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INDIAN POINT 3

OFF SITE DOSE CALCULATION MANUAL

Offsite Dose Calculation Manaual

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Chapter I

Set Points

1.0 This section provides equations and methodology used at this Indian Point Station for each alarm and trip set point on each effluent release point according to Specifications 3.3.3.8 and 3.3.3.9.

The alarm and control location monitor, monitor description, location, power source, scale, range and identification number and the effluent isolation control device location, power source and identification number are provided in Tables 1-1A and 1-1B.

The equations used to determine set points for gaseous monitors are shown in Section 1.1, and for liquid monitors in Section 1.2.

1.1 Set Points for Gaseous Effluent Monitors

Set points for gaseous monitors are based on the permissible discharge rate as calculated in sections 4.5 and 4.6 of the 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, the quarterly average or instantaneous set points may be used. (per Reference 10, AP-11). The set points are based on the following permissible discharge rates:

Basis of Limit	Permissible Discharge Rate (ci/sec): Iodine/Particulate*	Permissible Discharge Rate (ci/sec): Noble Gases
Annual Average	8.32E-08	1.55E-03
Quarterly Average	1.66E-07	3.01E-03
Instantaneous	2.68E-06	9.51E-03

*(half-lives 8 days)

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

$$S = \frac{D}{(E)\ (F)\ (4.72 \times 10^{-4})}$$

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

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 vent 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.

The iodine monitors' set points are set at 5000 cpm to assure compliance with the instantaneous and annual average limits for a sampler that is changed once per week. For the iodine monitors, the following equation applies

$$S = \underline{E_1 \; C \; fk \; (1 - e^{-\lambda t})}$$

E_1 = efficiency of detector (cpm/uCi)

C = concentration required to reach release rate limit. This concentration is 3.53E-9 uCi/cc for a plant vent flow of 50,000 cfm and the annual average release rate limit of 8.32E-8 Ci/sec

f = pump flow rate (ft^3/ min)

λ = decay constant for I-131 (min^{-1})

t = time of sample collection (min)

k = constant to convert ft^3 to cc

The set points are normally set at 5000 cpm so that a short spike (15 min) of iodine activity at the instantaneous release limit would alarm the monitor. This is a more conservative Set Point than assuming a release at the annual average limit for 1 week.

1.2 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:

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

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

F = Dilution Flow in Discharge Canal (gpm)

f = Release Discharge Rate (gpm)

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

The set points are normally determined quarterly and are based on conservative assumptions such as the following:

MPCw:	1.0E-6 uCi/cc
F:	168,000 gpm
f:	150 gpm

If the set point is too restrictive, the actual MPCw, F and f can be used.

TABLE 1-1A

EFFLUENT MONITORING SYSTEM DATA

CHANNEL	MONITOR DESCRIPTION	LOCATION	ALARM & CONTROL LOC.	POWER SOURCE	EFFLUENT ISOLATION CONTROL DEVICE I.D.	LOCATION	POWER SOURCE
R 11	Containment Air Particulate Monitor	CCR-Rack D-2	ALARMS-LOC. at Monitor and CCR Safeguards Panel	125V AC INSTR Bus 34 CKT7	FCV 1170/SOV 1270 FCV 1172/SOV 1272	PAB-80' elev. PAB-80' elev.	125VAC PNL 33CKT26 PNL 33CKT26
R 12	Containment Gas Monitor				PCV 1190/SOV 1290 PCV 1191/SOV 1191 PCV 1192/SOV 1192	inside VC 46' elev outside VC 68' elev	PNL 33CKT25 PNL 34CKT24
	Sample Collection Equipment/ Detector	PAB elev 68' Penetration area	<u>Control</u>-CCR Rack D-2	MCC-36B		outside VC 68' elev	PNL 34CKT24
R 13	Plant Vent Particulate Monitor	CCR-Rack D-2	Alarms same as R 11	125VAC INSTR Bus 34 CKT7			
	Sample Collection/Detector	73' level of Fan House	Control-CCR Rack D-2	MCC-36B			
R-14	Plant Vent Radiogas Monitor	CCR-Rack D-2	Alarms-same as R 11 Remote alarm at WDS panel	125VAC INSTR Bus 34 CKT7	RCV-014 Waste gas vent	PAB 15' elev. Near large gas decay tanks valving room	125VDC PNL 33 CKT14
R 15	Condenser Air ejector monitor	CCR-Rack D-2	local alarms same as R 11	125VAC INSR Bus 34 CKT7	PCV 1169/SOV 1169 AEJ Vent to VC	36' elev Turbine Hall	125 VDC PNL 32 Circuit 6
			Remote-Red light and buzzer at detector		PCV 113/SOV 1133 stm to condenser primary ejector	36' elev Turbine Hall	125 VDC PNL 31 CKT 3
R-18	Waste Disposal Liquid Effluent Monitor	CCR-Rack D-3	Alarm-local same as R 11 Remote at WDS PNL	125 VAC INSTR Bus #33 CKT 17	<u>RCV 018</u> Waste disch to condenser circ water	PAB-36' elev in Waste Condensate tank room	125 VDC PNL 33 CKT 14

TABLE 1-1A CONTINUED

CHANNEL	MONITOR DESCRIPTION	LOCATION	ALARM & CONTROL LOC.	POWER SOURCE	EFFLUENT ISOLATION CONTROL DEVICE I.D.	LOCATION	POWER SOURCE
R 19	5/6 Sample & Blowdown monitor	CCR-Rack D-3	local alarm same as R 11 remote-red light & buzzer at detector	125VAC INSTR Bus 33 CKT 17	PCV 1223/SOV 1523 PCV 1224/SOV 1524 PCV 1225/SOV 1525 PCV 1226/SOV 1526	5/6 31-34 Sample Isolation Valves	125VDC PNL 31 CKT3
					PCV 1223A/PCV 1223A PCV 1224A/PCV 1524A PCV 1225A/PCV 1525A PCV 1226A/PCV 1526A	PAB piping penetration area 55' elevation	125VDC PNL 32 CKT6
					PCV 1214/SOV 1314 PCV 1215/SOV 1315 PCV 1216/SOV 1316 PCV 1217/SOV 1317		125VDC DNL 31 CKT3
					PCV 1214A/SOV 1214A PCV 1215A/SOV 1215A PCV 1216A/SOV 1216A PCV 1217A/SOV 1217A		125VDC PNL 32 CKT6
					PCV 1227/SOV 1527	46' elevation in blowdown tank room	125VDC PNL 31 CKT3
R 20	Waste Gas Analyzer	CCR-Rack D-3	Local alarms same as R 11 Remote alarm at WDS PNL		none		

Effluent Monitoring System Data Table I-1B

1. Location of the effluent monitor, working system (i.e., principal release point building ventilation exhaust point)

R-12-Containment Gas Monitor
The detector and equipment is located in a cabinet on the 68' elevation of the penetration area. The sample is drawn form the intake of Containment Fan Coolers No. 32 and 35. The sample air is returned to Containment at the penetration approximately the 58' elevation near the RCP seal flow manifolds.

R-14-Plant Vent Radiogas Monitor
This monitor measures gaseous radioactivity in the Plant Vent Stack. The detectors are located in the Plant Vent at approximately the 105' elevation.

R-15-Condenser Air Ejector Monitor
This detector is located above the 33' elev. in the Turbine Hall Bldg. The discharge from the air ejector exhaust header of the condensers is monitored by this channel with an inline detector for gaseous activity, which is indicative of a primary to secondary leak.

R-20-Waste Disposal System Gas Analyzer Monitor
This detector is located above the 15' elev. in the primarly auxiliary building and monitors the waste gas decay tank activity. The detector is mounted in a special sampler and is in direct contact with the gas sample being monitored.

Radio-Iodine Monitors - Located in a cabinet on approximately the 90' elevation in the Fan Building. The four channel system is hookedup to the following locations.

Channel I Plant Vent
Channel II Containment
Channel III Primary Auxiliary Bldg. Overhead
Channel IV Steam Generator Blowdown Room

2. Detector Information

R-12-GM-Tube-The detector assembly is in a completly enclosed housing containing the GM tube in a vessel. Lead shielding envelops the housing to reduce background level. The sample is constantly mixed in a fixed and shielded volume.

R-14-GM-Tube-The detector assembly consists of four GM tubes which are electrically connected in parallel. The GM tubes are oriented so as to assure a representative sample of the air flow is constantly monitored.

R-15-GM-Tube-The detector assembly consists of a GM tube mounted into an inline container which includes adequate shielding to reduce any possible background radiation.

R-20-Ionization Chamber-The detector is mounted in a special sampler, because of the extremely high level of radiation in the waste gas decay tanks.

Radioiodine Monitors — Scintillation detector The gamma detector consists of a canned Thallium Activated Sodium Iodine Crystal optically coupled to the phototube.

3. Readout Range of the detector (minimum/maximum cpm)

R12	0-1x10^6cpm
R14	0-1x10^6cpm
R15	0-1x10^6cpm
R20	0-1x10^5mR/hr

<u>Iodine Monitors</u>

Channel I	0 - 10^8cpm
Channel II	0 - 10^8cpm
Channel III	0 - 10^8cpm
Channel IV	0 - 10^8cpm

4. 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)

4.72 E-04 is a conversion factor from $\frac{uCi}{cc}$ $\frac{ft^3}{min}$ to Ci/sec

5. Reference radionuclide used to calibrate system

R-11-Swipes of representative particulate activity counted on Ge(Li) and R-11.

R-12-Gas Marinelli sample of vapor containment counted on Ge(Li) and related to R-12 reading.

R-13-Swipes of representative particulate activity counted on Ge(Li) and R-13.

R-14-Primary Gas in Volume Control Tank A mixture of Xenon & Krypton gases.

R-15-Gas Marinelli sample taken of Condenser Air Ejector and related to the R-15 meter reading.

R-20-None Available

Radioiodine Monitors
Channel I
Channel II ^{133}Ba, ^{137}Cs (Mock iodine) or I131, if available
Channel III
Channel IV

6. Alarm function of system (e.g. isolaton of purge, alarm in control room, etc.) Each channel process monitor has a high and low level alarm on the channels power supply drawer. The low level alarm is used to indicate instrument failure. The high-level alarm functions at preset levels.

R-12-A) Containment evacuation alarm annunciates.
B) Alarms in CCR III, meter readout and recorder printout also available.
C) When R12 alarms, Containment Ventilation isolation occurs (i.e. closure of the valves in the purge supply and exhaust lines, and the Pressure Relief Line. The containment isolation valves for the sample and return lines (PCV1234 to PCV1237) for channel R11 and 12 are normally open and controlled from the Central Control Room's Containment Isolation Panel, and are also tripped closed by a Phase A Containment Isolation Signal. When these valves are closed the space between them is treated with Weld Channel air.

R-14-A) Alarm in CCR III, meter readout and recorder printout also.
B) On an alarm condition on Channel R14 an alarm, "Stack Monitor Hi Radiation" is annunciated on the Waste Disposal System panel in the Primary Auxiliary Building. When Channel R14 alarms valve RCV014 will trip shut, securing waste gas release.

R-15-A) Alarm in CCR III, meter readout and recorder printout also.
B) On an alarm condition on channels R15, a red light and buzzer are energized at the detector.
C) Three separate controls are actuated to prevent excessive readiogas release to the environment.

1. This signal opens the containment isolation valves to allow venting the air ejector discharge to containment. Then SOV1169 is deenergized and PCV1169 changes position to vent the Air Ejector to Containment via the blower which is started by this signal.

2. PCV1133 (Steam to Condenser Priming Ejectors) is closed if open and/or denied permission to be opened. This protects the detector from overtemperature and protects against an uncontrolled release since the priming ejector discharge is not monitored by this Channel R15.

3. The Flash Evaporator is shut down by this signal to prevent activity from the extraction steam from getting to the atmosphere or contaminating the flash evaporator. This Channel R15 will trip the brine recycle pumps, brine heater drain pumps, distillate pumps and the vacuum pump of the Flash Evaporator.

R-20-Waste Disposal System Gas Analyzer Monitor

A) Alarms in CCR III, meter readout and recorder print out also available.

B) On an alarm condition on Channel R20 an alarm, "Gas Activity Monitor Hi Activity", is annunciated on the Waste Disposal System panel in the PAB.

Chapter 2

Liquid Effluent Concentrations

2.0 This section provides a description of the means that will be used to demonstrate compliance with Technical Specification 3.11.1.1.

2.1 Compliance with the instantaneous limits of 10CFR20 is achieved by observance of discharge limits and monitor set points. Only dilution water from Unit 3 circulators is taken credit for so the maximum concentration will not exceed limits if Unit 2 is discharging simultanteously. 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. This report will also contain a calculation of dose based on the method provided in section 3.5 of the ODCM. This dose will be compared to one half of the Appendix I, 10CFR50 limits to determine whether time averaged limits are being approached.

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

2.3 A discharge line radiation monitor with automatic discharge line isolation valve control shall be operable for all liquid discharges. Radioactivity in liquid waste shall be continuously monitored and recorded during release. If monitor is inoperable, two independent samples are required prior to release. No release is allowed if the monitor is inoperable for more than 72 hours. The flow rate of liquid radioactive waste effluents shall be continuously measured and recorded.

2.4 The radioactive liquid waste sampling and analysis program is showed in Table 2-1.

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

$$C = E \times R$$

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

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

R = count rate of monitor (cpm)

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

$$C_D = \frac{E \times R \times f}{F} \quad \text{(eq.2-2)}$$

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)

TABLE 2-1

RADIOACTIVE LIQUID WASTE SAMPLING AND ANALYSIS PROGRAM

Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml)[a]
Batch Waste Release Tanks[d]	P Each Batch	P Each Batch	Principal Gamma Emitters[f]	5×10^{-7}
(Waste Condensate and Monitor Tanks)	P Each Batch	W Composite	I-131	1×10^{-6}
	P One Batch/M	M	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	P Each Batch	M Composite[b]	H-3 Gross alpha P-32	1×10^{-5} 1×10^{-7} 1×10^{-6}
	P Each Batch	Q Composite[b]	Sr-89, Sr-90 Fe-55	5×10^{-8} 1×10^{-6}
Plant Continuous Releases[e] (Steam Generator Blowdown)	Continous[c]	W Composite[c]	Principal Gamma Emitters[f] I-131	5×10^{-7} 1×10^{-6}
	M Grab Sample	M	Dissolved and Entrained Gases	1×10^{-5}
	Continous[c]	M Composite[c]	H-3 Gross alpha P-32	1×10^{-5} 1×10^{-7} 1×10^{-6}
	Continuous[c]	Q Composite[c]	Sr-89, Sr-90 Fe-55	5×10^{-8} 1×10^{-6}

TABLE 2-1 (Continued)

TABLE NOTATION

Sample and Analysis Frequencies

M = At least once per 31 days
P = Prior to each release
Q = At least once per 92 days
W = At least once per 7 days

a. The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 s_b}{EVY\ (2.22 \times 10^6)\ \exp(-\lambda \Delta t)}$$

where

LLD is the "a priori" lower limit of detection as defined above (as uCi per unit mass or volume):

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute):

E is the counting efficiency (as counts per transformation);

V is the sample size (in units of mass or volume);

2.22×10^6 is the number of transformations per minute per microcurie;

Y is the fractional radiochemical yield (when applicable);

is the radioactive decay constant for the particular radionuclide;

is the elapsed time between sample collection and time of counting.

The value of s_b used in the calculation of the LLD for a detection system shall be used on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance: Typical values of E, L, V, Y and t shall be used in the calculation.

b. A composite sample is one in which the quanity of liquid samples is proportional to the quanty of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released.

c. To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release. Composite samplers must be engineered and backfit and will not be operational until September 1, 1981.

d. A batch release is the discharge of liquid wastes of a dicrete volume. Prior to sampling for analysis, each batch shall be isolated, and thoroughly mixed (2 tank volumes) to assure representative sampling.

e. A continuous release is the discharge of liquid wastes of a non-discrete volumes; e.g., from a volume of system that has an input flow during the continuous relesae.

f. The principal gamma emitters for which the LLD specification applies exclusively are the following radionuclides: Mn54, Fe59, Co58, Co60, Zn65, Mo99, Cs134, Cs137, Ce141, and Ce144. This list dose not mean that only these nuclides are to be detected and reported. Other peaks which are measureable and identifiable, together with the above nuclides, shall also be identified and reported.

Chapter 3

Liquid Effluent Dose Calculations

3.1 Calculational Requirements

3.1.1 Section 3.11.1.2, of the Technical Specification requires that the dose or dose commitment above background to an individual in an unrestricted area from radioactive materials in liquid effluents released from all reactors at the site 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.

Cumulative dose concentrations shall be calculated at least once per 31 days.

3.1.2 Section 3.11.1.3, 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 all reactors on the site when averaged over 31 days, would exceed 0.06 mrem to the total body of 0.2 mrem to any organ. Also doses due to liquid release shall be projected at least once per 31 days.

3.1.3 Section 3.11.1.1, 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. For dissolved or entrained noble gases the concentration shall be limited to 2×10^{-4} uCi/ml total activity.

3.2 General Information Pertaining to Liquid Effluent Releases

3.2.1 The surveillance and lower limit of detection requirements for liquid radioactive effluents are contained in Section 4.11.1 of the Technical Specifications. For any and all discharges, a minimum of 100,000 gpm of dilution flow should be available for IP3NPP.

3.2.2 A completed and properly authorized Liquid Radioactive Waste Permit (Att. 3-1) 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.

3.2.3 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. One half of the limits delineated in Section 3.1 are applicable to IP3NPP since it is a two unit site.

3.2.4 The radioactivity in liquid waste and the discharge flow rate of that waste shall be continuously monitored and recorded during release. If the radiation monitor is inoperable for up to 72 hours, two independent samples of each tank shall be taken and two plant personnel shall independently check valving prior to discharge. If the discharge radiation monitor is inoperable for more than 72 hours, that liquid discharge shall be stopped until the monitor is placed back in service.

3.2.5 The radioactivity in steam generator blowdown shall be continuously monitored and recorded. Whenever this monitor is inoperable, the blowdown shall be sampled once per watch until the monitor is returned to service.

3.2.6 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. The chemistry technician will provide to the watch the concentration of radioactivity and the MPC for the sample taken and this information will be used to determine the permissible discharge rate and alarm set point as shown in Attachment 3-1.

3.2.7 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 (Att. 4-1) on a daily basis using data supplied by the Chemistry technician.

3.2.8 Assurance that combined liquid releases from units 2 and 3 do not exceed section 3.1.3 limits for the site is provided by administrative controls agreed to in the Memorandum of Understanding (#15) between Con Edison and the Power Authority concerning liquid discharges and the requirements of this document.

3.2.9 The dilution flow from Unit No. 3 should be used for calculating discharge canal concentrations. However, by agreement with Con Edison's, IP2NPP 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.

3.3 Calculation of Dose to Maximum Exposed Individual from Liquid Effluent

3.3.1 NUREG 0133 (ref. 1, section 4.3, pg. 14) states that cumalative 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 3.4.

3.3.2 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 3.1. The cumulative dose factors ($A_{i\tau}$) are calculated in Section 3.4. the following equation is generally applicable and can be used for any number of isotopes released over any time period.

$$D_\tau = \sum_i [A_{i\tau} \sum_{\ell=1}^{m} \Delta t_\ell \quad C_{i\ell} \quad F_\ell]$$

where:

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

Δt_ℓ = the length of the ℓth time period over which $C_{i\ell}$ and F_ℓ are averaged for all liquid releases, in hours.

