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May 15, 2001
BVY 01-42

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Reference: (a) Letter, VYNPC to USNRC, "2000 Annual Radioactive Effluent Release Report," BVY 01-41, dated May 15, 2001.

Subject: **Vermont Yankee Nuclear Power Station**
License No. DPR-28 (Docket No. 50-271)
Changes to the Off-site Dose Calculation Manual made during 2000

Vermont Yankee (VY) Technical Specification 6.7.B requires reporting of changes to the Off-site Dose Calculation Manual (ODCM) in the Annual Radioactive Effluent Release Report.

In Reference (a), VY provided a summary of changes that were made to the ODCM during 2000 and noted that copies of the revised pages associated with Revision 26 and a copy of Revision 27 would be submitted concurrently. Attachment 1 provides copies of the pages associated with Revision 26 and Attachment 2 provides a copy of Revision 27 of the ODCM. Due to the volume of information, the attachments will only be sent to the USNRC Document Control Desk.

We trust that the information provided is adequate; however, should you have questions or require additional information, please contact Mr. David P. Tkatch at (802) 258-5500.

Sincerely,

VERMONT YANKEE NUCLEAR POWER CORPORATION

Gautam Sen
Licensing Manager

Attachments

cc: USNRC Region 1 Administrator
USNRC Resident Inspector – VYNPS
USNRC Project Manager – VYNPS
Vermont Department of Public Service

A009

SUMMARY OF VERMONT YANKEE COMMITMENTS

BVY NO.: 01-42

The following table identifies commitments made in this document by Vermont Yankee. Any other actions discussed in the submittal represent intended or planned actions by Vermont Yankee. They are described to the NRC for the NRC's information and are not regulatory commitments. Please notify the Licensing Manager of any questions regarding this document or any associated commitments.

COMMITMENT	COMMITTED DATE OR "OUTAGE"
None	N/A

Attachment 1

Vermont Yankee Nuclear Power Station

Pages Associated with Revision 26 of the Off-site Dose Calculation Manual

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VERMONT YANKEE NUCLEAR POWER STATION

OFF-SITE DOSE CALCULATION MANUAL

REVISION 26

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*Appendix A deleted with Revision 26. Appendices C and E removed and archived with Revision 26.

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TABLE 1.1-2

Summary of Methods to Calculate
Unrestricted Area Liquid Concentrations

Equation Number	Category	Equation	Reference Section
2-1	Sum of the Fractions of Combined Effluent Concentrations in Liquids [Except Noble Gases]	$F_l^{ENG} = \sum_i \frac{Cpi}{ECL_i} \leq 10$	2.1
2-2	Total Activity of Dissolved and Entrained Noble Gases from all Station Sources	$C_l^{NG}\left(\frac{\mu Ci}{ml}\right) = \sum_i C_{li}^{NG} \leq 2E-04$	2.1

TABLE 1.1-6

Summary of Methods to Calculate
Dose to an Individual from Tritium, Iodine, and Particulates in
Gas Releases and Direct Radiation

Equation Number	Category	Equation	Reference Section
3-25	Dose to Critical Organ from Stack Release of I-131, I-133, Tritium, and Particulates	$D_{cos}(mrem) = \sum_i Q_i^{STP} DFG_{sico}$	3.9.1
3-44	Dose to Critical Organ from Ground Level Release of I-131, I-133, Tritium, and Particulates	$D_{cog}(mrem) = \sum_i Q_i^{GLP} DFG_{gico}$	3.9.1
	Direct Dose		
3-27	Turbine Building	$D_d(mrem) = K_{N16}(L) \times E$	3.11.1
	North Warehouse		
3-28	Shielded End	$D_s = 0.25 \times \dot{R}_s$	3.11.2
3-29	Unshielded End	$D_u = 0.53 \times \dot{R}_u$	3.11.2
	LLW Storage Pad		
3-30	Direct Line (Module Short Side Out)	$D_{de} = 0.28 \times \dot{R}_d \times f_d$	3.11.3
3-31	Direct Line (Module Long Side Out)	$D_{ds} = 0.39 \times \dot{R}_d \times f_d$	3.11.3
3-32	Skyshine (Resin Liners)	$D_{SKR} = 0.016 \times \dot{R}_{SKR} \times f_{SK}$	3.11.3
3-33	Skyshine (DAW)	$D_{SKD} = 0.015 \times \dot{R}_{SKD} \times f_{SK}$	3.11.3
3-34	Resin Liner Transfer (Unshielded)	$D_{Tran} = 0.0025 \times \dot{R}_{Tran} \times T_{Tran}$	3.11.3
3-35	Intermodular Gap Dose	$D_{Gap} = 2.44E-2 \times W_{Gap} \times A_{RL} \times f_{Gap}$	3.11.3

Summary of Variables

Variable		Definition	Units
$\dot{R}_d$	=	Dose rate at 3 feet from unobstructed side of storage module facing site boundary.	$\frac{mrem}{hr}$
D_{dE}	=	Direct dose at site boundary per unobstructed storage module (short end).	$\frac{mrem}{yr - module}$
D_{dS}	=	Direct dose at site boundary per unobstructed storage module (long side).	$\frac{mrem}{yr - module}$
D^{γ}_{finite}	=	Gamma dose to air, corrected for finite cloud.	mrad
D_{Gap}	=	Intermodular gap dose projected to the maximum site boundary location from resin waste not directly shielded by DAW modules.	$\frac{mrem}{yr}$
D_{mo}	=	Dose to the maximum organ.	mrem
D^S	=	Dose to skin from beta and gamma.	mrem
$\dot{R}_S$	=	Dose rate at 1 meter from source in shielded end of North Warehouse.	$\frac{mrem}{hr}$
D_S	=	Annual dose at site boundary from fixed sources in shielded end of North Warehouse.	$\frac{mrem}{yr}$
$\dot{R}_{SKD}$	=	Maximum dose rate at 3 feet over top of DAW in a storage module.	$\frac{mrem}{hr}$
$\dot{R}_{SKR}$	=	Maximum dose rate at 3 feet over top of each resin liner in a storage module.	$\frac{mrem}{hr}$
D_{SKD}	=	Skyshine dose at the site boundary from DAW in storage modules (unobstructed top surfaces).	$\frac{mrem}{yr - module}$
D_{SKR}	=	Skyshine dose at the site boundary from resin liners in storage modules (unobstructed top surfaces).	$\frac{mrem}{yr - liner}$

TABLE 1.1-8
(Continued)

Summary of Variables

Variable		Definition	Units
$\dot{Q}_i$	=	Release rate for radionuclide "i" at the point of interest.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{ST}$	=	The noble gas radionuclide "i" release rate at the plant stack.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{GL}$	=	The noble gas radionuclide "i" release rate from ground level.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{SJAE}$	=	The noble gas radionuclide "i" release rate at the steam jet air ejector.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{AOG}$	=	The noble gas radionuclide "i" release rate at the exhaust of the Advanced Off-Gas System	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{STP}$	=	The iodine, tritium, and particulate radionuclide "i" release rate from the plant stack.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{GLP}$	=	The iodine, tritium, and particulate radionuclide "i" release rate from ground level.	$\frac{\mu Ci}{sec}$
Q_i^{ST}	=	The release of noble gas radionuclide "i" from the plant stack.	curies
Q_i^{GL}	=	The release of noble gas radionuclide "i" from ground level.	curies
Q_i^{STP}	=	The release of iodine, tritium, and particulate radionuclide "i" from the plant stack.	curies
Q_i^{GLP}	=	The release of iodine, tritium, and particulate radionuclide "i" from ground level.	curies
R_{spt}^{L}	=	Liquid monitor response for the limiting concentration at the point of discharge.	cps

3.0 OFF-SITE DOSE CALCULATION METHODS

Chapter 3 provides the basis for plant procedures required to meet the 10CFR50, Appendix I, ALARA dose objectives, and the 40CFR190 total dose limits to members of the public in unrestricted areas, as stated in the Radiological Effluent Technical Specifications (hereafter called RETS). A simple, conservative method (called Method I) is listed in Tables 1.1-2 to 1.1-7 for each of the requirements of the RETS. Each of the Method I equations is presented, along with their bases in Sections 3.2 through 3.9 and Section 3.11. In addition, reference is provided to more sophisticated but still conservative methods (called Method II) for use when more accurate results are needed. This chapter provides the methods, data, and reference material with which the operator can calculate the needed doses and dose rates. Setpoint methods for effluent monitor alarms are described in Chapter 5.

