described in this section. These relationships can be used to meet the calculational requirements of Section 2.3.1. The cumulative dose factors (Ai_τ) are calculated in Section 2.4.3. The following equation is generally applicable and can be used for any number of isotopes released over any time period.

$$D_\tau = \sum_i \left[Ai \sum_{\ell=1}^{m} \Delta t\ell \, Ci\ell \, F\ell \right]$$

where:

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

$\Delta t\ell$ = The length of the ℓth time period over which $Ci\ell$ and $F\ell$ are averaged for all liquid releases, in hours.

Ci^ℓ = The average concentration of radionuclide, i, in undiluted liquid effluent during time period $\Delta t\ell$ from any liquid release, in uCi/ml.

Ai^τ = The site related ingestion dose commitment factor to the total body or any organ for each IP3-NPP identified principal gamma and beta emitter listed in table 2-1, in mrem-ml per hr - uCi.

F^ℓ = The near field average dilution factor for Ci^ℓ during any liquid effluent releases. Defined as the ratio of the maximum undiluted liquid waste flow during release to the average flow from the site discharge structure to unrestricted receiving waters.

The term Ci^ℓ is the composite undiluted concentration of radioactive material in liquid waste at the release point as determined by the radioactive liquid waste sampling and analysis program as contained in the Technical Specifications. All dilution factors beyond the sample point are included in the F^ℓ and Ai^τ terms.

The term F_ℓ is a near field average dilution factor and is determined as follows:

$$F = \frac{\text{Liquid Radioactive Waste Flow}}{[\text{Discharge Structure Exit Flow x (Applicable Factor)}]}$$

The liquid radioactive waste flow is the flow from all continuous and batch radioactive effluent releases specified in Technical Specifications from all liquid radioactive waste management systems. The discharge structure exit flow is the average flow during disposal from the discharge structure release point into the receiving body of water. As recommended in NUREG 0133 (ref. 1, section 4.3, pg. 16) the "Applicable Factor" is set equal to 1 because the plant has a once through cooling system.

In order to accurately determine F_ℓ, it is calculated based on actual operating parameters that exist at the time of releases. This affords a quantitative assessment of radiation dose resulting from liquid effluent releases at IP3NPP. The determination and use of dilution factors is discussed in Section 2.2.

2.4.3 Dose Factor for Liquid Effluent Calculations

2.4.3.1 The equation for dose from liquid effluents requires the use of a dose factor $A_{i\tau}$ for each nuclide, i, which embodies the dose factors, pathway transfer factor, pathway usage factors, and dilution factors for the points of pathway origin. IP3NPP has followed the guidance of NUREG 0133 and has calculated $A_{i\tau}$ for the total body and critical organ of the maximum exposed individual e.g. the adult. All the factors needed in the equation were obtained from Regulatory Guide 1.109 (ref.3) with the exception of the fish and invertebrate bioaccumulation factors (BFi and BIi) for Cesium. A site specific factor of 150 was used instead of the 2,000 presented in Table A-1 of the Regulatory Guide for fish. Similarly, a factor of 150 was used for invertebrates instead of the Regulator Guide value of 1000. The justification for these substitutions is discussed in Section 2.5.3. The summary dose factor is as follows:

$$A_{i\tau} = K_o \left(U_F BF_i + U_I BI_i\right) \quad DF_i$$

where:

A_i = Composite dose parameter for the total body or critical organ for nuclide, i, for all appropriate pathways, mrem/hr per uCi/ml.

K_o = units conversion factor, 1.14E05= 10^6pci/uCi · x 10^3 ml/kg÷8760 hr/yr.

U_F = 21 kg/yr, adult fish consumption from Table E-5 of Regulatory Guide 1.109.

BF_i = Bioaccumulation factor for nuclide, i, in fish pCi/kg per pCi/ from Table A-1 of Regulatory Guide 1.109.

U_I = 5 kg/yr, adult invertebrate consumption from Table E-5 of Regulatory Guide 1.109.

BI_i = Bioaccumulation Factor for nuclide, i, in invertebrates, pCi/kg per pCi/ℓ from Table A-1 of Regulatory Guide 1.109.

DF_i = Dose conversion factor for nuclide, i, for adults in pre-selected organs, τ, in mrem/pCi, from Table E-11 of Regulatory Guide 1.109.

For the IN3NPP site, Ai_τ can be expressed as:

$$Ai_\tau = 1.14E05 \; (21\; BF_i + 5\; BI_i)\; DFi$$

IP3NPP has complied Ai_τ factors for total body and various organs for the maximum exposed individual. These are included as Table 2-1.

2.5 Backup Dose Methodology (Hand Calculation)

2.5.1 This method is a simplified version of that presented in Section 2.4. and is more amenable to manual calculation. However, doses calculated using this method will be used only as a backup to the method of Section 2.4.

2.5.2 This method is identical to that presented in Section 2.4 except that the number of nuclides considered in the dose calculation is reduced to a number that is more manageable for manual calculations. The pathways of concern are fish and invertebrate consumption.

Review of past release data indicates that there are a group of radionuclides that are released most frequently and abundantly relative to total activity released. These radionuclides make up at least 90% of the total activity and calculated dose for a release. The equation in Section 2.4.2 will be utilized to calculate doses resulting from liquid releases by calculating the dose committment to each organ at and the total body for these major contributors. To ensure a conservative result the result using equation 2.4.2 will be multiplied by a factor of 1.2. 3

2.5.3 As stated in Section 2.4.3 the bioaccumulation factor (BF_i) for cesium in fish is assumed to be 150 instead of the 2000 listed in Regulatory Guide 1.109 (Ref. 3). This is based on the fact that the Hudson River at IP3NPP is not completely fresh, BF_i for salt water is 40 (Ref. 2), and that the behavior of cesium in the Hudson is a complex phenomenon.

Similarly, the bioaccumulation factor for invertebrates is 150.

The NYU study (Ref. 2) shows that cesium concentrations in fish are regulated at a relatively constant value independent of the concentration of cesium in water, and the bioaccumulator factors are thus inversely proportional to the water concentration of cesium. This explains the lower bioaccumulation factor for cesium reported by numerous investigators for salt water fish as opposed to fresh water fish because of the higher stable cesium content of sea water. The NYU report states that water at Indian Point has a dissolved cesium concentration which is much higher than would be expected from simple mixing between sea water and fresh water and postulates that these higher concentrations result from leaching of cesium from bottom sediment by saline water.

Use of the bioaccumulation factors of Regulatory Guide 1.109 for a fresh water site will thus substantially overestimate fish ingestion doses because no account is taken of the phenomena just discussed. However, radiocesium concentrations in fish may still be estimated through the use of a bioaccumulation factor, provided that this factor is determined from the body of water at interest. This factor has been estimated (ref. 2, Table IX-5) to be about 150 for the flesh of indigenous fish caught in the Indian Point area. In contrast, the cesium fresh water bioaccumulation factor presented by Regulatory Guide 1.109 for fish is 2000. Fish ingestion doses would therefore be overestimated by a factor of 13 if the Regulatory Guide value were used.

Similarly, for invertebrates, the site specific bioaccumulation factor of 150 is used. This is larger than the value of 25 given in Reg. Guide 1.109 for salt water invertebrates.

A second conservatism in the NRC model concerns the location at which the concentrations in the river of the discharged cesium are evaluated. Use of this model implies that these fish have grown directly in such a location prior to being caught, which is unrealistic and adds about a factor of five (ref. 2) in conservation. This conservatism remains in the calculation, thus the use of the NYU (Ref. 2) bioaccumulation factor is justifiable since this remains as a conservative calculation.

In summary, with the exception of the site specific bioaccumulation factors discussed above, all remaining factors are as follows: fish factors are for fresh water and invertebrate factors are for salt water.

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Table 2-1 Site Related Ingestion Dose Commitment Factor

(Freshwater Fish and Saltwater Invertebrate Comsumption)

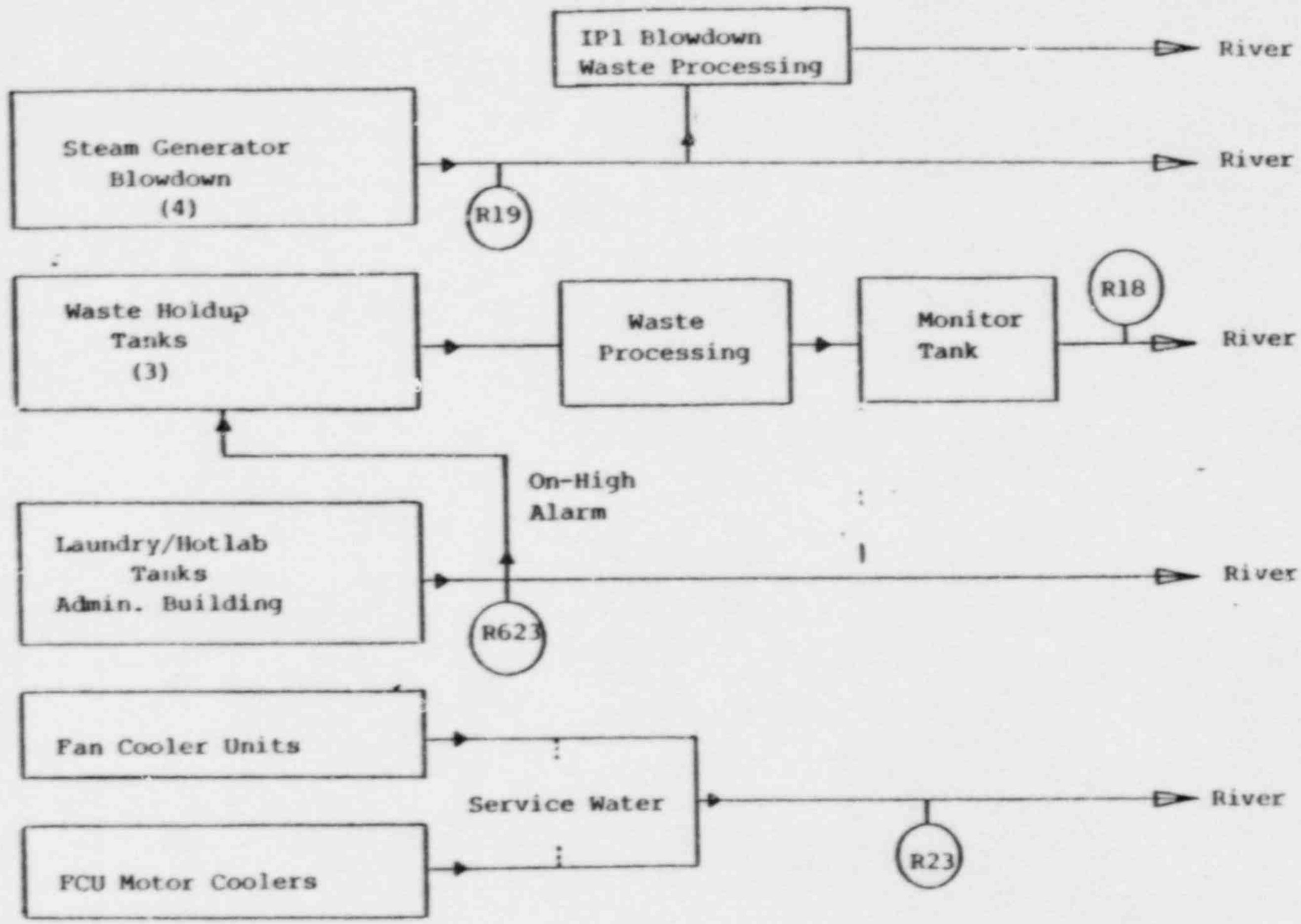
$(A_{i\tau})$

mrem/hr per μCi/ml

ISOTOPE	BONE	LIVER	TOT-BODY	THYROID	KIDNEY	LUNG	GI-LLI
H-3	0.00E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01	2.99E-01
C-14	3.35E 04	6.71E 03	6.71E 03	6.71E 03	6.71E 03	6.71E 03	6.71E 03
NA-24	4.07E 02	4.07E 02	4.07E 02	4.07E 02	4.07E 02	4.07E 02	4.07E 02
P-32	4.95E 07	3.08E 06	1.91E 06	0.00E-01	0.00E-01	0.00E-01	5.57E 06
CR-51	0.00E-01	0.00E-01	4.31E 00	2.57E 00	9.49E-01	5.72E 00	1.08E 03
MN-54	0.00E-01	5.42E 03	1.03E 03	0.00E-01	1.61E 03	0.00E-01	1.66E 04
MN-56	0.00E-01	1.36E 02	2.42E 01	0.00E-01	1.73E 02	0.00E-01	4.35E 03
FE-55	3.20E 04	2.21E 04	5.16E 03	0.00E-01	0.00E-01	1.22E 04	1.27E 04
FE-59	5.05E 04	1.19E 05	4.55E 04	0.00E-01	0.00E-01	3.32E 04	3.96E 05
CO-58	0.00E-01	5.14E 02	1.15E 03	0.00E-01	0.00E-01	0.00E-01	1.04E 04
CO-60	0.00E-01	1.48E 03	3.26E 03	0.00E-01	0.00E-01	0.00E-01	2.77E 04
NI-63	4.97E 04	3.44E 03	1.67E 03	0.00E-01	0.00E-01	0.00E-01	7.18E 02
NI-65	2.02E 02	2.62E 01	1.20E 01	0.00E-01	0.00E-01	0.00E-01	6.65E 02
CU-64	0.00E-01	9.07E 01	4.26E 01	0.00E-01	2.29E 02	0.00E-01	7.73E 03
ZN-65	1.61E 05	5.13E 05	2.32E 05	0.00E-01	3.43E 05	0.00E-01	3.23E 05
BR-83	0.00E-01	0.00E-01	4.05E 01	0.00E-01	0.00E-01	0.00E-01	5.83E 01
BR-84	0.00E-01	0.00E-01	5.25E 01	0.00E-01	0.00E-01	0.00E-01	4.12E-04
BR-85	0.00E-01	0.00E-01	2.16E 00	0.00E-01	0.00E-01	0.00E-01	1.01E-15
RB-86	0.00E-01	1.01E 05	4.72E 04	0.00E-01	0.00E-01	0.00E-01	2.00E 04
RB-88	0.00E-01	2.90E 02	1.54E 02	0.00E-01	0.00E-01	0.00E-01	4.01E-09
RB-89	0.00E-01	1.92E 02	1.35E 02	0.00E-01	0.00E-01	0.00E-01	1.12E-11
SR-91	4.73E 02	0.00E-01	1.91E 01	0.00E-01	0.00E-01	0.00E-01	2.25E 03
SR-92	1.79E 02	0.00E-01	7.76E 00	0.00E-01	0.00E-01	0.00E-01	3.55E 03
Y-91M	5.73E-02	0.00E-01	2.22E-03	0.00E-01	0.00E-01	0.00E-01	1.68E-01
Y-92	5.32E-01	0.00E-01	1.56E-02	0.00E-01	0.00E-01	0.00E-01	9.32E 03
Y-93	1.69E 00	0.00E-01	4.66E-02	0.00E-01	0.00E-01	0.00E-01	5.36E 04
ZR-95	1.63E 00	5.23E-01	3.54E-01	0.00E-01	8.21E-01	0.00E-01	1.66E 03
ZR-97	9.02E-02	1.82E-02	8.32E-03	0.00E-01	2.75E-02	0.00E-01	5.64E 03
NB-95	4.47E 02	2.49E 02	1.34E 02	0.00E-01	2.46E 02	0.00E-01	1.51E 06
MO-99	0.00E-01	1.28E 02	2.44E 01	0.00E-01	2.91E 02	0.00E-01	2.98E 02
TC-99M	1.60E-02	4.51E-02	5.74E-01	0.00E-01	6.85E-01	2.21E-02	2.67E 01
TC-101	1.64E-02	2.36E-02	2.32E-01	0.00E-01	4.26E-01	1.21E-02	7.10E-14
RU-103	1.10E 02	0.00E-01	4.74E 01	0.00E-01	4.19E 02	0.00E-01	1.28E 04
RU-105	9.15E 00	0.00E-01	3.61E 00	0.00E-01	1.18E 04	0.00E-01	5.60E 03
RU-106	1.63E 03	0.00E-01	2.07E 02	0.00E-01	3.15E 03	0.00E-01	1.06E 05
AG-110M	3.02E 02	2.79E 02	1.66E 02	0.00E-01	5.49E 02	0.00E-01	1.14E 05
TE-125M	2.72E 03	9.85E 02	3.64E 02	8.18E 02	1.11E 04	0.00E-01	1.09E 04
TE-129	3.19E 01	1.20E 01	7.76E 00	2.45E 01	1.34E 02	0.00E-01	2.41E 01
TE-131M	1.76E 03	8.59E 02	7.15E 02	1.36E 03	8.70E 03	0.00E-01	8.52E 04
TE-131	2.00E 01	8.35E 00	6.31E 00	1.64E 01	8.76E 01	0.00E-01	2.83E 00
TE-132	2.56E 03	1.65E 03	1.55E 03	1.83E 03	1.59E 04	0.00E-01	7.82E 04
I-130	4.88E 01	1.44E 02	5.68E 01	1.22E 04	2.25E 02	0.00E-01	1.24E 02
I-131	2.69E 02	3.84E 02	2.20E 02	1.26E 05	6.59E 02	0.00E-01	1.01E 02
I-132	1.31E 01	3.51E 01	1.23E 01	1.23E 03	5.59E 01	0.00E-01	6.59E 00
I-133	9.17E 01	1.60E 02	4.86E 01	2.34E 04	2.78E 02	0.00E-01	1.43E 02
I-134	6.85E 00	1.86E 01	6.65E 00	3.22E 02	2.96E 01	0.00E-01	1.62E-02
I-135	2.86E 01	7.49E 01	2.76E 01	4.94E 03	1.20E 02	0.00E-01	8.46E 01
CS-134	2.77E 04	6.58E 04	5.38E 04	0.00E-01	2.13E 04	7.07 E 03	1.15E 03

Table 2-1 (Continued)

ISOTOPE	BONE	LIVER	TOT-BODY	THYROID	KIDNEY	LUNG	GI-LLI
CS-136	2.89E 03	1.14E 04	8.23E 03	0.00E-01	6.36E 03	8.71E 02	1.30E 03
CS-137	3.54E 04	4.85E 04	3.18E 04	0.00E-01	1.65E 04	5.47E 03	9.38E 02
CS-138	2.06E 01	4.07E 01	2.02E 01	0.00E-01	2.99E 01	2.95E 00	1.74E-04
BA-139	6.47E 00	4.61E-03	1.90E-01	0.00E-01	4.31E-03	2.62E-03	1.15E 01
BA-141	3.14E 00	2.38E-03	1.06E-01	0.00E-01	2.21E-03	1.35E-03	1.48E-09
BA-142	1.42E 00	1.46E-03	8.94E-02	0.00E-01	1.23E-03	8.28E-04	2.00E-18
LA-140	1.58E 00	7.94E-01	2.10E-01	0.00E-01	0.00E-01	0.00E-01	5.83E 04
LA-142	8.06E-02	3.67E-02	9.14E-03	0.00E-01	0.00E-01	0.00E-01	2.67E 02
CE-141	3.23E 00	2.18E 00	2.47E-01	0.00E-01	1.01E 00	0.00E-01	8.34E 03
CE-143	5.69E-01	4.20E 02	4.65E-02	0.00E-01	1.65E-01	0.00E-01	1.57E 04
CE-144	1.68E 02	7.03E 01	9.03E 00	0.00E-01	4.17E 01	0.00E-01	5.69E 04
PR-143	5.80E 00	2.32E 00	2.87E-01	0.00E-01	1.34E 00	0.00E-01	2.54E-09
PR-144	1.90E-02	7.88E-03	9.64E-04	0.00E-01	4.44E-03	0.00E-01	2.73E-09
ND-147	3.96E 00	4.58E 00	2.74E-01	0.00E-01	2.68E 00	0.00E-01	2.20E 04
W-187	2.98E 02	2.49E 02	8.70E 01	0.00E-01	0.00E-01	0.00E-01	8.15E 04
NP-239	3.55E-02	3.49E-03	0.00E-01	0.00E-01	1.09E-02	0.00E-01	7.15E 02



Liquid Radioactive Waste Effluent System
Flow Diagram

Figure 2-1

3.0 GASEOUS EFFLUENTS

3.1 Gaseous Effluent Releases - General Information

3.1.1 The surveillance and lower limit of detection requirements for gaseous radioactive effluents are contained in section 3.4 of the technical Specifications. All releases at IP3NPP are assumed to be ground level so there are no elevated releases.

3.1.2 A completed and properly authorized Airborne Radioactive Waste Release Permit shall be issued prior to the release of airborne activity from the waste gas holding system, and containment purge.

The unit shall maintain Airborne Radioactive Release Permits for the life of the plant.

3.1.3 One half of the derived Ci/sec. instantaneous limits delineated in section 3.2.1 are applicable to IP3NPP since it is a two unit site. The time-average limits presented in 3.2.2, 3.2.3 and 3.2.4 are "per reactor" limits, and the full Ci/sec limits are applicable to IP3.

3.1.4 During normal operations without a primary to secondary leak, almost all gaseous ground level releases occur through the main plant vent, - with a neglibigle amount released from the Administration Building and the Radioactive Machine Shop. However, in the event of a leak, the blowdown flash tank vent and condenser air ejector releases shall be added to those from the main plant vent for the purpose of determining if total release criteria are met.