$C_{i\ell}$ = the average concentration of radionuclide, i, in undiluted liquid effluent during time period Δt_ℓ from any liquid release, in uCi/ml.

$A_{i\tau}$ = the site related ingestion dose commitment factor to the total body or any organ τ for each IP3-NPP identified principal gamma and beta emitter listed in table 3-1, in mrem-ml per hr - uCi.

$F\ell$ = the near field average dilution factor for $Ci\ell$ during any liquid effluent release. 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 $Ci\ell$ 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 $F\ell$ and Ai_{τ} terms.

The term $F\ell$ is a near field average dilution factor and is determined as follows:

$$F\ell = \frac{\text{Liquid Radioactive Waste Flow}}{(\text{Discharge Structure Exit Flow} \times (\text{Applicable Factor}))}$$

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 $F\ell$, 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 3.2.1 and on Attachment 3-1.

3.4 Dose Factor for Liquid Effluent Calculations.

3.4.1. The equation for dose from liquid effluents requires the use of a dose factor Ai_τ 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 Ai_τ 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 Guidel.109 (ref. 3) with the exception of the fish bioaccumulator factor (BFi) for Cesium. A factor of 150 was used instead of the 2,000 presented in Table A-1 of the Regulatory Guide. The justification for this substitution is presented in Section 3.5.3. The summary dose factor is as follows:

$$Ai_\tau = Ko \, (U_F BFi + U_I \, BIi) \, DFi$$

where:

Ai = 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 = 10^6 pci/uCi/ml 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/ℓ 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 IP3NPP site, Ai_τ can be expressed as:

$$Ai_\tau = 1.14E05 \, (21 \, BF_i + 5 \, BI_i) \, DF_i$$

IP3NPP has complied Ai_τ factors for total body and critical organs for the maximum exposed individual. These are included as table 3-1.

3.5 Operational Method for Calculation of Dose to Maximum Exposed Individual from Liquid Effluent

3.5.1 This method is a simple version of that presented in section 3.3. and 3.4. and is more amenable to manual calculation. However, if the resultant dose calculated using this method exceeds 10% of the limits presented in section 3.1, the calculational method presented in Section 3.3. and 3.4. must be utilized.

3.5.2 This method is identical to that presented in section 3.2 except that only releases of Cs-134 and Cs-137 are considered and that ingestion of invertebrates is not considered. This is justified based on a previous study (ref. 4) of past releases which identified that doses via the fish ingestion pathway were found to account for more than 90% of the total dose received by the hypothetical maximum exposed individual. In addition, the isotopes Cs-134 and Cs-137 contributed more than 90% of the dose received from fish ingestion. Utilizing these assumptions the equation reduces to the following.

$$D_\tau = \sum_{\ell=1}^{m} \Delta t_\ell \, F_\ell \, (A_{\tau_1} C_{\ell_1} + A_{\tau_2} C_{\ell_2})$$

where:

All terms have been previously defined and the subscripts 1 and 2 refer to Cs-134 and Cs-137 respectively.

3.5.3. As stated in section 3.4.1, the bioaccumulation factor (BF_I) for cesium 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. 3), and that the behavior of cesium in the Hudson is a complex phenomenon.

The NYU study (ref. 3) 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.

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 justifible since this remains as a conservative calculation.

3.5.4. Based on the discussions in previous paragraphs, the equation for the cumulative dose factor (Ait) reduces to the following assuming the whole body is the critical organ:

$$A_{i\tau} = K_o \quad U_F BF_I \; DF_I$$

where:

All factors have been previously defined. The resultant values for Cs-134 and Cs-137 are as follows:

$$\text{Cs-134} = A_{\tau_1} = (1.14E05)\ (21)\ (150)\ (1.21E\text{-}04) = 4.35\ E04$$
$$\text{Cs-137} = A_{\tau_2} = (1.14E05)\ (21)\ (150)\ (7.14E\text{-}05) = 2.56\ E04$$

3.5.5. The final dose equation is as follows:

$$D = \sum_{\ell=1}^{m} \Delta t_\ell \quad F_\ell \quad (4.35\ E04\ C_{\ell_1} + 2.56E04\ C_{\ell_2})$$

where:

All terms have been previously defined and the subscripts 1 and 2 refer to Cs-134 and Cs-137 respectively.

3.6 Calculation of Maximum Permissible Concentrations in Liquid Effluents

3.6.1 This section describes the methodology used to meet the requirements of section 3.1.3. The total discharge canal concentration of discharge from all three 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. The dissolved noble gas limit is contained in Section 3.1.3.

3.6.5. The following methodology is utilized to meet the requirements of section 3.1.3., the results are entered on Attachment 4-1:

1. 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).

2. 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.

3. After recirculation have the tank sampled and obtained the radioactive concentration and MPC for the sample. Record this and the total dilution flow from this unit on Att. 4-1.

4. 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. The adjusted dilution flow is calculated as follows:

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

where:

Dr = current release discharge rate (gpm)

E = required dilution flow for current release (gpm)

A = Activity of current release (uCi/cc)

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

Adjusted Dilution Flow = Available dilution flow (Att. 3-1)-E

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

$$D = \frac{(MPCw\ \ )\quad (B)}{C}$$

where:

D = maximum permissible discharge rate (gpm)

B = Adjusted dilution flow available from unit (gpm)

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

TABLE 3-1

AiΥ - Liquid Effluent

Case - Adult (maximum exposed individual)

Pathway: Invertebrates & Fish

$$Ai\Upsilon = (1.14E05)\ (21BFi + 5BFi)\ DFi$$

Isotope	BFi (Fish)	BIi (Inver)	DFi Whole Body	DFi Critical Organ	Critical Organ	Ai Υ Whole Body	Ai Υ Critical Organ
^{3}H	9.0E-01	9.0E-01	1.05E-07	1.05E-07	Whole Body	2.80E-01	2.80E-01
^{14}C	4.6E+03	9.1E+-3	5.68E-07	2.84E-06	Bone	9.20E+03	4.60E+04
^{24}Na	1.0E+02	2.0E+02	1.70E-06	1.70E-06	Whole Body	6.01E+02	6.01E+02
^{32}P	1.0E+05	2.0E+04	7.46E-06	1.93E-04	Bone	1.87E+06	4.84E+07
^{51}Cr	2.0E+02	2.0E+03	2.66E-09	6.69E-07	GI-LLI	4.31E+00	1.08E+03
^{54}Mn	4.0E+02	9.0E+04	8.72E-07	1.40E-05	GI-LLI	4.56E+04	7.32E+05
^{56}Mn	4.0E+02	9.0E+04	2.04E-08	3.67E-06	GI-LLI	1.07E+03	1.92E+05
^{55}Fe	1.0E+02	3.2E+03	4.43E-07	2.75E-06	Bone	9.14E+02	5.67E+03
^{59}Fe	1.0E+02	3.2E+03	3.91E-06	3.40E-05	GI-LLI	7.15E+03	7.02E+04
^{58}Co	5.0E+01	2.0E+02	1.67E-06	1.51E-05	GI-LLI	3.90E+02	3.53E+03
^{60}Co	5.0E+01	2.0E+02	4.72E-06	4.02E-05	GI-LLI	1.10E+03	9.39E+03
^{63}Ni	1.0E+02	1.0E-02	4.36E-06	1.30E-04	Bone	1.29E+03	3.85E+04
^{65}Ni	1.0E+02	1.0E+02	3.13E-08	1.74E-06	GI-LLI	9.28E+00	5.16E+02
^{64}Cu	5.0E+01	4.0E+02	3.91E-08	7.10E-06	GI-LLI	1.36E+01	2.47E+03
^{65}Zn	2.0E+03	1.0E+04	6.96E-06	1.54E-05	Liver	7.30E+04	1.62E+05
^{69}Zn	2.0E+03	1.0E+04	1.37E-09	1.97E-08	Liver	1.44E+01	2.07E+02
^{83}Br	4.2E+02	3.3E+02	4.02E-08	5.79E-08	GI-LLI	4.80E+01	6.91E+01
^{84}Br	4.2E+02	3.3E+02	5.21E-08	5.21E-08	Whole Body	6.22E+01	6.22E+01
^{85}Br	4.2E+02	3.3E+02	2.14E-09	2.14E-09	Whole Body	2.55E+00	2.55E+00
^{86}Rb	2.0E+03	1.0E+03	9.83E-06	2.11E-05	Liver	5.27E+04	1.13E+05
^{88}Rb	2.0E+03	1.0E+03	3.21E-08	6.05E-08	Liver	1.72E+02	3.24E+02

Table 3-1 Continued

Isotope	BFi (Fish)	BLi (Inver)	DFi Whole Body	DFi Critical Organ	Critical Organ	Ai Whole Body	Ai Critical Organ
^{131m}Te	4.0E+02	6.1E+03	7.05E-07	8.40E-05	GI-LLI	3.13E+03	3.73E+05
^{131}Te	4.0E+02	6.1E+03	6.22E-09	8.63E-08	Kidney	2.76E+01	3.83E+02
^{132}Te	4.0E+02	6.1E+03	1.53E-06	7.71E-05	GI-LLI	6.78E+03	3.42E+05
^{130}I	1.5E+01	5.0E+00	8.80E-07	1.89E-04	Thyroid	3.41E+01	7.33E+03
^{131}I	2.0E+03	5.0E+00	3.41E-06	1.95E-03	Thyroid	1.63E+04	9.34E+06
^{132}I	2.0E+03	5.0E+00	1.90E-07	1.90E-05	Thyroid	9.1E+02	9.1E+04
^{133}I	2.0E+03	5.0E+00	7.53E-07	3.63E-04	Thyroid	3.6E+03	1.74E+06
^{134}I	2.0E+03	5.0E+00	1.03E-07	4.99E-06	Thyroid	4.94E+02	2.4E+04
^{135}I	2.0E+03	5.0E+00	4.28E-07	7.65E-05	Thyroid	2.1E+03	3.7E+05
^{134}Cs	1.5E+02	1.0E+03	1.21E-04	1.48E-04	Liver	1.12E+05	1.38E+05
^{136}Cs	1.5E02	1.0E+03	1.85E-05	2.57E-05	Liver	1.72E+04	2.39E+04
^{137}Cs	1.5E+02	1.0E+03	7.14E-05	1.09E-04	Liver	6.63E+04	1.01E+05
^{138}Cs	1.5E+02	1.0E+03	5.40E-08	1.09E-07	Liver	5.02E+01	1.01E+02
^{139}Ba	4.0E+00	2.0E+02	2.84E-09	1.72E-07	GI-LLI	3.51E-01	2.13E+01
^{140}Ba	4.0E+00	2.0E+02	1.33E-06	4.18E-05	GI-LLI	1.64E+02	5.17E+03
^{141}Ba	4.0E+00	2.0E+02	1.59E-09	4.71E-08	Bone	1.96E-01	5.82E+00
^{142}Ba	4.0E+00	2.0E+02	1.34E-09	2.13E-08	Bone	1.66E-01	2.63E+00
^{140}La	2.5E+01	1.0E+03	3.33E-10	9.25E-05	GI-LLI	2.10E-01	5.83E+04
^{142}La	2.5E+01	1.0E+03	1.45E-11	4.25E-07	GI-LLI	9.13E-03	2.68E+02
^{141}Ce	1.0E+00	1.0E+03	7.18E-10	2.42E-05	GI-LLI	4.11E-01	1.39E+04
^{143}Ce	1.0E+00	1.0E+03	1.35E-10	4.56E-05	GI-LLI	7.73E-02	2.61E+04
^{144}Ce	1.0E+00	1.0E+03	2.62E-08	1.65E-04	GI-LLI	1.50E+01	9.44E+04
^{143}Pr	2.5E+01	1.0E+03	4.56E-10	4.03E-05	GI-LLI	2.87E-01	2.54E+04
^{144}Pr	2.5E+01	1.0E+03	1.52E-12	3.01E-11	GI-LLI	9.57E-04	1.90E-02
[illegible] Nd	2.5E+01	1.0E+03	4.35E-10	3.49E-05	Bone	2.74E-01	2.20E+04
^{187}W	1.2E+03	1.0E+01	3.01E-08	2.82E-05	GI-LLI	8.66E+01	8.12E+04
^{239}Np	1.0E+01	4.0E+02	6.45E-11	2.40E-05	Liver	1.63E-02	6.05E+03

Table 3-1 Continued

Isotope	BFi (Fish)	BIi (Inver)	DFi Whole Body	DFi Critical Organ	Critical Organ	Ai γ Whole Body	Ai γ Critical Organ
^{89}Rb	2.0E+03	1.0E+03	2.82E-08	4.01E-08	Liver	1.51E+03	2.15E+02
^{89}Sr	3.0E+01	1.0E+02	8.84E-06	3.08E-04	Bone	1.14E+03	3.97E+04
^{90}Sr	3.0E+01	1.0E+02	1.86E-03	7.58E-03	Bone	2.40E+05	9.76E+05
^{91}Sr	3.0E+01	1.0E+02	2.29E-07	2.70E-05	GI-LLI	2.95E+01	3.48E+03
^{92}Sr	3.0E+01	1.0E+02	9.30E-08	4.26E-05	GI-LLI	1.20E+01	5.49E+03
^{90}Y	2.5E+01	1.0E+03	2.58E-10	1.02E-04	GI-LLI	1.63E-01	6.42E+04
^{91m}Y	2.5E+01	1.0E+03	3.52E-12	2.67E-10	GI-LLI	2.22E-03	1.68E-01
^{91}Y	2.5E-01	1.0E+03	3.77E-09	7.76E-05	GI-LLI	2.37E+00	4.89E+04
^{92}Y	2.5E+01	1.0E+03	2.47E-11	1.48E-05	GI-LLI	1.56E-02	9.32E+03
^{93}Y	2.5E+01	1.0E+03	7.40E-11	8.50E-05	GI-LLI	4.66E-02	5.35E+04
^{95}Zr	3.3E+00	6.7E+00	6.60E-09	3.09E-05	GI-LLI	7.73E-02	3.62E+02
^{97}Zr	3.3E+00	6.7E+00	1.55E-10	1.05E-04	GI-LLI	1.82E-03	1.23E+03
^{95}Nb	3.0E+04	1.0E+02	1.86E-09	2.10E-05	GI-LLI	1.34E-02	1.51E+06
^{99}Mo	1.0E+01	1.0E+01	8.70E-07	9.99E-06	GI-LLI	2.43E+01	2.96E+02
^{99m}Tc	1.5E+01	5.0E+00	8.89E-09	4.13E-07	GI-LLI	3.45E-01	1.60E+01
^{101}Tc	1.5E+01	5.0E+00	3.59E-09	6.59E-09	Kidney	1.39E-01	2.55E-01
^{103}Ru	1.0E+01	3.0E+02	7.97E-08	2.16E-05	GI-LLI	5.80E+00	4.21E+03
^{105}Ru	1.0E+01	3.0E+02	6.08E-09	9.42E-06	GI-LLI	1.19E+00	1.84E+03
^{106}Ru	1.0E+01	3.0E+02	3.48E-07	1.78E-04	GI-LLI	6.78E+01	3.47E+04
^{110m}Ag	1.0	1.0	8.79E-08	6.04E-05	GI-LLI	2.61E-01	1.79E+02
^{125m}Te	4.0E+02	6.1E+03	3.59E-07	1.09E-05	Kidney	1.59E+03	4.83E+04
^{127m}Te	4.0E+02	6.1E+03	8.25E-07	2.75E-05	Kidney	3.66E+03	1.22E+05
^{127}Te	4.0E+02	6.1E+03	2.38E-08	8.68E-06	GI-LLI	1.06E+02	3.85E+04
^{129m}Te	4.0E+02	6.1E+03	1.82E-06	5.79E-05	GI-LLI	8.07E+03	2.57E+05
^{129}Te	4.0E+02	6.1E+03	7.65E-09	1.32E-07	Kidney	3.39E+01	5.85E+02

ATTACHMENT 3-1

POWER AUTHORITY OF THE STATE OF NEW YORK
INDIAN POINT NO. 3 NUCLEAR POWER PLANT

Liquid Radioactive Waste Release Permit

No. ________

Tank ________________ Isolated ________________ ________________
Date Date

Volume ________________ Recirculation ____________ * ____________ ____________
Rate Start Time Stop Time

Radio Analysis ____________ at ____________ on ____________ showed on activity of
Sample No. Time Date

____________ uCi/ml. Based on this isotopic mixture the allowable mpcw in discharge canal is ____________ uCi/ml.

Dilution flow for this release is ____________ gpm (____________ circ's from unit III, ____________ circ's from Unit I & II if considered for this release).

Other simultaneous releases from this unit result in a discharge canal concentration of ____________ uCi/ml.

Permissible discharge rate ____________ gpm. Radiation Monitor Alarm Setpoint ____________

Boron concentration in this tank is ____________ ppm.

Discharge Rate Based on Waste Chemistry ____________ gpm. Chemical Species ____________

Discharge radiation monitor operable ____________ yes ____________ no if no:

1. Monitor out of service ____________ ____________ (max 72 hours).
Date Time

2. Discharge valve line up checked by ____________ and ____________.
Name Name

3. Second Sample taken by ____________.
Name

Discharge flow meter & recorder operable ______ yes ______ no.

Discharged authorized by ________________

Discharge initiated ________________ ________________
Date Time

Dishcarge terminated ____________ ____________ actual volume released ____________ gals.
Date Time

* Determined from pump curve when flow meter unavailable.

CHAPTER 4

GASEOUS EFFLUENT DOSE CALCULATIONS

4.1 Calculational Requirements

4.1.1. Section 3.11.2.1 of the Technical Specifications requires that the dose rate due to radioactive materials released in gaseous effluents from the site 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 from and radionuclides (other than noble gases) with half lives greater than 8 days: less than or equal to 1500 mrem/yr to any organ.

4.1.2. Section 3.11.2.2. of the Technical Specifications requires that the air dose due to noble gases released in gaseous effluents 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.

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

4.1.3. Section 3.11.2.3 of the Technical Specifications requires that the dose to an individual from radioiodines, and radioactive materials in particulate form, and radionuclides (other than noble gases) with half lives greater than 8 days in gaseous effluents released from the site 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.

4.1.4. Section 3.11.2.4. of the Technical Specifications requires that 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 when averaged over 31 days, would exceed 0.2 mrad for gamma radiation, 0.4 mrad for beta radiation. 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 0.31 mrem to any organ.

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

4.2 General Information Pertaining to Gaseous Effluent Releases

4.2.1. The surveillance and lower limit of detection requirements for gaseous radioactive effluents are contained in section 4.11.2. of the Technical Specifications. All releases at IP3NPP are assumed to be ground level so there are no elevated releases.

4.2.2. A completed and properly authorized Airborne Radioactive Waste Release Permit (Att. 4-1) shall be issued prior to the release of airborne activity from the waste gas holding system, containment purge, and containment pressure relief. The unit shall maintain its own Airborne Radioactive Release Permit book for the life of the plant. The site meteorology indicated in the control room shall be recorded on the Release Permit on an hourly basis during these discharges.

4.2.3. All activity determinations for gaseous effluent releases shall be performed in such a manner as to be representative of the activity released from the site. In general, one half of the limits delineated in section 4.1 are applicable to IP3NPP since it is a two unit site.

4.2.4. During normal operations without a primary to secondary leak, all gaseous ground level releases occur through the main plant vent. 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.