Demonstration of compliance with the dose limits of 40CFR190 is considered to be a demonstration of compliance with the 0.1 rem limit of 10CFR20.1301(a)(1) for members of the public in unrestricted areas (Reference 56 FR23374, 3rd column).

Method I is conservative because it is based on dose factors DFL_{itb} which were chosen from the base case to be the highest of the four age groups for each radionuclide, as well as assuming minimum river dilution flow.

3.2.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable, such as the use of actual river flow at the time of actual discharge as opposed to the minimum river flow of 1,260 cfs that is assumed in the Method I dose factors (except for the fish pathway). The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

where:

DFL_{imo} = Site-specific maximum organ dose factor (mrem/Ci) for a liquid release. See Table 1.1-11.

Q_i = Total activity (Ci) released for radionuclide "i".

Because of the assumptions about receptors, environment, and radionuclides; and because of the low Objective and Standard, the lack of immediate restriction on plant operation, and the adherence to 10CFR20 concentrations (which limit public health consequences) a failure of Method I (i.e., the exposure of a real individual being underestimated) is improbable and the consequences of a failure are minimal.

3.3.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

3.4 Method to Calculate the Total Body Dose Rate From Noble Gases

Technical Specification 3.8.E.1 limits the instantaneous dose rate at any time to the total body from all release sources of noble gases at any location at or beyond the site boundary equal to or less than 500 mrem/year.

Use Method I first to calculate the Total Body Dose Rate from the peak release rate via both elevated and ground level release points. The dose rate limit of Technical Specification 3.8.E.1.a is the total contribution from both ground and elevated releases occurring during the period of interest.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limit (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1 had actually been exceeded during a short time interval.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant stack noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site dose rate limit of Technical Specification 3.8.E.1, or a value below it, taking into account the potential contribution of releases from all ground level sources.

Determinations of dose rates for compliance with Technical Specifications (3.8.E.1) are performed when the effluent monitor alarm setpoint is exceeded and the corrective action required by Specification 3.8.E.2 is unsuccessful, or as required by the notations to Technical Specification Table 3.9.2 when the stack noble gas monitor is inoperable.

3.4.1 Method I

The Total Body Dose Rate due to noble gases can be determined by multiplying the individual radionuclide release rates by their respective dose factors, summing all the products together, and then multiplying this total by a conversion constant (0.61), as seen in the following Equation 3-5 :

For ground level noble gas releases, the total body dose rate is calculated as follows:

$$\dot{R}_{tbg} = 6.4 \sum_i \dot{Q}_i^{GL} \; DFB_i \qquad (3\text{-}39)$$

$$\left(\frac{pCi-sec}{\mu Ci-m^3}\right)\left(\frac{\mu Ci}{sec}\right)\left(\frac{mrem-m^3}{pCi-yr}\right)$$

where:

$\dot{Q}_i^{GL}$ = Ground level release rate (μCi/sec) of noble gas.

The total body dose rate for the site is equal to $\dot{R}_{tbs} + \dot{R}_{tbg}$.

During periods (beyond the first five days) when the plant is shutdown and no radioactivity release rates can be measured at the SJAE, Xe-133 may be used in place of the last SJAE measured mix as the referenced radionuclide to determine off-site dose rate and monitor setpoints. In this case, the ratio of each Q_i^{SJAE} to the sum of all Q_i^{SJAE} in Equation 3-28 above is assumed to reduce to a value of 1, and the total body gamma dose factor DFB_i for Xe-133 (2.94 E-04 mrem-m^3/ρCi-yr) is used in Equation 3-5. Alternately, a relative radionuclide "i" mix fraction (f_i) may be taken from Table 5.2-1 as a function of time after shutdown, and substituted in place of the ratio of Q_i^{SJAE} to the sum of all Q_i^{SJAE} in Equation (3-28) above to determine the relative fraction of each noble gas potentially available for release to the total. Just prior to plant startup before a SJAE sample can be taken and analyzed, the monitor alarm setpoints should be based on Xe-138 as representing the most prevalent high dose factor noble gas expected to be present shortly after the plant returns

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

In the case of noble gas dose rates, Method II cannot provide much extra realism because $\dot{R}_{tbs}$ and $\dot{R}_{tbg}$ are already based on several factors which make use of current plant parameters. However, should it be needed, the dose rate analysis for critical receptor can be performed making use of current meteorology during the time interval of recorded peak release rate in place of the default atmospheric dispersion factor used in Method I.

3.4.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

3.5 Method to Calculate the Skin Dose Rate from Noble Gases

Technical Specification 3.8.E.1 limits the instantaneous dose rate at any time to the skin from all release sources of noble gases at any location at or beyond the site boundary to 3,000 mrem/year.

Use Method I first to calculate the Skin Dose Rate from both elevated and ground level release points to the atmosphere. The dose rate limit of Technical Specification 3.8.E.1.a is the total contribution from both ground and elevated releases occurring during the period of interest. Method I applies at all release rates.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limits (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1 had actually been exceeded during a short time interval.

Compliance with the dose rate limits for noble gases are continuously demonstrated when effluent release rates are below the plant stack noble gas activity monitor alarm setpoint by virtue of the fact that the alarm setpoint is based on a value which corresponds to the off-site Technical Specification dose rate limit, or a value below it, taking into account the potential contribution releases from all ground level sources.

Determinations of dose rate for compliance with Technical Specifications (3.8.E.1) are performed when the effluent monitor alarm setpoint is exceeded and the corrective action required by Specification 3.8.E.2 is unsuccessful, or as required by the notations to Technical Specification Table 3.9.2 when the stack noble gas monitor is inoperable.

3.5.1 Method I

The skin dose rate due to noble gases is determined by multiplying the individual radionuclide release rates by their respective dose factors, and summing all the products together as seen in the following Equation 3-7:

For ground level releases, the skin dose rate from noble gases is calculated by Equation 3-38:

$$\dot{R}_{sking} = \sum_i \dot{Q}_i^{GL} DF'_{ig} \qquad (3\text{-}38)$$

where:

$\dot{Q}_i^{GL}$ = The noble gas release rate from ground level (µCi/sec) for each radionuclide "i" identified.

DF'_{ig} = Combined skin dose factor for a ground level release [see Table 1.1-10A].

The skin dose rate for the site is equal to $\dot{R}_{skins} + \dot{R}_{sking}$.