3.1.5 For releases that are expected to continue for periods over two days a new release permit will normally be issued each day. Containment purge release permits may be terminated at the discretion of the RESS and be considered as a continuous release until the purge is terminated. However, when plant conditions change that will cause the activity in containment to significantly change a new permit shall be issued.

3.1.6 Assurance that the combined gaseous releases from Units 2 & 3 do not exceed section 3.2.1 limits for the site is provided by administrative controls agreed to in the Memorandum of Understanding (#16) between Con Edison and the Power Authority concerning gaseous effluent discharge and the requirements of the document.

3.1.7 By mutual agreement with Con Edison's IP2NPP Watch Supervisor and the Power Authority's IP3NPP Shift Supervisor, one unit can reduce or eliminate discharges for a period of time to allow the other unit to use the full site permissible discharge rate, or a specific portion thereof, for a discharge when necessary.

3.1.8 Conservative release rate limitations have been established to aid in controlling time average dose limits. The annual average limit shall be used for calculating limitations on discharge. If this limit restricts operating flexibility the quarterly average limit may be used by the Shift Supervisor as long as releases for the calendar month stay within the quarterly average and the Operations Superintendent is in agreement. The Shift Supervisor may use the instantaneous limit for release if the Superintendent of Power is in agreement. The instantaneous limit should be checked by the Radiological and Environmental Services Department when applied.

When the instantaneous limit applies the monitor response should be averaged over a one hour time interval. 3

3.1.9 Containment Pressure Reliefs

Containment pressure reliefs occur on a frequent enough basis to be considered continuous and are sampled as part of the plant vent release path. However, to ensure that the release rate will not be exceeded, the containment noble gas monitor (R-12) and the expected flow rate are used to calculate a release rate. The effluent noble gas monitor in the plant vent is used to verify these calculations. (REF. NUREG 0472 REV 3 DRAFT 6 TABLE 3.1-13)

3.1.10 Composite Particulate Samples

One of these methods will be used to obtain a composite sample:

1. Samples will be taken weekly and integrated monthly, or

2. Samples will be taken weekly and counted together once per month.

(REF. NUREG 0472 REV 3 DRAFT 6 TABLE 4.11-12)

3.1.11 Gas Storage Tank Activity Limit

The noble gas activity limit of 50,000 Ci in the gas storage tanks was calculated using the equations from Section 5.6.1 of NUREG 0133 and the following parameters:

$K_1 = 294 \frac{mrem - m^3}{uCi\ yr}$, Xe-133 equivalent Table B-1 Reg. Guide 1.109

$X/Q = 1.03 \times 10^{-3}\ s\text{-}m^{-3}$, Indian Point 3 FSAR

$$Q_{it} \leq 500\ mrem \frac{(3.15 \times 10^7\ sec/year}{10^6\ uCi/Ci(294 \frac{mrem\ m^3}{uCi\ yr})\ 1.03 \times 10^{-3}\ \frac{s}{m^3}}$$

$Q_{it} = 52{,}011\ Ci \sim 50{,}000\ Ci$

3.1.12 Gas Storage Tank Activity - Surveillance Requirements

There are two methods available to ensure that the activity in the gas storage tank is within the 50,000 Ci, Xe-133 equivalent concentration:

1. Gas samples of the tank's contents which are less than 430 uCi cc^{-1} will ensure that there are less than 50,000 Ci in the tank.

2. The waste gas line monitor R-20 will have an exposure rate to activity concentration conversion factor which will also allow for activity determinations. (REF NUREG 0472 REV 3 DRAFT 6 3.11.2.6)

3.1.13 The ventilation flow rate utilized to monitor environmental releases from the Administrative Building Controlled Area and the Radioactive Machine Shop shall be the system's design flow rate. The system design flowrate for the Administration Building and the Radioactive Machine Shop is 12,500 and 33,750 cubic feet per minute respectively. Using the system design flowrate will result in a conservative quantification of releases as the flowrate cannot exceed design. (REF NUREG 0472 REV 3 DRAFT 6 TABLE 3.3-13)

3.1.14 The activity released via the blowdown flash tank vent if determined as follows. The release rate of radioactivity from the steam generator blowdown is determined. The partition factors for the blowdown flash tank vent as listed in Regulatory Guide 1.42 "Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases from Light Water Cooled Nuclear Power Reactors" are then applied to determine how much activity is being released via the blowdown flash tank vent. (REF NUREG 0472 REV 3 DRAFT 6 TABLE 3.3-13)

3.2 Gaseous Effluent Dose Calculation Requirements

3.2.1 Section 2.4.1 of the Technical Specifications requires that the dose rate due to radioactive materials released in gaseous effluents from the site at or beyond the site boundary shall be limited to the following:

a) For noble gases: less than or equal to 500 mrem/yr to the total body and less than or equal to 3000 mrem/yr to the skin, and

b) For all radioiodines and for all radioactive materials in particulate form and radionuclides (other than noble gases) with half lives greater than 8 days: less than or equal to 1500 mrem/yr to any organ.

The methodologies for performing these calculations are discussed in Section 3.3.1 and 3.3.2, respectively.

3.2.2 Section 2.4.2 of the Technical Specifications requires that the air dose due to noble gases released in gaseous effluents from each reactor unit at or beyond the site boundary shall be limited to the following:

a) During any calendar quarter: less than or equal to 5 mrad for gamma radiation and less than or equal to 10 mrad for beta radiation.

b) During any calendar year: less than or equal to 10 mrad for gamma radiation and less than or equal to 20 mrad for beta radiation.

The methodology for calculating these dose rates is discussed in Section 3.3.3.

Note: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech. Spec. 2.6.B.

3.2.3 Section 2.4.3 of the Technical Specifications requires that the dose to a member of the general public from Iodine-131, tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from each reactor unit shall be limited to the following:

a) During any calendar quarter: less than or equal to 7.5 mrem to any organ and

b) During any calendar year: less than or equal to 15 mrem to any organ.

Cumulative dose contributions for the current calendar quarter and current calendar year shall be determined at least once every 31 days.

The methodology for calculating these dose rates is discussed in Section 3.3.4.

Note: If either of the above limits is exceeded by a factor of two or more, then cumulative dose contributions from direct radiation would be determined by evaluation of existing perimeter and environmental TLDs per Tech. Spec. 2.6.B.

3.2.4 Section 2.4.4 of the Technical Specifications requires that for each reactor unit, the appropriate portions of the gaseous radwaste treatment system shall be used to reduce radioactive effluents in gaseous waste prior to their discharge when projected gaseous effluent air dose at the site boundary when averaged over 31 days, would exceed 0.2 mrad for gamma radiation. 0.4 mrad for beta radiation. These doses are projected based on the dose methodology discussed in Section 3.3.3 (gas) and 3.3.4 (iodine) and the average previous months' doses are is used to project future doses. The appropriate portions of the ventilation exhaust treatment system shall be used to reduce radioactive materials in gaseous releases when the projected doses when averaged over 31 days, would not exceed 0.3 mrem to any organ (at nearest residence).

Dose due to gaseous release from the site shall be calculated at least once every 31 days.

3.3 Dose Methodology (Computer Calculation)

3.3.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies the monitor response should be averaged over a one hour time interval. | 3

3.3.1.1 The equations developed in this section are used to meet the calculational requirements of paragraph 3.2.1. The magnitude of this pathway is the same for all age groups so there is no critical group. Based on an agreement with Consolidated Edison, IP3NPP utilizes 50% of the site release limit as measured in Ci/sec which translates to 63% of the applicable dose rate limit for Noble gas releases. Each unit has different dispersion factors due to their relative positions to the critical sector of the unrestricted area boundary. The conversion from dose rate to Ci/sec was determined with the use of a finite cloud exposure model. The methodology is discussed in Section 3.6

A calculation showing the relationship between Ci/sec and dose rates from Units 2 and 3 is shown in Appendix 3-A. The equations for calculating the dose rate limitations are obtained from NUREG 0133 (Ref. 1, Section 5.1). Utilizing the above assumptions, these equations reduce to the following:

$$\sum_i (K_i) \overline{(X/Q)} (Qi) = 317 \text{ mrem/yr whole body}$$

$$\sum_i (Li + 1.1 Mi) (\overline{X/Q} (Qi) = \text{mrem/yr skin}$$

$$\sum_i (si) (\overline{X/Q} (Qi) = 2046 \text{ mrem/yr to the skin}$$

where:

Ki = the total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per uCi/m^3. (finite cloud correction included)

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide, in mrem/yr per uCi/m^3.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrad/yr per uCi/m^3 (finite cloud correction included)

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per uCi/m^3.

Si = The total skin dose factor. (Li + 1.1Mi) in mrem/yr per uCi/m^3.

Qi = The release rate of radionuclides, i, in gaseous effluent for all release points in uCi/sec.

$\overline{(X/Q)}$ = For all vent releses, the highest calculated annual average relative concentration for any area at the unrestricted area boundary, 3.0 E-5 sec/m^3 in the SW sector at 350 meters.

The Ki, Li, Mi, Ni and Si factors were obtained from Table B-1 of Regulatory Guide 1.109 and are included in this document as Tables 3-4, 3-5, 3-6, 3-7, and 3-8 respectively. The Ki, Mi, and Si factors have a finite cloud correction factor included.

3.3.1.2 These equations can also be expressed in the following manner:

$\overline{K}$ (Qt) = mrem/yr (dose to whole body)

$(\overline{L} + 1.1\overline{M})$ (Qtv) =

$(\overline{S})$ (Qt) = mrem/yr (dose to the skin)

where:

Qt = The release rate of all noble gases summed together in uCi/sec.

$Qt = \Sigma Qi$

$\overline{K} = (1/Qt)\ \Sigma (Qi\ \overline{Ki})$

$\overline{Ki} = Ki\ (\overline{X/Q})$

$\overline{L} = (1/Qt)\ \Sigma (Qi\ \overline{Li})$

$\overline{Li} = Li\ (\overline{X/Q})$

$\overline{M} = (1/Qt)\ \Sigma (Qi\ \overline{Mi})$

$\overline{Mi} = Mi\ (\overline{X/Q})$

$\overline{N} = (1/Qt\ \Sigma (Qi\ \overline{Ni})$

$\overline{Ni} = Ni\ (\overline{X}/Q)$

$\overline{S} = (1/Qt)\ \Sigma (Qi\ \overline{Si})$

$\overline{Si} = Si\ (\overline{X}/Q)$, where the summations are from i to n i being the ith nuclide.

The values of $\overline{K}$, $\overline{L}$, $\overline{M}$, $\overline{N}$ and $\overline{S}$ are listed in Table 3-9 for the unrestricted area boundary.

3.3.2 Instantaneous Dose Rates - Radioiodines and Particulate Releases

The equation developed in this section is used to meet the calculational requirements of Paragraph 3.2.1.b. The critical organ is considered to be the child thyroid as stated in Section 4.0 of the Technical Specifications. Based on a previous agreement with Consolidated Edison, IP3NPP utilizes 50% of the site release limit as measured in Ci/sec which translates to 71% of the applicable dose rate limit. This is a result of the different dispersion factors for each unit due to their relative positions to the critical sector of the unrestricted area boundary. A calculation showing the relationship between Ci/sec released and dose rates from units 2 and 3 is shown in Appendix 3-A. The equation for calculating the dose rate limitation is obtained from NUREG-0133 (Ref. 1, Section 5.2.1, Pg. 25). Utilizing the above assumptions this equation reduces to the following:

$\sum_i P_i\ (W\ Q_i) < 1070$ mrem/yr

where:

Pi(in) = The dose parameter for radionuclides other than noble gases for the inhalation pathway in mrem/yr per uCi/m^3. The dose factors are based on the critical individual organ and most restrictive age group which is the child thyroid.

.i = The release rate of radionuclides, i, in gaseous effluents for all release points in uCi/sec.

W = The highest calculated annual average dispersion parameter for estimating the dose to an individual at the controlling location due to all vent releases (see Section 3.5).

W(in) = 3.0E-5 sec/m^3, for the inhalation pathway release. The location is the unrestricted area boundary in the SW sector at 350 meters.

3.3.2.a <u>Calculation of Pi(in): Inhalation Dose Factor</u>

Pi (inhalation) = K' (BR) DFAi (mrem/yr per uCi/m^3)

where:

K' = A constant of conversion, 10^6 pCi/uCi

BR = The breathing rate of the child age group (3700m^3/yr) from Table E-5 of Regulatory Guide 1.109.

DFAi = The thyroid inhalation dose factor for the child age group for the ith radionuclide, in mrem/pCi. Taken from Table E-1- of Regulatory Guide 1.109. These values are reproduced in Table 3-1a

Resolution of units yields:

Pi (inhalation) = 3.7E09 DFAi

3.3.3 Time Average Dose - Noble Gas Release

3.3.3.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.2 and 3.2.4. All releases at IP3NPP are assumed to be ground level so there are no elevated releases. The magnitude for this pathway is the same for all age groups so there is no critical group. Dispersion parameters are discussed in Section 3.5.

3.3.3.2 The equations for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). The doses are evaluated at the unrestricted area boundary in the worst meteorological section (SW sector at 350 meters). These equations reduce to the following:

a) During any calendar quarter, for gamma radiation:

$$3.17 \times 10^{-8} \sum_i M_i \left[((\overline{X/Q}) \quad \tilde{Q}i + (\overline{x/q} \quad \tilde{q}i) \right] \leq 5 \text{ mrad}$$

during any calendar quarter for the beta radiation:

$$3.17 \times 10^{-8} \sum N_i \left[((\overline{X/Q}) \quad \tilde{Q}i + (\overline{x/q}) \quad \tilde{q}i) \right] \leq 10 \text{ mrad}$$

b) during any calendar year for gamma radiation:

$$3.17 \times 10^{-8} \sum M_i \left[((\overline{X/Q} \quad \tilde{Q}i + (\overline{x/q}) \quad \tilde{q}i) \right] \leq 10 \text{ mrad}$$

during any calendar year for beta radiations:

$$3.17 \times 10^{-8} \sum N_i \left[((\overline{X/Q}) \quad \tilde{Q}i < (\overline{x/q}) \quad \tilde{q}i) \right] < 20 \text{ mrad}$$

where:

$(\overline{X/Q})$ = The highest calculated annual average relative concentration for the unrestricted area boundary in the SW sector at 350 meters for long term releases (greater than 500 hrs/years), 3.0 E-5 sec/m^3.

$(\overline{x/q})$ = The relative concentration for the unrestricted area boundary for short term releases (equal to or less than 500 hrs/ year), in the SW sector at 350 meters. This value is calculated as per Section 3.5.

M_i = The air dose factor due to gamma emission for each identified noble gas radionuclide in mrad/yr per uCi/m^3.

N_i = the air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per uCi/m^3.

$\tilde{q}_i$ = The average release of noble gas radionuclides in gaseous effluents, i, for short term releases (equal to or less than 500 hrs/yr) from all vents, in uCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

$\tilde{Q}_i$ = The average release of noble gas radionuclides in gaseous effluents, i, for long term releases (greater than 500 hrs/yr) from all vents, in uCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

3.17×10^{-8} = The inverse of the number of seconds in a year.

The air dose factors Mi and Ni were obtained from Table B-1 of Regulatory Guide 1.109 and are listed in Table 3-6 and 3-7 respectively. The M air dose factors are finite cloud corrected

3.3.4 Time Averaged Dose - Radioiodines and Particulates

3.3.4.1 The equations in this section are used to meet the calculational requirements of Paragraphs 3.2.3 and 3.2.4. All releases at IP3NPP are assumed to be ground level so there are no elevated releases. Only the infant and child factors are calculated for the purpose of this manual, since they are the most restrictive age groups, NUREG 0133 (Ref. 1, Section 5.3.1, Page 31)

3.3.4.2 The pathways considered in this analysis are inhalation, ground plane, vegetable ingestion and milk ingestion. The meat ingestion pathway is not considered because of the high degree of commercial, industrial and residential land usage in the area, and the fact that this pathway was not indicated within ten miles of the plant. The inhalation, ground plane and vegetation ingestion pathways only are assumed to exist at the nearest residence in the worst meteorological sector, which is the SSW sector at 1526 meters. Since no real cow exists within 5 miles of the plant, a hypothetical cow has been placed at 5 miles in the worst meteorological sector, which is the SSW. All 4 pathways will be considered at this secondary receptor. Calculated doses for the nearest resident and the secondary receptor will be compared and the higher calculated dose will be reported.

3.3.4.3 The equations for calculating the dose limitations are obtained from NUREG 0133 (Ref. 1, Section 5.3). These equations reduce to the following:

During any calendar quarter:

$$3.17 \times 10^{-8} \sum_i Ri \; (W \; \dot{Q}i \; + \; w \; \dot{q}i) \leq 7.5 \text{ mrem}$$

During any calendar year:

$$3.17 \times 10^{-8} \sum Ri \; (W \; \dot{Q}i \; + \; w\dot{q}i) \leq 15 \text{ mrem}$$

where:

$\tilde{Q}_i$ = The plant releases of radioiodines and radioactive materials in particulate form with half lives greater than eight days, for long term releases greater than 500 hr/yr, in uCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

$\tilde{q}_i$ = The plant releases of radioiodines and radioactive materials in particulate form withhalf lives greater than eight days, for short term releases equal to or less than 500 hrs/yr, in uCi. Releases shall be cumulative over the calendar quarter or year as appropriate.

W = The dispersion or deposition parameter (based on meteorological data defined in Section 3.5) for estimating the dose to an individual at the controlling location for long term releases (greater than 500 hrs/yr):

W_n(in) = The highest calculated annual average dispersion parameter for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1526 meters, 2.7 E-6 sec/m^3.

W_n(dep) = The highest calculated annual average deposition parameter for the nearest residence in the unrestricted area located in the S sector at 1279 meters, 8.7 E-9 m^{-2}.

W_s(in) = The calculated annual average dispersion parameter for the inhalation pathway for the secondary receptor located in the SSW sector at 5 miles, 2.9E-7 sec/m^3.

W_s(dep) = The highest calculated annual average deposition parameter for the secondary receptor located in the SSW sector at 5 miles, 4.7E-10 m^{-2}.

w = The vent dispersion or deposition parameter for estimating the dose to an individual at the controlling location for short term releases (equal or less than 500 hrs/yr) calculated as in Section 3.5.

3.17×10^{-8} = The inverse number of seconds in a year.

R_i = The dose factor for each identified pathway, organ and radionuclide, i, in m^2 - mrem/yr per uCi/sec or mrem/yr per uCi/m^3. These dose factors are determined as described in Sections 3.3.4.5a-d.

3.3.4.4 Utilizing the assumptions contained in Section 3.3.1.2, these equations for the nearest resident and the secondary receptor respectively, reduce to the following:

$$D_N = 3.17E\text{-}08 \sum_i \{R^I_i \{(W_n(in)\ \tilde{Q}i + w_n(in)\ \tilde{q}i)\} + \{(R^G_i + R^V_i)\ (W_n\ (dep)\ \tilde{Q}i + w_n\ (dep)\ \tilde{q}i)\}$$

$$D_S = 3.17E\text{-}08\ \{R^I_i\{W_s(in)\ \tilde{Q}i + ws\ (in)\ \tilde{q}i\} + \{(R^G_i + R^C_i + R^V\ (W_s\ (dep)\ \tilde{Q}i + w_s\ (dep)\ \tilde{q}i)\}$$

$\leq$ 7.5 mrem Quarterly
$\leq$ 15 mrem Annual

Note: The subscript s refers to the secondary receptor and the subscript n refers to the nearest residence.

3.3.4.5 Calculation of Dose Factors

a. <u>Calculation of $R^I i$ (X/Q) Inhalation Pathway Factor</u>

$R^I i$ (X/Q) = K' (BR) a (DFAi)a (mrem/yr per uCi/m^3

where:

K' = Constant of unit conversion, 10^6 pCi/uCi

(BR)a = Breathing rate of the receptor of age group (a)in M^3/yr

(DFAi)a = The maximum organ inhalation dose factor for the receptor of age group (a) for the i^{th} radionuclide, in mrem/pCi. The total body is considered as an organ in the selection of $(DFAi)_a$.

Only the child and the infant R factors are needed for the purpose of this manual, since they are the most restrictive groups. The $(DFAi)_a$ values are listed in Table 3-1a and 3-1b respectively.

Breathing rates:

Infant = 1400 (m^3/yr) *

Child = 3700 (m^3/yr) *

The values of (BR), $(DFAi)_a$ and $(DFAi)_i$ were obtained from Tables E-5, E-9 and E-10 respectively of Regulatory Guide 1.109.

3.3.4.5.b Calculation of R^G_i (D/Q) Ground Plane Pathway Factor

$$R^G (D/Q) = K'K'' (SF) (DFG_i (1-e^{-\lambda i \tau}/\lambda i)$$

(m^2 x mrem/yr per uCi/sec)

where:

K' = A constant of conversion, 10^6 pCi/uCi

K" = A constant of conversion, 8760 hr/yr

λi = Decay constant for the ith radionuclide sec^{-1}.

t = The exposure time, 4.73 x 10^8 sec (15 years)

DFGi = The ground plane dose conversion factor for ith radionuclide (mrem/hr per pCi/m^2)

SF = Shielding factor (dimensionless) = 0.7 from Table E-15 of Regulatory Guide 1.109.

The values of DFGi were obtained from Table E-6 of Regulatory Guide 1.109. These values were used to calculate R^Gi, which is the same for all age groups and is listed in Table 3-2.