4.2.5. Prior to starting a release of airborne waste from the primary waste gas holding system, the plant vent radiogas monitor, the iodine collection device, and the particulate collection device shall be operating. A waste gas decay tank or containment purge shall be sampled and tested prior to release. For containment pressure relief the radioactive concentration indicated by the containment radiogas monitor may be used.

4.2.6. If the plant vent radiogas monitor (R-14) or the condenser air ejector monitor (R-15) become inoperable when the associated discharge path is in use, grab samples shall be taken daily for gross radioactivity and a release permit shall be issued for the 24 hour period using values obtained from this analysis. If either monitor has been inoperable for more than seven days, releases by the associated path shall be terminated.

4.2.7. For release that are expected to continue for periods over two days a new release permit shall 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.

4.2.8. Gaseous releases to the environment, except for the turbine building ventilation exhaust shall be continuously monitored. If the monitors are inoperable, samples will be taken daily for up to seven days. Beyond that, the release shall be terminated.

4.2.9. Assurance that the combined gaseous releases from Units 2 and 3 do not exceed section 4.1 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.

4.2.10. 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.

4.3 Instantaneous Dose Rate Calculation for Airborne Releases of Iodines and Particulates with Half Lives Greater Than 8 Days

4.3.1. The equations developed in this section are used to meet the calculational requirements of paragraph 4.1.1. The critical age group is assumed to be the infant as recommended in NUREG-0133 (ref. 1, section 5.2.1. pg. 25). Based on a previous agreement with Consolidated Edison, IP3NPP utilizes 50% of the site release limit as measured in Ci/sec, which translates to 70% 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. 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:

$$\sum_i Pi \quad [Wv \quad \dot{Q}iv] \leq 1000 \quad mrem/yr \quad \text{(to any organ)}$$

where:

Pi = The dose parameter for radionuclides other than noble gases for the inhalation pathway in mrem/yr per uCi/m^3 and for food and ground plan pathways in m^2 mrem/yr per pCi/second. The dose factors are based on the critical individual organ and most restrictive age group.

Paragraph 4.3.3., of Gaseous Effluents - calculation of Pi (inhalation), contains the bases and models for calculation of Pi (inhalation) and its tabulated values. Designated Pi (in).

Paragraph 4.3.4., of this manual, Gaseous Effluents - calculation of Pi (ground plane) contains the bases and models for calculation of Pi (ground plane) and its tabulated values. Designated Pi (gp).

Paragraph 4.3.5., of this manual, Gaseous Effluents Calculation of Pi (food) contains the bases and models for Pi (food) and its tabulated values. Designated Pi (f).

$\dot{Q}iv$ = the release rate of radionuclides, i, in gaseous effluents from the release in uCi sec.

W_v = 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 4.5.)

W_v(in)= 1.4E-05 sec/m^3, for the inhalation pathway release. The location is the unrestricted area boundary in the SW sector, at 350 meters.

W_v(gp)= 8.13 E0-8 m^{-2}, for the ground plane pathway, vent release. (continued)

The location is the unrestricted are boundary in the SSW sector, at 380 meters.

Wv(F) = 6.7E-11 M^{-2}, for the food pathway release. The location is in the SSW sector at 8.9 miles. For tritium in the food pathway use Wv(in) at this location, 1.5E-08 sec/m^3.

4.3.2. To estimate the dose rate for radioiodines and radioactive materials in particulate form other than noble gases, and with half lives greater than 8 days, the following relationships shall be used.

$$[Pi(in)\ Wv(in)\ \dot{Q}iv + Pi(gp)\ Wv(gp)\ \dot{Q}iv + Pi(food)\ Wv(f)\ \dot{Q}iv + Pi(Food\text{-}H\text{-}3)\ Wv(in)] = mrem/yr \quad \text{(to any organ)}$$

4.3.3. Gaseous Effluents - Calculation of Pi (Inhalation Dose Factor)

The Pi parameter contained in the radioiodine and particulates Specification represents the transport pathway of the ith radionuclide, the receptors usage of the pathway media, and dosimetry of the exposure. Pathway usage rates and the internal dosimetry are functions of the receptor's age; however, the youngest age group, the infant, will always receive the maximum dose under the exposure conditions for the Specification delineated in paragraph 4.1.1.

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 infant age group ($1400m^3/yr$) from Table E-5 of Regulatory Guide 1.109.

DFAi = the maximum organ inhalation dose factor for the infant age group for the ith radionuclide, in mrem/pCi. Taken from Table E-10 of Regulatory Guide 1.109.

Resolution of units yields:

Pi (inhalation) = 1.4E09 DFAi

All Pi (in) factors for the infant age group have been calculated using the above equation and as listed in table 4-1.

4.3.4. Gaseous Effluents - Calculation of Pi (Ground Plane)

The factor Pi (ground plane) represents the dose parameter contained in the radioiodine and particulates Specification for the ground plane pathway. This dose factor is based on the critical individual organ (skin or total body), and the most restrictive age groups (infant).

$$Pi = \frac{K'K''DFGi\ (1-e^{-\lambda it})}{\lambda i} \quad (m^2 mrem/yr\ per\ uCi/sec)$$

where:

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

K" = Constant of unit conversion, 8760 hr/yr

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

t = Exposure period, 3.15×10^7 sec (1 year)

Resolution of units yields:

$$Pi\ (ground\ plane) = 8.76E09\ DFG_i\ (1-e^{-\lambda it})/_{i}\lambda$$

The deposition rate onto the ground plane results in a ground plane concentration that is assumed to persist over a year with radiological decay the only operating removal mechanism for each radionuclide. The ground plane dose conversion factors for the ith radionuclide, DFG_i, are taken from Regulatory Guide 1.109, Table E-6. All Pi (gp) factors have been calculated using the above equations and are listed in Table 4-2.

4.3.5. Gaseous Effluents Calculation of Pi (Food Dose Factor)

The factor Pi (food) represents the dose parameter contained in the radioiodine and particulate Specification for the food pathway. The organ with the maximum ingestion dose factor will be the limiting organ, and the infant, the limiting age group.

$$P_i \text{ (food)} = K'r \left[\frac{Q_F \text{ (Uap)}}{Y_p \; (\lambda_i + \lambda_w)} \right] \text{Fm } DFL_i \left[e^{-\lambda_i t_f} \right]$$

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

where:

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

Q_F = The cow's consumption rate, in Kg/day (wet weight)

Uap = The infant's milk consumption rate, in liters/yr

Y_p = The agricultural productivity by unit area, in Kg/m^2

Fm = The stable element transfer coefficients, in days/liter

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

DFLi = The maximum organ ingestion dose factor for the ith radionuclide, i mrem/pCi.

λ_i = The decay constant for the ith radionuclide, in sec^{-1}

λ_w = The decay constant for removal of activity on leaf and plant surfaces by weathering, 5.73×10^{7} sec^{-1} (corresponding to a 14 day half-time)

tf = The transport time from pasture to cow, to milk, to infant, in sec.

A fraction of the airborne deposition is captured by the ground plant vegetation cover. The captured material is removed from the vegetation (grass) by both radiological decay and weathering processes.

Regulatory Guide 1.109 provides the following parameters:

1. Q_F = 50Kg/day (Table E-3)

2. Uap = 330 liters/yr (Table E-5)

3. Y_p = 0.7 Kg/m^2 (Table E-15)

4. t_f = 2 days (1.73×10^5 sec)(Table E-15)

5. r = 1.0 for radioiodines; r = 0.2 for particulates (Table I-15)

6. Fm values - Table E-1

7. DFLi values - Table E-14

Resolution of units yields (all radionuclides except H-3):

$$Pi\ (food) = 2.4.\ \times 10^{10} \frac{rFm}{\lambda i + \lambda w}\ DFLi\ [e^{-\lambda_i t_f}]$$

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

The concentration of tritium in milk is based on its airborne concentration rather than the deposition rate.

$$Pi = K'K'''\ F_m\ QF\ Uap\ \ DFLi\ [0.75\ (0.5/H)]$$

where:

K''' = Constant of conversion, 10^3 gm/kg

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

0.75 = Fraction of total feed that is water

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

Regulatory Guide 1.109 provides the following parameters:

1. Fm = 1.0×10^{-2} day/liter (Table E-1)

2. DFLi = 3.08×10^{-7} mrem/pCi (Table E-14)

Assuming an average absolute humidity of 8 grams/m^3, the resolution of units yields (H-3 only):

$$Pi\ (food) = 2.4 \times 10^3 \text{ mrem/yr per uCi/m}^3$$

all P_i (f) factors have been calculated using the above equations and are listed in Table 4-3.

4.4 Instantaneous Dose Rate Calculation for Airborne Releases of Noble Gas

4.4.1. The equations developed in this section are used to meet the calculational requirements of paragraph 4.1.1. The magnitude of this pathway is the same for all age groups so there is no critical group. Based on a previous agreement with Consolidated Edison IP3NPP utilizes 50% of the site release limit as measured in uCi/ml, which translates to 70% of the applicable dose rate limit. This is a result of the different dispersion facotrs for each unit due to their relative positions to the critical sector of the unrestricted area boundary. The equations for calculating the dose rate limitations are obtained from NUREG 0133 (ref. 1, section 5.1). Utilizing the above assumption, these equations reduce to the following:

$$\sum_i (K_i)\ \overline{(X/Q)}_v\ (\dot{Q}iv) < 350 \text{ mrem/yr} \quad \text{whole body}$$

$$\sum_i (Li + 1.1Mi)\ \overline{(X/Q)}v\ (\dot{Q}iv) =$$

$$\sum_i (si)\ \overline{(X/Q)}v\ (\dot{Q}iv) < 2100 \text{ mrem/yr} \quad \text{to the skin}$$

where:

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

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 (unit conversion constant of 1.1 mrem/mrad converts air dose to skin dose).

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

Si = (Li + 1.1Mi) in mrem/yr per uCi/m^3.

$\dot{Q}iv$ = The release rate of radionuclides, i, in gaseous effluent from the release, in Ci/sec.

$\overline{(X/Q)}v$ = For all vent releases, the highest calculated annual average relative concentration for any area at the unrestricted area boundary, 1.4 E-05 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 4-4, 4-5, 4-6, 4-7 and 4-8 respectively.

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

$\bar{K}\ (\dot{Q}tv) < 350$ mrem/yr - dose to whole body

$(\bar{L} + 1.1\ \bar{M})\ (\dot{Q}tv) =$

$(\bar{S})\ (\dot{Q}tv) < 2100$ mrem/yr dose to the skin

where:

$\dot{Q}tv$ = The release rate of all noble gases summed together, in uCi/sec

$$\dot{Q}tv = \sum_i Qiv$$

$$\bar{K} = (1/\dot{Q}tv) \sum \dot{Q}iv\ \bar{K}i$$

$$\bar{K}i = Ki\ (\overline{X/Q})_v$$

$$\bar{L} = (1/\dot{Q}tv) \sum \dot{Q}iv\ \bar{L}i$$

$$\bar{L}i = Li\ (\overline{X/Q})_v$$

$$\bar{M} = (1/\dot{Q}tv) \sum \dot{Q}iv\ \bar{M}i$$

$$\bar{M}i = Mi\ (\overline{X/Q})v$$

$$\bar{N} = (1/\dot{Q}tv) \sum_i \dot{Q}iv\ \bar{M}i$$

$$\bar{N}i = Ni\ (\bar{X}/Q)v$$

$$\bar{S} = (1/\dot{Q}tv) \sum_i \dot{Q}iv\ \bar{S}i$$

$$\bar{S}i = Si\ (\bar{X}/Q)_v$$

The values of $\bar{K}i$, $\bar{L}i$, $\bar{M}i$, $\bar{N}i$ and $\bar{S}i$ have been listed in Table 4-9 for the unrestricted area boundary and Table 4-19 for the nearest residence.

4.5 Operational Method of Determining Compliance with Instantaneous Dose Rate Limitations for Airborne Releases of Iodines and Particulates with HalfLives Greater than Eight Days

4.5.1. This section describes an alternative calculational method to meet the requirements of paragraph 4.1.1. The purposes of this method is to provide a calculational technique which is readily amenable to hand calculation and yields conservative results. Thus, enabling the use of a quick and easy calculation instead of the tedious method presented in Section 4.3, for certain release conditions.

4.5.2. 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 is 2.0 x 10^4 or more greater in the vapor containment than the concentration of radioiodine and radioactive materials in particulate from with half-lives greater than eight days. The method described in the following paragraphs may also be utilized to determine whether or not the iodine and particulate release rate is acceptable.

4.5.3. From past semi-annual effluent release reports (ref. 6) for IP3NPP it was observed that the total iodine release was on the average 45% of the total release of iodines and all particulates with half lives greater than eight days.

4.5.4. The doses to various organs and the whole body for gaseous releases typical of IP3NPP for the inhalation, ground plane, and ingestion pathways, was calculated (ref. 4) for infants and children which are the critical age group. From the calculations, the following generalizations were observed:

a) For the inhalation pathway the dose to the thyroid exceeded that to any other organ of the whole body by at least a factor of 10 for the child and at least a factor of 14 for the infant.

b) For the milk ingestion pathway, the dose to the thyroid exceeded that to any other organ or the whole body by at least a factor of 8 for the child and at least a factor of 10 for the adult.

c) For the ground plane pathway, the dose is calculated to the whole body including the thyroid.

4.5.5. From the data listed in paragraph 4.5.4 it is assumed that the thyroid is the critical organ for gaseous releases of iodine and particulates typical of IP3NPP.

4.5.6. In performing this analysis it is assumed that the inhalation and ground plane pathways occur at the worst X/Q and D/Q unrestricted area boundary sectors for the instantaneous limit and at the nearest residence in the worst X/Q and D/Q sector for the annual and quarterly limits. The milk pathway is assumed to occur at 8.9 miles in the ESE direction, which is the closest location to the site at which cows are currently kept. In reveiwing the dose factors from section 4.3, it was noted that for I-131 the dose from the ground plane pathway is approximately a factor of 100 less than the inhalation pathway so it is neglected in this calculation.

4.5.7. 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.

4.5.8. The assumptions presented in the previous paragraphs can be used with the equations presented in section 4.3 to determine the instantaneous dose rate to the maximum organ of the maximum individual for iodine. However, for the purpose of this operational calculation only 50% of the applicable dose limit will apply as explained in paragraph 4.2.3. the instantaneous dose equation reduces to the following:

$$D = (P(in)\ Wv(in) + P(f)\ Wv(f))\ \dot{Q}v < 750 \text{ mrem/yr}$$ to the thyroid

Where:

D = the dose in mrem/yr

P(in) = The dose parameter of I-131 for the inhalation pathway, 1.48E07 mrem/yr per uCi/m^3.

P(f) = The dose parameter of I-131 for the milk ingestion pathway, (1.08E12 m.mrem/yr per uCi/sec.

Wv(in) = The highest calculated annual average dispersion parameter, for the inhalation pathway at the unrestricted area boundary in the SW sector at 350 meters, 1.4E-05 sec/m^3.

Wv(f) = the highest calculated annual average deposition parameter for the food pathway for existing dairy farms in the unrestricted area located in the ESE sector at 8.9 miles, 6.7E-11 m^{-2}. For tritium in the food pathway use Wv(in) at this location, 1.5E-08 sec/m^3.

$\dot{Q}v$ = The vent release ratio of all iodines and particulates summed together in uCi/sec.

4.5.9. In addition to the instantaneous release rate limitation further release rate limitations can be derived from the quarterly and annual requirements of section 4.1.3. For this calculation the release is assumed to persist for the whole year and one half of the limits stated in the specification is utilized as per paragraph 4.2.3. These equations are as follows:

quarterly:

$$D = (P(in)\ Wv(in) + P(f)\ Wv(f))\ \dot{Q}v \leq 15 \text{ mrem/yr to the thyroid}$$

annual:

$$D = (P(in)\ Wv(in) + P(f)\ Wv(f))\ \dot{Q}v \leq 7.5 \text{ mrem/yr to the thyroid}$$

Where:

Wv(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, 1.2E-06 sec/m^3.

and all other parameters are defined in paragraph 4.5.8.

4.5.10. Since iodines make up only 45% of the total gaseous releases of iodine and particulates, the above equations assume that all iodine and particulate isotopes are Iodine-131. However, since the thyroid is the critical organ this is a conservative assumption as explained in paragraph 4.5.7 and these equations can then be solved to yield an estimate of the maximum allowable release rate as follows:

$$\dot{Q}v = \frac{D}{(P(in)\ Wv(in) + P(f)\ Wv(f))}$$

instantaneous:

$$\dot{Q}v = \frac{750}{2.80E02} = 2.68 \text{ uCi/sec}$$

quarterly:

$$\dot{Q}v = \frac{15}{9.01E01} = 1.66 \text{ E-01 uCi/sec}$$

annual

$$\dot{Q}v = \frac{7.5}{9.01E01} = 8.32 \text{ E-02 uCi/sec}$$

4.5.10. In summary the calculated limits are as follows for maximum iodine release rate:

Limit	Permissible Discharge Rate		
annual	8.32	E-02	uCi/sec
quarterly	1.66	E-01	uCi/sec
instantaneous	2.68		uCi/sec

4.5.11. If the method described in paragraph 4.5.2 is not used the limits presented in paragraph 4.5.10 shall be utilized based on iodine-131 equivalent release rates. 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.

4.5.12. Although this method uses assumptions it is felt that they were conservative such that utilization of the derived limits will insure that the instantaneous dose rate specification will not be exceeded. This is based on the assumptions and discussions delineated in the preceding paragraphs of this section and those in the sections describing instrument calibration, monitoring, and set points.

4.5.13. If a release must be made at a rate that exceeds the iodine limits of this section a sample of that release should be taken prior to starting the release, or in the case of an uncontrolled or unplanned release, during discharge if possible. This sample shall be analyzed as soon as possible to determine if Technical Specification limits have been violated. In these instances the method described in Section 4.3 shall be utilized. In addition, the method of Section 4.3 can be utilized at any time since it offers a more accurate calculation of the dose rate.

4.5.14. When the unit is operating with a primary to secondary leak, the RESS or his designee shall provide information to the Shift Supervisor on radioactivity releases from all points on site and the limitations that these releases impose on discharges from the waste gas holdup and containment systems.

4.6 Operational Method of Determining Compliance With Instantaneous Dose Rate Limitations For Airborne Releases of Noble Gases.

4.6.1 This section describes an alternative calculational method to meet the requirements of paragraph 4.1.1. The purpose of this method is to provide a calculational technique which is readily amenable to hand calculation and yields conservative results. Thus, enabling the use of a quick and easy calculation, instead of the tedious method presented in Section 4.4, for certain release conditions.

4.6.2. 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 a standard $\bar{K}_S$, $\bar{L}_S$, $\bar{M}_S$, $\bar{N}_S$, and $\bar{S}_S$ can be determined using the technique presented in paragraph 4.4.2 and the $\bar{K}i$, $\bar{L}i$, $\bar{M}i$, $\bar{N}i$ and $\bar{S}i$ values from Table 4-9. The data and results of this calculation are shown in Table 4-10.