During periods (beyond the first five days) when the plant is shutdown and no radioactivity release rates can be measured at the SJAE, Xe-133 may be used in place of the last SJAE measured mix as the referenced radionuclide to determine off-site dose rate and monitor setpoints. In this case, the ratio each of $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation 3-28 above is assumed to reduce to a value of 1, and the combined skin dose factor DF'_{is} for Xe-133 (5.58 E-04 mrem-sec/µCi-year) is used in Equation 3-7. Alternately, a relative radionuclide "i" mix fraction (f_i) may be taken from Table 5.2-1 as a function of time after shutdown, and substituted in place of the ratio of each $\dot{Q}_i^{SJAE}$ to the sum of all $\dot{Q}_i^{SJAE}$ in Equation 3-28 above to determine the relative fraction of each noble gas potentially available for release to the total. Just prior to plant startup before a SJAE sample can be taken and analyzed, the monitor alarm setpoints should be based on Xe-138 as representing the most prevalent high dose factor noble gas expected to be present shortly after the plant returns to power. Monitor alarm setpoints which have been determined to be conservative under any plant conditions may be utilized at any time in lieu of the above assumptions.

Equations 3-7 and 3-38 can be applied under the following conditions (otherwise, justify Method I or consider Method II):

1. Normal operations (not emergency event), and

2. Noble gas releases via both elevated and ground level vents to the atmosphere.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

3.5.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

3.6 Method to Calculate the Critical Organ Dose Rate from Iodines, Tritium and Particulates with $T_{1/2}$ Greater Than 8 Days

Technical Specification 3.8.E.1.b limits the dose rate to any organ, denoted $\dot{R}_{co}$, from all release sources of I-131, I-133, H-3, and radionuclides in particulate form with half lives greater than 8 days to 1500 mrem/year to any organ. The peak release rate averaging time in the case of iodines and particulates is commensurate with the time the iodine and particulate samplers are in service between changeouts (typically a week).

Use Method I first to calculate the critical organ dose rate from both elevated and ground level release points to the atmosphere. The dose rate limit of Technical Specification 3.8.E.1.b is the total contribution from both ground and elevated releases occurring during the period of interest. Method I applies at all release rates.

Use Method II if Method I predicts a dose rate greater than the Technical Specification limits (i.e., use of actual meteorology over the period of interest) to determine if, in fact, Technical Specification 3.8.E.1.b had actually been exceeded during the sampling period.

3.6.1 Method I

The critical organ dose rate from stack releases can be determined by multiplying the individual radionuclide release rates by their respective dose factors and summing all their products together, as seen in the following Equation 3-16:

$$\dot{R}_{COS} = \sum_i \dot{Q}_i^{STP} \; DFG'_{sico} \qquad (3\text{-}16)$$

$$\left(\frac{\text{mrem}}{\text{yr}}\right) \qquad \left(\frac{\mu\text{Ci}}{\text{sec}}\right)\left(\frac{\text{mrem - sec}}{\mu\text{Ci - yr}}\right)$$

DFG'_{sico} and DFG'_{gico} (North Warehouse waste oil burner vent releases) incorporates the conversion constant of 31.54 and has assumed that the shielding factor (S_F) applied to the direct exposure pathway from radionuclides deposited on the ground plane is equal to 1.0 in place of the S_F value of 0.7 assumed in the determination of DFG_{sico} and DFG_{gico} for the integrated doses over time.

The selection of critical receptor (based on the combination of exposure pathways which include direct dose from the ground plane, inhalation and ingestion of vegetables, meat, and milk) which is outlined in Section 3.10 is inherent in Method I, as are the maximum expected off-site atmospheric dispersion factors based on past long-term site-specific meteorology.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

Should Method II be needed, the analysis for critical receptor critical pathway(s) and atmospheric dispersion factors may be performed with actual meteorologic and latest land use census data to identify the location of those pathways which are most impacted by these type of releases.

3.6.3 Method II

If Method I cannot be applied, or if the Method I dose exceeds the limit, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

The main difference between Method I and Method II is that Method II would allow the use of actual meteorology to determine $[X/Q]^{\gamma}$ rather than use the maximum long-term average value obtained for the years 1981 to 1985.

3.7.3 Method II

If the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable.

$$= \quad 3.52E\text{-}05 \text{ sec/m}^3$$

leading to:

$$D^{\beta}_{airg} = 1.12 \sum_i Q_i^{GL} \quad DF_i^{\beta} \tag{3-43}$$

The calculation of ground level release dispersion parameters are based on the location of the North Warehouse with respect to the site boundary that would experience the highest exposure. The North Warehouse contains a waste oil burner that can be used for the incineration of low level contaminated waste oil, and is designated as a ground level release point to the atmosphere. Due to differences in building cross sectional areas and resulting building wake effects, the North Warehouse atmospheric dispersion factors are conservative in comparison to those associated with the main plant facilities, such as the Turbine Building. As a consequence, any potential or unexpected ground level release from the Turbine Building or adjoining structures can utilize the above ground release dose assessment equations.

3.8.3 Method II

If Method I cannot be applied, or if the Method I dose determination indicates that the Technical Specification limit may be exceeded, or if a more exact calculation is required, then Method II may be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable.

of the base case. The dose factors DFG_{ico} used in Method I were chosen from the base case to be the highest of the set for that radionuclide. In effect each radionuclide is conservatively represented by its own critical age group and critical organ.

3.9.3 METHOD II

If Method I cannot be applied, or if the Method I dose exceeds the limit or if a more exact calculation is required, then Method II should be applied. Method II consists of the models, input data and assumptions in Regulatory Guide 1.109, Rev. 1 (Reference A), except where site-specific models, data or assumptions are more applicable. The base case analysis, documented above, is a good example of the use of Method II. It is an acceptable starting point for a Method II analysis.

TABLE 3.9-1

Environmental Parameters for Gaseous Effluents at Vermont Yankee
(Derived from Reference A)*

Variable			Vegetables		Cow Milk		Goat Milk		Meat	
			Stored	Leafy	Pasture	Stored	Pasture	Stored	Pasture	Stored
YV	Agricultural Productivity	(Kg/m^2)	2	2	0.70	2	0.70	2	0.70	2
P	Soil Surface Density	(Kg/m^2)	240	240	240	240	240	240	240	240
T	Transport Time to User[(5)]	(Hrs)			48	48	48	48	480	480
TB	Soil Exposure Time[(1)]	(Hrs)	131400	131400	131400	131400	131400	131400	131400	131400
TE	Crop Exposure Time to Plume	(Hrs)	1440	1440	720	1440	720	1440	720	1440
TH	Holdup After Harvest	(Hrs)	1440	24	0	2160	0	2160	0	2160
QF	Animals Daily Feed	(Kg/Day)			50	50	6	6	50	50
FP	Fraction of Year on Pasture[(2)]				0.50		0.50		0.50	
FS	Fraction Pasture When on Pasture[(3)]				1		1		1	
FG	Fraction of Stored Veg. Grown in Garden		0.76							
FL	Fraction of Leafy Veg. Grown in Garden			1						
FI	Fraction Elemental Iodine = 0.5									
A	Absolute Humidity = 5.6 (gm/m^3)[(4)]									

*Regulatory Guide 1.109, Revision 1.

TABLE 3.9-1
(Continued)

Notes:

(1) For Method II dose/dose rate analyses of identified radioactivity releases of less than one year, the soil exposure time for that release may be set at 8760 hours (1 year) for all pathways.

(2) For Method II dose/dose rate analyses performed for releases occurring during the first or fourth calendar quarters, the fraction of time animals are assumed to be on pasture is zero (nongrowing season). For the second and third calendar quarters, the fraction of time on pasture (FP) will be set at 1.0. FP may also be adjusted for specific farm locations if this information is so identified and reported as part of the land use census.