3.3.4.5.c Calculation of R^C (D/Q) - Grass-Cow-Milk Pathway Factor

$$R^C (D/Q) = \frac{K' Q_F (Uap) \ Fm (r) (DFL_i) a}{\lambda i + \lambda w} \times \left[\frac{f_p f_s}{Y_p} + \frac{(1-f_p f_s) e^{-\lambda i t h}}{Y_s} \right] (e^{-\lambda i t f})$$

where:

K' = Constant of conversion, 10^6 pCi/uCi

Q_F = Cow's consumption rate, in kg/day (wet weight)

Uap = Receptor's milk consumption rate for age (a), in liters/yr.

Y_p = Agricultural productivity by unit area of pasture grass, in kg/m^2.

Y_s = Agricultural productivity by unit area of stored feed, in kg/m^2.

F_m = Stable element transfer coefficients, in days/liters.

r = Fraction of deposited activity retained on cow's feed grass.

$(DFL_i)a$ = The maximum organ ingestion dose factor for the ith radionuclides for the receptor in age group (a) in mrem/pCi. Values are from Tables E-13 and E-14 of Regulatory Guide 1.109 and are listed in Table 3-3a and 3-3b.

λi = Decay constant for the ith radionuclide, in sec^{-1}.

λw = Decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{-7} sec^{-1} (corresponding to a 14 day halflife).

t_f = The transport time from pasture, to cow, to milk, to receptor in sec.

t_h = The transport time from pasture, to harvest, to cow, to milk, to receptor, in sec.

f_p = Fraction of the year that the cow is on pasture.

f_s = Fraction of the cow feed that is pasture grass while the cow is on pasture.

The concentration of tritium in milk is based on the airborne concentration rather than the deposition. Therefore, the R^C_i is based on X/Q:

$$R^C_i\ (X/Q) = K'K'''F_m Q_F U_{ap} (DFL_i)_a 0.75(0.5/H)$$

(mrem/yr per uCi/m^3)

where:

K''' = A constant of unit conversion, 10^3 gm/kg.

H = Absolute humidity of the atmosphere, in gm/m^3.

0.75 = The fraction of total feed that is water.

0.5 = The ratio of the specific activity of the feed grass water to the atmospheric water.

and other parameters and values are given above. The value of H may be considered as 8 $grams/meter^3$, in lieu of site specific information.

R_i^c Parameters are taken from the following sources:

Parameter		Value	Table (R.G. 1.109
r (dimensionless)		1.0 for radioiodine	E-15
		0.2 for particulates	E-15
F_m (days/liter)		Each stable element	E-1
U_{ap} (liters/yr)	- infant	330	E-5
	- child	330	E-5
	- teen	400	E-5
	- adult	310	E-5
$(DFL_i)_a$(mrem/pCi)		Each radionuclide	E-11 to E-14
Y_p(kg/m^2)		0.7	E-15
Y_s(kg/m^2)		2.0	E-15
t_f (seconds)		1.73×10^5 (2 days)	E-15
t_h (seconds)		7.78×10^6 (90 days)	E-15
Q_f (kg/day)		50	E-3
f_s *			
f_p *			

* f_s and f_p are assumed to be unity

Only the R_i^c values for the child and the infant are calculated for the purpose of this manual as they are the most restrictive age groups.

Ingestion dose factors for these two age groups are given in Tables 3-3a and 3-3b.

3.3.4.5.d Calculation of Ri^V (D/Q) - Vegetation Pathway Factor

$$R^V (D/Q) = K' \frac{(r)}{Y_v (\lambda i + \lambda w)} (DFL_i)a \; U_a^L f_L e^{-\lambda i t L} + U_a^s f_g \, e^{-\lambda_i t_h}$$

where:

k' = Constant of conversion, 10^6pCi/uCi

U_a^L = Consumption rate of fresh leafy vegetation by the receptor in age group (a), in kg/yr.

U_a^S = Consumption rate of non-leafy vegetables by the receptor in age group (a), in kg/yr.

f_L = The fraction of the annual intake of leafy vegetation grown locally.

f_g = The fraction of the annual intake of non-leafy vegetation grown locally.

t_L = The average time between harvest of leafy vegetation and its consumption, in seconds.

t_h = The average time between harvest of stored vegetation and its consumption, in seconds.

Y_v = The vegetation area density, in kg/m^2 .

All other factors are defined in the Calculation of Grass-Cow-Milk Pathway Factor Section 3.3.4.5.c of this manual.

R Parameters Are From The Following Sources:

Parameter		Value	Table (R.G. 1.109
r (dimensionless)		1.0 for radioiodines 0.2 for particulates	E-15
$(DFL_i)_a$ (mrem/pCi)		Each radionuclide	E-11 to E-14
U^L_a (kg/yr)	- infant	0	E-5
	- child	26	E-5
	- teen	42	E-5
	- adult	64	E-5
U^S_a (kg/yr)	- infant	0	E-5
	- child	520	E-5
	- teen	630	E-5
	- adult	520	E-5
f_L (dimensionless		1.0	E-15
f_g (dimensionless)		0.76	E-15
t_L (seconds)		8.6×10^4 (1 day)	E-15
t_h (seconds		5.18×10^6 (60 days)	E-15
Y_v (kg/m^2)		2.0	E-15

The concentration of tritium in vegetation is based on the airborne concentration rather than the deposition. Therefore, the R^V_i is based on X/Q:

$$R^V_i \;\; X/Q = K'K"'\{ U^L_a f_L + U^S_a f_g\} (DFL_i)a \;\; (0.75(0.5/H)) \text{ (mrem/yr per uCi/m}^3)$$

where all terms have been defined above and in the grass-cow-milk pathway calculation section of this manual. $(DFL_i)_a$ for the child are given in Table 3-3a.

3.4 Backup-Simplified Dose Methodology

The dose calculation procedures described in this section are intended to serve as a backup only. They will be implemented whenever the computer implemented procedures cannot be followed.

3.4.1 Instantaneous Dose Rates - Noble Gas Releases

When the instantaneous limit applies the monitor response should be averaged over a one hour time interval. | 3

3.4.1.1 This section describes the alternative calculational method to meet the requirements of Paragraph 3.2.1. The purpose of this method is to provide a calculational technique which is readily amendable to hand calculation and yields conservative results.

3.4.1.2 To determine an acceptable noble gas instantaneous release rate, a standard isotopic mixture of noble gases is assumed. This isotopic mixture was measured for a mixture of isotopes typical of the condenser air ejector with a steam generator tube leak. This requirement is evaluated at the worst sector of the unrestricted area boundary. Based on this isotopic mixture, standard $\bar{K}_s$, $\bar{L}_s$, $\bar{M}_s$, and $\bar{S}_s$ (subscripts denote weighted sum see Table 3-10) can be determined using the technique presented in paragraph 3.3.1.2 and Ki, Li, Mi, Ni, and Si values from Table 3-9. The data and results of this calculation are shown in Table 3-10.

3.4.1.3 The isotopic mixture chosen was obtained from a condenser air ejector sample during a past primary to secondary leak. Table 3-10 contains the mixture data and the fractional relative abundance of each isotope.

These standard factors can be used with the equations and limits presented in Section 3.3.1. The instantaneous dose rate equations then reduce to the following:

Dose to whole body;

$$\bar{K}_s \times (Qtv) \leq 317 \text{ mrem/yr}$$

Dose to skin;

$$\bar{S}_s \times (Qtv) \leq 2046 \text{ mrem/yr}$$

3.4.1.4 Utilizing the equations from Paragraph 3.4.1.3 and the values from Table 3-10, maximum release limits for all noble gases in uCi/sec can be calculated as follows:

These equations can be solved to yield a maximum instantaneous release rate as follows:

$$Qtv = \frac{317}{\bar{K}_s} = \frac{317}{.0194} = 1.63\text{ E04 } \frac{uCi}{Sec} \quad \text{(Whole Body)}$$

$$Qtv = \frac{2046}{\bar{S}_s} = \frac{2046}{.0679} = 3.01\text{ E04 } \frac{uCi}{Sec} \quad \text{(Skin)}$$

3.4.2 Instantaneous Dose Rates - Radioiodines and Particulates

3.4.2.1 This section describes the alternative calculational method to meet the requirements of paragraph 3.2.1. The purposes of this method is to provide a calculational technique which is readily amendable to hand calculation and yields conservative results.

3.4.2.2 To determine an acceptable iodine and particulate release rate it is assumed that the limit on these releases shall be met if the total noble gas concentration in the VC is at least a factor of 20,000 more than the concentration of radioiodine and long lived particulates. This has historically been the case and this assures that the noble gas activity will be limiting.

3.4.2.3 The thyroid is the critical organ for gaseous releases of iodine and particulates typical of IP3NPP, based on analysis performed in Reference 4.

3.4.2.4 In performing this analysis only the child thyroid inhalation pathway at the worst annual average X/Q unrestricted area boundary sector is considered.

3.4.2.5 All iodines and particulates detected are assumed to be I-131 for the purpose of these calculations, which is a conservative assumption since this isotope has the highest thyroid dose factor of all iodines and particulates.

3.4.2.6 The assumptions presented in the previous paragraphs can be used with the equation presented in section 3.3.2 to determine the instantaneous dose rate.

$D = (P(in) \ WB(in)Q < 1070$ mrem/yr to the child thyroid

where:

D = The dose in mrem/yr

P(in) = The dose parameter of I-131 for the inhalation pathway, 1.62E07 mrem/yr per uCi/m^3

WB(in) = The highest calculated annual average dispersion parameter, for the inhalation pathway at the unrestricted area boundary in the SW sector at 350 meters, 3.0 E-5 sec/m^3
Note: Subscript B refers to site boundary.

Q = The total plant release rate of all iodines and particulates summed together in uCi/sec.

3.4.2.7 These equations can then be solved to yield an estimate of the maximum allowable release rate as follows:

$$Qv = \frac{D}{[P(in) \quad WB(in)]}$$, where

D = 1070 mrem/yr, and the denominator equals 486 $\frac{mrem \; s}{uCi \; yr.}$ (See Appendix 3-A; instantaneous release rate:

$$Qv = \frac{1071}{486} = 2.2 \text{ uCi/sec}$$

3.4.3 Time Averaged Dose - Noble Gas Releases

3.4.3.1 This section describes the alternative method of meeting the requirements of Paragraphs 3.2.2 and 3.2.4 and the alternative method of implementing the calculation techniques presented in Section 3.3.3.

3.4.3.2 On a monthly basis collect the analytical results of all noble gas samples required by the surveillance requirements for IP3NPP.

3.4.3.3 A value of $\overline{K}_t$, $\overline{L}_t$, $\overline{M}_t$, $\overline{N}_t$ and $\overline{S}_t$ is determined for each release using the dispersion parameter for the site boundary in the worst sector. The calculation is as follows:

$$\overline{Ki} = Ki \; (\overline{X/Q})$$

$$\overline{Li} = Li \; (\overline{X/Q})$$

$$\overline{Mi} = Mi \; (\overline{X/Q})$$

$$\overline{Ni} = Ni \; (\overline{X/Q})$$

$$\overline{Si} = Si \; (\overline{X/Q})$$

where:

Ki = The total body dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per uCi/m^3. (finite cloud correction used)

Li = The skin dose factor due to beta emissions for each identified noble gas radionuclide in mrem/yr per uCi/m^3.

Mi = The air dose factor due to gamma emissions for each identified noble gas radionuclide, in mrem/yr per uCi/m^3. (finite cloud correction used)

Ni = The air dose factor due to beta emissions for each identified noble gas radionuclide, in mrad/yr per uCi/m^3.

Si = The skin dose factor due to beta and gamma emissions for each identified noble gas radionuclide, (Li + 1.1 Mi) in mrem/yr per uCi/m^3. (finite cloud corrected M used)

$\overline{(X/Q)}$ = The highest calculated annual average dispersion parameter for the noble gas pathway at the unrestricted area boundary, 3.0E-05 sec/m^3.

Determine weighted average dose factors as follows:

All values of $\bar{K}i$, $\bar{L}i$, $\bar{M}i$, $\bar{N}i$, and $\bar{S}i$ are shown in Table 3-9 for the unrestricted area boundary.

$$Ct = \sum_i Ci$$

$$Kt = (1/Ct) \sum_i Ki \; Ci$$

$$Lt = (1/Ct) \sum_i Li \; Ci$$

$$Mt = (1/Ct) \sum_i Mi \; Ci$$

$$Nt = (1/Ct) \sum_i Ni \; Ci$$

$$St = (1/Ct) \sum_i Si \; Ci$$

where:

Ci = Concentration of isotope i (uCi/cc) in analysis, t

Ct = Concentration of all noble gas isotopes (uCi/cc) for a specific analysis, t

Calculate resultant doses and compare with limits:

Considering both the continuous and batch releases, determine the total weighted average M and N factors for the calendar month. Utilizing the highest calculated (X/Q) for the site boundary; add the resulting value of:

3.17 E-8 $\frac{yr}{s}$ x total uCi released x ($\bar{M}_t\overline{(X/Q)}$ and $\bar{N}_t\overline{(X/Q)}$),

to the appropriate values for the current calendar quarter or calendar year. Compare these sums to the limits of Section 3.2.2 and 3.2.4.

3.4.4 Time Averaged Dose - Iodines and Particulates

3.4.4.1 This section describes the alternate method of meeting the requirements of Paragraph 3.2.3 and 3.2.4 and of implementing the calculational techniques presented in Section 3.3.4.

3.4.4.2 On a monthly basis collect the analytical results of iodines and particulates samples required by the surveillance requirements, for IP3NPP.

3.4.4.3 The activity of I-131 and particulate released for each weekly sampling period, are summed together to get the total activity released for the month, prorating when time periods overlap the monthly periods. This value is then divided by the time in seconds for the month to find Qt in uCi/sec. the average release rate for the month. To simplify the calculations, all measured iodine and particulate activity (with a half-life greater than 8 days) is assumed to be I-131.

3.4.4.4 Determine the monthly dose and monthly time averaged fraction of the quarterly dose requirements in Paragraph 3.2.3. At the nearest residence the inhalation and vegetation pathways are considered. At the secondary receptor as defined in Section 3.3.4.2 the cow-milk, and inhalation pathways are considered. Because of the cow-milk pathway, the infant is considered the critical age group at the secondary receptor. At the nearest resident the child age group is critical. For both receptors the ground plane pathway is omitted because it is relatively insignificant. Incorporating these assumptions, the equations from Section 3.3.4.4 can be simplified as follows:

Child Thyroid Dose at the Nearest Residence,

$$D_n = \left[R^I_c \, W_n(in) + R^V_c \, W_n(dep) \right] Q_t \left\{ \frac{1 \text{ year}}{12 \text{ months}} \right\} = \text{mrem/month}$$

where:

D_n = Estimated dose to the nearest resident

R^I_c = Child inhalation thyroid dose factor for I-131 = 1.62×10^7 $\frac{\text{mrem}}{\text{yr}}$ per $\frac{\text{uCi}}{\text{m}^3}$

R^V_c = Child vegetation thyroid dose factor for I-131 = 4.73×10^{10} $\frac{\text{m}^2 \text{ mrem}}{\text{year}}$ per $\frac{\text{uCi}}{\text{sec}}$

$W_N(in)$ = X/Q at the nearest residence = 2.7 E-6 s/m^3

$W_N(dep)$ = D/Q at the nearest residence = 8.7 E-9 m^{-2}

Infant Thyroid Dose at the Secondary Receptor,

$$D_S = \left\{ R^I_I W_S(in) + \left[(R^V_I + R^C_I) \, W_{S(dep)} \right] \right\} Qt \left\{ \frac{1 \text{ year}}{12 \text{ months}} \right\} = \text{mrem/month}$$

D_s = Estimated dose to the secondary receptor

R^I_I = Infant inhalation thyroid dose factor for I-131
= 1.48×10^7 $\frac{mrem}{yr}$ per $\frac{uCi}{m^3}$

R^V_I = Infant vegetation thyroid dose factor for I-131 = 0
(no ingestion of vegetables for infant)

R^C_I = Infant cow-milk thyroid dose factor for I-131
= 1.06×10^{12} m^2 $\frac{mrem}{yr}$ per $\frac{uCi}{s}$

W_s(in)=X/Q at the secondary receptor = 2.9E-7 s/m^3

W_s(dep)=D/Q at the secondary receptor = 4.7E-10m^{-2}

Substituting the parameters into both equations,

D_n = 38.3 Qt mrem/month

D_s' = 41.9 Qt mrem/month

The largest of these two dose parameters (D_s) should be used for manual dose calculations.

Compare this thyroid dose to the limits in paragraph 3.2.4. Add this calculated thyroid dose the calculated values for the period time period in the calendar quarter and calendar year. Compare these sums to the limits of paragraph 3.2.3. If the dose is excessive, the calculation will be performed in greater detail, using methodology described in Section 3.3.4.

3.5 Calculation of Meteorological Dispersion Factors

3.5.1 For the purupose of these calculations the site boundary was taken to be the unrestricted area boundary. The distances to the site boundary as measured from the center of IP3NPP containment are shown in Table 3-18 for each of the 16 major compass sectors. The distances to the nearest residence in each of these sectors is also shown on this table. In the sectors where the Hudson River is the site boundary, the opposite shore is assumed as the boundary of the unrestricted area. This is based on the definition of unrestricted area in NUREG 0133 (ref. 1, section 22, page 6), which states that the unrestricted area boundary does not include areas over bodies of water. The nearest opposite shore distances is five times that of the closest land restricted area boundary. Therefore, these locations are unimportant when evaluating the maximum unrestricted area boundary concentrations.

3.5.2 The atmospheric transport and diffusion model used in the evaluation of dispersion and deposition factors is the straight line flow model presented by Sagendorf in NUREG 0324 (ref. 5). All releases were treated as ground level with credit taken for building wake dilution as applicable and no credit was taken for plume depletion or decay during travel time. Values of sigma Y and sigma Z were defined by onsite measurements of temperature differential which determine the atmosphere stability classes of Regulatory Guide 1.23. These measurements were taken from the onsite meteorological tower; wind data were taken at the 33 foot elevation and temperature differentials between the 200 foot and 33 foot levels. Data recovery for the two years used (1978-1979) was 96.3% and 98.2% respectively. Calms were assigned to the lowest windspeed class and to wind directions in proportion to the directional distribution of the lowest windspeed within an atmospheric stability class. Comparison of these meteorological data with the previous data in the Indian Point area shows that these data are representative of long term conditions at the IP3NPP site. The program of meteorological monitoring and data acquisition is in accordance with Regulatory Guide 1.23.

3.5.3 To meet the calculational requirements of Paragraph 3.2.1, 3.2.2 and 3.2.4 the annual average dispersion factors were calculated for each compass sector at the site unrestricted area boundary. The most restrictive X/Q was determined to be 3.0E-05 in the SW sector at 350 meters. The distances to the site boundary in each sector are listed in Table 3-11.

3.5.4 To meet the calculational requirements of Paragraphs 3.2.3 iodines and particulates, the annual average deposition and dispersion parameters were calculated for the nearest residence in each of the compass sectors. Distance to the nearest residence in each sector are listed in Table 3-11. Because no real dairy exists within 5 miles of the power plant, a hypothetical cow was placed in the worst meteorological sector at 5 miles. Dispersion and deposition parameters for both locations are given below.

$W_n(in)$ = The highest calculated annual average dispersion parameters for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1526 meters, 2.7E-6 sec/m^3.

$W_n(dep)$ = The highest calculated annual average deposition parameters for the ground plane and vegetation pathways for the nearest residence in the unrestricted area located in the S sector at 1279 meters, 8.7E-9 m^{-2}. For tritium in the vegetation pathway $W_N(in)$ is used.

$W_s(in)$ = The calculated annual average dispersion factor for the inhalation pathway for the secondary receptor occurs in the SSW sector at 5 miles, 2.9E-7 sec/m^3.

$W_s(dep)$ = The highest calculated annual average deposition factor for the cow-milk vegetation, and ground plane pathways for the secondary receptor occurs in the SSW sector at 5 miles, 4.7 E-10 m^{-2}. For tritium in the cow-milk and vegetation pathways $W_s(in)$ is used.

3.5.5 To meet the calculational requirements of Paragraphs 3.2.2, 3.2.3, and 3.2.4 and the calculation methodologies described in Sections 3.3.4 and 3.3.3 short term release dispersion and deposition factors may need to be calculated. For this document short term release dispersion and deposition factors are determined from the long term annual average parameters. The method utilized is that presented by Sagendorf in NUREG 0324 (ref.5) as recommended by NUREG 0133 (ref. 5 section 3.3, page 8). This short term release calculation assumes that the plume uniformly distributes in the horizontal within a 22½ degree sector as recommended in NUREG 0324 (ref. 5, page 22). It is further assumed that all releases are ground level. No credit is taken for plume depletion or decay during plume travel time, and all short term releases are cumulative over the calendar year or quarter as appropriate, NUREG 0133 (ref 1, section 5.3.1., page 29). Utilizing the following equation, a factor (F) is developed for a particular compass sector and distance which is simply multiplied against the annual average for the same sector and distance to develop the short term dispersion or deposition factor:

$$F = \left[\frac{NTOTAL}{8760}\right]^{m}$$

where:

F = The non-dimensional correction factor used to convert annual average dispersion or deposition factors to short term dispersion or deposition factors.

NTOTAL = The total number of hours of intermittent releases.

8760 = The total number of hours in a year.