4.6.3. These standard factors can be used with the equations and limits presented in Section 4.4. The instantaneous dose rate equations then reduces to the following

dose to whole body:

$$\bar{K}_s\ (\dot{Q}tv) \leq 350 \text{ mrem/yr}$$

dose to skin:

$$\bar{S}_s\ (\dot{Q}tv) \leq 2100 \text{ mrem/yr}$$

4.6.4 In addition to the instantaneous release rate limitation further release rate limitations can be derived from the quarterly and annual requirements of paragraph 4.1.2. These requirements are evaluated at the nearest residence in the unrestricted area as described in paragraph 4.8.2. Standard $\bar{K}_s$, $\bar{L}_s$, $\bar{M}_s$, $\bar{N}_s$, and $\bar{S}_s$ factors can be determined for this location using the technique presented in paragraph 4.4.2. and the $\bar{K}i$, $\bar{L}i$, $\bar{M}i$, $\bar{N}i$ and $\bar{S}i$ factors from Table 4-19. The data and values are shown in Table 4-10A. In this case the release is assumed to persist for the whole year and one half of the limits stated in the specification are utilized. These equations are as follows:

quarterly:

$\bar{M}_s\ (\dot{Q}tv) \leq$ 10 mrad/yr dose to whole body

$\bar{N}_s\ (\dot{Q}tv) \leq$ 20 mred/yr dose to skin annual:

$\bar{M}_s$ $(\dot{Q}tv) \leq$ 5 mrad/yr dose to whole body

$\bar{N}_s$ $(\dot{Q}tv) \leq$ 10 mrad/yr dose to skin

4.6.5. Utilizing the equations from paragraphs 4.6.3 and 4.6.4 and the values from Table 4-10 and 4-10A maximum release limits for all noble gases in uCi/sec can be calculated as follows:

instantaneous:

$$\dot{Q}tv = \frac{350}{\bar{K}_s} = \frac{350}{3.68E-02} = 9.51\ E03\ \frac{uCi}{sec}\ \text{(whole body)}$$

$$\dot{Q}tv = \frac{2100}{\bar{S}_s} = \frac{2100}{6.40E-02} = 3.28\ E04\ \frac{uCi}{sec}\ \text{(Skin)}$$

quarterly:

$$\dot{Q}tv = \frac{10}{\bar{M}_s} = \frac{10}{3.32E-03} = 3.01E03\ \frac{uCi}{sec}\ \text{(Whole body)}$$

$$\dot{Q}tv = \frac{20}{\bar{N}_s} = \frac{20}{2.57E-03} = 7.78E03\ \frac{uCi}{sec}\ \text{(Skin)}$$

annual:

$$\dot{Q}tv = \frac{5}{\bar{M}_s} = \frac{5}{3.23E-03} = 1.55E03\ \frac{uCi}{sec}\ \text{(Whole body)}$$

$$\dot{Q}tv = \frac{10}{\bar{N}_s} = \frac{10}{2.57E-03} = 3.89E03\ \frac{uCi}{sec}\ \text{(Skin)}$$

4.6.6 The more restrictive value from each of the instantaneous, quarterly and annual calculations are used to represent maximum total noble gas discharge rates.

Limit	Permissible Discharge Rate
annual	1.55 E03 uCi/sec
quarterly	3.01 E03 uCi/sec
instantaneous	9.51 E03 uCi/sec

4.6.7. 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 to date for the calender month stay within the quarterly average and the Operations Superintendent is in agreement. The Shift Supervisor may use the instantaneous limit for a release if the Superintendent of Power is in agreement. These limits may change with changes in primary coolant gas mixtures and the instantaneous limit should be checked by the Radiological and Environmental Services Department when applied.

4.6.8. Although this method uses assumptions it is felt that they were conservative such that utilization of the derived limits will assure that the instantaneous dose rate specification will not be exceeded. This is based on the assumptions and discussions delineated in the preceeding paragraphs of this section and those in the sections describing instrument calibration, monitoring, and set points.

4.6.9. If a release must be made at a rate that exceeds the instantaneous limits of paragraph 4.6.6 a sample of that release should be taken prior to starting the release, or in the case of an uncontrolled or unplanned release, during discharge if possible. This sample shall be analyzed as soon as possible to determine if Technical Specification limits have been violated. In these instances the method described in Section 4.4 shall be utilized. In addition, the method of Section 4.4 can be used at any time since it offers a more accurate calculation of the dose rate.

4.6.10. When the unit is operating with a primary to secondary leak, the RESS or his designee shall provide information to the Shift Supervisor on radioactivity releases from all points on site and the limitations that these releases impose on discharges from the waste gas holdup and containment systems.

4.7 Calculation of Dose From Airborne Releases of Iodines and Particulates with Half Lives Greater Than 8 Days.

4.7.1. The equations in this section are used to meet the calculational requirements of paragraphs 4.1.3 and 4.1.4. 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, p. 31).

4.7.2. The pathways considered in this analysis are the 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 are assumed to exist at the nearest residence in the worst meteorological sector, which is the SSW sector at 1526 meters. The individual at this location is considered to ingest milk from the closest actual dairy farm located in the worst meteorological sector within ten miles of the plant, which is the ESE sector at 8.9 miles. This is believed to be a conservative calculation of dose to the maximum individual.

4.7.3. The equations for calculating the dose limitations are obtained from NUREG 0133 (ref. 1, section 5.3,). Since this is a two unit site IP3NPP is limited to one half of the limits specified in paragraphs 4.1.3. and 4.1.4. Utilizing the assumptions contained in paragraph 4.6.1 these equations reduce to the following:

During any calendar quarter:

$$3.17 \times 10^{-8} \sum_i Ri \quad (Wv\ \tilde{Q}iv + wv\tilde{q}iv) \leq 15 \text{ mrem}$$

During any calendar year:

$$3.17 \times 10^{-8} \sum_i Ri \quad (Wv\ \tilde{Q}iv + wv\tilde{q}iv) \leq 7.5 \text{ mrem}$$

Where:

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

$\tilde{q}_{iv}$ = The plant vent releases of radioiodines and radioactive materials in particulate with half lives greater than eight days, i, 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.

Wv = The vent dispersion or deposition parameter for estimating the dose to an individual at the controlling location for long term releases (greater than 500 hrs/yr):

Wv(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, 1.2E-06 sec/m^3.

Wv(dep) = The highest calculated annual average deposition parameter for the ground plane pathway for the nearest residence in the unrestricted area located in the S sector at 1279 meters, 8.8E-09 m^{-2}.

Wv(f) = The highest calculated annual average deposition parameter for the food pathway for existing dairy in the unrestricted area located in the ESE sector at 8.9 miles, 6.7E-11 m^{-2}. For tritium in the food pathway use Wv(in) at this location 1.5E-08 sec/m^3.

wv = 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 4.9:

wv(in) = The highest calculated annual average short term dispersion parameters for the inhalation pathway for the nearest residence in the unrestricted area located in the SSW sector at 1526 meters, in sec/m^3.

wv(dep) = The highest calculated annual average deposition parameter for the ground plane pathway for the nearest residence in the unrestricted area located in the S sector at 1279 meters in m^{-2}.

wv(f) = The highest calculated annual average short term deposition parameter for the food pathway for existing dairy farms in the unrestricted area located in the ESE sector at 8.9 miles, in m^{-2}. For tritium in the food pathway use wv(in) at this location in sec/m^3.

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.

4.7.4. Utilizing the assumptions contained in section 4.4.2., these equations reduce to the following:

$$3.17E\text{-}08 \sum_i Ri \; (Wv(in)\, \tilde{Q}iv + wv\, (in)\, \tilde{q}iv) \; +$$

$$(R_i^G + R_i^V)\, (Wv(dep)\, \tilde{Q}iv + wv\, (dep)\, \tilde{q}iv) + R_I^C\, (Wv\, (milk)$$

$$\tilde{Q}iv \; + \; wv\, (milk)\, \tilde{q}iv)$$

$\leq$ 15 mrem Quarterly

$\leq$ 7.5 mrem Annual

4.7.5. Calculation of R_i^I (X/Q) Inhalation Pathway Factor

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 infant and the child R factors are calculated for the purpose of this manual, since they are the most restrictive age groups. These values are listed in Table 4-11 and 4-12 respectively.

Breathing rates:

Infant = 1400 (m^3/yr) *

Child = 3700 (m^3/yr) *

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

4.7.6. Calculation of R_i^G (D/Q) Ground Plane Pathway Factor.

R_i^G (D/Q) = K' K'' (SF) $(DFG_i\ (1-e^{-\lambda_i t}/\lambda_i))$

(m^2. 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 the 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_i^G, which is the same for all age groups and is listed in Table 4-13.

4.7.7 Calculation of R_i^C (D/Q) - Grass-Cow-Milk Pathway Factor.

$$R_i^C (D/Q) = \frac{k' \; Q_F \; (Uap) \; Fm \; (r) \; (DFL_i)a}{\lambda i + \lambda w} \left[\frac{fpfs}{Y_P} + \frac{(1-fpfs)e^{-\lambda i t h}}{Y_S} \right] e^{-\lambda i t f}$$

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 = Agriculatural 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/liter

r = Fraction of deposited activity retrained 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.

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.

Parameters are taken from the following sources:

Parameter	Value	Table (R.G. 1.10
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 infant and the child are calculated for the purpos of this manual as they are the most restrictive age groups. These values are listed in Table 4-14 and 4-15 respectively.

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

$$R_i^C\ (X/Q) = K'K'''F_m Q_F U_{ap} (DFL_i)_a 0.75(0.5/H) \quad \text{(mrem/yr per uCi/m}^3\text{)}$$

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.

4.7.8 Calculation of R_i^V [D/Q] - Vegetation Pathway Factor

$$R_i^V [D/Q] = K' \left[\frac{(r)}{Y_v (\lambda i + \lambda w)} \right] (DFL_i)a \left[U_a^L f_L e^{-\lambda i t L} + U_a^s fg e^{-\lambda i t h} \right]$$

$$= (m^2 \cdot \text{mrem/yr per } \mu\text{Ci/sec})$$

Where:

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

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

f_L = fraction of annual intake of fresh leafy vegetation grown locally.

f_g = the fraction of the annual intake of stored 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 4.7.7 of this manual.

Parameter	Value	Table (R.G. 1.10
r (dimensionless)	1.0 for radioiodines 0.2 for particulates	E-1
$(DFL_i)_a$ (mrem/pCi)	Each radionuclide	E-11 to E-14
U_a^L (kg/yr) - infant	0	E-5
- child	26	E-5
- teen	42	E-5
- adult	64	E-5
U_a^S (kg/yr) - infant	0	E-5
- child	520	E-5
- teen	630	E-5
- adult	520	E-5
f_L (dimensionless)	site specific (default = 1.0)	
f_g (dimensionless)	site specific (default = 0.76) (see Ref. 6, pg.28)	
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_i^V is based on χ/Q :

$$R_i^V \chi/Q = K'K''' \quad U_a^L f_L + U_a^S f_g \; (DFL_i)a \left[0.75(0.5/H)\right]$$ (mrem/yr per μCi/m^3).

where all terms have been defined above and in the grass-cow-milk pathway calculation section of this manual.

Since the infant consumption rate is zero, only the child R_i^V values are calculated. These values are listed in Table 4-16.

4.8 Calculation of Air Dose From Airborne Releases of Noble Gases

4.8.1. The equations in this section are used to meet the calculational requirements of paragraphs 4.1.2. and 4.1.4. 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.

4.8.2. The equations for calculating the dose limitiations are obtained from NUREG 0133 (ref. 1 section 5.3.) Since this is a two unit site, IP3NPP is limited to one half of the limits specification paragraphs 4.1.2. and 4.1.4. The doses are evaluated at the nearest residence in the unrestricted area in the worst meteorological sector. This is the worst location for which it is reasonable to assume a 100% occupancy factor for a full year. Utilizing the assumptions contained in paragraphs 4.8.1. and 4.8.2. these equations reduce to the following:

a) during any calendar quarter, for gamma radiation:

$$3.17\text{x}10^{-8} \sum_i M_i \left(\overline{(X/Q)}_v \tilde{Q}iv + \overline{(x/q)}_v \tilde{q}iv\right) \leq 10 \text{ mrad}$$

during any calendar quarter for the beta radiation:

$$3.17\text{x}10^{-8} \sum_i N_i \left(\overline{(X/Q)}_v \tilde{Q}iv + \overline{(x/q)}_v \tilde{q}iv\right) \leq 20 \text{ mrad}$$

b) During any calendar year for gamma radiation:

$$3.17\text{x}10^{-8} \sum_i M_i \left(\overline{(X/Q)}_v \tilde{Q}iv + \overline{(x/q)}_v \tilde{q}iv\right) \leq 5 \text{ mrad}$$

during any calendar year for beta radiations:

$$3.17\text{x}10^{-8} \sum_i N_i \left(\overline{(X/Q)}_v \tilde{Q}iv + \overline{(x/q)}_v \tilde{q}iv\right) \leq 10 \text{ mrad.}$$

where:

$\overline{(X/Q)}_V$ = For vent releases, the highest calculated annual average relative concentration for the area beyond the unrestricted area boundary in the SSW sector at 1526 meters for long term releases (greater than 500 hrs/years), 1.2E-06 sec/m^3.

$\overline{(x/q)}_v$ = For vent releases, the relative concentration for the areas beyond the unrestricted area boundary for short term releases (equal to or less than 500 hrs/year) in the SSW sector at 1526 meters. This value is calculated as per Section 4.9.

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 emisssions for each identified noble gas radionuclide, in mrad/yr per uCi/m^3.

$\tilde{q}_{iv}$ = The average relesae 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 quarters or year as appropriate.

$\tilde{Q}_{iv}$ = The average release of noble gas radionuclides in gaseous efflunets, 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 M_i and N_i were obtained from Table B-1 of Regulatory Guide 1.109[1] and are listed in Tables 4-6 and 4-7 respectively.

4.9 Calculation of Meteorological DIspersion Factors

4.9.1. For the purpose 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 4-10 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 to the boundary of the unrestricted area. This is based on the definition of unrestriced 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.

4.9.2 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 porportion 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.

4.9.3 To meet the calculational requirements of prargraph 4.1.1a, the annual average dispersion and deposition factors were calculated for each compass sector at the site unrestricted area boundary, except in the cases where the river was the boundary, to be used for the inhalation and ground plane pathways. For the food pathway the annual average dispersion and deposition factors were calculated for each compass sector at 7 miles which is the closest cows have been kept to the site. In fact, cows are now no longer present this close to the site. The most restrive compass sector values were chosen and are as follows:

W_v(in) = The highest calculated annual average dispersion parameter for the inhalation pathway at the unrestrictive area boundary in the SW sector at 350 meters, 1.4E-05 sec/m^3.

Wv(gp) = The highest calculated annual deposition parameter for the ground plane pathway at the unrestricted area boundary in the SSW sector at 380 meters, 8.1E-08 m^{-2}.

Wv(f) = The highest calculated annual average desposition parameter for the food pathway located in the SSW sector at 8.9 miles 6.7E-11 m^{-2}. For tritium in the food pathway use Wv(in) at this location, 1.5E-08 sec/m^3.

4.9.4 To meet the calculational requirements of paragraph 4.1.1.b, the annual average coverage dispersion factors were calculated for each compass sector at the site unrestricted area boundary except in the cases where the river was the boundary. The most restrictive compass sector value was chosen as follows:

$(\overline{X/Q})v$ = The highest calculated annual average dispersion parameter, for the noble gas pathway at the unrestricted area boundary in the SW sector at 350 meters, 1.4E-05 sec/m^3.

4.9.5 To meet the calculational requirements of paragraphs 4.1.3 and 4.1.4, for iodines and particulates, the annual average deposition and dispersion parameters were calculated for the nearest residence in each of the compass sectors. In addition, the dispersion and deposition parameters for all dairies within ten miles of the site were calculated. These locations and distances are shown in Table 4-18. The most restrictive compass sector values were chosen and are as follows:

Wv(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, 1.2E-06 sec/m^3.

Wv(dep) = The highest calculated annual average deposition parameters for the ground plane pathway for the nearest residence in the unrestricted area located in S sector at 1279 meters, 8.8E-09 m^{-2}.

Wv(f) = The highest calculated annual average depostion paramter for the food pathway for existing dairy farms in the unrestricted area located in the ESE sector at 8.9 miles, 6.7E-11 m^{-2}. For tritium in the food pathway use Wv(in) at this location, 1.5E-08 sec/m^3.

4.9.6. To meet the calculational requirements of paragraphs 4.1.2 and 4.1.4 for noble gases, the annual average dispersion parameters were calculated for the nearest residence in each of the compass sectors, since these are the worst locations for which it is reasonable to assume a 100% occupancy factor. The most restrictive compass sector value was chosen as follows:

$(\overline{X/Q})v$ = The highest calculated annual average dispersion parameters for the noble gas pathway, at the closest residence in the unrestricted area located in the SSW sector at 1526 meters, 1.2E-06 sec/m^3.

4.9.7 To meet the calculational requirements of paragraphs 4.1.2, 4.1.3, and 4.1.4 and the calculation methodologies described in Sections 4.7 and 4.8 short term release dispersion and deposition factors need to be calculated. For this document short term release dispersion and depositon 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). The short term release calculations assume that the plume uniformly distributes in the horizontal within a 22½ degree sector as recommended in NUREG 0324 (ref. 5, page 22) for many short period releases. All releases are assumed to be ground level, and 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., p. 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:

$$F = \left(\frac{NTOTAL}{8760}\right) \exp \left[\frac{\log (ANMX/F\ 15\ MX)}{\log\ 8760}\right]$$

where:

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

NTOTAL = The total number of intermittent releases in hours.

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.

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

Paragraph 4.9.5.

a) F15MX (Wv(in)) = 1.38 E-05

$$F(Wv(in)) = \left(\frac{NTOTAL}{8760}\right) \exp \left[\frac{\log (1.2 E-06/1.38 E-05)}{\log 8760}\right]$$

$$F(Wv(in)) = \left(\frac{NTOTAL}{8760}\right) \exp (-0.269)$$

b) F15MX (Wv(gp)) = 1.6 E-05

$$F (Wv(gp)) = \left(\frac{NTOTAL}{8760}\right) \exp \left[\frac{(\log (1.0E-06/1.6 E-05)}{\log 8760}\right]$$

$$F (Wv(gp)) = \left(\frac{NTOTAL}{8760}\right) \exp (-0.305)$$

c) F15MX (Wv(f)) = 6.43 E-07

$$F (Wv(f)) = \left(\frac{NTOTAL}{8760}\right) \exp \left[\frac{\log (1.5E-08/6.43 E-07)}{\log 8760}\right]$$

$$F (Wv(f)) = \left(\frac{NTOTAL}{8760}\right) \exp (-0.414)$$

Paragraph 4.9.6.

d) F15MX $((\overline{X/Q})v)$ = 1.38 E-05

$$F ((\overline{X/Q})v) = \left(\frac{NTOTAL}{8760}\right) \exp \left[\frac{\log (1.2 E-06/1.38 E-05)}{\log 8760}\right]$$

$$F ((\overline{X/Q})v) = \left(\frac{NTOTAL}{8760}\right) \exp (-0.269)$$

4.10 Operational Method for Determining Compliance With Dose Limitations for Airborne Releases of Iodines and Particulates with Half-Lives Greater than Eight Days

4.10.1. This section describes the operational method of meeting the requirements of paragraph 4.1.3. and 4.1.4. and the operational method of implementing the calculational techniques presented in Section 4.7.

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

4.10.3 Add together the activity of I-131 and particulates with half life greater than eight days for each release point for each weekly sampling period. The highest weekly sample period for the month will be divided by the total volume for the sampling period to obtain the release rate (Qv) which will be used in the following paragraph.