(3) For Method II analyses, the fraction of pasture feed while on pasture may be set to less than 1.0 for specific farm locations if this information is so identified and reported as part of the land use census.

(4) For all Method II analyses, an absolute humidity value equal to 5.6 (gm/m^3) shall be used to reflect conditions in the Northeast (Reference: Health Physics Journal, Vol. 39 (August), 1980; Page 318-320, Pergammon Press).

(5) Variable T is a combination of variables TF and TS in Regulatory Guide 1.109, Revision 1.

3. The point of maximum ground level air concentration (maximum depleted X/Q) of radioiodines and other particulates for determining critical organ dose from inhalation; and

4. The point of maximum deposition (maximum D/Q) of radioiodines and other particulates for determining critical organ dose from ingestion.

The Stack release pathway was evaluated as an elevated release assuming a constant nominal Stack flow rate of 175,000 cfm. The point of maximum gamma exposure from Stack releases (SSE sector, 750 meters) was determined by finding the maximum five-year average gamma X/Q at any off-site location. The location of the maximum ground level air concentration and deposition of radioiodines and other particulates (NW sector, 2700 meters) was determined by finding the maximum five-year average depleted X/Q and D/Q at any off-site location. For the purposes of determining the Method I dose factors for radioiodines, tritium, and particulates, a milk animal was assumed to exist at the location of highest calculated ground level air concentration and deposition of radioiodines and other particulates as noted above. This location then conservatively bounds the deposition of radionuclides at all real milk animal locations.

The North Warehouse release pathway was evaluated as a ground level release using the same meteorological period-of-record as the stack. The highest long-term atmospheric dispersion factors at the site boundary were determined (see Table 3.10-1) and doses and dose rates to the critical off-site receptor were calculated assuming the highest site boundary atmospheric dispersion factors all occurred at the same location.

3.10.2 Vermont Yankee Atmospheric Dispersion Model

The long-term average atmospheric dispersion factors are computed for routine releases using AEOLUS-2 Computer Code (Reference B). AEOLUS-2 is based, in part, on the constant mean wind direction model discussed in Regulatory Guide 1.111 (Reference C). Since AEOLUS-2 is a straight-line steady-state model, site-specific recirculation correction factors were developed for each release pathway to adjust the AEOLUS-2 results to account for temporal variations of atmospheric transport and diffusion conditions. The applicable recirculation correction factors are listed in Table 3.10-3.

3.11 Method to Calculate Direct Dose From Plant Operation

Technical Specification 3.8.M.1 (40CFR190) restricts the dose to the whole body or any organ to any member of the public from all station sources (including direct radiation from fixed sources on-site) to 25 mrem in a calendar year (except the thyroid, which is limited to 75 mrem).

3.11.1 Turbine Building

The maximum contribution of direct dose to the whole body or to any organ due to N-16 decay from the turbine is:

$$D_d = K_{N16}(L) \times E \qquad (3\text{-}27)$$

$$(\text{mrem}) \qquad \frac{(\text{mrem})}{MW_e h} \qquad (MW_e h)$$

where:

D_d = The dose contribution from N-16 decay at either the site boundary of maximum impact (west site boundary) or maximum off-site residence - (mrem).

E = Gross electric output over the period of interest ($MW_e h$).

$K_{N16}(L)$ = The N-16 dose conversion factor for (L) equal to either:

(1) 3.39E-06 for the maximum west site boundary; or

(2) 2.63E-06 for the maximum residence (i.e., SW site boundary with respect to Turbine Hall)(mrem/$MW_e h$). The maximum resident dose may also be corrected for occupancy time (i.e., multiply the dose by the fraction of time typically spent by the resident at the location during the period of interest) if documented.

3.11.2 North Warehouse

Radioactive materials and low level waste can be stored in the North Warehouse. The maximum annual dose contributions to off-site receptors (west site boundary line) from sources in the shielded (east) end and the unshielded (west) end of the North Warehouse are:

D_{dE} = The annual direct dose contribution at the maximum site boundary from a single rectangular storage module which has an unobstructed short end surface (not shielded by other modules) orientated toward the west site boundary $\left(\frac{\text{mrem}}{\text{yr- module}}\right)$.

D_{dS} = The annual direct dose contribution at the maximum site boundary from a single rectangular storage module which has an unobstructed long side surface (not shielded by other modules) orientated toward the west site boundary $\left(\frac{\text{mrem}}{\text{yr- module}}\right)$.

$\dot{R}_d$ = Maximum dose rate measured at 3 feet from the side of the storage module whose unobstructed face (i.e., a side or end surface which is not shielded by other waste modules) is toward the west site boundary.

f_d = The fraction of a year that a storage module is in use on the storage pad.

0.28 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 3 feet from the narrow end of the rectangular storage module when that face is orientated toward the west boundary.

0.39 = Dose rate to dose conversion factor which relates mrem/yr at the west site boundary per mrem/hr measured at 3 feet from the long side of the rectangular storage module when that face is orientated toward the west boundary.

(b) Scatter From Skyshine

(3-32)

$$D_{SKR} = 0.016 \times \dot{R}_{SKR} \times f_{sk}$$

$$\left(\frac{\text{mrem}}{\text{yr-liner}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) \quad (\#)$$

and

(3-33)

$$D_{SKD} = 0.015 \times \dot{R}_{SKD} \times f_{SK}$$

$$\left(\frac{\text{mrem}}{\text{yr-module}}\right) \quad \left(\frac{\text{mrem/yr}}{\text{mrem/hr}}\right) \quad \left(\frac{\text{mrem}}{\text{hr}}\right) \quad (\#)$$

where:

R_{SKR} = The annual skyshine scatter contribution to the dose at the maximum site boundary from a single spent ion exchange media liner in a storage module whose top surface is not obstructed due to stacking of modules $\left(\frac{\text{mrem}}{\text{yr-liner}}\right)$.

R_{SKD} = The annual skyshine scatter contribution to the dose at the maximum site boundary from a rectangular storage module containing DAW whose top surface is not obstructed due to stacking of modules $\left(\frac{\text{mrem}}{\text{yr-module}}\right)$.

$\dot{R}_{SKR}$ = For Resins, the maximum dose rate measured at 3 feet over the top of each liner in a storage module (mrem/hr).

$\dot{R}_{SKD}$ = For DAW, the maximum dose rate measured at 3 feet over the top surface of a storage module with DAW (mrem/hr).

f_{SK} = The fraction of a year that a storage module is in use on the storage pad.

0.016 = Dose rate to dose conversion factor for the scatter dose from each resin liner source in storage which relates mrem/yr at the west site boundary per mrem/hour at 3 feet from the top of the module.

0.015 = Dose rate to dose conversion factor for the scatter dose from DAW boxes in storage which relates mrem/yr at the west site boundary per mrem/hr at 3 feet from the top of the module.

(c) Dose From Resin Liners During Transfer

During the movement of resin liners from transfer casks to the storage modules, the liners will be unshielded in the storage pad area for a short period of time. The maximum dose contribution at the site boundary during the unshielded movement of resin liners can be calculated from:

$$D_{trans} = 0.0025 \times \dot{R}_{tran} \times T_{trans} \qquad (3\text{-}34)$$

$$(\text{mrem}) \quad \left(\frac{\text{mrem/hr}}{\text{rad/hr}}\right) \quad \left(\frac{\text{rad}}{\text{hr}}\right) \quad (\text{hr})$$

where:

D_{trans} = The dose contribution to maximum site boundary resulting from the unshielded movement of resin liners between a transfer cask and a storage module (mrem).