ANMX = The calculated annual average dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest.

F15MX = The short term dispersion (sec/m^3) or deposition (m^{-2}) factor for the compass sector and distance of interest. This is the 15th percentile value such that worse weather conditions can only exist 15% of the time and better weather conditions 85% of the time.

$$M = \frac{\log(ANMX/F15MX)}{\log(8760)}$$

3.5.6 The short term 15th percentile dispersion or deposition factor for use in the equation of the preceeding paragraphs and the simplified F factor equation are as follows:

a.) Nearest Residence Inhalation:

F15MX (1526m, SSW, inhalation) = 3.07E-5 sm^{-3}
ANMX (" ") = 2.7E-6 sm^{-3}

$$F = \frac{NTOTAL}{8760}^{m}; \quad m = \frac{\log(?.7E\text{-}6/3.07E\text{-}5)}{\log(8760)} = -0.27$$

$$F = \frac{NTOTAL}{8760}^{-0.27}$$

b.) Nearest Residence Deposition:

F15MX (1526m, SSW, Dep.) = 9.89E-8m^{-2}
ANMX (1526m, SSW, Dep.) = 8.7E-9m^{-2}

$$F = \frac{NTOTAL}{8760}^{m}; \quad m = \frac{\log(8.7E\text{-}9/9.89E\text{-}8)}{\log(8760)} = -.27$$

$$F = \frac{NTOTAL}{8760}^{-0.27}$$

c.) 5 mile Inhalation:

F15MX (5 mi, SSW, inhal.) = 3.36E-6 sm^{-3},
ANMX (5 mi, SSW, inhal.) = 2.80E-7 sm^{-3}

$$F = \left[\frac{NTOTAL}{8760}\right]^{m}; \quad m = \frac{\log(2.80E\text{-}7/3.36E\text{-}6)}{\log(8760)} = -0.27$$

$$F = \left[\frac{NTOTAL}{8760}\right]^{-0.27}$$

d.) 5 mile Deposition:

F15MX (5 mi, SSW, Dep) = 5.64E-9 m^{-2}
ANMX (5 mi, SSW, Dep) = 4.7E-10 m^{-2}

$$F = \left[\frac{NTOTAL}{3760}\right]^{m}; = \frac{\log(4.7E\text{-}10/5.64E\text{-}9)}{\log(8760)} = -0.27$$

$$F = \left[\frac{NTOTAL}{8760}\right]^{-0.27}$$

3.6 Justification for the Use of the Finite Cloud Assumption for Assessing Site Boundary Dose

If the dimensions of a homogenous cloud of gamma-emitting material are large compared to the distance that the photons travel, an equilibrium condition will exist. Under these conditions the rate of energy absorption per unit volume is equal to the rate of energy release per unit volume.

When the above conditions are satisfied the geometry is referred to as an infinite cloud geometry. In a situation where these conditions are not met (e.g. dimensions of cloud are not large with respect to photon path length) then a finite cloud geometry is said to exist. Under finite cloud conditions the resultant dose rate from exposure to the cloud will be less than that for an infinite cloud. This difference can be expressed in the form of a ratio and is a function of both cloud dimension and photon energy.

The site boundaries of the Indian Point power station are in close enough proximity to the reactor units that the conditions of infinite cloud geometry are not met. Using the data and assumptions presented in Meteorology and Atomic Energy, 1968 (TID24190); nuclide specific finite to infinite dose ratios were developed in order to more accurately assess doses at the site boundary. These ratios were applied to the appropriate Reg. Guide 1.109 dose factors. The results of the finite/infinite dose ratio calculations are on file with IP3 Radiological Engineering. The site boundary finite corrected dose factors are contained in this ODCM (Tables 3-4, 3-6, 3-8, 3-9).

TABLE 3-1a

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07	3.04E-07
C 14	9.70E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06	1.82E-06
NA 24	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06	4.35E-06
P 32	7.04E-04	3.09E-05	2.67E-05	NO DATA	NO DATA	NO DATA	1.14E-05
CR 51	NO DATA	NO DATA	4.17E-08	2.31E-08	6.57E-09	4.59E-06	2.93E-07
MN 54	NO DATA	1.16E-05	2.57E-06	NO DATA	2.71E-06	4.26E-04	6.19E-06
MN 56	NO DATA	4.48E-10	8.43E-11	NO DATA	4.52E-10	3.55E-06	3.33E-05
FE 55	1.28E-05	6.80E-06	2.10E-06	NO DATA	NO DATA	3.00E-05	7.75E-07
FE 59	5.59E-06	9.04E-06	4.51E-06	NO DATA	NO DATA	3.43E-04	1.91E-05
CO 58	NO DATA	4.79E-07	8.55E-07	NO DATA	NO DATA	2.99E-04	9.29E-06
CO 60	NO DATA	3.55E-06	6.12E-06	NO DATA	NO DATA	1.91E-03	2.60E-05
NI 63	2.22E-04	1.25E-05	7.56E-06	NO DATA	NO DATA	7.43E-05	1.71E-06
NI 65	8.08E-10	7.99E-11	4.44E-11	NO DATA	NO DATA	2.21E-06	2.27E-05
CU 64	NO DATA	5.39E-10	2.90E-10	NO DATA	1.63E-09	2.59E-06	9.92E-06
ZN 65	1.15E-05	3.06E-05	1.90E-05	NO DATA	1.93E-05	2.69E-04	4.41E-06
ZN 69	1.81E-11	2.61E-11	2.41E-12	NO DATA	1.58E-11	3.84E-07	2.75E-06
BR 83	NO DATA	NO DATA	1.28E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.48E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	6.84E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	5.36E-05	3.09E-05	NO DATA	NO DATA	NO DATA	2.16E-06
RB 88	NO DATA	1.52E-07	9.90E-08	NO DATA	NO DATA	NO DATA	4.66E-09
RB 89	NO DATA	9.33E-08	7.83E-08	NO DATA	NO DATA	NO DATA	5.11E-10
SR 89	1.62E-04	NO DATA	4.66E-06	NO DATA	NO DATA	5.83E-04	4.52E-05
SR 90	2.73E-02	NO DATA	1.74E-03	NO DATA	NO DATA	3.99E-03	9.28E-05
SR 91	3.28E-08	NO DATA	1.24E-09	NO DATA	NO DATA	1.44E-05	4.70E-05
SR 92	3.54E-09	NO DATA	1.42E-10	NO DATA	NO DATA	6.49E-06	6.55E-05
Y 90	1.11E-06	NO DATA	2.99E-08	NO DATA	NO DATA	7.07E-05	7.24E-05
Y 91M	1.37E-10	NO DATA	4.98E-12	NO DATA	NO DATA	7.60E-07	4.64E-07
Y 91	2.47E-04	NO DATA	6.59E-06	NO DATA	NO DATA	7.10E-04	4.97E-05
Y 92	5.50E-09	NO DATA	1.57E-10	NO DATA	NO DATA	6.46E-06	6.46E-05

This table was taken from
NRC Regulatory Guide 1.109

Table E-9

TABLE 3-1a CONT'D

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	5.04E-08	NO DATA	1.38E-09	NO DATA	NO DATA	2.01E-05	1.05E-04
ZR 95	5.13E-05	1.13E-05	1.00E-05	NO DATA	1.61E-05	6.03E-04	1.65E-05
ZR 97	5.07E-08	7.34E-09	4.32E-09	NO DATA	1.05E-08	3.06E-05	9.49E-05
NB 95	6.35E-06	2.48E-06	1.77E-06	NO DATA	2.33E-06	1.66E-04	1.00E-05
MO 99	NO DATA	4.66E-06	1.15E-06	NO DATA	1.06E-07	3.66E-05	3.42E-05
TC 99M	4.81E-13	9.41E-13	1.56E-11	NO DATA	1.37E-11	7.57E-07	1.30E-06
TC101	2.19E-14	2.30E-14	2.91E-13	NO DATA	3.92E-13	1.58E-07	4.41E-09
RU103	7.55E-07	NO DATA	2.90E-07	NO DATA	1.90E-06	1.79E-04	1.21E-05
RU105	4.13E-10	NO DATA	1.50E-10	NO DATA	3.63E-10	4.30E-06	2.69E-05
RU106	3.68E-05	NO DATA	4.57E-06	NO DATA	4.97E-05	3.87E-03	1.16E-04
AG110M	4.56E-06	3.08E-06	2.47E-06	NO DATA	5.74E-06	1.48E-03	2.71E-05
TE125M	1.82E-06	6.29E-07	2.47E-07	5.20E-07	NO DATA	1.29E-04	9.13E-06
TE127M	6.72E-06	2.31E-06	8.16E-07	1.64E-06	1.72E-05	4.00E-04	1.93E-05
TE127	7.49E-10	2.57E-10	1.65E-10	5.30E-10	1.91E-09	2.71E-06	1.52E-05
TE129M	5.19E-06	1.85E-06	8.22E-07	1.71E-06	1.36E-05	4.76E-04	4.91E-05
TE129	2.64E-11	9.45E-12	6.44E-12	1.93E-11	6.94E-11	7.93E-07	6.89E-06
TE131M	3.63E-08	1.60E-08	1.37E-08	2.64E-08	1.08E-07	5.56E-05	8.32E-05
TE131	5.87E-12	2.28E-12	1.78E-12	4.59E-12	1.59E-11	5.55E-07	3.60E-07
TE132	1.30E-07	7.36E-08	7.12E-08	8.58E-08	4.79E-07	1.02E-04	3.72E-05
I 130	2.21E-06	4.43E-06	2.28E-06	4.99E-04	6.61E-06	NO DATA	1.38E-06
I 131	1.30E-05	1.30E-05	7.37E-06	4.39E-03	2.13E-05	NO DATA	7.68E-07
I 132	5.72E-07	1.10E-06	5.07E-07	5.23E-05	1.69E-06	NO DATA	8.65E-07
I 133	4.48E-06	5.49E-06	2.08E-06	1.04E-03	9.13E-06	NO DATA	1.48E-06
I 134	3.17E-07	5.84E-07	2.69E-07	1.37E-05	8.92E-07	NO DATA	2.58E-07
I 135	1.33E-06	2.36E-06	1.12E-06	2.14E-04	3.62E-06	NO DATA	1.20E-06
CS134	1.76E-04	2.74E-04	6.07E-05	NO DATA	8.93E-05	3.27E-05	1.04E-06
CS136	1.76E-05	4.62E-05	3.14E-05	NO DATA	2.58E-05	3.93E-06	1.13E-06
CS137	2.45E-04	2.23E-04	3.47E-05	NO DATA	7.63E-05	2.81E-05	9.78E-07
CS138	1.71E-07	2.27E-07	1.50E-07	NO DATA	1.68E-07	1.84E-08	7.29E-08
BA139	4.98E-10	2.66E-13	1.45E-11	NO DATA	2.33E-13	1.56E-06	1.56E-05

TABLE 3-1a CONT'D

INHALATION DOSE FACTORS FOR CHILD

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	2.00E-05	1.75E-08	1.17E-06	NO DATA	5.71E-09	4.71E-04	2.75E-05
BA141	5.29E-11	2.95E-14	1.72E-12	NO DATA	2.56E-14	7.89E-07	7.44E-08
BA142	1.35E-11	9.73E-15	7.54E-13	NO DATA	7.87E-15	4.44E-07	7.41E-10
LA140	1.74E-07	6.08E-08	2.04E-08	NO DATA	NO DATA	4.94E-05	6.10E-05
LA142	3.50E-10	1.11E-10	3.49E-11	NO DATA	NO DATA	2.35E-06	2.05E-05
CE141	1.06E-05	5.28E-06	7.83E-07	NO DATA	2.31E-06	1.47E-04	1.53E-05
CE143	9.89E-08	5.37E-08	7.77E-09	NO DATA	2.26E-08	3.12E-05	3.44E-05
CE144	1.83E-03	5.72E-04	9.77E-05	NO DATA	3.17E-04	3.23E-03	1.05E-04
PR143	4.99E-06	1.50E-06	2.47E-07	NO DATA	8.11E-07	1.17E-04	2.63E-05
PR144	1.61E-11	4.99E-12	8.10E-13	NO DATA	2.64E-12	4.23E-07	5.32E-08
ND147	2.92E-06	2.36E-06	1.84E-07	NO DATA	1.30E-06	8.87E-05	2.22E-05
W 187	4.41E-09	2.61E-09	1.17E-09	NO DATA	NO DATA	1.11E-05	2.46E-05
NP239	1.26E-07	9.04E-09	6.35E-09	NO DATA	2.63E-08	1.57E-05	1.73E-05

TABLE 3-1b

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INAHLED)

Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07	4.62E-07
C 14	1.89E-05	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06	3.79E-06
NA 24	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06	7.54E-06
P 32	1.45E-03	8.03E-05	5.53E-05	NO DATA	NO DATA	NO DATA	1.15E-05
CR 51	NO DATA	NO DATA	6.39E-08	4.11E-08	9.45E-09	9.17E-06	2.55E-07
MN 54	NO DATA	1.81E-05	3.56E-06	NO DATA	3.56E-06	7.14E-04	5.04E-05
MN 56	NO DATA	1.10E-09	1.58E-10	NO DATA	7.86E-10	8.95E-06	5.17E-05
FE 55	1.41E-05	8.39E-06	2.38E-06	NO DATA	NO DATA	6.21E-05	7.82E-07
FE 59	9.69E-06	1.68E-05	6.77E-06	NO DATA	NO DATA	7.25E-04	1.77E-05
CO 58	NO DATA	8.71E-07	1.30E-06	NO DATA	NO DATA	5.55E-04	7.95E-06
CO 60	NO DATA	5.73E-06	8.41E-06	NO DATA	NO DATA	3.22E-03	2.28E-05
NI 63	2.42E-04	1.46E-05	8.29E-06	NO DATA	NO DATA	1.49E-04	1.73E-06
NI 65	1.71E-09	2.03E-10	8.79E-11	NO DATA	NO DATA	5.80E-06	3.58E-05
CU 64	NO DATA	1.34E-09	5.53E-10	NO DATA	2.84E-09	6.64E-06	1.07E-05
ZN 65	1.38E-05	4.47E-05	2.22E-05	NO DATA	2.32E-05	4.62E-04	3.67E-05
ZN 69	3.85E-11	6.91E-11	5.13E-12	NO DATA	2.87E-11	1.05E-06	9.44E-06
BR 83	NO DATA	NO DATA	2.72E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	2.86E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.46E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.36E-04	6.30E-05	NO DATA	NO DATA	NO DATA	2.17E-06
RB 88	NO DATA	3.98E-07	2.05E-07	NO DATA	NO DATA	NO DATA	2.42E-07
RB 89	NO DATA	2.29E-07	1.47E-07	NO DATA	NO DATA	NO DATA	4.87E-08
SR 89	2.84E-04	NO DATA	8.15E-06	NO DATA	NO DATA	1.45E-03	4.57E-05
SR 90	2.92E-02	NO DATA	1.85E-03	NO DATA	NO DATA	8.03E-03	9.36E-05
SR 91	6.83E-08	NO DATA	2.47E-09	NO DATA	NO DATA	3.76E-05	5.24E-05
SR 92	7.50E-09	NO DATA	2.79E-10	NO DATA	NO DATA	1.70E-05	1.00E-04
Y 90	2.35E-06	NO DATA	6.30E-08	NO DATA	NO DATA	1.92E-04	7.43E-05
Y 91M	2.91E-10	NO DATA	9.90E-12	NO DATA	NO DATA	1.99E-06	1.68E-06
Y 91	4.20E-04	NO DATA	1.12E-05	NO DATA	NO DATA	1.75E-03	5.02E-05
Y 92	1.17E-08	NO DATA	3.29E-10	NO DATA	NO DATA	1.75E-05	9.04E-05

This table was taken from
NRC Regulatory Guide 1.109

Table E-10

TABLE 3-1b CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

Page 2 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.07E-07	NO DATA	2.91E-09	NO DATA	NO DATA	5.46E-03	1.19E-04
ZR 95	8.24E-05	1.99E-05	1.45E-05	NO DATA	2.22E-05	1.25E-03	1.55E-05
ZR 97	1.07E-07	1.83E-08	8.36E-09	NO DATA	1.85E-08	7.88E-05	1.00E-04
NB 95	1.12E-05	4.59E-06	2.70E-06	NO DATA	3.37E-06	3.42E-04	9.05E-06
MO 99	NO DATA	1.18E-07	2.31E-08	NO DATA	1.89E-07	9.63E-05	3.48E-05
TC 99M	9.98E-13	2.06E-12	2.66E-11	NO DATA	2.22E-11	5.79E-07	1.45E-06
TC101	4.65E-14	5.98E-14	5.80E-13	NO DATA	6.99E-13	4.17E-07	6.03E-07
RU103	1.44E-06	NO DATA	4.85E-07	NO DATA	3.03E-06	3.94E-04	1.15E-05
RU105	8.74E-10	NO DATA	2.93E-10	NO DATA	6.42E-10	1.12E-05	3.46E-05
RU106	6.20E-05	NO DATA	7.77E-06	NO DATA	7.61E-05	8.26E-03	1.17E-04
AG110M	7.13E-06	5.16E-06	3.57E-06	NO DATA	7.80E-06	2.62E-03	2.36E-05
TE125M	3.40E-06	1.42E-06	4.70E-07	1.16E-06	NO DATA	3.19E-04	9.22E-06
TE127M	1.19E-05	4.93E-06	1.48E-06	3.48E-06	2.68E-05	9.37E-04	1.95E-05
TE127	1.59E-09	6.81E-10	3.49E-10	1.32E-09	3.47E-09	7.39E-06	1.74E-05
TE129M	1.01E-05	4.35E-06	1.59E-06	3.91E-06	2.27E-05	1.20E-03	4.93E-05
TE129	5.63E-11	2.48E-11	1.34E-11	4.82E-11	1.25E-10	2.14E-06	1.88E-05
TE131M	7.62E-08	3.93E-08	2.59E-08	6.38E-08	1.89E-07	1.42E-04	8.51E-05
TE131	1.24E-11	5.87E-12	3.57E-12	1.13E-11	2.85E-11	1.47E-06	5.87E-06
TE132	2.66E-07	1.69E-07	1.26E-07	1.99E-07	7.39E-07	2.43E-04	3.15E-05
I 130	4.54E-06	9.91E-06	3.98E-06	1.14E-03	1.09E-05	NO DATA	1.42E-06
I 131	2.71E-05	3.17E-05	1.40E-05	1.06E-02	3.70E-05	NO DATA	7.56E-07
I 132	1.21E-06	2.53E-06	8.99E-07	1.21E-04	2.82E-06	NO DATA	1.36E-06
I 133	9.46E-06	1.37E-05	4.00E-06	2.54E-03	1.60E-05	NO DATA	1.54E-06
I 134	6.58E-07	1.34E-06	4.75E-07	3.18E-05	1.49E-06	NO DATA	9.21E-07
I 135	2.76E-06	5.43E-06	1.98E-06	4.97E-04	6.05E-06	NO DATA	1.31E-06
CS134	2.83E-04	5.02E-04	5.32E-05	NO DATA	1.36E-04	5.69E-05	9.53E-07
CS136	3.45E-05	9.61E-05	3.78E-05	NO DATA	4.03E-05	8.40E-06	1.02E-06
CS137	3.92E-04	4.37E-04	3.25E-05	NO DATA	1.23E-04	5.09E-05	9.53E-07
CS138	3.61E-07	5.58E-07	2.84E-07	NO DATA	2.93E-07	4.67E-08	6.26E-07
BA139	1.06E-09	7.03E-13	3.07E-11	NO DATA	4.73E-13	4.25E-06	3.64E-05

TABLE 3-1b CONT'D

INHALATION DOSE FACTORS FOR INFANT

(MREM PER PCI INHALED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	4.00E-05	4.00E-08	2.07E-06	NO DATA	9.59E-09	1.14E-03	2.74E-05
BA141	1.12E-10	7.70E-14	3.55E-12	NO DATA	4.64E-14	2.12E-06	3.39E-06
BA142	2.84E-11	2.36E-14	1.40E-12	NO DATA	1.36E-14	1.11E-06	4.95E-07
LA140	3.61E-07	1.43E-07	3.68E-08	NO DATA	NO DATA	1.20E-04	6.06E-05
LA142	7.36E-10	2.69E-10	6.46E-11	NO DATA	NO DATA	5.87E-06	4.25E-05
CE141	1.98E-05	1.19E-05	1.42E-06	NO DATA	3.75E-06	3.69E-04	1.54E-05
CE143	2.09E-07	1.38E-07	1.58E-08	NO DATA	4.03E-08	8.30E-05	3.55E-05
CE144	2.28E-03	8.65E-04	1.26E-04	NO DATA	3.84E-04	7.03E-03	1.06E-04
PR143	1.00E-05	3.74E-06	4.99E-07	NO DATA	1.41E-06	3.09E-04	2.66E-05
PR144	3.42E-11	1.32E-11	1.72E-12	NO DATA	4.80E-12	1.15E-06	3.06E-06
ND147	5.67E-06	5.81E-06	3.57E-07	NO DATA	2.25E-06	2.30E-04	2.23E-05
W 187	9.26E-09	6.44E-09	2.23E-09	NO DATA	NO DATA	2.83E-05	2.54E-05
NP239	2.65E-07	2.37E-08	1.34E-08	NO DATA	4.73E-08	4.25E-05	1.78E-05