4.10.4 Calculate the maximum fraction of the instantaneous iodine and particulate release rate requirement (paragraph 4.1.1) for the month. The assumptions utilized in this calculation are the same as those delineated in Section 4.5. and paragraph 4.5.8. The equations are as follows:

$$\frac{(P(in)\ Wv(in) + P(f)\ Wv(f))\ \dot{Q}v}{750 \text{ mrem/yr (thyroid)}}$$

$$= \frac{[(1.48\ E07)(1.4\ E\text{-}05) + (1.08\ E12)(6.7\ E\text{-}11)]\ \dot{Q}v}{750 \text{ mrem/yr (thyroid)}}$$

$$= (0.373)Qv$$

where:

$\dot{Q}v$ = The highest weekly iodine and particulate release rate from paragraph 4.10.3. in uCi/sec and all other parameters are defined in section 4.5.

and all other terms have been previously defined in paragraph 4.5.8.

4.10.5 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.

4.10.6. To meet the requirements of paragraph 4.1.4 the value of Qt calculated in paragraph 4.10.5 is used. The assumptions utilized in the equation are the same as those delineated in section 4.5. and papargraph 4.5.9. The following equation is used to calculate the dose for this requirement:

dose to the thyroid:

$$[P(in)\ Wv(in) + P(f)\ Wv(f)]\ Qt\ \left(\frac{yr}{365\ days}\right)(31\ days) \leq 0.155\ mrem\ per\ 31\ days$$

$$= 7.65\ Qt \quad 0.155\ mrem\ per\ 31\ days$$

where: all terms have been defined in section 4.5.

4.10.7 Determine the monthly dose and monthly time averaged fraction of the quarterly dose requirements in paragraph 4.1.3. The assumptions utilized for this calculation are the same as those delineated in paragraph 4.5 and paragraph 4.5.9. The inhalation and groundplane pathways are assumed to take place at the nearest residence, when it is reasonable to assume a 100% occupancy time and the cow-milk pathway takes place at the worst actual dairy farm in the vicinity of IP3NPP. The equations from Section 4.7 are simplified as follows:

thyroid dose:

$$D = [R^{I}\ Wv(in) + R^{c}\ Wv(f)]\ Qt\ \left(\frac{1\ yr}{12\ mos.}\right) = mrem\ per\ month$$

$$D = [(1.48\ E07)(1.2\ E\text{-}06) + (1.08\ E12)(6.7\ E\text{-}11)]\ Qt\ \left(\frac{1\ yr}{12\ mos}\right) = mrem\ per\ month$$

$$D = (7.51\ mrem\text{-}sec/uCi\text{-}month)Qt = mrem\ per\ month$$

Fraction of limit:

$$\frac{[R^{I}\ Wv(in) + R^{c}\ Wv(f)]}{15\ mrem/yr}\ Qt = Fraction$$

$$\frac{[(1.48\ E07)(1.2\ E\text{-}06) + (1.08\ E12)(6.7\ E\text{-}11)}{15\ mrem/yr}\ Qt = Fraction$$

$$(6.01\ sec/uCi)\ Qt = Fraction$$

where:

D = The dose in mrem/month

R^{I} = The dose parameter of I-131 for the inhalation pathway, 1.48 E07 mrem/yr per uCi/m^3.

R^{c} = The dose parameter of I-131 for the milk ingestion pathway, 1.08 E12 mrem/yr per uCi/sec.

Wv(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, 1.2 E-06 sec/m^3.

Wv(f) = The highest calculated annual average deposition parameter for the food pathway for existing dairy farms in the unrestricted area located in the ESE sector at 8.9 mile, 6.7 E-11 m^2.

Qt = Average total iodine and particulate release rate for the month from paragraph 4.10.5., uCi/sec.

4.10.8. Determine the monthly time averaged fraction of the annual dose requirements in paragraph 4.1.3. The assumptions utilized are the same as those delineated in paragraph 4.10.7. the equation from Section 4.7 is simplified as follows:

Fraction of limit:

$$\frac{[R^I \quad Wv(in) + R^c \quad Wv(f)]}{7.5 \text{ mrem/yr}} \, Qt = \text{Fraction}$$

$$\frac{[(1.48 \text{ E07})(1.2 \text{ E-06}) + (1.08 \text{ E12})(6.7 \text{ E-11})}{7.5 \text{ mrem/yr}} \, Qt = \text{Fraction}$$

$$(12.02 \text{ sec/uCi}) \, (Qt) = \text{Fraction}$$

when all terms have been defined in paragraph 4.10.7.

4.10.9. The quarterly and annual dose is obtained by summing the dose for each month calculated in paragraph 4.10.7. over 3 and 12 months respectively.

4.11 **Operational Method for Determining Compliance with Dose Limitations for Airborne Releases of Noble Gases**

4.11.1 This section describes the operational method of meeting the requirements of paragraphs 4.1.2. and 4.1.4. and the operational method of implementing the calculation techniques presented in section 4.8.

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

4.11.3 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 nearest resistence in the worst sector. The calculation is as follows:

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

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

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

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

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

where:

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

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.

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.

$(\overline{X/Q})v$ = The highest calculated annual average dispersion parameter for the noble gas pathway, at the closest residence in the unrestricted area located in the SSW sector at 1526 meters, 1.2 E-06 sec/m^3; at the unrestricted area boundary, 1.4E-05 sec/m^3.

All values of $\overline{Ki}$, $\overline{Li}$, $\overline{Mi}$, $\overline{Ni}$, and $\overline{Si}$ are shown in Table 4-9 for the worst location at the unrestricted area boundary and in Table 4-19 for the worst residence in the unrestricted area.

$$Ct = \sum_i Ci$$

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

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

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

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

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

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.

4.11.4. Enter in Table 4-20 the information on all batch releases for the month obtained from waste release permits and paragraph 4.11.3.

4.11.5 Calculate the continuous noble gas discharges for each source (ie plant vent, condenser air ejector) for the month by the use of Table 4-21 or by the Airborne release program of the Control Room Computer.

4.11.6 Review all data from Table 4-20 & 4-21 and select the combination of batch plus continuous releases which results in the highest noble gas discharge rate. The release rate shall be summed over all sources. If an unplanned release occurs use the actual Kt, Lt, Mt, Nt, St if a sample can be obtained or else use the values obtained from the reactor coolant sample for that day. In this case the standard isotope mixture discussed in paragraph 4.6 may also be utilized.

4.11.7 Determine $\overline{\overline{K}}$, $\overline{\overline{L}}$, $\overline{\overline{M}}$, $\overline{\overline{N}}$, $\overline{\overline{S}}$, as necessary for the instantaneous release rate using the $\overline{Kt}$, $\overline{Lt}$, $\overline{Mt}$, $\overline{Nt}$, $\overline{St}$ calculated as in paragraph 4.11.3 using table 4-9 for each batch and continuous source utilized in paragraph 4.11.6. This calculation is performed using the following equations:

$$Cx = \sum Ct$$

$$\overline{\overline{K}} = (1/Cx) \sum \overline{Kt} \; Ct$$

$$\overline{\overline{L}} = (1/Cx) \sum \overline{Lt} \; Ct$$

$$\overline{\overline{M}} = (1/Cx) \sum \overline{Mt} \; Ct$$

$$\overline{\overline{N}} = (1/Cx) \sum \overline{Nt} \; Ct$$

$$\overline{\overline{S}} = (1/Cx) \sum \overline{St} \; Ct$$

where:

Cx = Total noble gas concentration from all batch and continuous sources in uCi/cc and all other terms have been previously defined.

4.11.8 Calculate the maximum fraction of the instantaneous noble gas release rate requirement (paragraph 4.1.1) for the month applying 0.7 of the limit as explained in paragraph 4.4.1. This calculation is performed using the following equations and the larger of the two values is utilized.

dose to whole body:

$$\frac{\bar{\bar{K}}\ Qi}{350\ \text{mrem/yr}} = \text{fraction}$$

dose to skin:

$$\frac{\bar{\bar{S}}\ Qi}{2100\ \text{mrem/yr}} = \text{fraction}$$

where:

Qi = The maximum instantaneous release rate determined in paragraph 4.11.6 in uCi/sec.

and all other terms have been previously defined.

4.11.9 Determine the total activity of noble gases released by the unit during the month. This is done by summing the activity released through the plant vent, condenser air ejector and any other release pathways either in the batch or continuous mode. This can be performed by the central control room computer (CCR) Airborne release program or manualy. If done manualy Table 4-21 is used to calculate continuous plant vent releases and Table 4-20 is added to it to account for batch releases. The value is added to the condenser air ejector releases and any other pathway releases. If the CCR airborne release program is used the activity determined for the plant vent takes both Table 4-20 & 4-21 into account.

4.11.10 The $\bar{\bar{K}}$, $\bar{\bar{L}}$, $\bar{\bar{M}}$, $\bar{\bar{N}}$, $\bar{\bar{S}}$ factors are determined for the total monthly release of noble gases as necessary. This is done by using the $\bar{K}t$, $\bar{L}t$, $\bar{M}t$, $\bar{N}t$, $\bar{S}t$ factors calculated for each batch and continuous release and the following equations:

$$Cs = \sum Cv$$

$$\bar{\bar{K}} = (1/Cs) \sum \bar{K}t\ \ Cv$$

$$\bar{\bar{L}} = (1/Cs) \sum \bar{L}t\ \ Cv$$

$$\bar{\bar{M}} = (1/Cs) \sum \bar{M}t\ \ Cv$$

$$\bar{\bar{N}} = (1/Cs) \sum \bar{N}t\ \ Cv$$

$$\bar{\bar{S}} = (1/Cs) \sum \bar{S}t\ \ Cv$$

where:

Cv = The total activity released from this batch or continuous release in uCi.

Cs = The total activity released from all batch and continous releases in uCi.

4.11.11 To meet the requirements of paragraph 4.1.4 the value of Cv obtained in paragraph 4.11.10 is divided by the total number of seconds in the month of concern. This results in the average release rate in uCi/sec from the unit for the month. For the purpose of this calculation 0.5 of the applicable limits are utilized as explained in paragraph 4.2.3. The average release rate is used in the following equation to calculate the doses for this requirement:

For gamma radiation:

$$D = \bar{\bar{M}}\ Qr \left(\frac{yr}{365\ days}\right)(31\ days) \qquad 0.1\ mrad\ per\ 31\ days$$

For the beta radiation:

$$D = \bar{\bar{N}}\ Qr \left(\frac{yr}{365\ days}\right)(31\ days) \qquad 0.2\ mrad\ per\ 31\ days$$

where:

D = The dose for the specified month, in mrad

Qr = The average release rate for the month calculated in this paragraph in uCi/sec.

4.11.12 The monthly time averaged fraction of the quarterly dose requirements in paragraph 4.1.2 is calculated as follows utilizing 0.5 of the applicable limit as described in paragraph 4.2.3:

For gamma radiation:

$$\frac{\bar{\bar{M}}\ Qr}{10} = Fraction$$

For beta radiation:

$$\frac{\bar{\bar{N}}\ Qr}{20} = Fraction$$

4.11.13 The monthly time averaged fraction of the annual dose requirements in paragraph 4.1.2 and the monthly dose is calculated as follows utilizing 0.5 of the applicable limit as described in paragraph 4.2.3:

For gamma radiation:

$$\frac{\overline{\overline{M}}\ Qr}{5} = \text{Fraction}$$

$$D = (\overline{\overline{M}}\ Qr)\ (1/12)$$

For beta radiation:

$$\underline{\overline{\overline{N}}\ \ Qr} = \text{Fraction}$$

$$D = \overline{\overline{N}}\ Qr\ (1/12)$$

Where:

All parameters have been previously defined.

4.11.14 The quarterly and annual dose is obtained by summing the dose for each month calculated in paragraph 4.11.13 over 3 and 12 months respectively.

4.11.15 In the calculations involved in paragraphs 4.11.12 through 4.11.14 only long term annual average meteorology is used. It is recognized that this is a nonconservative assumption. In reviewing the short term correction factor discussed in paragraph 4.9.8 for noble gases it was determined that the factor can take on a high value of 11.5 and a low value of 2.2 with a value of 3.6 representative of IP3NPP releases. In addition, is noted that batch releases are typically only 10% of the total noble gas releases. Using these typical values indicates that not using short term releases could result in a 25-30% under prediction. Therefore, if the values calculated in paragrph 4.11. 4 are 50% of the applicable limit the short term release calculation will be included.

Pi (inhalation) TABLE 4-1

INHALATION DOSE FACTORS

NUCLIDE	CONSTANT (pCi/μCi)	DFAi (mrem/pCi)	ORGAN	Pi (mrem/yr per μCi/m^3)
H-3	1.4E09	4.62E-07	Total body	6.47E02
Cr-51		9.17E-06	Lung	1.28E04
Mn-54		7.14E-04	Lung	1.00E06
Fe-59		7.25E-04	Lung	1.02E06
Co-58		5.55E-04	Lung	7.77E05
CO-60		3.22E-03	Lung	4.51E06
Zn-65		4.62E-04	Lung	6.47E05
Sr-89		1.45E-03	Lung	1.03E06
Sr-90		2.92E-02	Bone	4.09E07
Zr-95		1.25E-03	Lung	1.75E06
I-131		1.06E-02	Thyroid	1.48E07
I-133		2.54E-03	Thyroid	3.56E06
Cs-134		5.02E-04	Liver	7.03E05
Cs-136		9.61E-05	Liver	1.35E05
Cs-137		4.37E-04	Liver	6.12E05
Ba-140		1.14E-03	Lung	1.60E06
Ce-141		3.69E-04	Lung	5.17E05
P-32		1.45E-03	Bone	2.03E06
Fe-55		6.21E-05	Lung	9.25E04
C-14		1.89E-05	Bone	2.65E04

GROUND PLANE DOSE FACTORS
Pi (ground plane)

TABLE 4-2

NUCLIDE	CONSTANT	DFGi (mrem/hr per pCi/m^2)	λi (sec^{-1})	Pi (m^2mrem/yr per µCi/sec)
H-3	8.76E09	0	1.78E-09	0
Cr-51		2.60E-10	2.89E-07	7.88E06
Mn-54		6.80E-09	2.57E-08	1.29E10
Fe-59		9.4E-09	1.80E-07	4.56E08
Co-58		8.20E-09	1.13E-07	6.18E08
Co-60		2.00E-08	4.18E-09	5.17E09
Zn-65		4.60E-09	3.29E-08	7.90E08
Sr-89		6.50E-13	1.58E-07	3.58E04
Sr-90		not given	7.60E-10	0
Zr-95		5.80E-09	1.22E-07	4.08E08
I-131		3.40E-09	9.95E-07	2.98E07
I-133		4.50E-09	9.26E-06	4.26E06
Cs-134		1.40E-08	1.07E-08	3.27E09
Cs-136		1.70E-08	6.17E-07	2.41E08
Cs-137		4.90E-09	7.28E-10	1.34E09
Ba-140		2.40E-09	6.27E-07	3.35E07
Ce-141		6.20E-10	2.48E-07	2.19E07
P-32		0	5.61E-07	0
Fe-55		0	8.14E-09	0
C-14		0	3.84E-12	0

FOOD DOSE FACTORS
P_i (food)

TABLE 4-3

	CONSTANT	r	Fm	λi	λw	DFLi	tf	Pi
Cr-51	2.4E10	0.2	2.2E-03	2.89E-07	5.73E-07	4.11E-07	1.73E05	4.78E06
Mn-54			2.5E-04	2.57E-08		1.99E-05		3.97E07
Fe-59			1.2E-03	1.80E-07		5.38E-05		3.99E08
Co-58			1.0E-03	1.13E-07		8.98E-06		6.17E07
Co-60			1.0E-03	4.18E-09		2.57E-05		2.14E08
Zn-65			3.9E-02	3.29E-08		6.31E-05		1.94E10
Sr-89			8.0E-04	1.58E-07		2.51E-03		1.28E10
Sr-90			8.0E-04	7.60E-10		1.85E-02		1.24E11
Zr-95			5.0E-06	1.22E-07		2.50E-05		8.46E05
I-131			6.0E-03	9.95E-07		1.39E-02		1.08E+12
I-133			6.0E-03	9.26E-06		3.31E-03		9.74E09
Cs-134			1.2E-02	1.07E-08		7.03E-04		6.92E10
Cs-136			1.2E-02	6.17E-07		1.35E-04		5.88E09
Cs-137			1.2E-02	7.28E-10		6.11E-04		6.13E10
Ba-140			4.0E-04	6.27E-07		1.71E-04		2.46E08
Ce-141			1.0E-04	2.48E-07		2.48E-05		1.39E07
P-32			2.5E-02	5.61E-07		1.70E-03		1.63E11
Fe-55			1.2E-03	8.14E-09		1.39E-05		1.38E08
C-14			1.2-02	3.84E-12		2.37E-05		2.38E09

TABLE 4-4

TOTAL BODY DOSE FACTORS

Ki

FROM NOBLE GASES (GAMMA)

NUCLIDE	γ - BODY *		10^6(pCi/μCi)	Ki **
Kr-83m	7.56×10^{-8}	X	10^6	7.56×10^{-2}
Kr-85m	1.17×10^{-3}	X	10^6	1.17×10^{3}
Kr-85	1.61×10^{-5}	X	10^6	1.61×10^{1}
Kr-87	5.92×10^{-3}	X	10^6	5.92×10^{3}
Kr-88	1.47×10^{-2}	X	10^6	1.47×10^{4}
Kr-89	1.66×10^{-2}	X	10^6	1.66×10^{4}
Kr-90	1.56×10^{-2}	X	10^6	1.56×10^{4}
Xe-131m	9.15×10^{-5}	X	10^6	9.15×10^{1}
Xe-133m	2.51×10^{-4}	X	10^6	2.51×10^{1}
Xe-133	2.94×10^{-4}	X	10^6	2.94×10^{2}
Xe-135m	3.12×10^{-3}	X	10^6	3.12×10^{3}
Xe-135	1.81×10^{-3}	X	10^6	1.81×10^{3}
Xe-137	1.42×10^{-3}	X	10^6	1.42×10^{3}
Xe-138	8.83×10^{-3}	X	10^6	8.83×10^{3}
Ar-41	8.84×10^{-3}	X	10^6	8.84×10^{3}

* from Regulatory Guide 1.109, Table B-1

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

TABLE 4-5

SKIN DOSE FACTORS

Li

FROM NOBLE GASES (BETA)

NUCLIDE	β - SKIN *		10^6 (pCi/μCi)	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

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

TABLE 4-6

AIR DOSE FACTORS

Mi

FROM NOBLE GASES (GAMMA)

NUCLIDE	γ - Air *		10^6(pCi/μCi)	Mi **
Kr-83m	1.93×10^{-5}	X	10^6	1.93×10^{1}
Kr-85m	1.23×10^{-3}	X	10^6	1.23×10^{3}
Kr-85	1.72×10^{-5}	X	10^6	1.72×10^{1}
Kr-87	6.17×10^{-5}	X	10^6	6.17×10^{3}
Kr-88	1.52×10^{-2}	X	10^6	1.52×10^{4}
Kr-89	1.73×10^{-2}	X	10^6	1.73×10^{4}
Kr-90	1.63×10^{-2}	X	10^6	1.63×10^{4}
Xe-131m	1.56×10^{-4}	X	10^6	1.56×10^{2}
Xe-133m	3.27×10^{-4}	X	10^6	3.27×10^{2}
Xe-133	3.53×10^{-4}	X	10^6	3.53×10^{2}
Xe-135m	3.36×10^{-3}	X	10^6	3.36×10^{3}
Xe-135	1.92×10^{-3}	X	10^6	1.92×10^{3}
Xe-137	1.51×10^{-3}	X	10^6	1.51×10^{3}
Xe-138	9.21×10^{-3}	X	10^6	9.21×10^{3}
Ar-41	9.30×10^{-3}	X	10^6	9.30×10^{3}