$\dot{R}_{trans}$ = Dose rate measured at contact (2") from the unshielded top surface of the resin liner in R/hr.

T_{tran} = The time (in hours) that an unshielded resin liner is exposed in the storage pad area.

0.0025 = The dose rate to dose conversion factor for an unshielded resin liner which relates mrem/hour at the west site boundary per rad/hr at contact (2") from the unshielded surface of the liner.

(d) Intermodular Gap Dose

In addition to the above methods for determining doses at the west site boundary from the LLW storage pad, another dose assessment model has been included to address the possible condition of spaces or gaps existing between the placement of the DAW storage modules situated along the west facing side of the pad. This could result in a radiation streaming condition existing if ion exchange resin liners were placed in storage directly behind the gap. The direct dose equations (3-30 and 3-31) consider that the storage modules situated on the outside of the pad area provide a uniform shield to storage modules placed behind them. The intermodular gap dose equation (3-35) accounts for any physical spacing between the outside storage modules which have not been covered by additional external shielding.

$$D_{Gap} = 2.44E\text{-}2 \times W_{Gap} \times A_{RL} \times f_{Gap} \quad (3\text{-}35)$$

$$\left(\frac{mrem}{yr}\right) \quad \left(\frac{mrem}{yr\text{-}in\text{-}Ci}\right) \quad (in) \quad (Ci) \quad (\#)$$

where:

D_{Gap} = The annual dose contribution at the maximum site boundary (west) from radiation streaming through the intermodular gap between DAW storage modules used to shield resin modules from direct radiation (mrem/yr).

W_{Gap} = The intermodular gap width (inches) between adjacent DAW storage modules facing the west site boundary.

A_{RL} = The total gamma activity contained in a condensate resin liner stored directly in line with the intermodular gap adjacent DAW modules (Ci).

4.0 ENVIRONMENTAL MONITORING PROGRAM

The radiological environmental monitoring stations are listed in Table 4.1. The locations of the stations with respect to the Vermont Yankee plant are shown on the maps in Figures 4-1 to 4-6.

4.1 Intercomparison Program

All routine radiological analyses for environmental samples are performed at a contracted environmental laboratory. The contracted laboratory participates in several commercial inter-comparison programs in addition to an internal QC sample analysis program and the analysis of client-introduced QC sample programs. The external programs include the Department of Energy – Environmental Measurements Laboratory Quality Assessment Program (EMLQAP), Department of Energy – Mixed Analyte Performance Evaluation Program (MAPEP), Analytics Cross-Check Program - Environmental Inter-laboratory Cross-Check Program, and Environmental Resources Association - Environmental Radioactivity Performance Evaluation Program.

4.2 Airborne Pathway Monitoring

The environmental sampling program is designed to achieve several major objectives, including sampling air in predominant up-valley and down-valley wind directions, and sampling air in nearby communities and at a proper control location, while maintaining continuity with two years of preoperational data and all subsequent years of operational data (post 1972.) The chosen air sampling locations are discussed below.

To assure that an unnecessarily frequent relocation of samplers will not be required due to short-term or annual fluctuations in meteorology, thus incurring needless expense and destroying the continuity of the program, long term, site specific ground level D/Qs (five-year averages - 1978 through 1982) were evaluated in comparison to the existing air monitoring locations to determine their adequacy in meeting the above-stated objectives of the program and the intent of the NRC general guidance. The long-term average meteorological data base precludes the need for an annual re-evaluation of air sampling locations based on a single year's meteorological history.

The Connecticut River Valley in the vicinity of the Vermont Yankee plant has a pronounced up- and down-valley wind flow. Based on five years of meteorological data, wind blows into the 3 "up-valley" sectors (N, NNW, and NW) 27 percent of the time, and the 4 "down-valley" sectors (S, SSE, SE, and ESE) 40 percent of the time, for a total "in-valley" time of 67 percent.

Table 4.1

Radiological Environmental Monitoring Stations[1]

Exposure Pathway and/or Sample	Sample Location and Designated Code[2]		Distance (km)[5]	Direction[5]
1. AIRBORNE (Radioiodine and Particulate)				
	AP/CF-11	River Station No. 3-3	1.88	SSE
	AP/CF-12	N. Hinsdale, NH	3.61	NNW
	AP/CF-13	Hinsdale Substation	3.05	E
	AP/CF-14	Northfield, MA	11.61	SSE
	AP/CF-15	Tyler Hill Road[4]	3.14	WNW
	AP/CF-21	Spofford Lake	16.36	NNE
2. WATERBORNE				
a. Surface	WR-11	River Station No. 3-3	1.88	Downriver
	WR-21	Rt. 9 Bridge	11.83	Upriver
b. Ground	WG-11	Plant Well	0.24	On-Site
	WG-12	Vernon Nursing Well	2.13	SSE
	WG-13	COB Well[4]	0.26	On-Site
	WG-14	Plant Support Bldg Well[4]	0.27	On-Site
	WG-22	Skibniowsky Well	13.73	N
c. Sediment From Shoreline	SE-11	Shoreline Downriver	0.57	SSE
	SE-12	North Storm Drain Outfall[3]	0.13	E
3. INGESTION				
a. Milk[8]	TM-11	Miller Farm[4]	0.82	W
	TM-14	Brown Farm	2.22	S
	TM-16	Meadow Crest Farm	4.26	NW
	TM-18	Blodgett Farm	3.60	SE
	TM-22	Franklin Farm[4]	9.73	WSW
	TM-24	County Farm	21.64	N
	TM-25	Downey-Spencer[4]	6.90	W
	TM-26	Cheney Hill Farm	7.53	WNW
b. Mixed Grasses	TG-11	River Station No. 3-3	1.88	SSE
	TG-12	N. Hinsdale, NH	3.61	NNW
	TG-13	Hinsdale Substation	3.05	E
	TG-14	Northfield, MA	11.61	SSE
	TG-15	Tyler Hill Rd.[4]	3.07	WNW
	TG-21	Spofford Lake	16.36	NNE

Table 4.1

(Continued)

Radiological Environmental Monitoring Stations[1]

Exposure Pathway and/or Sample	Sample Location and Designated Code[2]		Distance (km)[5]	Direction[5]
c. Silage	TC-11	Miller Farm[4]	0.82	W
	TC-14	Brown Farm	2.22	S
	TC-16	Meadow Crest Farm	4.26	NW
	TC-18	Blodgett Farm	3.60	SE
	TC-22	Franklin Farm[4]	9.73	WSW
	TC-24	County Farm	21.64	N
	TM-25	Downey-Spencer[4]	6.90	W
	TM-26	Cheney Hill Farm	7.53	WNW
d. Fish	FH-11	Vernon Pond	(6)	(6)
	FH-21	Rt. 9 Bridge	11.83	Upriver
4. DIRECT RADIATION				
	DR-1	River Station No. 3-3	1.61	SSE
	DR-2	N. Hinsdale, NH	3.88	NNW
	DR-3	Hinsdale Substation	2.98	E
	DR-4	Northfield, MA	11.34	SSE
	DR-5	Spofford Lake	16.53	NNE
	DR-6	Vernon School	0.52	WSW
	DR-7	Site Boundary[7]	0.28	W
	DR-8	Site Boundary	0.25	SSW
	DR-9	Inner Ring	1.72	N
	DR-10	Outer Ring	4.49	N
	DR-11	Inner Ring	1.65	NNE
	DR-12	Outer Ring	3.58	NNE
	DR-13	Inner Ring	1.23	NE
	DR-14	Outer Ring	3.88	NE
	DR-15	Inner Ring	1.46	ENE
	DR-16	Outer Ring	2.84	ENE
	DR-17	Inner Ring	1.24	E
	DR-18	Outer Ring	2.97	E
	DR-19	Inner Ring	3.65	ESE
	DR-20	Outer Ring	5.33	ESE
	DR-21	Inner Ring	1.82	SE
	DR-22	Outer Ring	3.28	SE
	DR-23	Inner Ring	1.96	SSE
	DR-24	Outer Ring	3.89	SSE
	DR-25	Inner Ring	1.91	S