TABLE 3-2

GROUND PLANE DOSE FACTOR

(MREM/HR PER PCI/M^2)

Page 1 of 1

ELEMENT	TOTAL BODY	ELEMENT	TOTAL BODY
H-3	0.0	Ru-103	3.60E-09
C-14	0.0	Ru-105	4.50E-09
NA-24	2.50E-08	Ru-106	1.50E-09
P-32	0.0	Ag-110M	1.80E-08
Cr-51	2.20E-10	Te-125M	3.50E-11
Mn-54	5.80E-09	Te-127M	1.10E-12
Mn-56	1.10E-08	Te-127	1.00E-11
Fe-55	0.0	Te-129M	7.70E-10
Fe-59	8.00E-09	Te-129	7.10E-10
Co-58	7.00E-09	Te-131M	8.40E-09
Co-60	1.70E-08	Te-131	2.20E-09
Ni-63	0.0	Te-132	1.70E-09
Ni-65	3.70E-09	I-130	1.40E-08
Cu-64	1.50E-09	I-131	2.80E-09
Zn-65	4.00E-09	I-132	1.70E-08
Zn-69	0.0	I-133	3.70E-09
Br-83	6.40E-11	I-134	1.60E-08
Br-84	1.20E-08	I-135	1.20E-08
Br-85	0.0	Cs-134	1.20E-08
Rb-86	6.30E-10	Cs-136	1.50E-08
Rb-88	3.50E-09	Cs-137	4.20E-09
Rb-89	1.50E-08	Cs-138	2.10E-08
Sr-89	5.60E-13	Ba-139	2.40E-09
Sr-91	7.10E-09	Ba-140	2.10E-09
Sr-92	9.00E-09	Ba-141	4.30E-09
Y-90	2.20E-12	Ba-142	7.90E-09
Y-91M	3.80E-09	La-140	1.50E-08
Y-91	2.40E-11	La-142	1.50E-08
Y-92	1.60E-09	Ce-141	5.50E-10
Y-93	5.70E-10	Ce-143	2.20E-09
Zr-95	5.00E-09	Ce-144	3.20E-10
Zr-97	5.50E-09	Pr-143	0.0
Nb-95	5.10E-09	Pr-144	2.00E-10
Mo-99	1.90E-09	Nd-147	1.00E-09
Tc-99M	9.60E-10	W-187	3.10E-09
Tc-101	2.70E-09	Np-239	9.50E-10

This table was taken from
NRC Regulatory Guide 1.109

Table E-6

TABLE 3-3a

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07	3.08E-07
C 14	2.37E-05	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06	5.06E-06
NA 24	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05	1.01E-05
P 32	1.70E-03	1.00E-04	6.59E-05	NO DATA	NO DATA	NO DATA	2.30E-05
CR 51	NO DATA	NO DATA	1.41E-08	9.20E-09	2.01E-09	1.79E-08	4.11E-07
MN 54	NO DATA	1.99E-05	4.51E-06	NO DATA	4.41E-06	NO DATA	7.31E-06
MN 56	NO DATA	8.18E-07	1.41E-07	NO DATA	7.03E-07	NO DATA	7.43E-05
FE 55	1.39E-05	8.98E-06	2.40E-06	NO DATA	NO DATA	4.39E-06	1.14E-06
FE 59	3.08E-05	5.38E-05	2.12E-05	NO DATA	NO DATA	1.59E-05	2.57E-05
CO 58	NO DATA	3.60E-06	8.98E-06	NO DATA	NO DATA	NO DATA	8.97E-06
CO 60	NO DATA	1.08E-05	2.55E-05	NO DATA	NO DATA	NO DATA	2.57E-05
NI 63	6.34E-04	3.92E-05	2.20E-05	NO DATA	NO DATA	NO DATA	1.95E-06
NI 65	4.70E-06	5.32E-07	2.42E-07	NO DATA	NO DATA	NO DATA	4.05E-05
CU 64	NO DATA	6.09E-07	2.82E-07	NO DATA	1.03E-06	NO DATA	1.25E-05
ZN 65	1.84E-05	6.31E-05	2.91E-05	NO DATA	3.06E-05	NO DATA	5.33E-05
ZN 69	9.33E-08	1.68E-07	1.25E-08	NO DATA	6.98E-08	NO DATA	1.37E-05
BR 83	NO DATA	NO DATA	3.63E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	3.82E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 85	NO DATA	NO DATA	1.94E-08	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	1.70E-04	8.40E-05	NO DATA	NO DATA	NO DATA	4.35E-06
RB 88	NO DATA	4.98E-07	2.73E-07	NO DATA	NO DATA	NO DATA	4.85E-07
RB 89	NO DATA	2.86E-07	1.97E-07	NO DATA	NO DATA	NO DATA	9.74E-08
SR 89	2.51E-03	NO DATA	7.20E-05	NO DATA	NO DATA	NO DATA	5.16E-05
SR 90	1.85E-02	NO DATA	4.71E-03	NO DATA	NO DATA	NO DATA	2.31E-04
SR 91	5.00E-05	NO DATA	1.81E-06	NO DATA	NO DATA	NO DATA	5.92E-05
SR 92	1.92E-05	NO DATA	7.13E-07	NO DATA	NO DATA	NO DATA	2.07E-04
Y 90	8.69E-08	NO DATA	2.33E-09	NO DATA	NO DATA	NO DATA	1.20E-04
Y 91M	8.10E-10	NO DATA	2.76E-11	NO DATA	NO DATA	NO DATA	2.70E-06
Y 91	1.13E-06	NO DATA	3.01E-08	NO DATA	NO DATA	NO DATA	8.10E-05
Y 92	7.65E-09	NO DATA	2.15E-10	NO DATA	NO DATA	NO DATA	1.46E-04

This table was taken from
NRC Regulatory Guide 1.109
Table E-14

TABLE 3-3a CONT'D

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	2.43E-08	NO DATA	6.62E-10	NO DATA	NO DATA	NO DATA	1.92E-04
ZR 95	2.06E-07	5.02E-08	3.56E-08	NO DATA	5.41E-08	NO DATA	2.50E-05
ZR 97	1.48E-08	2.54E-09	1.16E-09	NO DATA	2.56E-09	NO DATA	1.62E-04
NB 95	4.20E-08	1.73E-08	1.00E-08	NO DATA	1.24E-08	NO DATA	1.46E-05
MO 99	NO DATA	3.40E-05	6.63E-06	NO DATA	5.08E-05	NO DATA	1.12E-05
TC 99M	1.92E-09	3.96E-09	5.10E-08	NO DATA	4.26E-08	2.07E-09	1.15E-06
TC101	2.27E-09	2.86E-09	2.83E-08	NO DATA	3.40E-08	1.56E-09	4.86E-07
RU103	1.48E-06	NO DATA	4.95E-07	NO DATA	3.08E-06	NO DATA	1.80E-05
RU105	1.36E-07	NO DATA	4.58E-08	NO DATA	1.00E-06	NO DATA	5.41E-05
RU106	2.41E-05	NO DATA	3.01E-06	NO DATA	2.85E-05	NO DATA	1.83E-04
AG110M	9.96E-07	7.27E-07	4.81E-07	NO DATA	1.04E-06	NO DATA	3.77E-05
TE125M	2.33E-05	7.79E-06	3.15E-06	7.84E-06	NO DATA	NO DATA	1.11E-05
TE127M	5.85E-05	1.94E-05	7.08E-06	1.69E-05	1.44E-04	NO DATA	2.36E-05
TE127	1.00E-06	3.35E-07	2.15E-07	8.14E-07	2.44E-06	NO DATA	2.10E-05
TE129M	1.00E-04	3.43E-05	1.54E-05	3.84E-05	2.50E-04	NO DATA	5.97E-05
TE129	2.84E-07	9.79E-08	6.63E-08	2.38E-07	7.07E-07	NO DATA	2.27E-05
TE131M	1.52E-05	6.12E-06	5.05E-06	1.24E-05	4.21E-05	NO DATA	1.03E-04
TE131	1.76E-07	6.50E-08	4.94E-08	1.57E-07	4.50E-07	NO DATA	7.11E-06
TE132	2.08E-05	1.03E-05	9.61E-06	1.52E-05	6.44E-05	NO DATA	3.81E-05
I 130	6.00E-06	1.32E-05	5.30E-06	1.48E-03	1.45E-05	NO DATA	2.83E-06
I 131	3.59E-05	4.23E-05	1.86E-05	1.39E-02	4.94E-05	NO DATA	1.51E-06
I 132	1.66E-06	3.37E-06	1.20E-06	1.58E-04	3.76E-06	NO DATA	2.73E-06
I 133	1.25E-05	1.82E-05	5.33E-06	3.31E-03	2.14E-05	NO DATA	3.08E-06
I 134	8.69E-07	1.78E-06	6.33E-07	4.15E-05	1.99E-06	NO DATA	1.84E-06
I 135	3.64E-06	7.24E-06	2.64E-06	6.49E-04	8.07E-06	NO DATA	2.62E-06
CS134	3.77E-04	7.03E-04	7.10E-05	NO DATA	1.81E-04	7.42E-05	1.91E-06
CS136	4.59E-05	1.35E-04	5.04E-05	NO DATA	5.38E-05	1.10E-05	2.05E-06
CS137	5.22E-04	6.11E-04	4.33E-05	NO DATA	1.64E-04	6.64E-05	1.91E-06
CS138	4.81E-07	7.82E-07	3.79E-07	NO DATA	3.90E-07	6.09E-08	1.25E-06
BA139	8.81E-07	5.84E-10	2.55E-08	NO DATA	3.51E-10	3.54E-10	5.58E-05

TABLE 3-3a CONT'D

INGESTION DOSE FACTORS FOR INFANT

(MREM PER PCI INGESTED)

Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	1.71E-04	1.71E-07	8.81E-06	NO DATA	4.06E-08	1.05E-07	4.20E-05
BA141	4.25E-07	2.91E-10	1.34E-08	NO DATA	1.75E-10	1.77E-10	5.19E-06
BA142	1.84E-07	1.53E-10	9.06E-09	NO DATA	8.81E-11	9.26E-11	7.59E-07
LA140	2.11E-08	8.32E-09	2.14E-09	NO DATA	NO DATA	NO DATA	9.77E-05
LA142	1.10E-09	4.04E-10	9.67E-11	NO DATA	NO DATA	NO DATA	6.86E-05
CE141	7.87E-08	4.80E-08	5.65E-09	NO DATA	1.48E-08	NO DATA	2.48E-05
CE143	1.48E-08	9.82E-06	1.17E-09	NO DATA	2.96E-09	NO DATA	5.73E-05
CE144	2.98E-06	1.22E-06	1.67E-07	NO DATA	4.93E-07	NO DATA	1.71E-04
PR143	8.13E-08	3.04E-08	4.03E-09	NO DATA	1.13E-08	NO DATA	4.29E-05
PR144	2.74E-10	1.06E-10	1.38E-11	NO DATA	3.84E-11	NO DATA	4.93E-06
ND147	5.53E-08	5.68E-08	3.48E-09	NO DATA	2.19E-08	NO DATA	3.60E-05
W 187	9.03E-07	6.28E-07	2.17E-07	NO DATA	NO DATA	NO DATA	3.69E-05
NP239	1.11E-08	9.93E-10	5.61E-10	NO DATA	1.98E-09	NO DATA	2.87E-05

TABLE 3-3b

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

Page 1 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
H 3	NO DATA	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07	2.03E-07
C 14	1.21E-05	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06	2.42E-06
NA 24	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06	5.80E-06
P 32	8.25E-04	3.86E-05	3.18E-05	NO DATA	NO DATA	NO DATA	2.28E-05
CR 51	NO DATA	NO DATA	8.90E-09	4.94E-09	1.35E-09	9.02E-09	4.72E-07
MN 54	NO DATA	1.07E-05	2.85E-06	NO DATA	3.00E-06	NO DATA	8.98E-06
MN 56	NO DATA	3.34E-07	7.54E-08	NO DATA	4.04E-07	NO DATA	4.84E-05
FE 55	1.15E-05	6.10E-06	1.89E-06	NO DATA	NO DATA	3.45E-06	1.13E-06
FE 59	1.65E-05	2.67E-05	1.33E-05	NO DATA	NO DATA	7.74E-06	2.78E-05
CO 58	NO DATA	1.80E-06	5.51E-06	NO DATA	NO DATA	NO DATA	1.05E-05
CO 60	NO DATA	5.29E-06	1.56E-05	NO DATA	NO DATA	NO DATA	2.93E-05
NI 63	5.38E-04	2.88E-05	1.83E-05	NO DATA	NO DATA	NO DATA	1.94E-06
NI 65	2.22E-06	2.09E-07	1.22E-07	NO DATA	NO DATA	NO DATA	2.56E-05
CU 64	NO DATA	2.45E-07	1.48E-07	NO DATA	5.92E-07	NO DATA	1.15E-05
ZN 65	1.37E-05	3.65E-05	2.27E-05	NO DATA	2.30E-05	NO DATA	6.41E-06
ZN 69	4.38E-08	6.33E-08	5.85E-09	NO DATA	3.84E-08	NO DATA	3.99E-06
BR 83	NO DATA	NO DATA	1.71E-07	NO DATA	NO DATA	NO DATA	LT E-24
BR 84	NO DATA	NO DATA	1.98E-07	NO DATA	NO DATA	NO DATA	LT E-24
RB 85	NO DATA	NO DATA	9.12E-09	NO DATA	NO DATA	NO DATA	LT E-24
RB 86	NO DATA	6.70E-05	4.12E-05	NO DATA	NO DATA	NO DATA	4.31E-06
RB 88	NO DATA	1.90E-07	1.32E-07	NO DATA	NO DATA	NO DATA	9.32E-09
RB 89	NO DATA	1.17E-07	1.04E-07	NO DATA	NO DATA	NO DATA	1.02E-09
SR 89	1.32E-03	NO DATA	3.77E-05	NO DATA	NO DATA	NO DATA	5.11E-05
SR 90	1.70E-02	NO DATA	4.31E-03	NO DATA	NO DATA	NO DATA	2.29E-04
SR 91	2.40E-05	NO DATA	9.06E-07	NO DATA	NO DATA	NO DATA	5.30E-05
SR 92	9.03E-06	NO DATA	3.62E-07	NO DATA	NO DATA	NO DATA	1.71E-04
Y 90	4.11E-08	NO DATA	1.10E-09	NO DATA	NO DATA	NO DATA	1.17E-04
Y 91M	3.82E-10	NO DATA	1.39E-11	NO DATA	NO DATA	NO DATA	7.48E-07
Y 91	6.02E-07	NO DATA	1.61E-08	NO DATA	NO DATA	NO DATA	8.02E-05
Y 92	3.60E-09	NO DATA	1.03E-10	NO DATA	NO DATA	NO DATA	1.04E-04

This table was taken from
MRC Regulatory Guide 1.109

Table E-13

TABLE 3-3b CONT'D

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
Y 93	1.14E-08	NO DATA	3.13E-10	NO DATA	NO DATA	NO DATA	1.70E-04
ZR 95	1.16E-07	2.55E-08	2.27E-08	NO DATA	3.65E-08	NO DATA	2.66E-05
ZR 97	6.99E-09	1.01E-09	5.96E-10	NO DATA	1.45E-09	NO DATA	1.53E-04
NB 95	2.25E-08	8.76E-09	6.26E-09	NO DATA	8.23E-09	NO DATA	1.62E-05
MO 99	NO DATA	1.33E-05	3.29E-06	NO DATA	2.84E-05	NO DATA	1.10E-05
TC 99M	9.23E-10	1.81E-09	3.00E-08	NO DATA	2.63E-08	9.19E-10	1.03E-06
TC101	1.07E-09	1.12E-09	1.42E-08	NO DATA	1.91E-08	5.92E-10	3.56E-09
RU103	7.31E-07	NO DATA	2.81E-07	NO DATA	1.84E-06	NO DATA	1.89E-05
RU105	6.45E-08	NO DATA	2.34E-08	NO DATA	5.67E-07	NO DATA	4.21E-05
RU106	1.17E-05	NO DATA	1.46E-06	NO DATA	1.58E-05	NO DATA	1.82E-04
AG110M	5.39E-07	3.64E-07	2.91E-07	NO DATA	6.78E-07	NO DATA	4.33E-05
TE125M	1.14E-05	3.09E-06	1.52E-06	3.20E-06	NO DATA	NO DATA	1.10E-05
TE127M	2.89E-05	7.78E-06	3.43E-06	6.91E-06	8.24E-05	NO DATA	2.34E-05
TE127	4.71E-07	1.27E-07	1.01E-07	3.26E-07	1.34E-06	NO DATA	1.84E-05
TE129M	4.87E-05	1.36E-05	7.56E-06	1.57E-05	1.43E-04	NO DATA	5.94E-05
TE129	1.34E-07	3.74E-08	3.18E-08	9.56E-08	3.92E-07	NO DATA	8.34E-06
TE131M	7.20E-06	2.49E-06	2.65E-06	5.12E-06	2.41E-05	NO DATA	1.01E-04
TE131	8.30E-08	2.53E-08	2.47E-08	6.35E-08	2.51E-07	NO DATA	4.36E-07
TE132	1.01E-05	4.47E-06	5.40E-06	6.51E-06	4.15E-05	NO DATA	4.50E-05
I 130	2.92E-06	5.90E-06	3.04E-06	6.50E-04	8.82E-06	NO DATA	2.76E-06
I 131	1.72E-05	1.73E-05	9.83E-06	5.72E-03	2.84E-05	NO DATA	1.54E-06
I 132	8.00E-07	1.47E-06	6.76E-07	6.82E-05	2.25E-06	NO DATA	1.73E-06
I 133	5.92E-06	7.32E-06	2.77E-06	1.36E-03	1.22E-05	NO DATA	2.95E-06
I 134	4.19E-07	7.78E-07	3.58E-07	1.79E-05	1.19E-06	NO DATA	5.16E-07
I 135	1.75E-06	3.15E-06	1.49E-06	2.79E-04	4.83E-06	NO DATA	2.40E-06
CS134	2.34E-04	3.84E-04	8.10E-05	NO DATA	1.19E-04	4.27E-05	2.07E-06
CS136	2.35E-05	6.46E-05	4.18E-05	NO DATA	3.44E-05	5.13E-06	2.27E-06
CS137	3.27E-04	3.13E-04	4.62E-05	NO DATA	1.02E-04	3.67E-05	1.96E-06
CS138	2.28E-07	3.17E-07	2.01E-07	NO DATA	2.23E-07	2.40E-08	1.46E-07
BA139	4.14E-07	2.21E-10	1.20E-08	NO DATA	1.93E-10	1.30E-10	2.39E-05

TABLE 3-3b CONT'D

INGESTION DOSE FACTORS FOR CHILD

(MREM PER PCI INGESTED)

Page 3 of 3

NUCLIDE	BONE	LIVER	T.BODY	THYROID	KIDNEY	LUNG	GI-LLI
BA140	8.31E-05	7.28E-08	4.85E-06	NO DATA	2.37E-08	4.34E-08	4.21E-05
BA141	2.00E-07	1.12E-10	6.51E-09	NO DATA	9.69E-11	6.58E-10	1.14E-07
BA142	8.74E-08	6.29E-11	4.88E-09	NO DATA	5.09E-11	3.70E-11	1.14E-09
LA140	1.01E-08	3.53E-09	1.19E-09	NO DATA	NO DATA	NO DATA	9.84E-05
LA142	5.24E-10	1.[illegible]7E-10	5.23E-11	NO DATA	NO DATA	NO DATA	3.31E-05
CE141	3.97E-08	1.[illegible]E-08	2.94E-09	NO DATA	8.68E-09	NO DATA	2.47E-05
CE143	6.99E-09	3.79E-06	5.49E-10	NO DATA	1.59E-09	NO DATA	5.55E-05
CE144	2.08E-06	6.52E-07	1.11E-07	NO DATA	3.61E-07	NO DATA	1.70E-04
PR143	3.93E-08	1.18E-08	1.95E-09	NO DATA	6.39E-09	NO DATA	4.24E-05
PR144	1.29E-10	3.99E-11	6.49E-12	NO DATA	2.11E-11	NO DATA	8.59E-08
ND147	2.79E-08	2.26E-08	1.75E-09	NO DATA	1.24E-08	NO DATA	3.58E-05
W 187	4.29E-07	2.54E-07	1.14E-07	NO DATA	NO DATA	NO DATA	3.57E-05
NP239	5.25E-09	3.77E-10	2.65E-10	NO DATA	1.09E-09	NO DATA	2.79E-05

TABLE 3-4

TOTAL BODY DOSE FACTORS

Ki

FROM NOBLE GASES (GAMMA)

NUCLIDE	γ - BODY *		10^6(pCi/ Ci)		Finite Cloud ** Correction Factor	Ki ***
Kr-83m	7.56×10^{-8}	X	10^6	X	1.0	7.56E-2
Kr-85m	1.17×10^{-3}	X	10^6	X	0.29	3.39E+2
Kr-85	1.61×10^{-5}	X	10^6	X	0.26	4.19E+0
Kr-87	5.92×10^{-3}	X	10^6	X	0.26	1.54E+3
Kr-88	1.47×10^{-2}	X	10^6	X	0.22	3.23E+3
Kr-89	1.66×10^{-2}	X	10^6	X	0.26	4.32E+3
Kr-90	1.56×10^{-2}	X	10^6	X	0.26	4.06E+3
Xe-131m	9.15×10^{-5}	X	10^6	X	0.31	2.84E+1
Xe-133m	2.51×10^{-4}	X	10^6	X	0.29	7.28E+1
Xe-133	2.94×10^{-4}	X	10^6	X	0.33	9.70E+1
Xe-135m	3.12×10^{-3}	X	10^6	X	0.27	8.42E+2
Xe-135	1.81×10^{-3}	X	10^6	X	0.29	5.25E+2
Xe-137	1.42×10^{-3}	X	10^6	X	0.26	3.69E+2
Xe-138	8.83×10^{-3}	X	10^6	X	0.25	2.21E+3
Ar-41	8.84×10^{-3}	X	10^6	X	0.22	1.94E+3

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6.