* from Regulatory Guide 1.109, Table B-1

** Mi (mrad/yr per $\mu Ci/m^3$)

Table 4-7

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

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

TABLE 4-8

SKIN DOSE FACTORS FROM NOBLE GASES (BETA-GAMMA)

Si = (Li+1.1Mi)

NUCLIDE	Li *	Mi **	Si = (Li+1.1Mi) ***
Kr-83m		1.93×10^{1}	2.12E03
Kr-85m	1.46×10^{3}	1.23×10^{3}	2.81×10^{3}
Kr-85	1.34×10^{3}	1.72×10^{1}	1.36×10^{3}
Kr-87	9.73×10^{3}	6.17×10^{3}	1.62×10^{4}
Kr-88	2.37×10^{3}	1.52×10^{4}	1.91×10^{4}
Kr-89	1.01×10^{4}	1.73×10^{4}	2.91×10^{4}
Kr-90	7.29×10^{3}	1.63×10^{4}	2.52×10^{4}
Xe-131m	4.76×10^{2}	1.56×10^{2}	6.48×10^{2}
Xe-133m	9.94×10^{2}	3.27×10^{2}	1.35×10^{3}
Xe-133	3.06×10^{2}	3.53×10^{2}	6.94×10^{2}
Xe-135m	7.11×10^{2}	3.36×10^{3}	4.41×10^{3}
Xe-135	1.86×10^{3}	1.92×10^{3}	3.97×10^{3}
Xe-137	1.22×10^{4}	1.51×10^{3}	1.39×10^{3}
Xe-138	4.13×10^{3}	9.21×10^{3}	1.43×10^{4}
Ar-41	2.69×10^{3}	9.30×10^{3}	1.29×10^{4}

* From Table NG-2 (mrad/yr per $\mu Ci/m^3$)

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

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

Table 4-9 Dose Factors for Site Boundary

Nuclide	$\overline{Ki}$	$\overline{Li}$	$\overline{Mi}$	$\overline{Ni}$	$\overline{Si}$
Kr-83m	1.06E-06		2.70E-04	4.03E-03	2.97E-02
Kr-85m	1.64E-02	2.04E-02	1.72E-02	2.76E-02	3.93E-02
Kr-85	2.25E-04	1.88E-02	2.41E-04	2.73E-02	1.90E-02
Kr-87	8.29E-02	1.36E-01	8.64E-02	1.44E-01	2.31E-01
Kr-88	2.06E-01	3.32E-02	2.13E-01	4.10E-02	2.67E-01
Kr-89	2.32E-01	1.41E-01	2.42E-01	1.48E-01	4.07E-01
Kr-90	2.18E-01	1.02E-01	2.28E-01	1.10E-01	3.53E-01
Xe-131m	1.28E-04	6.66E-03	2.18E-03	1.55E-02	9.07E-03
Xe-133m	3.51E-03	1.39E-02	4.58E-03	2.07E-02	1.89E-02
Xe-133	4.12E-03	4.28E-03	4.94E-03	1.47E-02	9.72E-03
Xe-135m	4.37E-02	9.95E-03	4.70E-02	1.03E-02	6.17E-02
Xe-135	2.53E-02	2.60E-02	2.69E-02	3.44E-02	5.56E-02
Xe-137	1.99E-02	1.71E-01	2.11E-02	1.78E-01	1.95E-02
Xe-138	1.24E-01	5.78E-02	1.29E-01	6.65E-02	2.00E-01
Ar-41	1.24E-01	3.77E-02	1.30E-01	4.59E-02	1.81E-01

$\overline{(X/Q)}v$ = 1.4E-05 sec/m3

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

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

TABLE 4-10

Dose Factors for Site Boundary for Standard Isotopic Mixture

Nuclide	Relative (Qiv) Concentration	Qiv $\overline{Ki}$	Qiv $\overline{Li}$	Qiv $\overline{Mi}$	Qiv $\overline{Ni}$	Qiv $\overline{Si}$
Kr-85M	2.26E-04	3.71E-06	4.61E-06	3.89E-06	6.24E-06	8.88E-06
Kr-87	2.88E-04	2.39E-05	3.92E-05	2.49E-05	4.15E-05	6.65E-05
Kr-88	4.46E-04	9.19E-05	1.48E-05	9.50E-05	1.83E-05	1.19E-04
Xe-133	3.08E-03	1.27E-05	1.32E-05	1.52E-05	4.53E-05	2.99E-05
Xe-133M	2.00E-04	7.02E-07	2.78E-06	9.16E-07	4.14E-06	3.78E-06
Xe-135	1.32E-03	3.34E-05	3.43E-05	3.55E-05	4.54E-05	7.34E-05
Xe-138	4.08E-04	5.06E-05	2.36E-05	5.26E-05	2.71E-05	8.16E-05
Xe-135M	4.46E-04	1.95E-05	4.44E-06	2.10E-05	4.59E-06	2.75E-05
Total	6.41E-03	2.36E-04	1.37E-04	2.49E-04	1.93E-04	4.11E-04

$$\overline{Ks} = \frac{2.36E-04}{6.41E-03} = 3.68E-02$$

$$\overline{Ls} = \frac{1.37E-04}{6.41E-03} = 2.14E-02$$

$$\overline{Ms} = \frac{2.49E-04}{6.41E-03} = 3.88E-02$$

$$\overline{Ns} = \frac{1.93E-04}{6.41E-03} = 3.01E-02$$

$$\overline{Ss} = \frac{4.11E-04}{6.41E-03} = 6.40E-02$$

$\overline{K}_s$, $\overline{L}_s$, $\overline{S}_s$, (mrem - sec per uCi/yr)

$\overline{M}_s$, $\overline{N}_s$ (mrad - sec per uCi/yr)

TABLE 4-10A

Dose Factors at Nearest Residence for
Standard Isotopic Mixture

Nuclide	Relative (Qiv) Concentration	$Qiv\ \overline{Ki}$	$Qiv\ \overline{Li}$	$Qiv\ \overline{Mi}$	$Qiv\ \overline{Ni}$	$Qiv\ \overline{Si}$
Kr-85M	2.26E-04	3.16E-07	3.96E-07	3.34E-07	5.33E-07	7.62E-07
Kr-87	2.88E-04	2.04E-06	3.37E-06	2.13E-06	3.57E-06	5.70E-06
Kr-88	4.16E-04	7.49E-06	1.27E-06	8.12E-06	1.57E-06	1.02E-05
Xe-133	3.08E-03	1.09E-06	1.13E-06	1.31E-06	3.88E-06	2.57E-06
Xe-133M	2.00E-04	6.02E-08	2.38E-07	7.84E-08	3.56E-07	3.24E-07
Xe-135	1.32E-03	2.86E-06	3.08E-06	3.04E-06	3.89E-06	6.28E-06
Xe-135M	4.46E-04	1.67E-06	3.80E-07	1.80E-06	3.96E-07	2.36E-06
Xe-138	4.08E-04	4.32E-06	2.02E-06	4.53E-06	2.33E-06	7.02E-06
Total	6.41E-03	1.98E-05	1.19E-05	2.13E-05	1.65E-05	3.52E-05

$$K_s = \frac{1.98E-05}{6.41E-03} = 3.09E-03$$

$$L_s = \frac{1.19E-05}{6.41E-03} = 1.86E-03$$

$$M_s = \frac{2.13E-05}{6.41.E-03} = 3.32E-03$$

$$N_s = \frac{1.65E-05}{6.41E-03} = 2.57E-03$$

$$S_s = \frac{3.52E-05}{6.41E-03} = 5.49E-03$$

$\overline{K}_s$, $\overline{L}_s$, $\overline{S}_s$ (mrem - sec per uCi/yr)

$\overline{M}_s$, $\overline{N}_s$ (mrad - sec per uCi/yr)

$\overline{Ki}$, $\overline{Li}$, $\overline{Mi}$, $\overline{Ni}$, $\overline{Si}$ from Table 4-19

R_i^I Infant

Table 4-11

Radionuclide	(pCi/μCi) K'	(m^3/yr) BR	mrem/Pci* DFAi	Organ	R_i^I mrem/yr per μCi/m^3
Cr-51	10^6	1.4E03	9.17E-06	Lung	1.28E04
Mn-54	↓	↓	7.14E-04	Lung	1.00E06
Fe-59			7.25E-04	Lung	1.02E06
Co-58			5.55E-04	Lung	7.77E05
Co-60			3.22E-03	Lung	4.51E06
Zn-65			4.62E-04	Lung	6.47E07
Sr-89			1.45E-03	Lung	2.03E06
Sr-90			2.92E-02	Bone	4.09E07
Zr-95			1.25E-03	Lung	1.75E06
I-131			1.06E-02	Thyroid	1.48E07
I-133			2.54E-03	Thyroid	3.56E06
Cs-134			5.02E-04	Liver	7.03E05
Cs-136			9.61E-05	Liver	1.35E05
Cs-137			4.37E-04	Liver	6.12E05
Ba-140			1.14E-03	Lung	1.60E06
Ce-141			3.69E-04	Lung	5.17E05
H-3			4.62E-07	Body	6.47E02
P-32			1.45E-03	Bone	2.03E06
Fe-55			6.21E-05	Lung	8.69E04
C-14			1.89E-05	Bone	2.65E04

* From Table E-10, Regulatory Guide 1.109

CHILD INHALATION DOSE FACTORS

R_i^I Child

Table 4-12

Radionuclide	(pCi/μCi) K'	(m^3/yr) BR	mrem/Pci* DFAi	Organ	R_i^I mrem/yr per μCi/m^3
Cr-51	10^6	3.7E03	4.59E-06	Lung	1.70E04
Mn-54	↓	↓	4.26E-04	Lung	1.58E06
Fe-59			3.43E-04	Lung	1.27E06
Co-58			2.99E-04	Lung	1.11E06
Co-60			1.91E-03	Lung	7.07E06
Zn-65			2.69E-04	Lung	9.95E05
Sr-89			5.83E-04	Lung	2.16E06
Sr-90			2.73E-02	Bone	1.01E08
Zr-95			6.03E-04	Lung	2.23E06
I-131			4.39E-03	Thyroid	1.62E07
I-133			1.04E-03	Thyroid	3.85E06
Cs-134			2.74E-04	Liver	1.01E06
Cs-136			4.62E-05	Liver	1.71E05
Cs-137			2.45E-04	Bone	9.07E05
Ba-140			4.71E-04	Lung	1.74E06
Ce-141			1.47E-04	Lung	5.44E05
H-3			3.04E-07	Body	1.12E03
P-32			7.04E-04	Bone	2.60E06
Fe-55			3.00E-05	Lung	1.11E05
C-14	↓	↓	9.70E-06	Bone	3.59E04

* From Table E-9, Regulatory Guide 1.109

INFANT GROUND PLANE DOSE FACTORS

R_i^G

Table 4-13

Nuclide	(pCi/µCi) K'	hr/yr K''	* SF	** DFG_i	(sec) t	(sec^{-1}) λi	R_i^G
Cr-51	10^6	8.76E03	7.0E-01	2.6E-10	4.73E08	2.89E-07	5.52E06
Mn-54				6.8E-09		2.57E-08	1.62E09
Fe-59				9.4E-09		1.80E-07	3.20E08
Co-58				8.2E-09		1.13E-07	4.45E08
Co-60				2.00E-08		4.18E-09	2.53E10
Zn-65				4.6E-09		3.29E-08	8.57E08
Sr-89				6.5E-13		1.58E-07	2.52E04
Sr-90				not given		7.60E-10	0
Zr-95				5.8E-09		1.22E-07	2.92E08
I-131				3.4E-09		9.95E-07	2.10E07
I-133				4.5E-09		9.26E-06	2.98E06
Cs-134				1.4E-08		1.07E-08	7.97E09
Cs-136				1.7E-08		6.17E-07	1.69E08
Cs-137				4.9E-09		7.28E-10	1.20E10
Ba-140				2.4E-09		6.27E-07	2.35E07
Ce-141				6.2E-10		2.48E-07	1.53E07
H-3				0		1.78E-09	0
P-32				0		5.61E-07	0
Fe-55				0		8.14E-09	0
C-14				0		3.84E-12	0

* From Table E-15 Regulatory Guide 1.109

** From Table E-6 Regulatory Guide 1.109

TABLE 4-14

R_i^C [D/Q] Grass-Cow-Milk Pathway Factor (infant)

Nucl.	K'	Q_F	Uap	Yp	Ys	Fm	r	DFL^i	Organ	λi	λw	tf	th	fp	fs	R_i^C
Cr-51	10^6	50	330	0.7	2.0	2.2E-03	0.2	4.11E-07	GI-LLI	2.89E-7	5.73E-7	1.73E5	7.78E6	1	1	4.71E06
Mn-54						2.5E-04	0.2	1.99E-05	Liver	2.57E-8						3.90E07
Fe-59						1.2E-03	0.2	5.38E-05	Liver	1.8E-7						3.92E08
Co-58						1.0E-03	0.2	8.98E-06	Body	1.13E-7						6.06E07
Co-60						1.0E-03	0.2	2.57E-05	GI-LLI	4.18E-9						2.10E08
Zn-65						3.9E-02	0.2	6.31E-05	Liver	3.29E-8						1.91E10
Sr-89						8.0E-04	0.2	2.51E-03	Bone	1.58E-7						1.26E10
Sr-90						8.0E-04	0.2	1.85E-02	Bone	7.6E-10						1.22E11
Zr-95						5.0E-06	0.2	2.50E-05	GI-LLI	1.22E-7						8.31E05
I-131						6.0E-03	1.0	1.39E-02	Thyroid	9.95E-7						1.06E12
I-133						6.0E-03	1.0	3.31E-03	Thyroid	9.26E-6						9.60E09
Cs-134						1.2E-02	0.2	7.03E-04	Liver	1.07E-8						6.81E10
Cs-136						1.2E-02	0.2	1.35E-04	Liver	6.17E-7						5.77E09
Cs-137						1.2E-02	0.2	6.11E-04	Liver	7.28E-10						6.03E10
Ba-140						4.0E-04	0.2	1.71E-04	Bone	6.27E-7						2.41E08
Ce-141						1.0E-04	0.2	2.48E-05	GI-LLI	2.48E-7						1.37E07
H-3						1.0E-02	0.2	3.08E-07	Body	1.78E-9						2.38E03
P-32						2.5E-02	0.2	1.70E-03	Bone	5.61E-7						1.61E11
Fe-55						1.2E-03	0.2	1.39E-05	Bone	8.14E-9						1.35E08
C-14						1.2E-02	0.2	2.37E-05	Bone	3.84E-12						2.34E09

TABLE 4-15

R_i^C [D/Q] Grass-Cow-Milk Pathway Factor (child)

Nucl.	K'	Q_F	Uap	Yp	Ys	Fm	r	DFL^i	Organ	λi	λw	tf	th	fp	fs	R_i^C
Cr-51	10^6	50	330	0.7	2.0	2.2E-03	0.2	4.72E-7	GI-LLI	2.89E-7	5.73E-7	1.73E5	7.78E6	1	1	5.41E06
Mn-54						2.5E-04	0.2	1.07E-5	Liver	2.57E-8						2.10E07
Fe-59						1.2E-03	0.2	2.78E-5	GI-LLI	1.8E-7						2.03E08
Co-58						1.0E-03	0.2	1.05E-5	GI-LLI	1.13E-7						7.08E07
Co-60						1.0E-03	0.2	2.93E-5	GI-LLI	4.18E-9						2.39E08
Zn-65						3.9E-02	0.2	3.65E-5	Liver	3.29E-8						1.10E10
Sr-89						8.0E-04	0.2	1.32E-3	Bone	1.58E-7						6.63E09
Sr-90						8.0E-04	0.2	1.70E-2	Bone	7.6E-10						1.12E11
Zr-95						5.0E-06	0.2	2.66E-5	GI-LLI	1.22E-7						8.84E05
I-131						6.0E-03	1.0	5.72E-3	Thyroid	9.95E-7						4.35E11
I-133						6.0E-03	1.0	1.36E-3	Thyroid	9.26E-6						3.95E09
Cs-134						1.2E-02	0.2	3.84E-4	Liver	1.07E-8						3.72E10
Cs-136						1.2E-02	0.2	6.46E-5	Liver	6.17E-7						2.76E09
Cs-137						1.2E-02	0.2	3.27E-4	Bone	7.28E-10						3.23E10
Ba-140						4.0E-04	0.2	8.31E-5	Bone	6.27E-7						1.17E08
Ce-141						1.0E-04	0.2	2.47E-5	GI-LLI	2.48E-7						1.36E07
H-3						1.0E-02	0.2	2.03E-7	Body	1.78E-9						3.52E02
P-32						2.5E-02	0.2	8.25E-4	Bone	5.61E-7						7.79E10
Fe-55						1.2E-03	0.2	1.15E-5	Bone	8.14E-9						1.12E08
C-14						1.2E-02	0.2	1.21E-5	Bone	3.84E-12						1.20E09

Table 4-16

Vegetation Pathway Dose Factors (Child)

R_i^v [D/Q]

Nucl.	K'	U_a^L	U_a^s	Yv		λw	r	DFL_i	λi	fl	fg	t_L	t_h			R_i^v
Cr-51	10^6	26	520	2.0		5.73E-07	0.2	4.27E-07	2.89E-07	1.0	0.76	8.6E4	5.18E6			6.23E06
Mn-54							0.2	1.07E-05	2.57E-08							6.65E08
Fe-59							0.2	2.78E-05	1.8E-07							6.69E08
Co-58							0.2	1.05E-05	1.13E-07							3.76E08
Co-60							0.2	2.93E-05	4.18E-09							1.71E09
Zn-65							0.2	3.65E-05	3.29E-08							2.16E09
Sr-89							0.2	1.32E-03	1.58E-07							3.61E10
Sr-90							0.2	1.70E-02	7.6E-10							1.24E12
Zr-95							0.2	2.66E-05	1.22E-07							9.02E08
I-131							1.0	5.72E-03	9.95E-07							4.77E10
I-133							1.0	1.36E-03	9.2E-06							8.20E08
Cs-134							0.2	3.84E-04	1.07E-08							2.63E10
Cs-136							0.2	6.46E-05	6.17E-07							2.22E08
Cs-137							0.2	3.27E-04	7.28E-10							2.39E10
Ba-140							0.2	8.31E-05	6.27E-07							2.77E08
Ce-141							0.2	2.47E-05	2.48E-07							4.06E08
H-3							0.2	2.03E-07	1.78E-09							4.01E03
P-32							0.2	8.25E-04	5.61E-07							3.38E09
Fe-55							0.2	1.15E-05	8.14E-09							8.01E08
C-14							0.2	1.21E-05	3.84E-12							8.89E08

TABLE 4-18

Locations of Site Boundary, Residences, Dairy Cows

Sector	Distance* Nearest Point of Site Boundary (Meters)	Distance* Nearest Residence (Meters)	Distance* Nearest Cow (Miles)
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	8.9
E	625	730	
ENE	760	1370	10.0
NE	790	1525	
NNE	River	3050	19.6

* Measured from Indian Point 3.