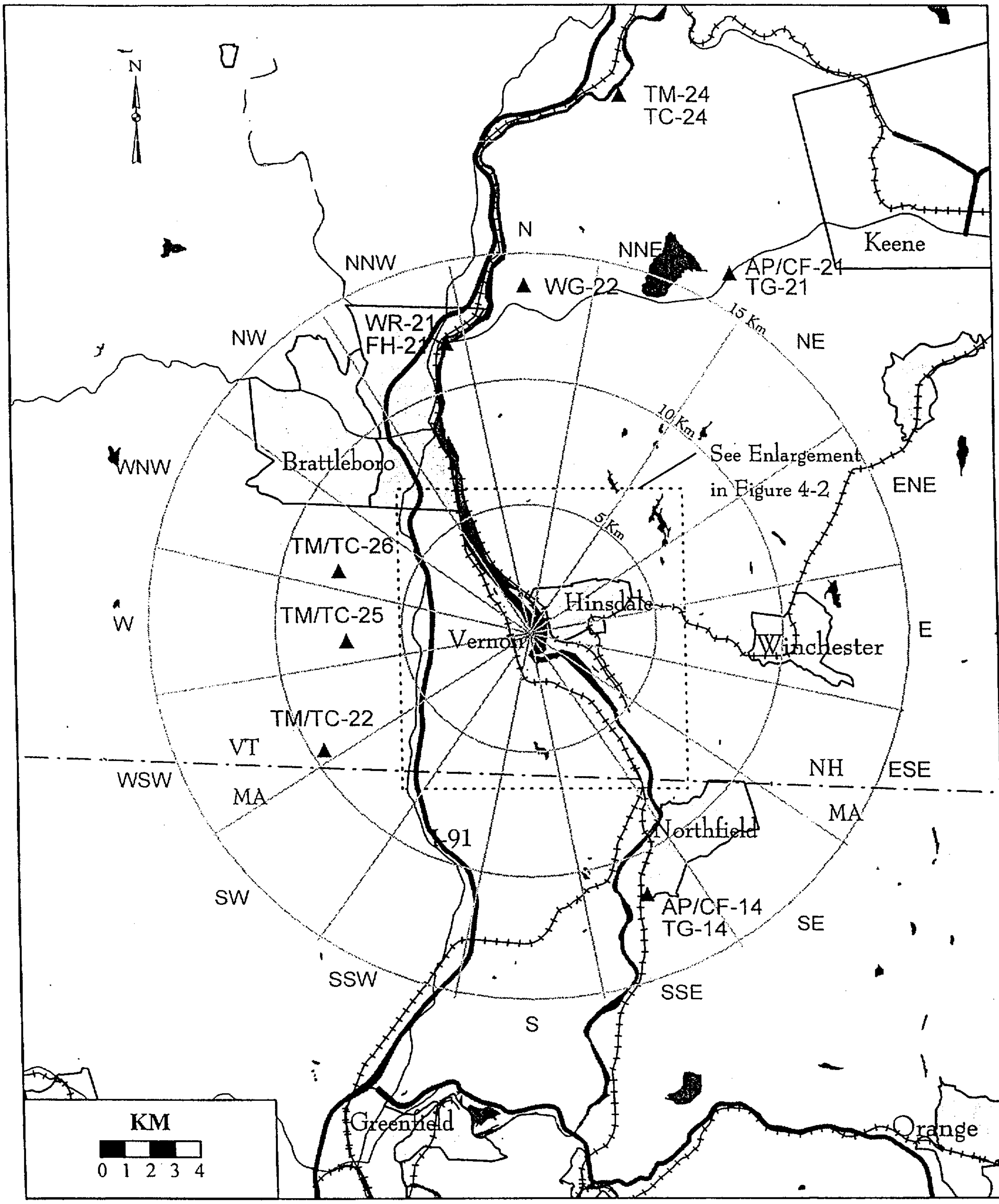

Figure 4-3 Environmental Sampling Locations Greater than 5 Km from Plant

$$\sum_i \dot{Q}_i^{SJAE} DF'_{is} = (1.03E+04) \quad (1.06E-02) + (4.73E-02) \quad (1.43E-02)$$

$$+ (2.57E+02) \quad (1.28E-02) + (1.20E+02) \quad (2.35E-03)$$

$$+ (3.70E+02) \quad (3.24E-03) + (1.97E+01) \quad (5.58E-04)$$

$$= 1.14E+02 \ (\mu Ci\text{-}mrem\text{-}sec/sec\text{-}\mu Ci\text{-}yr)$$

$$DF'_c = \frac{1.14E+02}{1.15E+04}$$

$$= 9.91E-03 \ (mrem\text{-}sec/\mu Ci\text{-}yr)$$

$$R_{spt}^{skin} = 3{,}000 \quad S_g \quad \frac{1}{F} \quad \frac{1}{DF'_c}$$

$$= (3{,}000) \quad (3E+07) \ \frac{1}{(7.32E+07)} \ \frac{1}{(9.91E-03)}$$

$$= 124{,}067 \text{ cpm}$$

The setpoint, R_{spt}, is the lesser of R_{spt}^{tb} and. R_{spt}^{skin} For the noble gas mixture in this example R_{spt}^{tb} is less than R_{spt}^{skin}, indicating that the total body dose rate is more restrictive. Therefore, in this example the "Stack Gas I" and "Stack Gas II" noble gas activity monitors should each be set at some administrative value below 39,348 cpm above background to provide conservatism for such issues as instrument uncertainty and secondary releases from other locations. As an example, a conservative value might be based on controlling release rates from the plant in order to maintain off-site air concentrations below 20 x ECL when averaged over an hour, or to account for other minor releases from the waste oil burner. For example, if an administrative limit of 70 percent of the Technical Specification whole body dose limit 500 mrem/yr (39,348 cpm) is chosen, then the noble gas monitor alarms should be set at no more than 27,543 cpm above background (0.7 x 39,348 = 27,543).