*** Ki (mrem/yr per μCi/m^3)

TABLE 3-5

SKIN DOSE FACTORS

Li

FROM NOBLE GASES (BETA)

NUCLIDE	B - SKIN *		10^6 (pCi/ Ci)	Li **
Kr-83m		X	10^6	
Kr-85m	$1.46x10^{-3}$	X	10^6	$1.46x10^3$
Kr-85	$1.34x10^{-3}$	X	10^6	$1.34x10^3$
Kr-87	$9.73x10^{-3}$	X	10^6	$9.73x10^3$
Kr-88	$2.37x10^{-3}$	X	10^6	$2.37x10^3$
Kr-89	$1.01x10^{-2}$	X	10^6	$1.01x10^4$
Kr-90	$7.29x10^{-3}$	X	10^6	$7.29x10^3$
Xe-131m	$4.76x10^{-4}$	X	10^6	$4.76x10^2$
Xe-133m	$9.94x10^{-4}$	X	10^6	$9.94x10^2$
Xe-133	$3.06x10^{-4}$	X	10^6	$3.06x10^2$
Xe-135m	$7.11x10^{-4}$	X	10^6	$7.11x10^2$
Xe-135	$1.86x10^{-3}$	X	10^6	$1.86x10^3$
Xe-137	$1.22x10^{-2}$	X	10^6	$1.22x10^4$
Xe-138	$4.13x10^{-3}$	X	10^6	$4.13x10^3$
Ar-41	$2.69x10^{-3}$	X	10^6	$2.69x10^3$

* From Regulatory Guide 1.109, Table B-1 (mrem/yr per pCi/m^3)

** Li (mrem/yr per $\mu Ci/m^3$)

TABLE 3-6

AIR DOSE FACTORS

Mi

FROM NOBLE GASES (GAMMA)

NUCLIDE	γ - Air *		10^6(pCi/μCi)		Finite Cloud ** Correction Factor	Mi ***
Kr-83m	1.93×10^{-5}	X	10^6	X	1.0	1.93E+1
Kr-85m	1.23×10^{-3}	X	10^6	X	0.29	3.57E+2
Kr-85	1.72×10^{-5}	X	10^6	X	0.26	4.47E+0
Kr-87	6.17×10^{-3}	X	10^6	X	0.26	1.60E+3
Kr-88	1.52×10^{-2}	X	10^6	X	0.22	3.34E+3
Kr-89	1.73×10^{-2}	X	10^6	X	0.26	4.50E+3
Kr-90	1.63×10^{-2}	X	10^6	X	0.26	4.24E+3
Xe-131m	1.56×10^{-4}	X	10^6	X	0.31	4.84E+1
Xe-133m	3.27×10^{-4}	X	10^6	X	0.29	9.48E+1
Xe-133	3.53×10^{-4}	X	10^6	X	0.33	1.16E+2
Xe-135m	3.36×10^{-3}	X	10^6	X	0.27	9.07E+2
Xe-135	1.92×10^{-3}	X	10^6	X	0.29	5.57E+2
Xe-137	1.51×10^{-3}	X	10^6	X	0.26	3.93E+2
Xe-138	9.21×10^{-3}	X	10^6	X	0.25	2.30E+3
Ar-41	9.30×10^{-3}	X	10^6	X	0.22	2.05E+3

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** The finite cloud correction factor is described in Section 3.6

*** Mi (mrad/yr per μCi/m^3)

TABLE 3-7

AIR DOSE FACTORS (Ni) FROM NOBLE GASES (BETA)

NUCLIDE	*BETA AIR	10^6 (pCi/uCi)	Ni**
Kr-83m	2.88E-04	10^6	2.88E02
Kr-85m	1.97E-03	10^6	1.97E03
Kr-85	1.95E-03	10^6	1.95E03
Kr-87	1.03E-02	10^6	1.03E04
Kr-88	2.93E-03	10^6	2.93E03
Kr-89	1.06E-02	10^6	1.06E04
Kr-90	7.83E-03	10^6	7.83E03
Xe-131m	1.11E-03	10^6	1.11E03
Xe-133m	1.48E-03	10^6	1.48E03
Xe-133	1.05E-03	10^6	1.05E03
Xe-135m	7.39E-04	10^6	7.39E02
Xe-135	2.46E-03	10^6	2.46E03
Xe-137	1.27E-02	10^6	1.27E04
Xe-138	4.75E-03	10^6	4.75E03
Ar-41	3.28E-03	10^6	3.28E03

* From Regulatory Guide 1.109, Table B-1 (mrad/yr per pCi/m^3)

** Ni (mrad/yr per uCi/m^3)

TABLE 3-8

SKIN DOSE FACTORS FROM NOBLE GASES (BETA-GAMMA)

Si = (Li+1.1Mi)

(M is Finite Cloud Corrected)

NUCLIDE	* Li	** Mi	*** Si = (Li+1.1Mi)
Kr-83m		1.93E1	2.12E+1
Kr-85m	$1.46x10^3$	3.57E+2	1.85E+3
Kr-85	$1.34x10^3$	4.47E+0	1.34E+3
Kr-87	$9.73x10^3$	1.60E+3	1.15E+4
Kr-88	$2.37x10^3$	3.34E+3	6.04E+3
Kr-89	$1.101x10^4$	4.50E+3	1.60E+4
Kr-90	$7.29x10^3$	4.24E+3	1.20E+4
Xe-131m	$4.76x10^2$	4.84E+1	5.29E+2
Xe-133m	$9.94x10^2$	9.48E+1	1.10E+3
Xe-133	$3.06x10^2$	1.16E+2	4.34E+2
Xe-135m	$7.11x10^2$	9.07E+2	1.71E+3
Xe-135	$1.86x10^3$	5.57E+2	2.47E+3
Xe-137	$1.22x10^4$	3.93E+2	1.27E+4
Xe-138	$4.13x10^3$	2.30E+3	6.66E+3
Ar-41	$2.69x10^3$	2.05E+3	4.95E+3

* From Table 3-5 (mrad/yr per $\mu Ci/m^3$)

** From Table 3-6 (mrad/yr per $\mu Ci/m^3$)

*** Si (mrem/yr per $\mu Ci/m^3$)

TABLE 3-9

DOSE FACTORS FOR SITE BOUNDARY

(K, M, S are Finite Cloud Corrected)

Nuclide	$\overline{Ki}$ *	$\overline{Li}$ *	$\overline{Mi}$ **	$\overline{Ni}$ **	$\overline{Si}$ *
Kr-83m	2.27E-6	0.00E+0	5.79E-4	8.64E-3	6.36E-4
Kr-85m	1.02E-2	4.38E-2	1.07E-2	5.91E-2	5.55E-2
Kr-85	1.26E-4	4.02E-2	1.34E-4	5.85E-2	4.02E-2
Kr-87	4.62E-2	2.92E-1	4.80E-2	3.09E-1	3.45E-1
Kr-88	9.69E-2	7.11E-2	1.00E-1	8.79E-2	1.81E-1
Kr-89	1.30E-1	3.03E-1	1.35E-1	3.17E-1	4.80E-1
Kr-90	1.22E-1	2.19E-1	1.27E-1	2.36E-1	3.60E-1
Xe-131m	8.52E-4	1.43E-2	1.44E-3	3.33E-2	1.59E-2
Xe-133m	2.18E-3	2.98E-2	2.84E-3	4.44E-2	3.3E-2
Xe-133	2.91E-3	9.18E-3	3.48E-3	3.15E-2	1.30E-2
Xe-135m	2.53E-2	2.13E-2	2.72E-2	2.22E-2	5.13E-2
Xe-135	1.58E-2	5.58E-2	1.67E-2	7.38E-2	7.41E-2
Xe-137	1.11E-2	2.61E-1	1.18E-2	3.17E-1	3.81E-1
Xe-138	6.63E-2	1.24E-1	6.9E-2	1.43E-1	2.00E-1
Ar-41	5.82E-2	8.08E-2	6.15E-2	9.84E-2	1.49E-1

$(\overline{X/Q})v$ = 3.0E-5 sec/m3

* $\overline{Ki}$, $\overline{Li}$, $\overline{Si}$, (mrem.sec per uCi. yr)

** $\overline{Mi}$, $\overline{Ni}$, (mrad.sec per uCi. yr)

TABLE 3-10

Dose Factors For Site Boundary Using Standard Isotopic Mixtures

Instantaneous Release Mixture

Nuclide	Relative Abundance
Kr 85m	4.06E-2
Kr 87	4.36E-2
Kr 88	8.25E-2
Xe 131m	1.09E-1
Xe 133m	1.23E-2
Xe 133	4.11E-1
Xe 135m	2.88E-2
Xe 135	2.21E-1
Xe 138	5.18E-2

Weighted Dose Ractors

$\bar{K}$ = 1.94E-2 (mrem - sec per uCi-yr)

$\bar{L}$ = 4.54E-2 (mrem - sec per uCi-yr)

$\bar{M}$ = 2.05E-2 (mrad - sec per uCi-yr)

$\bar{N}$ = 6.46E-2 (mrad - sec per UCi-yr)

$\bar{S}$ = 6.79E-2 (mrem - sec per uCi-yr)

Time Averaged Release Mixture

Nuclide	Relative Abundance
Kr 85	5.33E-5
Kr 85m	1.63E-2
Xe 131m	4.72E-4
Xe 133	7.89E-1
Xe 133m	4.46E-4
Xe 135	1.93E-1

Weighted Dose Factors

$\bar{K}$ = 5.49E-3 (mrem - sec per uCi-yr) 3

$\bar{L}$ = 1.88E-2 (mrem - sec per uCi-yr)

$\bar{M}$ = 6.15E-3 (mrad - sec per uCi-yr)

$\bar{N}$ = 4.01E-2 (mrad - sec per uCi-yr)

$\bar{S}$ = 2.55E-2 (mrem - sec per uCi-yr)

TABLE 3-11

LOCATIONS OF SITE BOUNDARY AND NEAREST RESIDENCES

Sector	Distance* Nearest Point of Site Boundary (Meters)	Distance* Nearest Residence (Meters)
N	River	1950
NNW	River	1740
NW	River	1830
WNW	River	1830
W	River	1890
WSW	River	2135
SW	350	2745
SSW	380	1525
S	580	1280
SSE	595	1220
SE	580	1100
ESE	580	1070
E	625	730
ENE	760	1370
NE	790	1525
NNE	River	3050

* Measured from Indian Point 3.

APPENDIX 3-A

CALCULATION OF ALLOWABLE RELEASE RATES

Primary Assumptions:

1. Unit 3 and Unit 2 effective dose factor K_{eff}, values are equivalent,
2. Each unit shares 50% of the total allowable release rate, Q, in Ci s^{-1}. Therefore $Q_3 = Q_2$ for instantaneous releases.

Given:

	Location	Unit 3	Unit 2	Location
W_v(in) Annual Average Site Boundary X/Q	(SW350m)	3.0E-5 sm^{-3}	1.2×10^{-5}	(SW579m)
W_v(gp) Annual Ave. Ground Plane Site Boundary Deposition	(SSW380m)	7.9E-8 m^{-2}		
W_v(f) Food Pathway Dispersion Parameter	(SSW5.0mi)	4.7E-10 m^{-2}		
W_v(in) Annual Ave X/Q (5 mi)	(SSW 5mi)	2.9E-7 sm^{-3}		
W_v(in) Inhalation Pathway Nearest Residence	(SSW1526m)	2.7E-6 sm^{-3}		
W_v(gp) Annual Ave. Ground Plane Depos Parameter Nearest Residence	(S 1279 m)	8.7E-9 m^{-2}		

From Table 3-10 Ks = $1.94E\text{-}2 \; \frac{\text{mrem-sec}}{\text{uCi-yr}} \times \frac{1 \text{ yr}}{3.15E7 \text{ sec}} \times \frac{1}{3E\text{-}5 \text{ sec/m}^3} = 2.06E\text{-}5 \; \frac{\text{mrem-m}^3}{\text{uCi-s}}$ K effectiv

(X/Q)

INSTANTANEOUS
RELEASE RATE VS. DOSE RATE
UNITS 2 & 3

A. Instantaneous Dose Rate: Calculation of Allowable Release Rate: Noble Gas Release Including Finite Cloud Correction for Site Boundary

i. Whole Body

$\sum_i (\overline{Keff}) \overline{(X/Q)}_i (Qiv) \leq 500$ mrem yr^{-1} (values and units of above parameters are given on previous page)

(subscript i refers to each of the two sites)

a) 500 mrem yr^{-1} = 1.585E-5 mrem s^{-1}
b) Let $Q_3 = Q_2 = Q$ in uCi s^{-1}
c) Solve for Q

$$Q((Keff)_3(X/Q)_3 + (Keff)_2(X/Q)_2) \leq 500 \text{ mrem yr}^{-1}$$

$$Q((2.06E-5)(3.0E-5) + (2.98E-5)(1.2E-5)) = 1.585E-5 \text{ mrem s}^{-1}$$

$$Q = 1.63E4 \text{ uCi sec}^{-1} = 1.63E-2 \text{ Ci/sec}$$

d) Dose Committments per site for Q = 2.93E4 uCi sec^{-1}

Unit 3: $1.63E4 \frac{uCi}{sec} \times 2.06E-5 \frac{mrem-m^3}{uCi-s} \times 3.0E-5 \frac{s}{m^3} \times 3.15E7 \frac{s}{yr} = 317$ mrem y

Unit 2: $1.63E4 \frac{uCi}{sec} \times 2.98E-5 \frac{mrem-m^3}{uCi-s} \times 1.2E-5 \frac{s}{m^3} \times 3.15E7 \frac{s}{yr} = 183$ mrem yr

Unit 3 has 63% and Unit 2 had 37% of the dose rate limit.

ii. Skin*

$(L_i + 1.1 M_i) \quad (X/Q)_i (Q_{iv}) \leq 3000$ mrem yr^{-1}

a) 3000 mrem yr^{-1} = 9.51E-5 mrem s^{-1}
b) Let $Q_3 = Q_2$ in uCi s^{-1}
c) Solve for Q
d) $(L_1 + 1.1 Mi)$ for Unit 3 = 7.19E-5 $\frac{mrad-m^3}{uCi-s}$, for Unit 2 = 8.33E-5 $\frac{mrad-m^3}{uCi-s}$

$$Q((7.19E-5)(3.0E-5) + (8.33E-5)(1.2E-5)) = 9.51E-5$$

$$Q = 3.01E+4 \text{ uCi sec}^{-1}$$

* Dose factors for skin @ site boundary are finite cloud corrected: refer to ODCM Section 3.6 for discussion of finite cloud geometry.

NOTE: The allowable release rate is 1.63E-2 Ci s^{-1} as calculated in A above due to the limiting whole body dose rate.

RELEASE RATE LIMITS

Quarterly and Annual ⁄verage Noble Gas Releases

For a Calendar Quarter	For a Calendar Year
γ air dose $\leq$5 mrad	γ air dose $\leq$10 mrad
β air dose $\leq$10 mrad	β air dose $\leq$20 mrad

I. ASSUMPTIONS:

1. Doses are delivered to the air @ the site boundary.
2. Finite Cloud geometry is assumed for noble gas releases @ site boundary.
3. X/Q for Unit 3 = 3.0E-5 sm^{-3}, (Q = release rate uCi s^{-1})
4. Gamma air dose factor (M), Corrected for finite cloud geometry is: M = 2.05E+2 $\frac{\text{mrad-m}^3}{\text{uCi-yr}}$
5. Beta air dose factor (N) is unaffected by finite cloud assumption: N = 1.337E+3 $\frac{\text{mrad-m}^3}{\text{uCi-yr}}$

II. Calculation of Allowable Release Rates - Quarterly Limits

a. for dose: (Q)/(M)(X/Q) $\leq$ 5 mrad/qtr (20 mrad yr^{-1})
b. for dose: (Q)/(N)(X/Q) $\leq$ 10 mrad/qtr (40 mrad yr^{-1}) 3

Solve for a. $Q = \frac{\text{5 mrad/qtr}}{(M)\ (X/Q)} = 3.30E{+}3\ \text{uCi s}^{-1} = 3.30E{-}3\ \text{Ci s}^{-1}$

b. $Q = \frac{\text{10 mrad/qtr}}{(M)\ (X/Q)} = 1.01E{+}3\ \text{uCi s}^{-1} = 1.01E{-}3\ \text{Ci s}^{-1}$

Based on the above analysis the β dose is limiting for time average doses and therefore the allowable quarterly average release rate is 1.01E-3 Ci s^{-1}.

III. Allowable Release Rate - Calendar Year

Annual Limits are 1/2 the quarterly limits, therefore, maximum allowable annual average release rate is 5.06E+2 uCi s^{-1} or 5.06E-4 Ci s^{-1}

ALLOWABLE INSTANTANEOUS RELEASE RATE
IODINES/PARTICULATES ($T_{1/2}$ > 8 Days)

Given: X/Q for IP3 = 3.0 E-5 sm^{-3} @ 350m SW
X/Q for IP2 = 1.2 E-5 sm^{-3} @ 579m SW

$$P^{Inhal.}_{Child} = 1.62\text{ E7 } \frac{mrem/yr}{uCi/m^3}$$

Assumed Pathway: Child Inhalation at Unrestricted Area Boundary

Solve the following equation for Q:

$$Q\ (P^{Inhal.}_{Child})\ (X/Q)_{Unit\ 3} + Q(P^{Inhal.}_{Child})\ (X/Q)_{Unit\ 2} \leq 1500 \text{ mrem yr}^{-1}$$

$$\text{IP3} \quad Q\ P^{I}_{C}(X/Q)_3 = Q\ 1.62E7\ \frac{\text{mrem yr}^{-1}}{\text{uCi m}^{-3}}\ 3.0E\text{-}5\ \frac{s}{m^3} = Q\ 486\ \frac{\text{mrem yr}^{-1}}{\text{uCi s}^{-1}},$$

$$\text{IP2} \quad Q\ P^{I}_{C}(X/Q)_2 = Q\ 1.62E7\ \frac{\text{mrem yr}^{-1}}{\text{uCi m}^{-3}}\ 1.2E\text{-}5\ \frac{s}{m^3} = Q\ 194\ \frac{\text{mrem yr}^{-1}}{\text{uCi s}^{-1}}$$

$$\sum = 680\ Q\ \frac{\text{mrem yr}^{-1}}{\text{uCi s}^{-1}}$$

Limit is 1500 mrem yr^{-1} per <u>site</u>:

therefore: $680\ Q\ \frac{\text{mrem yr}^{-1}}{\text{uCi s}^{-1}} \leq 1500 \text{ mrem yr}^{-1}$

$$Q = 2.2 \text{ uCi s}^{-1}$$
$$Q = 2.2\text{ E-6 Ci s}^{-1} \text{ per unit}$$

IP3 Dose Contribution: $2.2\ \frac{uCi}{s} \times 1.62E7\ \frac{mrem}{yr}\ \frac{m^3}{uCi} \times 3.0\ E\text{-}5\ \frac{s}{m^3} = 1.07E3 \text{ mrem yr}^{-1}$

IP2 Dose Contribution: $2.2\ \frac{uCi}{s} \times 1.62E7\ \frac{mrem}{yr}\ \frac{m^3}{uCi} \times 1.2E\text{-}5\ \frac{s}{m^3} = 4.3\ E2 \text{ mrem yr}^{-1}$

$$\sum \cong 1500 \text{ mrem/yr}$$

Approximately a 71% - 29% dose split for IP3 and IP2 respectively.

ALLOWABLE RELEASE RATES FOR IODINE/PARTICULATE
TIME AVERAGE DOSES QUARTERLY AND ANNUAL DOSE LIMITS

There are two receptor pathways considered; a primary receptor - child at the nearest residence, and a secondary receptor - Infant at 5 miles.

As discussed in the ODCM, both receptors will be considered when evaluating time averaged dose committments. For the purpose of setting an administrative limit on quarterly and time average release rates the secondary receptor was chosen because it proved more limiting (only long term releases were considered, e.g. the possibility of intermittent releases was not considered for the calculation).

Calculations for both receptor locations are included in this attachment for reference.