Dose Factors for Nearest Residence

Table 4-19

Nuclide	$\overline{Ki}$	$\overline{Li}$	$\overline{Mi}$	$\overline{Ni}$	$\overline{Si}$
Kr-83m	9.07E-08		2.32E-05	3.46E-04	2.54E-03
Kr-85m	1.40E-03	1.75E-03	1.48E-03	2.36E-03	3.37E-03
Kr-85	1.93E-05	1.61E-03	2.06E-05	2.34E-03	1.63E-03
Kr-87	7.10E-03	1.17E-02	7.40E-03	1.24E-02	1.98E-02
Kr-88	1.68E-02	2.84E-03	1.82E-02	3.52E-03	2.29E-02
Kr-89	1.99E-02	1.21E-02	2.08E-02	1.27E-02	3.49E-02
Kr-90	1.87E-02	8.75E-03	1.96E-02	9.40E-03	3.02E-02
Xe-131m	1.10E-04	5.71E-04	1.87E-04	1.33E-03	7.78E-04
Xe-133m	3.01E-05	1.19E-03	3.92E-04	1.78E-03	1.62E-03
Xe-133	3.53E-04	3.67E-04	4.24E-04	1.26E-03	8.33E-04
Xe-135m	3.74E-03	8.53E-04	4.03E-03	8.87E-04	5.29E-03
Xe-135	2.17E-03	2.23E-03	2.30E-03	2.95E-03	4.76E-03
Xe-137	1.70E-03	1.46E-02	1.81E-03	1.52E-02	1.67E-03
Xe-138	1.06E-02	4.96E-03	1.11E-02	5.70E-03	1.72E-02
Ar-41	1.06E-02	3.23E-03	1.12E-02	3.94E-03	1.95E-01

$(\overline{X/Q})v$ = 1.2E-06 sec/m3

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

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

MONTHLY REPORT OF GASEOUS BATCH RELEASES

Month__________ Year 19__________ TABLE 4-20 Page________ of ________

Sample Point	Release Permit Number	Sample Number	Activity (uCi/cc)	Date	Release Start Time	Release Finish Time	K BAR	L BAR	M BAR	N BAR	Curies Released	Release Rate Ci/Sec.

TABLE 4-21

Determination of Gross Noble Gas Releases

Sample Point: Auxiliary Building Vent Exhaust (Continuous)*
Condenser Air Ejector Exhaust
Steam Generator Blowdown Tank Vent

Date: ____________ to ____________

Day	PRM Gross Count Rate (CPM)	PRM Background Count Rate (CPM)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		
28		
29		
30		
31		
Monthly Average		

Monthly Average Net Count Rate R = ____________ cpm

Gross Counting Efficiency Eg = ____________ cpm/uCi/cc

Monthly Average Gross Noble Gas Concentration C = R/Eg = ____________ uCi/cc

Vent Volume Discharged During Month V = ____________ cc

Total Noble Gases Released During Month 10^{-6} VC = ____________ Ci

ATTACHMENT 4-1

POWER AUTHORITY OF THE STATE OF NEW YORK

INDIAN POINT NO. 3 NUCLEAR POWER PLANT

No.__________________

AIRBORNE RADIOACTIVE WASTE RELEASE PERMIT

At_______ (time) on_______ (date) the________________________ (name) system was isolated and contained _______ ft^3 at ________ psig, the total activity in this system_______________ (Ci; max, 6000). Radioanalysis SN________showed the noble gas activity to be_________________uci/cc. Discharge monitor_______________

in service with alarm set point of________cpm. NOTE: For vapor containment pressure

relief R-12 reading___________cpm.

If discharge monitor is out of service complete this section.

Monitor out of service is________________. Date placed out of service___________. Vent

sample no.____________at___________showed noble gas activity to be_________uci/cc

with average vent flow rate____________cfm.

ᴇCHARGE AUTHORIZED BY___________________

start_________ (time) on_______ (date)

finish_________ (time) on_______ (date)

final pressure_________ (psig)

CALCULATIONS: D=_________,T=__________,S=______________,K=___________,L=_________

METEOROLOGY

TIME	WIND SPEED	WIND DIRECTION	PASQUILL CATEGORY

CHAPTER 5

OPERABILITY OF EQUIPMENT

5.0 This section includes flow diagrams defining the treatment paths and the components of the radioactive liquid, gaseous and solid waste management systems at Indian Point 3. These systems are maintained and used pursuant to requirements of 10CFR50.36a, to meet Technical Specifications 3.11.1.3, 3.11.2.4 and 3.11.3.1. The drawings are taken from the final Safety Analysis Report for Indian Point 3 and from the plant manual.

Figure 5.1 is a flow diagram of the Indian Point 3 radioactive liquid waste disposal system. Figure 5.2 is a flow diagram of the Indian Point 3 gaseous radioactive waste disposal system. Figure 5.1 also provides information on the solid waste handling system for evaporator bottoms and bailing of solids at Indian Point 3.

Figure 5.3 is a description of the intertie between the Unit No. 3 steam generator blowdown and the blowdown purification system which is physically installed in the Indian Point 1 facility. During periods of steam generator tube leakage the blowdown from the leaking steam generator is diverted to the Unit No. 1 system in order to reduce radioactive releases to the environment through the blowdown pathway. In addition, further redundance in liquid waste processing capability is provided by a line which allows for transfer of liquid waste from the Indian Point 3 waste holdup tank No. 31 shown on drawing 5.1 to the liquid waste handling system of the Indian Point 1 facility.

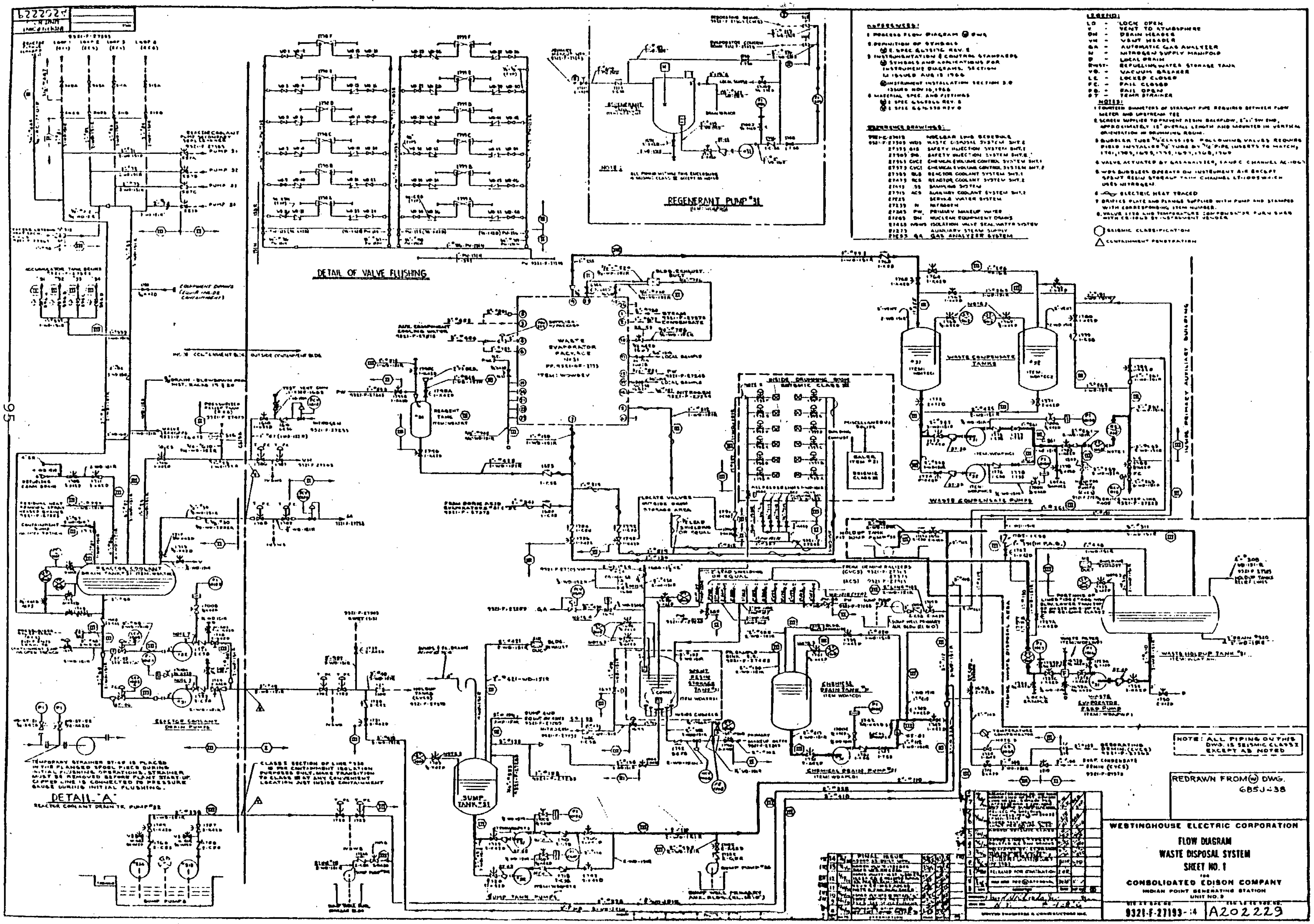

DETAIL OF VALVE FLUSHING
REGENERANT PUMP #31
REFERENCES:
LEGEND:
NOTES:
WASTE CONDENSATE TANKS
WASTE CONDENSATE PUMPS
REACTOR COOLANT DRAIN TANK
REACTOR COOLANT DRAIN PUMPS
DETAIL "A"
SUMP TANK #31
SUMP TANK PUMPS
CHEMICAL DRAIN TANK
CHEMICAL DRAIN PUMP #31
WASTE HOLDUP TANK #31
NOTE: ALL PIPING ON THIS DWG. IS SEISMIC CLASS I EXCEPT AS NOTED
REDRAWN FROM (W) DWG. 685J438
WESTINGHOUSE ELECTRIC CORPORATION
FLOW DIAGRAM
WASTE DISPOSAL SYSTEM
SHEET NO. 1
CONSOLIDATED EDISON COMPANY
INDIAN POINT GENERATING STATION
UNIT NO. 3
9321-F-27193-14
A202229

Figure 5-1

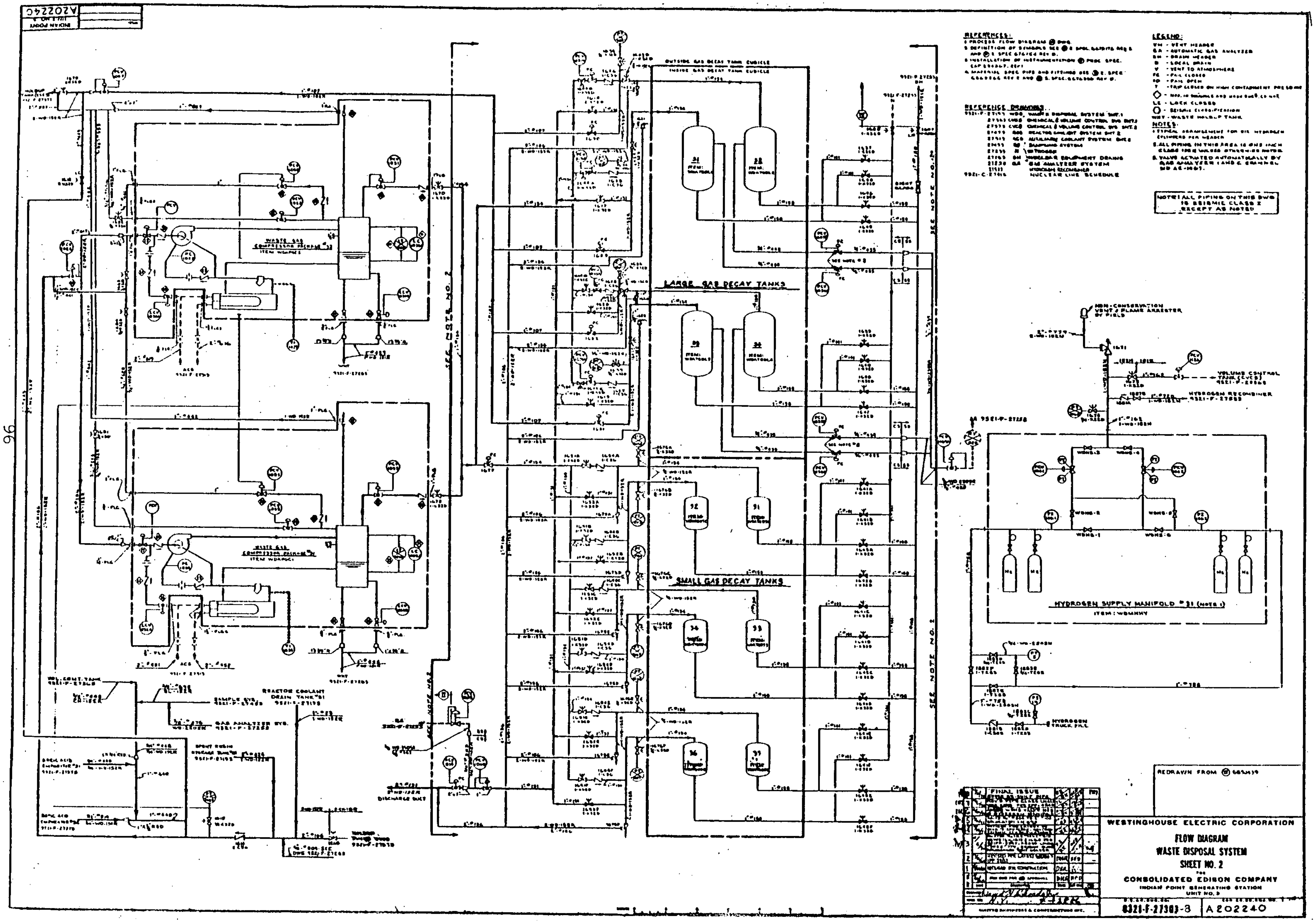
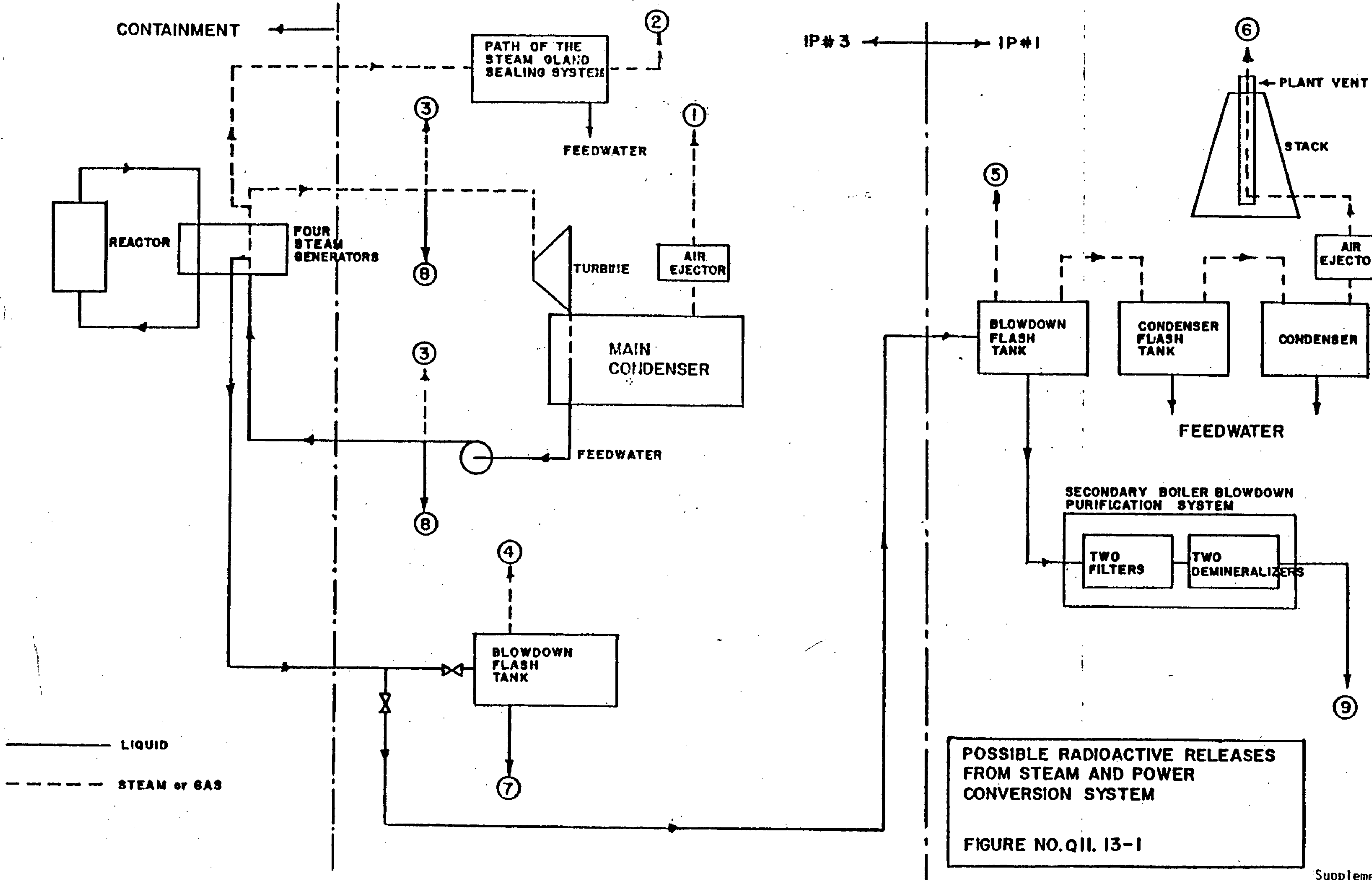

A202240
LARGE GAS DECAY TANKS
SMALL GAS DECAY TANKS
WASTE GAS COMPRESSOR PACKAGE
HYDROGEN SUPPLY MANIFOLD
SEE NOTE NO. 2
NOTE: ALL PIPING ON THIS DWG IS SEISMIC CLASS I EXCEPT AS NOTED
REFERENCES:
REFERENCE DRAWINGS:
LEGEND:
NOTES:
VOLUME CONTROL TANK (CVCS)
HYDROGEN RECOMBINER
HYDROGEN TRUCK FILL
REACTOR COOLANT DRAIN TANK
SAMPLE SYS.
GAS ANALYZER SYS.
DISCHARGE DUCT
FINAL ISSUE
REDRAWN FROM (W) 6854619
WESTINGHOUSE ELECTRIC CORPORATION
FLOW DIAGRAM
WASTE DISPOSAL SYSTEM
SHEET NO. 2
FOR
CONSOLIDATED EDISON COMPANY
INDIAN POINT GENERATING STATION
UNIT NO. 3
9321-F-27303-8
A202240

Figure 5-2



POSSIBLE RADIOACTIVE RELEASES FROM STEAM AND POWER CONVERSION SYSTEM

FIGURE NO. QII. 13-1

Figure 5-3

Supplement 10
January, 1973

CHAPTER 6

Sample Locations

Figure 6.1 is a map which shows the location of environmental sampling points within 2.5 miles of the Indian Point Plant and Figure 6.2 is a map providing the same information for points at greater distances from the plant.

Table 6.1 provides a description of environmental sampling locations and the sample types collected at each of these locations. Table 6.1 lists all TLD sites, including those recently added to the program. Table 6.2 provides information on methods of sample collection, sampling frequency and types of analysis performed.

Table 6.3 provides information on limits of detection for each type of analysis performed.