5.2.1.3 Basis for the Plant Stack and AOG System Noble Gas Activity Monitor Setpoints

The setpoints of the plant stack and AOG system noble gas activity monitors must ensure that Technical Specification 3.8.E.1.a is not exceeded. Sections 3.4 and 3.5 show that Equations 3-5 and 3-7 are acceptable methods for determining compliance with that Technical Specification. Which equation (i.e., dose to total body or skin) is more limiting depends on the noble gas mixture. Therefore, each equation must be considered separately. The

derivations of Equations 5-9 and 5-10 begin with the general equation for the response R of a radiation monitor:

$$R = \sum_i S_{gi} \; C_{mi} \qquad (5\text{-}13)$$

$$(\text{cpm}) \quad \left(\frac{\text{cpm-cm}^3}{\mu\text{Ci}}\right) \left(\frac{\mu\text{Ci}}{\text{cm}^3}\right)$$

where:

R = Response of the instrument (cpm)

S_{gi} = Detector counting efficiency for noble gas "i" (cpm/(μCi/cm^3))

C_{mi} = Activity concentration of noble gas "i" in the mixture at the noble gas activity monitor (μCi/cm^3)

The relative release rate of each noble gas, $\dot{Q}_i$ μCi/sec), in the total release rate is normally determined by analysis of a sample of off-gas obtained at the Steam Jet Air Ejector (SJAE). Noble gas release rates at the plant stack and the AOG discharge are usually so low that the activity concentration is below the Lower Limit of Detection (LLD) for sample analysis. As a result, the release rate mix ratios measured at the SJAE are used to represent any radioactivity being discharged from the stack, such as may have resulted from plant steam leaks that have been collected by building ventilation. For the AOG monitor downstream of the charcoal delay beds, this leads to a conservative setpoint since several short-lived (high dose factor) noble gas radionuclides are then assumed to be present at the monitor, which in reality, would not be expected to be present in the system at that point. During periods when the plant is shutdown (after five days), and no radioactivity release rates can be measured at the SJAE, Xe-133 is the dominant long-lived noble gas and may be used as the referenced radionuclide to determine off-site dose rates and monitor setpoints. Alternately, a relative radionuclide, "i", mix fraction, (f_i), may be taken from Table 5.2-1 as a function of time after shutdown (including periods shorter than five days) to determine the relative fraction of each noble gas potentially available for release to the total. However, prior to plant startup before a SJAE sample can be taken and analyzed, the monitor alarm setpoints should be based on Xe-138 as representing the most prevalent high dose factor noble gas expected to be present shortly after the plant returns to power. Monitor alarm setpoints which have been determined to be conservative under any plant conditions may be utilized at any time in lieu of the above assumptions. C_{mi}, the activity concentration of noble gas "i" at the noble gas activity

The skin dose rate due to noble gases is determined with Equation 3-7:

$$\dot{R}_{skin} = \sum_i \dot{Q}_i \; DF'_{is} \qquad (3\text{-}7)$$

$$(\frac{mrem}{yr}) \qquad (\frac{\mu Ci}{sec}) \; (\frac{mrem-sec}{\mu Ci-yr})$$

Where:

$\dot{R}_{skins}$ = Skin dose rate (mrem/yr)

$\dot{Q}_i$ = The release rate of noble gas "i" in the mixture for each noble gas identified (μCi/sec) equivalent to $\dot{Q}_i^{ST}$ for noble gases released at the plant stack).

DF'_{is} = Combined skin dose factor (see Table 1.1-10) (mrem-sec/μCi-yr).

A composite combined skin dose factor, DF'_c, may be defined such that:

$$DF'_c \sum_i \dot{Q}_i = \sum_i \dot{Q}_i \; DF_{is} \qquad (5\text{-}19)$$

$$(\frac{mrem-sec}{\mu Ci-yr}) \quad (\frac{\mu Ci}{sec}) \qquad (\frac{\mu Ci}{sec}) \; (\frac{mrem-sec}{\mu Ci-yr})$$

Solving Equation 5-19 for DF′ yields:

$$DF'_c = \frac{\sum_i \dot{Q}_i \, DF'_{is}}{\sum_i \dot{Q}_i}$$

TABLE 5.2-1

Relative Fractions of Core Inventory
Noble Gases After Shutdown

Time	Kr-83m	Kr-85m	Kr-85	Kr-87	Kr-88	Xe-131m	Xe-133m	Xe-133	Xe-135m	Xe-135	Xe-138
t < 24 h	.02	.043	.001	.083	.118	.002	.010	.306	.061	.093	.263
24 hr ≤ t < 48 h	---	.003	.004	---	.001	.004	.022	.758	.010	.198	---
48 h ≤ t < 5 d	---	---	.005	---	---	.006	.024	.907	.001	.058	---
5 d ≤ t < 10 d	---	---	.007	---	---	.008	.016	.969	---	---	---
10 d ≤ t < 15 d	---	---	.014	---	---	.014	.006	.966	---	---	---
15 d≤ t < 20 d	---	---	.026	---	---	.022	.002	.950	---	---	---
20 d≤ t < 30 d	---	---	.048	---	---	.034	.001	.917	---	---	---
30 d ≤ t < 40 d	---	---	.152	---	---	.070	---	.777	---	---	---
40 d≤ t < 50 d	---	---	.378	---	---	.105	---	.517	---	---	---
50 d≤ t < 60 d	---	---	.652	---	---	.108	---	.240	---	---	---
60 d≤ t < 70 d	---	---	.835	---	---	.083	---	.082	---	---	---
t ≥ 70 d	---	---	.920	---	---	.055	---	.024	---	---	---

prepared for operation. To prevent operating unsafely, instrumentation is used to detect an explosive mixture.

Hydrogen control is accomplished by providing redundant hydrogen analyzers on the outlet from the Recombiner System. These analyzers initiate recombiner system shutdown and switchover if the hydrogen concentration at the system outlet exceeds 2% by volume. During an automatic shutdown, two main air process valves close to isolate the recombiner system. Additionally, the recombiner bed temperatures and recombiner outlet temperature provide information about recombiner performance to insure that inflammable hydrogen mixtures do not go beyond the recombiner.

Should a number of unlikely events occur, it would be hypothetically possible for a hydrogen explosion to occur in the off-gas system. Such an explosion within the recombiner system could propagate into the large "30-minute" delay pipe, through the condenser/dryer subsystem, and into the charcoal absorber tanks. However, the recombiner/adsorber subsystems, piping, and vessels are designed to withstand hydrogen detonation pressures of 500 psi at a minimum so that no loss of integrity would result. Furthermore, the seven tanks of charcoal would significantly attenuate a detonation shock wave and prevent damage to the downstream equipment.

During normal operation, the dryer/adsorber subsystem may be bypassed if it becomes unavailable provided the releases are within Technical Specification limits. With the dryer/adsorber subsystem bypassed, the air ejector off-gas exhausts through the recombiner/condenser subsystems, and the 30-minute delay pipe.

The off-gas mixture combines with steam at the air ejector stage to prevent an inflammable hydrogen mixture of 4% by volume from entering the downstream hydrogen recombiners. Approximately 6,400 lb/hr of steam introduced at the second stage air ejector reduces the concentration of hydrogen to less than 3% by volume.

The recombiner subsystem consists of a single path leading from the hydrogen dilution steam jet ejectors to two parallel flow paths for hydrogen recombination. Each recombination subsystem is capable of operating independently of the other and each is capable of handling the condenser off-gas at a startup design flow of 1,600 lb/hr air and the normal off-gas design flow rate of 370 lb/hr. The major components of each recombiner flow path are a preheater, a hydrogen-oxygen recombiner, and a desuperheating condenser.

Attachment 2

Vermont Yankee Nuclear Power Station

Revision 27 of the Off-site Dose Calculation Manual

VERMONT YANKEE NUCLEAR POWER STATION

OFF-SITE DOSE CALCULATION MANUAL

REVISION 27

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* Appendix A deleted with Revision 26. Appendices C and E removed and archived with Revision 26

ABSTRACT

The VYNPS ODCM (Vermont Yankee Nuclear Power Station Off-Site Dose Calculation Manual) contains the effluent and environmental control limits, and approved methods to estimate the maximum individual doses and radionuclide concentrations occurring at or beyond the boundaries of the plant due to normal plant operation. The effluent dose models are based on the U.S. NRC Regulatory Guide 1.109. Revision 1.