IODINE TIME AVERAGE*

Primary Receptor

Child at the nearest residence

Given:** $X/Q = 2.7 E{-}6\ sm^{-3}$ @ 1526m SSW inhalation
$D/Q = 8.7 E{-}9\ m^{-2}$ @ 1279 m S ground plane deposition factor
$R^{I}_{Child} = 1.62E{+}7\ \frac{mrem/yr}{uCi/m^3}$, child inhal. dose factor for I-131
$R^{G} = 2.1E7\ m^2\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$
$R^{Veg}_{Child} = 4.77E10\ m^2\ \frac{mrem/yr^{-1}}{uCi\ sec^{-1}}$ vegetation path for child

Calculate the allowable time ave. release rate by solving the following equation for Q:

$$Q\left[R^{I}_{C}\ X/Q + R^{G}\ D/Q + R^{V}_{C}\ D/Q\right] \leq mrem\ yr^{-1}$$

$$Q\ R^{I}_{c}\ X/Q = Q(1.62E{+}7)\ \frac{mrem\ yr^{-1}}{uCi\ m^{-3}}\ 2.7 E{-}6\ sm^{-3} = Q\ 43.7\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$Q\ R^{G}\ D/Q = Q(2.1E7)\ \frac{m^2\ mrem\ yr^{-1}}{uCi\ s^{-1}}\ 8.7 E{-}9\ m^{-2} = Q\ 0.2\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$Q\ R^{V}_{c}\ D/Q = Q(4.77E10)\ m^2\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}\ 8.7 E{-}9\ m^{-2} = Q\ 415\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$\sum = \left(459\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}\right)Q$$

Quarterly Time Ave. (Limit is 7.5 mrem to any organ or 30 mrem/yr)

Solving for Q yields: $Q\ 459\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}} \leq 30\ mrem\ yr^{-1}$

$$Q = 6.54E{-}2\ uCi\ s^{-1}$$
$$= 6.54E{-}8\ Ci\ s^{-1}$$

Annual Limit is ½ Quarterly Limit: 15 mrem to any organ (15 mrem yr^{-1})

$$Q = \frac{6.54E{-}8}{2} = 3.27E{-}8\ Ci\ s^{-1}$$

* All iodines and particulates with half lives greater than 8 days are assumed to be I-131 for the purposes of this calculation which is a conservative assumption since this nuclide has the highest thyroid dose factor of all iodines and particulates.

** Because the H-3 dose factor is 4 orders of magnitude less than the Iodine dose factor its contribution to the total dose is considered negligible.

IODINE TIME AVERAGE*

Secondary Receptor

Infant @ 5 miles

Given:** $X/Q = 2.9\text{E-}7$ SSW @ 5 mi
$D/Q = 4.7\text{E-}10$ SSW @ 5 mi

$R^{I}_{infant} = 1.48\text{E}7 \frac{mrem\ yr^{-1}}{uCi\ m^{-3}}$ infant inhal. dose factor

$R^{G} = 2.1\text{E}7 \frac{mrem\ yr^{-1} m^{2}}{uCi\ s^{-1}}$ ground plant dose factor

$R^{C}_{inf.} = 1.06\text{E}12 \frac{mrem\ yr^{-1} m^{2}}{uCi\ s^{-1}}$ cow-milk pathway dose factor for infant

R^{V}_{inf} is not calculated because the infant is assumed to have no intake of fresh vegetables.

Calculate the allowable time ave. release rate by solving the following equation for Q:

$$Q \left[R^{I}_{inf}\ X/Q + R^{G}\ D/Q + R^{C}_{inf}\ D/Q \right] = mrem\ yr^{-1}$$

$$Q\ R^{I}_{inf}\ X/Q = Q\ 1.48\text{E}7 \frac{mrem\ yr^{-1}}{uCi\ m^{-3}}\ 2.9\text{E-}7\ sm^{-3} = Q\ \ 4.3 \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$Q\ R^{G}\ D/Q = Q\ 2.1\text{E}7\ m^{2} \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}\ 4.7\text{E-}10\ m^{-2} = Q\ \ .01\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$Q\ R^{C}_{inf}\ D/Q = Q\ 1.06\text{E}12\ m^{2} \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}\ 4.7\ \text{E-}10\ m^{-2} = Q\ 498\ \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

$$\sum Q\ (502.3) \frac{mrem\ yr^{-1}}{uCi\ s^{-1}}$$

Quarterly Limit: 7.5 mrem to any organ (or 30 mrem/yr)

Solve for Q:

$$(502.3)\ \ Q \frac{mrem\ yr^{-1}}{uCi\ s^{-1}} = 30\ mrem\ yr^{-1}$$

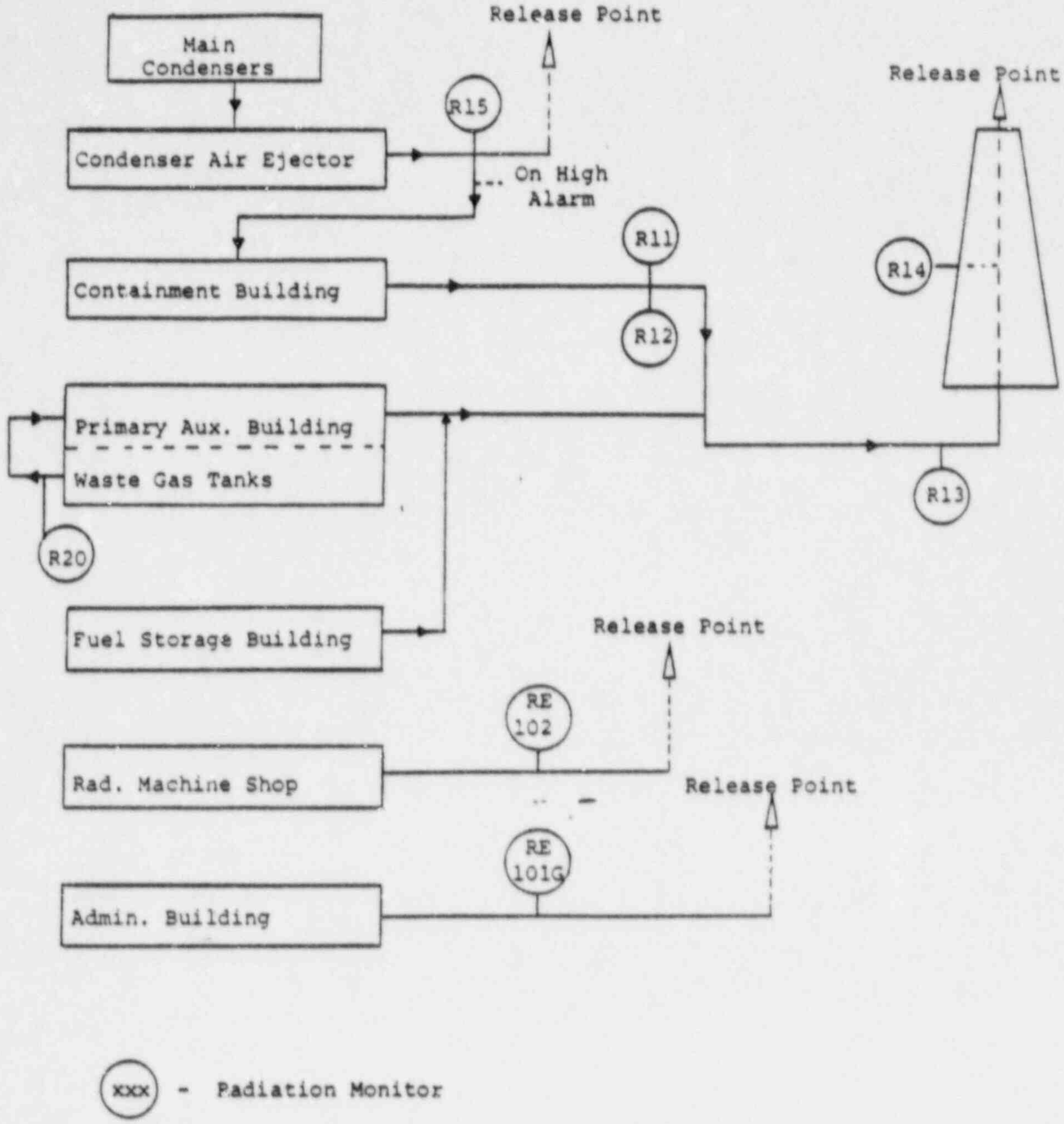
$$Q = 5.97\text{E-}2\ uCi\ s^{-1}$$
$$= 5.97\text{E-}8\ Ci\ s^{-1}$$

Annual Limit is ½ Qtrly Limit: 15 mrem (or 15 mrem/yr)

$$Q = 2.99\text{E-}8\ Ci\ s^{-1}$$

* See note under Primary Receptor Calculation

** See note under Primary Receptor Calculation



Gaseous Radioactive Waste Effluent System
Flow Diagram

Figure 3-1

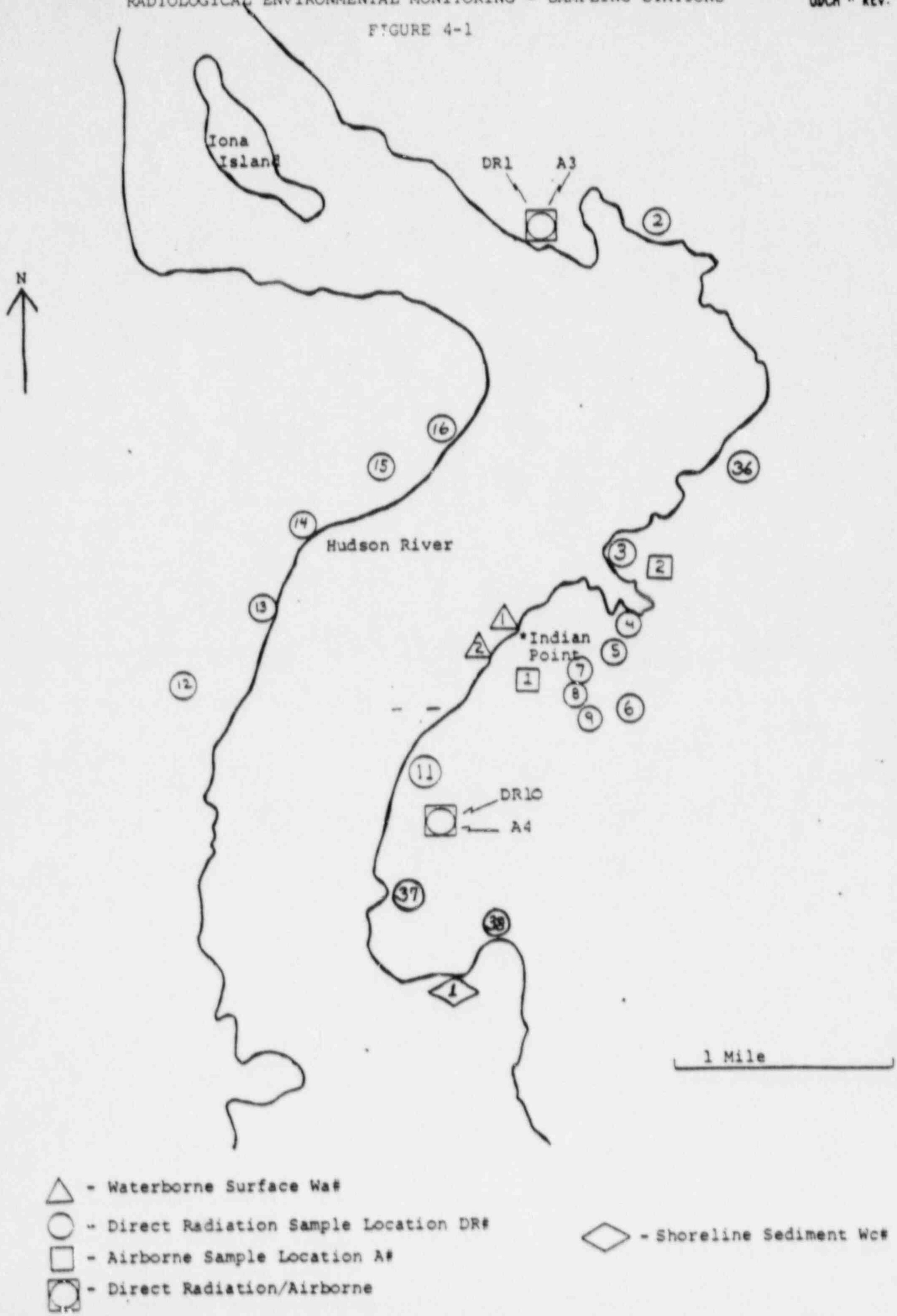
4.0 SAMPLE LOCATIONS

Figure 4.1 is a map which shows the location of environmental sampling points within 2.5 miles of the Indian Point Plant and Figure 4.2 is a map providing the same information for points at greater distances from the plant. Table 4.1 provides a description of environmental sample locations and the sample types collected at each of these locations.

The locations listed in Table 4.1 are the RETS designated locations only. The air sample locations were chosen considering the highest average annual D/Q sectors and the practicality of locating continuous air samples. There are backup sample locations not listed in Table 4.1 that may be maintained to provide the program with additional supporting information.

RADIOLOGICAL ENVIRONMENTAL MONITORING - SAMPLING STATIONS

FIGURE 4-1



RADIOLOGICAL ENVIRONMENTAL MONITORING - SAMPLING STATIONS

FIGURE 4-2

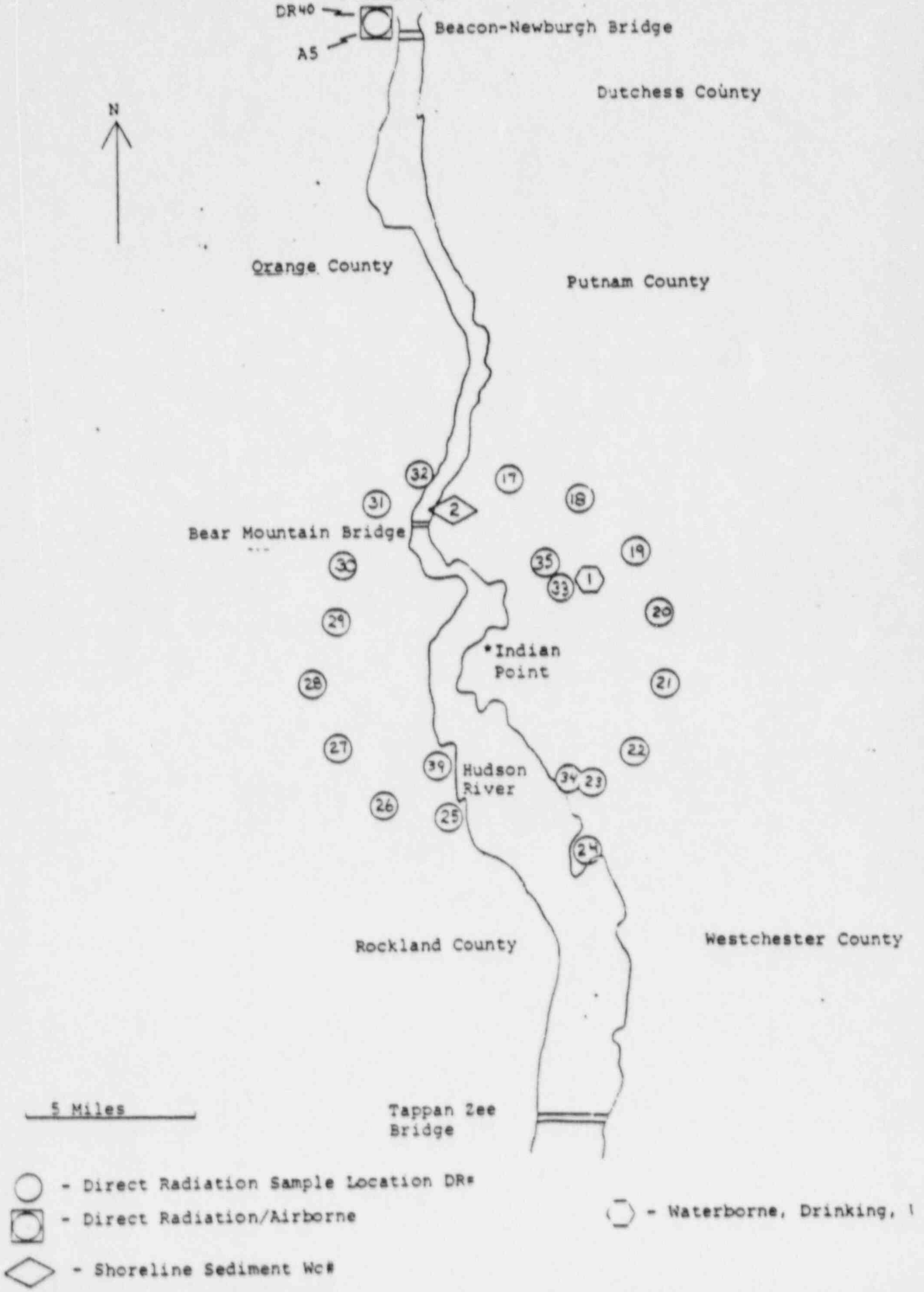


Table 4.1

Indian Point Station
Environmental Sampling Station Points

Exposure Pathway/Sample: Direct Radiation

RETS Sample Designation	Location	Distance
DR1	Cortlandt Sanitation Garage	2 mi - N
DR2	Old Pemart Ave.	2 mi - NNE
DR3	Charles Point	0.8 mi - NE
DR4	Lents Cove	0.5 mi - ENE
DR5	Broadway and Bleakley	0.4 mi - E
DR6	Sector Six Reuter Stokes Pole	0.5 mi - ESE
DR7	Water Meter House	0.3 mi - E
DR8	Service Center Building	0.4 mi - SSE
DR9	SE Corner	0.9 mi - SSE
DR10	NYU Tower	1 mi - SSW
DR11	White Beach	1 mi - SSW
DR12	Gays Hill Road South	1.5 mi - WSW
DR13	Gays Hill Road North	1 mi - W
DR14	Rt. 9W Pirates Cove	1 mi - WNW
DR15	Rt. 9W South of Ayers Road	1 mi - NW
DR16	Ayers Road	1 mi - NNW
DR17	Rt. 9D Garrison	5 mi - N
DR18	Gallows Hill Road	5 mi - NNE
DR19	Westbrook Drive	5 mi - NE
DR20	Pine Road - Cortlandt	5 mi - ENE
DR21	Croton Ave. - Cortlandt	5 mi - E
DR22	Colabaugh Pond Rd. Cortlandt	5 mi - ESE
DR23	Mt. Airy & Windsor Road	5 mi - SE
DR24	Croton Point	7.5 mi - SSE
DR25	Warren Ave. Haverstraw	5 mi - S
DR26	Railroad Ave. & 9W	5 mi - SSW
DR27	Willow Grove Road & Birch Drive	5 mi - SW
DR28	Palisades Parkway-NY/NJ Sign	5 mi - WSW
DR29	Palisades Parkway	4 mi - W
DR30	Anthony Wayne Park	4.5 mi - WNW
DR31	Palisades Pkwy Lake Welch Exit (South)	5 mi - NW
DR32	Rt. 9W Fort Montgomery	5 mi - NNW
DR33	Hamilton St.	3 mi - NNE
DR34	Furnace Dock	3.5 mi - SE
DR35	Highland Ave. & Sprout Brook	3 mi - NNE
DR36	Lower South & Bay Street	1.5 mi - NE
DR37	Verplanck-Broadway & Sixth St.	1.5 mi - SSW
DR38	Montrose Marina	1.5 mi - S
DR39	Grassy Point	3 mi - S
DR40	Roseton*	20 mi - N

Table 4.1 (Cont'd)

Exposure Pathway/Sample: Airborne

RETS Designation	Location	Distance
A1	Algonquin Gas Line	0.25 mi - SW
A2	Standard Brands	0.6 mi - NE
A3	Cortlandt Sanitation Garage	2 mi - N
A4	NYU Tower	1 mi - SW
A5	*Roseton	20 mi - N

Exposure Pathway/Sample: Waterborne-Surface (Hudson River Water)

Wa1	Plant Inlet	N/A
Wa2	Discharge Canal	N/A

Exposure Pathway/Sample: Waterborne- Drinking

Wb1	Camp Field Reservoir	3.5 mi - NE

Exposure Pathway/Sample: Sediment from Shoreline

Wc1	White Beach	0.9 mi - SSW
Wc2	*Manitou Inlet	4.5 mi - N

*Control Station Location

Exposure Pathway/Sample: Milk

There are no milch animals within 8 km distance of Indian Point; therefore, no milk samples are taken.

Exposure Pathway/Sample: Ingestion-Fish and Invertebrates

The RETS designate two required sample locations labeled Ib1 and Ib2. The downstream Ib1 location and samples will be chosen where it is likely to be effected by plant discharge. Ib2 will be a location upstream that is not likely to be effected by plant discharge. The following fish species are considered acceptable sample species.

Striped Bass	Bluegill Sunfish
White Perch	Pumpkin Seed Sunfish
White Catfish	Blueback Herring
American Eel	Crabs

Table 4.1 (Cont'd)

Exposure Pathway/Sample: Ingestion-Food Products (Broad Leaf Vegetation)

RETS Designation	Location	Distance
Ic1	SW and SSW Sectors N.Y.U.	0 - 1 mile
Ic2	N and NE Sectors Campsmith	1 - 3 miles
Ic3	Roseton (North)	20 miles

Corrections to Previously Submitted
<u>Semi-Annual Effluent Reports</u>

The following corrections should be made to previously submitted semi-annual effluent reports. The corrections to the "Average Stream Flow" where the result of identifying an error in calculation. The corrections to the 1984 isotopic activities is the result of a review performed for Brookhaven National Laboratory as requested by your letter dated May 16, 1986.