Radiological Environmental Monitoring - Sampling Stations

Figure 6-1

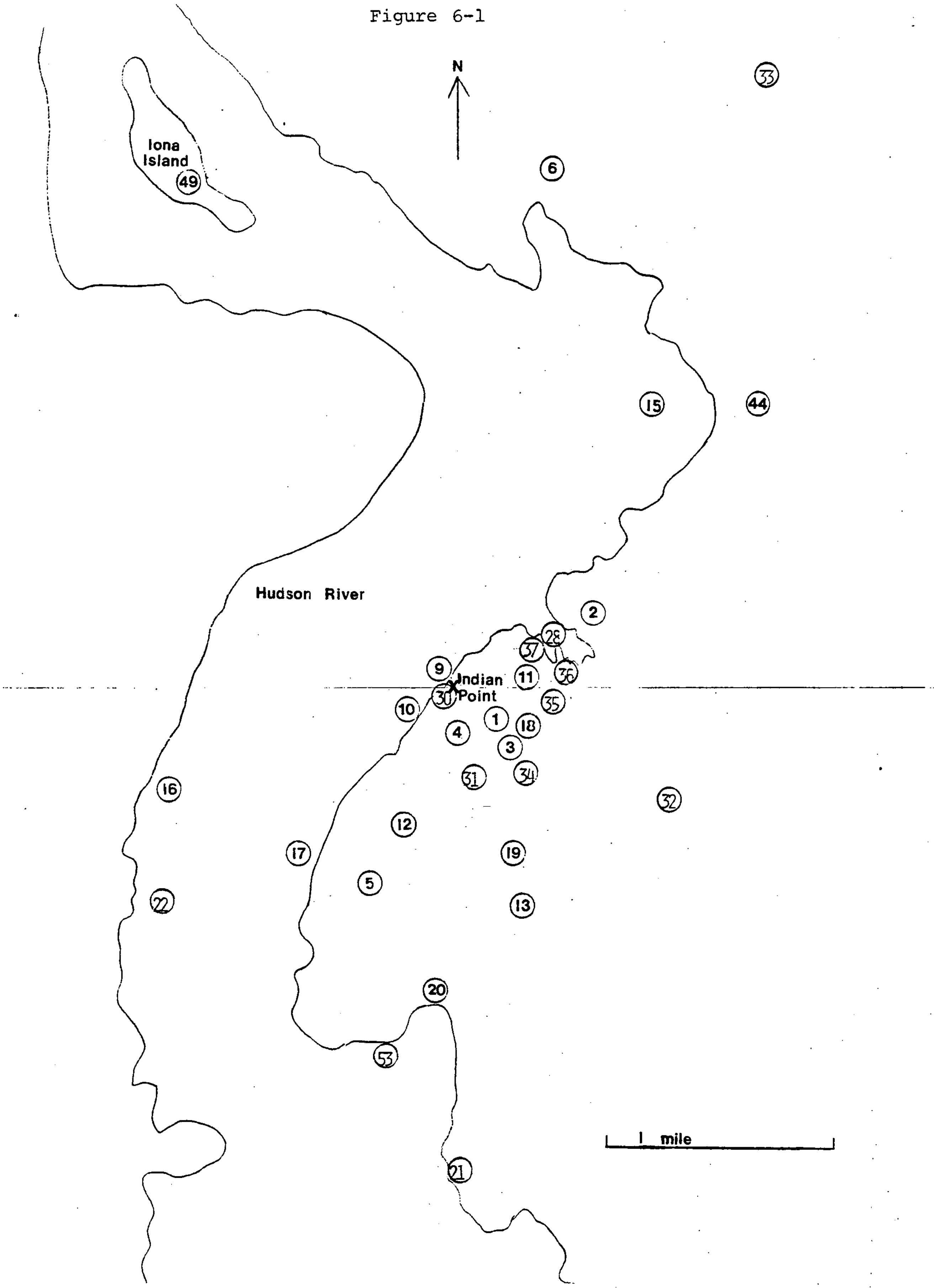
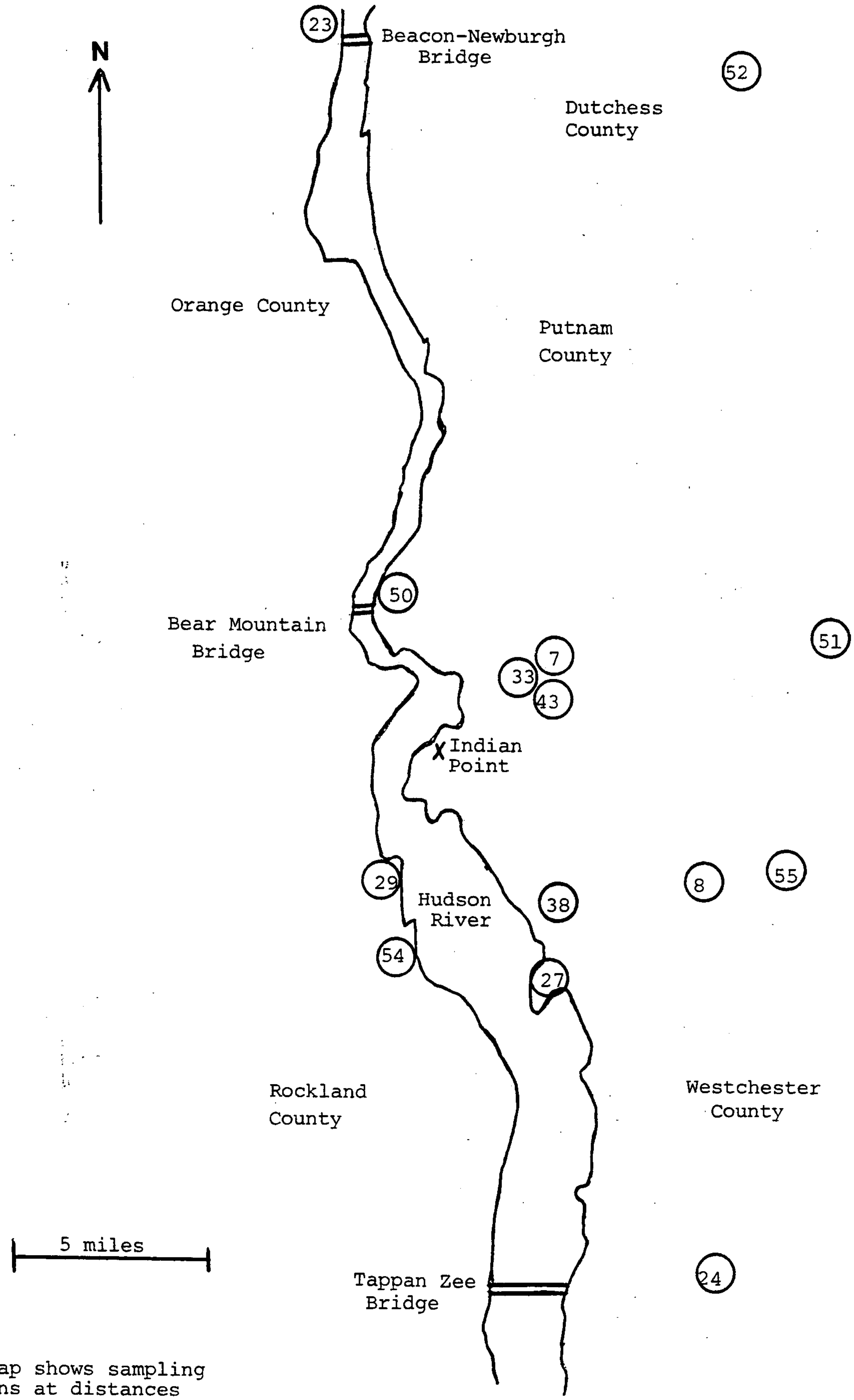


Figure 6-2

Radiological Environmental Monitoring - Sampling Stations



Note: this map shows sampling stations at distances greater than 2.5 miles from Indian Point

TABLE 6-1 (1 of 5)

INDIAN POINT STATION - LOCATION OF SAMPLING STATION POINTS

Sample Station Points	Location/Distance	Sample Types
1	Environmental Laboratory, Onsite - SSE	Fallout Air Particulate Radioiodine Direct Gamma Soil
2	Standard Brands, 0.6 mi - NNE	Air Particulate Radioiodine Direct Gamma Soil
3	Service Building, Onsite - SSE	Air Particulate Radioiodine Direct Gamma Soil
4.	Algonquin Gas Line, 0.25 mi - S	Air Particulate Radioiodine Direct Gamma Soil
5	NYU Tower, 1 mi - SSE	Air Particulate Radioiodine Direct Gamma Soil
6	Camp Smith, 2.5 mi - NNE	Well Water Soil
7	Camp Field Reservoir, 3.5 mi - NE	Drinking Water
8	New Croton Reservoir, 7 mi - ESE	Drinking Water
9	Inlet pipe into plants - NNE	HR* Water
10	Discharge Canal, Onsite - SW	HR Water HR Bottom Sediment
11	Iroquois Lake, Onsite - E	Surface Lake Water
12	Trap Rock Lake, 0.75 mi - SSE	Surface Lake Water
13	Lake Meahagh, 1 mi - SSE	Surface Lake Water

* HR = Hudson River

TABLE 6-1 (2 of 5)

INDIAN POINT STATION - LOCATION OF SAMPLING STATION POINTS

Sample Station Points	Location/Distance	Sample Types
14	Water Meter House, Onsite - E	Direct Gamma
15	Peekskill Bay, 1.5 mi - NE	Shoreline Soil HR Bottom Sediment
16	Tompkins Cove, 1.5 mi - WSW	HR Bottom Sediment
17	Off Verplanck, 1 mi - SSW	Shoreline Soil HR Bottom Sediment
18	Indian Point, Onsite - SE	Soil Well Water
19	St. Mary's Cemetery, 0.75 - SSE	Soil
20	Montrose Marina, 1.5 mi - S	Soil Direct Gamma
21	George's Island, 2.5 mi - SSE	Soil
22	Lovett, 1.5 mi - WSW	HR Bottom Sediment
23	Roseton**, 20 mi - N	Fallout Air Particulate Radioiodine Direct Gamma
24	Eastview, 15 mi - SE	Fallout
25	Where available near site	Fish
26	New York City Aqueduct, Onsite (tap water)	Drinking Water
27	Croton Point, 7.5 mi - SSE	Air Particulate Radioiodine Direct Gamma Fallout
28	Lent's Cove, 0.5 mi - NE	**Bottom Sediment Direct Gamma

**Control Station

TABLE 6-1 (3 of 5)

INDIAN POINT STATION - LOCATION OF SAMPLING STATION POINTS

Sample Station Points	Location/Distance	Sample Types
29	Grassy Point, 3 mi - S	Air Particulate Radioiodine Direct Gamma Fallout
30	Dock, Onsite - W	Direct Gamma Soil
31	Onsite Pole - S	Direct Gamma
32	Factory St. SS, 1 mi - ESE	Direct Gamma
33	Hamilton St. SS, 3 mi - NNE	Direct Gamma
34	SE Corner Onsite - SE	Direct Gamma
35	Bleakley & Broadway, Onsite - E	Direct Gamma
36	Old Dump, 0.5 mi - ENE	Direct Gamma
37	NE Corner, Onsite - NE	Direct Gamma
38	Furnace Dock, 3.5 mi - SE	Air Particulate Radioiodine Direct Gamma Fallout
41	Appropriate locations in critical wind sections	Food Products (leafy green vegetables)
43	Oregon Road, 3.4 mi - NE	Air Particulate Radioiodine
44	Gas Holder Bldg., 1.75 mi - NE	Air Particulate Radioiodine
49	Iona Island, 2.5 mi - NNW	HR Bottom Sediment Shoreline Soil
50	Manitou Inlet**, 4.5 mi - NNW	HR Bottom Sediment Shoreline Soil

**Control Station

Indian Point Station - Location of Sampling Station Points

Sample Station Points	Location/Distance	Sample Types
51	Windsor Farms, 10 mi - ENE	Milk
52	Shenandoah Farms**, 19.6 mi - NNE	Milk
53	White Beach, 0.9 mi - SSW (East side HR, below Ind. Pt.)	Shoreline Soil
54	Haverstraw Beach, 4 mi - SSW	Shoreline Soil
55	Hilltop Hanover Farms, 8.9 mi - ESE	Milk
-	Cortandt Sanitation Dept., 2 mi - N	Direct Gamma
-	Rte. 9D, 5 mi - N	Direct Gamma
-	Old Pemart Ave., 2 mi - NNE	Direct Gamma
-	Gallows Hill Rd., 5 mi - NNE	Direct Gamma
-	Lower South St. and Franklin, 1.5 mi - NE	Direct Gamma
-	Westbrook Dr., 5 mi - NE	Direct Gamma
-	Lower South St. and Louisa, 1 mi - ENE	Direct Gamma
-	Pine Rd., 5 mi - ENE	Direct Gamma
-	Welcher Ave., 1 mi - E	Direct Gamma
-	Croton Ave., 5 mi - E	Direct Gamma
-	Simulator Bldg., onsite - ESE	Direct Gamma
-	Calabaugh Pond Rd., 5 mi - ESE	Direct Gamma
-	Mt. Airy and Windsor Rd., 5 mi - SE	Direct Gamma
-	Village Hall, 1 mi - SE	Direct Gamma
-	Tate Ave., 1 mi - SE	Direct Gamma
-	Warren Ave., 5 mi - S	Direct Gamma
-	B'way and Kings Ferry Rd., 1.5 mi - SSW	Direct Gamma
-	Rte. 9W and RR Ave., 5 mi - SSW	Direct Gamma

Indian Point Station - Location of Sampling Station Points

Sample Station Points	Location/Distance	Sample Types
-	U.S. Gypsum, 3.5 mi - SSW	Direct Gamma
-	Willows Grove Rd. and Birch, 5 mi - SW	Direct Gamma
-	Gays Hill Rd. (South End), 1.5 mi - WSW	Direct Gamma
-	Palisades Pkwy., exit 14A, 5 mi - WSW	Direct Gamma
-	Gays Hill Rd. (North End), 1 mi - W	Direct Gamma
-	Palisades Pkwy., 4 mi - W	Direct Gamma
-	Rte. 9W and Pirates Cove, 1 mi - WNW	Direct Gamma
-	Anthony Wayne Pk. (Parking Area), 4.5 mi -WNW	Direct Gamma
-	Rte. 9W, South of Ayers Rd., 1 mi - NW	Direct Gamma
-	Palisades Pkwy., Lake Welch Exit, 5 mi -NW	Direct Gamma
-	Ayer Rd., 1 mi - NNW	Direct Gamma
-	Rte 9W, 5 mi - NNW	Direct Gamma

** CONTROL STATIONS

TABLE 6-2 (1 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE:			
a. Radioiodine and Particulates	Locations 1, 2, 3, 4, 5, 23, 27, 29, 38, 43, 44.	Continuous operation of sampler with sample collection as required by dust loading but at least once per 7 days.	Radioiodine canister. Analyze at least once per 7 days for I-131. Particulate sampler. Analyze for gross beta radioactivity $\geq$ 24 hours following filter change. Perform gamma isotopic analysis on each sample when gross beta activity is > 10 times the mean of control sample. Perform gamma isotopic analysis on composite (by location) sample at least once per 92 days.
2. DIRECT RADIATION:	Locations 1, 2, 3, 4, 5, 14, 20, 23, 27 through 38 and 30 additional non-numbered locations, listed in Table 6-1.	At least once per 31 days.	Gamma dose. At least once per 31 days.

**Sample locations are shown on Figures 6-1 and 6-2.

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE:			
a. Surface (River)	Locations 9, 10	Composite* sample collected over a period of ≤ 31 days.	Gamma Isotopic analysis of each sample by location. Tritium analysis of composite*** sample at least once per 92 days.
b. Surface (Lake)	Locations 11, 12, 13.	Grab sample at least once per 31 days.	Gamma isotopic analysis of each sample by location. Tritium analysis of composite**** sample at least once per 92 days.
c. Ground	Locations 6, 18.	Grab Sample at least once per 31 days.	Gamma isotopic analysis of each sample. Tritium analysis of composite posite**** sample at least once per 92 days.

* Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
** Sample locations are shown on Figures 6-1 and 6-2.
*** Composite of aliquots of monthly samples.
**** Composite of monthly grab samples.

TABLE 6-2 (3 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
d. Fallout (Rainwater)	Locations 1, 23, 24, 27, 29, 38.	Composite* sample collected over a period of $\leq$ 31 days.	Gamma isotopic and tritium analyses of each sample.
e. Drinking	Locations 7, 8, 26.	Grab sample at least once per 31 days.	I-131 analysis of each sample required if calculated dose for water consumption is > 1 mrem/yr. and Gamma isotopic analysis of each sample. Tritium analysis of composite**** sample at least once per 92 days.
f. Bottom Sediment	Locations 10, 15, 16, 17, 22, 28, 49, 50.	Once each in the spring and in the summer.	Gamma isotopic analysis of each sample.
g. Sediment from Shoreline	Locations 15, 17, 49, 50, 53, 54.	Once each in the spring and in the summer.	Gamma isotopic analysis of each sample.

* Composite samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.
** Sample locations are shown on Figures 6-1 and 6-2.
**** Composite of monthly grab samples.

TABLE 6-2 (4 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations**	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION:			
a. Milk	Locations 51, 52, 55.	When animals are on pasture at least once per 31 days or at least once per 15 days when the calculated dose is greater than 15 mrem/yr.	Gamma isotopic and I-131 analysis of each sample.
b. Fish and Invertebrates	Location 25.	One sample in season, or at least once per 184 days if not seasonal.	Gamma isotopic analysis on edible portions.
c. Food Products	Location 41.	At time of harvest, grab sample of leafy green vegetables grown within 10 miles of the site.	Gamma isotopic and I-131 analysis on edible portion
d. Soil	Locations 1, 2, 3, 4, 5, 6, 18, 19, 20, 21, 31.	Grab sample at least once per 3 years.	Gamma isotopic analysis.

**Sample locations are shown on Figures 6-1 and 6-2.

TABLE 6-3 (1 of 3)

MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a]

Analysis	Water (pCi/l)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/l)	Food Products (pCi/kg,wet)	Sediment (pCi/kg,dry)
gross beta	4[b]	1×10^{-2}				
^{3}H	2000(1000[b])					
^{54}Mn	15		130			
$^{58, 60}Co$	15		130			
^{95}Zr-Nb	15					
^{131}I	1	7×10^{-2}		1	60[c]	
$^{134, 137}Cs$	15(10[b]), 18	1×10^{-2}	130	15	80	150
^{140}Ba-La	15			15		

TABLE NOTATION

a - The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radio-chemical separation):

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

where:

LLD is the lower limit of detection as defined above (as pCi per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (as counts per minute),

E is the counting efficiency (as counts per transformation),

V is the sample size (in units of mass or volume),

2.22 is the number of transformations per minute per picocurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide,

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

The value of s_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., potassium-40 in milk samples).

TABLE 6-3 (3 of 3)

TABLE NOTATION

Analyses shall be performed in such a manner that the stated LLDs will be achieved under routine conditions. Occasionally background fluctuations, unavoidably small sample sizes, the presence of interferring nuclides, or other uncontrollable circumstances may render these LLDs unachievable. In such cases, the contributing factors will be identified and described in the Annual Radiological Environmental Operating Report.

b - LLD for drinking water.

c - LLD for leafy vegetables.