Average Stream Flow (CFS)

	Previous	Correct
1984 First Quarter	87000	9667
1984 Second Quarter	126000	14044
1984 Third Quarter	32950	10983
1984 Fourth Quarter	37050	12350
1985 First Quarter	60800	20267
1985 Secord Quarter	41550	13850

Table 1.A.B.1	4th Quarter 1984	
Total Iodine-131	1.61E-2	2.24E-3

Effluent and Waste Disposal

Semi-Annual Report

January 1 - June 30, 1986

Facility   Indian Point 3

Licensee   New York Power Authority

This information is provided in accordance with the requirements of Regulatory Guide 1.21. The numbered sections of this report reference corresponding sections of the subject Regulatory Guide, pages 1.21-10 to 12.

A. Supplemental Information

1. Regulatory Limits

Indian Point 3 is presently subject to limits on radioactive waste releases that are set forth in sections 2.3.1, 2.3.2, 2.3.3, 2.4.1, 2.4.2, 2.4.3 and 2.4.4 of Appendix B to Docket #50-286 entitled "Environmental Technical Specification Requirements Part II Radiological Environmental". The percentages of the technical specification limits reported in Tables 1A and 2A are the percent of the quarterly limits specified in the ETSR. If more than one limit applies to the release the most restrictive limit is applied.

2. Maximum Permissible Concentration

a. Fission and Activation Gases

The quarterly dose resulting from release of fission and activation gases is calculated in accordance with the methodology stated in the Off Site Dose Calculation Manual (ODCM). The specific isotopes listed in Table 1C are used to determine the effective dose factors for the time period.

b&c. Iodines, Tritium and Particulates

The quarterly organ dose limit for Iodine 131, tritium and particulates with half-lives greater than eight days is calculated in accordance with the methodology stated in the ODCM.

d. Liquid Effluents

The quarterly dose limit for liquid isotopic releases is calculated in accordance with the methodology stated in the ODCM. The instantaneous concentration limit for noble gases dissolved in liquid releases is calculated based upon a maximum permissible concentration of 2.00E-4 as required by section 2.3.1.A of the ETSR.

3. Average Energy

The average energies (E) of the radionuclide mixture in releases of fission and activation gases were as follows:

1st Quarter E	= 1.55E-1 MeV/dis	E = 6.75E-2 MeV/dis
2nd Quarter E	= 1.46E-1 MeV/dis	E = 5.55E-2 MeV/dis

4. Measurements and Approximations of Total Radioactivity

a. Fission and Activation Gases

Analysis of effluent gases has been performed in compliance with the requirements of Table 3.4-1 of the ETSR. In the case of isolated tanks (batch release) the total activity discharged is based on an isotopic analysis of each batch with the volume of gas in the batch corrected to standard temperature and pressure.

Vapor containment purge discharges have been treated as batch releases and pressure relief discharges have been treated as continuous releases (> 500 hrs/year as defined in NUREG 0133). At least one complete isotopic concentration analysis of containment air is performed monthly. This analysis is used in conjunction with a process monitor to obtain the isotopic mixture and quantification of each pressure relief. Isotopic analyses for each vapor containment purge are taken prior to and during the purge. This information is combined with the volume of air in each discharge to calculate the quantity of activity, from these discharges.

The continuous building discharges are based on weekly samples of ventilation air for isotopic content. This information is combined with total air volume discharged and the process radiation monitor readings to determine the quantity of activity from continuous discharges.

b&c. Iodines and Particulates

Iodine-131 and particulate releases are quantified by collecting a continuous sample of ventilation air on a TEDA impregnated activated charcoal cartridge and a glass-fiber filter paper. These samples are changed weekly as required in Table 3.4-1 of the ETSR and the concentration of isotopes found by analysis of these samples is combined with the volume or air discharged during the sampling period to calculate the quantity of activity discharged.

For other iodine isotopes the concentration of each isotope is determined monthly on a 24-hour sample. The concentration of the isotopes found by analysis is combined with the volume of air discharged during the sampling period to calculate the quantity of activity discharged.

d. Liquid Effluents

A sample of each batch discharge is taken and an isotopic analysis is performed in compliance with requirements specified in Table 3.3-1 of the ETSR. This isotopic concentration data is combined with information on volume discharged to determine the amount of each isotope discharged.

Proportional composite samples of continuous discharges are taken and analyzed in compliance with Table 3.3-1 of the ETSR. This concentration data is combined with the volume discharged to calculate the total activity discharged.

5. Batch Releases

a. Liquid

	1986 1st Quarter	1986 2nd Quarter
Number of Batch Releases	45	63
Total Time Period Batch Releases (Min.)	11567	17166
Maximum " " " " " "	412	513
Average " " " " " "	257	272
Minimum " " " " " "	155	120
Average Stream Flow (cfs)		

b. Gaseous

	1st Quarter	2nd Quarter
Number of Batch Releases	1	18
Total Time Period Batch Release (Min.)	75	8858
Maximum " " " " "	75	5075
Average " " " " "	75	492
Minimum " " " " "	75	30

6. Abnormal Releases

a. Liquid
None

b. Gaseous
None

7.0 Radiological Environmental Technical Specifications

The Radiological Environmental Technical Specifications require reporting of prolonged outage of effluent monitoring equipment (Sections 2.1.C and 2.2.B) and significant changes in the land use census, Radiological Environmental Monitoring Program or exceeding the total curie content limitations in outdoor tanks. (Sections 2.8.A, 2.8.B, 2.7.C and 2.3.4.B). During this reporting period no reportable events occurred.

The RETS modified the content and format of the Semi-Annual Effluent Release Report (Section 5.3.3.1). A Section G "Offsite Dose Calculation Manual Changes", has been included. During this reporting period there were several changes to the Offsite Dose Calculation Manual. There were no changes in the Process Control Program.

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

B. GASEOUS EFFLUENTS
FIRST AND SECOND

QUARTER, 1986

TABLE 1A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1986)

GASEOUS EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT 3	QUARTER 1st	QUARTER 2nd	EST. TOTAL Error %
A. Fission & Activation Gases				
1. Total release	Ci	5.54E+2	7.35E+2	2.50E+1
2. Average release rate for period	uCi/sec	7.12E+1	9.35E+1	
3. Percent of technical specification limit.	%	6.41E+0	7.90E+0	
B. Iodines				
1. Total iodine - 131	Ci	1.03E-3	2.14E-3	2.50E+1
2. Average release rate for period	uCi/sec	1.32E-4	2.72E-4	
3. Percent of technical specification limit.	%	2.19E-1	4.55E-1	
C. Particulates				
1. Particulates with half-lives >8 days	Ci	1.13E-5	1.29E-5	2.50E+1
2. Average release rate for period	uCi/sec	1.45E-6	1.64E-6	
3. Percent of technical specification limit.	%	2.19E-1	4.55E-1	
4. Gross alpha radioactivity	Ci	<3.89E-7	<3.86E-7	
D. Tritium				
1. Total release	Ci	9.45E-1	1.16E+0	2.50E+1
2. Average release rate for period	uCi/sec	1.22E-1	1.48E-1	
3. Percent of technical specification limit.	%	2.19E-1	4.55E-1	

TABLE 1C
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1986)
GASEOUS EFFLUENTS-GROUND RELEASES

		CONTINUOUS MODE		BATCH MODE	
Nuclides Released	Unit	1st Quarter	2nd Quarter	1st Quarter	2nd Quarter
1. Fission Gases					
Krypton (Kr) 85m	Ci	3.04E+0	2.29E+0		9.85E-2
Krypton (Kr) 85	Ci	1.41E+0	1.12E+0		3.05E+0
Krypton (Kr) 87	Ci	2.06E-3	6.62E-1		
Krypton (Kr) 88	Ci	1.32E-2	1.85E-2		4.13E-2
Xenon (Xe) 131m	Ci	2.28E+0	8.45E-1		4.01E+0
Xenon (Xe) 133m	Ci	3.45E+0	4.56E+0	9.47E-7	8.25E+0
Xenon (Xe) 133	Ci	4.87E+2	3.03E+2	8.33E-5	3.75E+2
Xenon (Xe) 135m	Ci	2.39E-4	1.30E-3		
Xenon (Xe) 135	Ci	5.72E+1	2.46E+1		7.31.E+0
Xenon (Xe) 138	Ci				
Argon (Ar) 41	Ci	9.74E-2	4.05E-2		
Unidentified	Ci				
TOTAL FOR PERIOD	Ci	5.54E+2	3.37E+2	8.42E-5	3.97E+2
2. Iodines					
iodine (I) 131	Ci	1.03E-3	2.14E-3		
iodine (I) 133	Ci				
iodine (I) 135	Ci				
TOTAL FOR PERIOD	Ci	1.03E-3	2.14E-3		

TABLE 1C
EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1986)
GASEOUS EFFLUENTS - GROUND RELEASES

Nuclides Released	Unit	CONTINUOUS MODE 1st Quarter	CONTINUOUS MODE 2nd Quarter	BATCH MODE 1st Quarter	BATCH MODE 2nd Quarter
3. Particulates					
Antimony (Sb) 125	Ci				
Barium (Ba) 133	Ci				
Cadmium (Cd) 109	Ci	6.08E-6	2.51E-6		
Cerium (Ce) 139	Ci				
Cerium (Ce) 141	Ci	6.96E-8	4.18E-7		
Cerium (Ce) 144	Ci		5.62E-7		
Cesium (Cs) 134	Ci				
Cesium (Cs) 137	Ci	6.37E-7	1.96E-6		
Cobalt (Co) 57	Ci				
Cobalt (Co) 58	Ci	2.48E-7	4.34E-6		
Cobalt (Co) 60	Ci	2.69E-6			
Chromium (Cr) 51	Ci	1.55E-6	2.24E-6		
Iron (Fe) 55	Ci		8.59E-7		
Niobium (Nb) 95	Ci				
Strontium (Sr) 85	Ci				
Strontium (Sr) 90	Ci				
Tin (Sn) 113	Ci				
TOTAL	Ci	1.13E-5	1.29E-5		

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

C. LIQUID EFFLUENTS
FIRST AND SECOND
QUARTERS, 1986

TABLE 2A

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT (1986)

LIQUID EFFLUENTS - SUMMATION OF ALL RELEASES

	UNIT	QUARTER 1st	QUARTER 2nd	EST.TOTAL ERROR %
A. Fission and activation products				
1. Total release (not including tritium, gases, alpha)	Ci	3.99E-2	7.90E-2	2.50E+1
2. Average diluted concentration during period	uCi/ml	1.56E-10	2.94E-10	
3. Percent of applicable limit	%	3.68E-1	9.48E-1	
B. Tritium				
1. Total release	Ci	1.95E+2	1.78E+2	2.50E+1
2. Average diluted concentration during period	uCi/ml	7.64E-7	6.62E-7	
3. Percent of applicable limit	%	3.68E-1	9.48E-1	
C. Dissolved and entrained gases				
1. Total release	Ci	1.16E+1	4.76E+0	2.50E+1
2. Average diluted concentration during period	uCi/ml	4.55E-8	1.77E-8	
3. Percent of applicable limit	%	3.68E-1	9.48E-1	
D. Gross alpha radioactivity				
1. Total release	Ci	<8.39E-5	<1.47E-4	2.50E+1
E. Volume of waste released (prior to dilution)	liters	1.48E+6	2.51E+6	1.00E+1
F. Volume of dilution water used during period	liters	2.55E+11	2.69E+11	1.00E+1

TABLE 2B

LIQUID EFFLUENT AND WASTE DISPOSAL SEMI-ANNUAL REPORT

		CONTINUOUS MODE		BATCH MODE	
Nuclides Released	Unit	1st Quarter	2nd Quarter	1st Quarter	2nd Quarter
Antimony (Sb) 122	Ci			2.18E-4	
Antimony (Sb) 124	Ci				1.17E-4
Antimony (Sb) 125	Ci			8.48E-5	9.51E-4
Barium (Ba) 140	Ci			4.39E-5	1.39E-5
Barium (Ba) 133	Ci			8.03E-5	2.24E-5
Cadmium (Cd) 109	Ci				1.93E-4
Cerium (Ce) 139	Ci				
Cerium (Ce) 141	Ci				
Cerium (Ce) 144	Ci			4.28E-4	
Cesium (Cs) 134	Ci				1.74E-4
Cesium (Cs) 137	Ci			1.20E-4	5.04E-4
Cesium (Cs) 138	Ci				6.84E-6
Chromium (Cr) 51	Ci			3.71E-4	3.12E-3
Cobalt (Co) 57	Ci			2.73E-5	3.69E-5
Cobalt (Co) 58	Ci			5.40E-3	2.01E-2
Cobalt (Co) 60	Ci		7.77E-5	8.98E-3	7.74E-3
Iodine (I) 131	Ci			6.67E-3	4.57E-3
Iodine (I) 133	Ci			1.42E-4	1.16E-4
Iodine (I) 134	Ci				
Iodine (I) 135	Ci				
Iron (Fe) 55	Ci			8.97E-3	2.75E-2
Iron (Fe) 59	Ci				4.27E-4
Lanthanum(La) 140	Ci			1.03E-5	
Mercury (Hg) 203	Ci			1.63E-5	5.42E-6

TABLE 2B

Nuclides	Unit	CONTINUOUS MODE 1s Quarter	CONTINUOUS MODE 2nd Quarter	BATCH MODE 1st Quarter	BATCH MODE 2nd Quarter
Manganese (Mn) 54	Ci			4.77E-4	5.26E-4
Molybdenum(Mo) 99	Ci			6.05E-5	
Nickel (Ni) 63	Ci			5.25E-3	2.49E-3
Copper (Cu) 64	Ci				6.97E-4
Niobium (Nb) 94	Ci			2.69E-6	
Niobium (Nb) 95	Ci			3.35E-4	1.19E-3
Yttrium (Y) 88	Ci				
Rubidium (Rb) 88	Ci			1.19E-3	1.83E-4
Ruthenium (Ru) 103	Ci			4.48E-5	1.04E-5
Ruthenium (Ru) 105	Ci			3.57E-5	1.58E-5
Ruthenium (Ru) 106	Ci				1.83E-4
Silver (Ag)110m	Ci			3.62E-4	6.71E-3
Sodium (Na) 24	Ci				
Strontium (Sr) 85	Ci			5.42E-5	5.18E-5
Technetium(Tc) 99m	Ci			1.65E-4	2.58E-4
Tin (Sn) 113	Ci			8.38E-5	6.99E-5
Tellurium (Te) 132	Ci				2.02E-6
Tungsten (W) 187	Ci			2.65E-5	1.22E-5
Zinc (Zn) 65	Ci				3.08E-5
Zirconium (Zr) 95	Ci			2.15E-4	4.77E-5
TOTAL FOR PERIOD			7.77E-5	3.99E-2	7.90E-2

TABLE 2B

Nuclides		Unit	CONTINUOUS MODE 1st Quarter	CONTINUOUS MODE 2nd Quarter	BATCH MODE 1st Quarter	BATCH MODE 2nd Quarter
Argon	(Ar) 41	Ci				1.35E-4
Xenon	(Xe) 131m	Ci			8.63E-2	3.46E-2
Xenon	(Xe) 133	Ci			1.13E+1	4.53E+0
Xenon	(Xe) 133m	Ci			1.50E-1	7.31E-2
Xenon	(Xe) 135	Ci			1.34E-1	1.06E-1
Xenon	(Xe) 135m	Ci			4.91E-4	3.82E-5
Krypton	(Kr) 85m	Ci			7.75E-4	1.28E-3
Krypton	(Kr) 85	Ci			1.22E-2	1.17E-2
Krypton	(Kr) 87	Ci			5.45E-5	
Krypton	(Kr) 88	Ci				1.30E-4
TOTAL DISSOLVED AND ENTRAINED GASES		Ci			1.16E+1	4.76E+0

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

D. SOLID WASTE
FIRST AND SECOND
QUARTERS, 1986

TABLE 3

EFFLUENT AND WASTE DISPOSAL SEMIANNUAL REPORT

January 1 - June 30, 1986

SOLID WASTE AND IRRADIATED FUEL SHIPMENTS

A. SOLID WASTE SHIPPED OFFSITE FOR BURIAL OR DISPOSAL (Not irradiated fuel)

1. Type of Waste	Unit	6 Month Period Class A	Class B	Est. Total Error, %
a. Spent Resins, filter sludges, etc.	m^3	4.81E+0	0	5.0E+1
	Ci	6.17E+0	0	
b. Dry Compressible, contaminated equip. etc.	m^3	0	0	N/A
	Ci	0	0	
c. Irradiated Components	m^3	0	0	N/A
	Ci	0	0	
d. Other	m^3	0	0	N/A
	Ci	0	0	

2. Estimate of major nuclide composition (by type of waste)

	NUCLIDE	UNIT	CLASS A	CLASS B
a.	Co-58	%	74	
	Co-60	%	8	N/A
	Fe-55	%	5	
	Ni-63	%	6	
	I-131	%	4	
	H-3	%	3	

3. Solid Waste Disposition

Number of Shipments	Mode of Transport	Destination
1	Truck	Barnwell, So. Carolina

4. Containers Shipped

Container	Class A Number	Class A Solid. Media	Class B Number	Class B Solid. Media
Steel Liner	1	None	N/A	N/A

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

E. RADIOLOGICAL IMPACT ON MAN

FIRST AND SECOND QUARTER, 1986

(Not to be submitted during this reporting period)

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

F. METERORLOGICAL DATA

FIRST AND SECOND QUARTER, 1986

(Not required to submitted during this reporting period)

Indian Point 3

EFFLUENT AND WASTE DISPOSAL

SEMI-ANNUAL REPORT

G. OFFSITE DOSE CALCULATION MANUAL CHANGES
FIRST AND SECOND
QUARTERS, 1986

Offsite Dose Calculation Manual (ODCM) Changes

Changes have been made to the ODCM since our last submittal. Each change is described and justified separately. These changes have been reviewed by the Plant Operating Review Committee as required by Section 6.5 of Appendix A to the facility operating license. These changes have been effective since March 5,1986.

Process Control Program (PCP) Changes

There have been no revisions to the PCP since our last semi-annual report.

ODCM Changes Since January 1986

1. DESCRIPTION:

   Table 1-1 was updated to include the Fan Cooler Service Water and Component Cooling Water Monitors and their associated data.

   JUSTIFICATION:

   The monitors associated with these potential liquid release paths were inadvertently left out of the last submittal.

   IMPACT:

   Results in a more accurate summary of our effluent monitors. There is no impact on dose assessments or set-point determinations.

2. DESCRIPTION:

   Section 2.1.10 is updated to reflect the newly installed variable speed pumps for condenser cooling intake.

   JUSTIFICATION:

   These pumps were installed to meet commitments of the Hudson River Settlement Agreement that required us to have the ability to vary pump flow rate.

   IMPACT:

   No impact relative to offsite dose assessment.

3. DESCRIPTION

   Section 2.1.11 was modified to allow storage of water in the refueling water storage tank at concentrations in excess of 7.3E-3 uCi/ml. The curie limit imposed by the RETS however remains unchanged.

   JUSTIFICATION:

   Since the RETS limits the total radioactivity in the tank it is not necessary to control to this value using a maximum activity concentration limit. Therefore we will control the activity by applying appropriate actions to reduce the activity concentration and/or the total allowable tank volume.

   IMPACT:

   This change will have no impact on set-point determinations or dose assessment.

4. <u>DESCRIPTION:</u>

The backup dose methodology for liquid effluents (Section 2.5) has been changed to improve calculation accuracy. It is now necessary to account for the top 90% of all radionuclides (based on activity content per release).

<u>JUSTIFICATION:</u>

This method will still allow for manageable hand calculations in the event they should become necessary and will add increased accuracy to the calculations. A multiplicative factor of 1.2 is retained in the equation employed to ensure conservative results.

<u>IMPACT:</u>

This change increases the accuracy of the dose calculations for liquid releases. Set-point determination is not effected by this change.

5. <u>DESCRIPTION:</u>

A more representative data set was used to re-calculate allowable time averaged noble gas release rates with the result that the annual and quarterly average release rates are increased. The change effects Section 1.2.1, Table 3-10 and Page 3 of Appendix 3-A.

<u>JUSTIFICATION:</u>

The increased limits were re-calculated after reviewing the radionuclide mixtures from past releases where the time average limit applied. Then after conservatively choosing the representative mixture to use in the calculation, the appropriate weighted dose factors were determined.

Use of these limits will allow increased operational flexibility when pressure relieving the vapor containment building.

<u>IMPACT:</u>

This change will cause set-point limits to be higher but offsite dose commitments will remain unchanged.

6. DESCRIPTION:

Time averaging the gaseous activity release rate over a time interval of one hour. This change will not effect the instantaneous release rate value from our last submittal which was based on the 500 millirem per year limit. This change effects Section 3.1.8, 3.3.1 and 3.4.1.

JUSTIFICATION:

The change allows for a realistic yet conservative dose assessment at the site boundary. There is a finite time required for the instantaneous dose rate limit to be reached from the resultant gas cloud. The time frame of one hour is consistent with 10 CFR 50.72 requirements. This change effectively allows a maximum dose at the site boundary of .06 millirem in a one hour period, based on annual average dispersion.

IMPACT:

Set points would not change; however, the comparison of instrument response (cpm) to the set-point would be averaged over one hour. This would allow short-term excursion above the set-point as long as the one hour average was below the set-point.

Dose assessments would not be effected, since the limitations of 5 mrad per quarter and 10 mrad per year must still be complied with.

7. DESCRIPTION:

Section 5 has been deleted to make the document more readable.

JUSTIFICATION:

The material contained in Section 5, back up information RETS items has been moved into the body of the ODCM in the appropriate sections.

IMPACT:

NONE