With initial approval by the U.S. Nuclear Regulatory Commission and the VYNPS Plant Management and approval of subsequent revisions by the Plant Management (as per the Technical Specifications) the methods contained in the ODCM are suitable to demonstrate compliance with effluent controls.

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1.0 INTRODUCTION

The ODCM (Off-Site Dose Calculation Manual) provides formal and approved methods for the calculation of off-site concentration, off-site doses, and effluent monitor setpoints in order to comply with the Vermont Yankee Control Limits which implement the program requirements of Technical Specification 6.7.D. The ODCM forms the basis for plant procedures and is designed for use by the procedure writer. In addition, the ODCM will be useful to the writer of periodic reports required by the NRC on the dose consequences of plant operation. The dose methods contained herein follow accepted NRC guidance for calculation of doses necessary to demonstrate compliance with the dose objectives of Appendix I to 10CFR50 (Regulatory Guide 1.109) unless otherwise noted in the text.

Demonstration of compliance with the dose limits of 40CFR190 (see Control 3.4.1) will be considered as demonstrating compliance with the 0.1 rem limit of 10CFR20.1301(a)(1) for members of the public in unrestricted areas (Reference 56 FR 23374, third column.)

It shall be the responsibility of the Chemistry Manager and Radiation Protection Manager to ensure that the ODCM is used in the performance of the surveillance requirements of the appropriate portions of ODCM Controls. The administration of the program for the onsite disposal of slightly contaminated waste, as described in Appendices, is also the responsibility of the Chemistry Manager.

All changes to the ODCM must be reviewed by PORC and approved by the Plant Manager, in accordance with Technical Specification 6.7.B, prior to implementation. All approved changes shall be submitted to the NRC for their information in the Radioactive Effluent Release Report for the period in which the change(s) was made effective. The plant's Document Control Center (DCC) shall maintain the current version of the ODCM and issue under controlled distribution all approved changes to it.

1.1 Summary of Methods, Dose Factors, Limits, Constants, and Radiological Effluent Control Cross-References

This section summarizes the dose calculation methods. The concentration and setpoint methods are also summarized in Table 1.1.2 through Table 1.1.7, as well as the Method I Dose equations. Where more accurate dose calculations are needed use the Method II for the appropriate dose as described in Sections 6.2 through 6.9 and 6.11. The dose factors used in the equations are in Tables 1.1.10 through 1.1.12 and the Regulatory Limits are summarized in Table 1.1.1.

A cross-reference of old Technical Specification sections to the new ODCM sections containing the equivalent Controls is presented in Table 1.1.8.

Special definitions and equation variables used in the ODCM are in Tables 2.1.1 and 2.1.2.

TABLE 1.1.1
Summary of Radiological Effluent Controls and Implementing Equations

	Control	Category	Method [1]	Limit
3.2.1	Liquid Effluent Concentration	Sum of the Fractions of Effluent Concentration Limits [Excluding Noble Gases] Total Noble Gas Concentration	Eq. 5-1 Eq. 5-2	≤10 $\leq 2 \times 10^{-4}$ µCi/cc
3.2.2	Liquid Effluent Dose	Total Body Dose Organ Dose	Eq. 6-1 Eq. 6-3	≤1.5 mrem in a qtr. ≤3.0 mrem in a yr. ≤5 mrem in a qtr. ≤10 mrem in a yr.
3.2.3	Liquid Radwaste Treatment Operability	Total Body Dose Organ Dose	Eq. 6-1 Eq. 6-3	≤0.06 mrem in a mo. ≤0.2 mrem in a mo.
3.3.1	Gaseous Effluents Dose Rate	Total Body Dose Rate from Noble Gases Skin Dose Rate from Noble Gases	Eq. 6-5 Eq. 6-39 Eq. 6-7 Eq. 6-38	≤500 mrem/yr. ≤3000 mrem/yr.
3.3.1	(Continued)	Organ Dose Rate from Iodines, Tritium and Particulates with $T_{1/2}$>8 Days	Eq. 6-16 Eq. 6-40	≤1500 mrem/yr.

TABLE 1.1.1
(Continued)
Summary of Radiological Effluent Controls
and Implementing Equations

Control		Category	Method [1]	Limit
3.3.2	Gaseous Effluents Dose from Noble Gases	Gamma Air Dose from Noble Gases	Eq. 6-21 Eq. 6-41	≤ 5mrad in a qtr. ≤10 mrad in a yr.
		Beta Air Dose from Noble Gases	Eq. 6-23 Eq. 6-43	≤10 mrad in a qtr. ≤ 20 mrad in a yr.
3.3.3	Gaseous Effluents Dose from Iodines, Tritium, and Particulates	Organ Dose from I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days	Eq. 6-25 Eq. 6-44	≤ 7.5 mrem in a qtr. ≤15 mrem in a yr.
3.3.5	Ventilation Exhaust Treatment	Organ Dose	Eq. 6-25	≤0.3 mrem in a mo.
3.4.1	Total Dose (from All Sources)	Total Body Dose	Footnote [2]	≤25 mrem in a yr.
		Organ Dose		≤25 mrem in a yr.
		Thyroid Dose		≤75 mrem in a yr.

TABLE 1.1.1
(Continued)

Summary of Radiological Effluent Controls
and Implementing Equations

	Control	Category	Method[1]	Limit
3.1.1	Liquid Effluent Monitor Setpoint			
	Liquid Radwaste Discharge Monitor	Alarm Setpoint	Eq. 8-1	Control 3.2.1
3.1.2	Gaseous Effluent Monitor Setpoint			
	Plant Stack and AOG Offgas System Noble Gas Activity Monitors	Alarm/Trip Setpoint for Total Body Dose Rate	Eq. 8-9	Control 3.3.1.a (Total Body)
		Alarm/Trip Setpoint for Skin Dose Rate	Eq. 8-10	Control 3.3.1.a (Skin)
	SJAE Noble Gas Activity Monitors	Alarm Setpoint	Eq. 8-21	T.S. 3.8.K.1 and Control 3.3.7

(1) More accurate methods may be available (see subsequent chapters).

(2) Effluent Control 3.4.1 requires this evaluation only if twice the limit of Equations 6-1, 6-3, 6-21, 6-23, or 6-25 is reached. If this occurs a Method II calculation shall be made considering available information for pathways of exposure to real individuals from liquid, gaseous, and direct radiation sources.

TABLE 1.1.2
Summary of Methods to Calculate
Unrestricted Area Liquid Concentrations

Equation Number	Category	Equation	Reference Section
5-1	Sum of the Fractions of Combined Effluent Concentrations in Liquids [Except Noble Gases]	$F_1^{ENG} = \sum_i \frac{Cpi}{ECL_i} \leq 10$	5.1
5-2	Total Activity of Dissolved and Entrained Noble Gases from all Station Sources	$C_i^{NG}\left(\frac{\mu Ci}{ml}\right) = \sum_i C_{ii}^{NG} \leq 2E-04$	5.1

TABLE 1.1.3

Summary of Methods to Calculate
Off-Site Doses from Liquid Concentrations

Equation Number	Category	Equation	Reference Section
6-1	Total Body Dose	$D_{tb}(\text{mrem}) = \sum_i Q_i \, DFL_{itb}$	6.2.1
6-3	Maximum Organ Dose	$D_{mo}(\text{mrem}) = \sum_i Q_i \, DFL_{imo}$	6.3.1

TABLE 1.1.4
Summary of Methods to Calculate
Dose Rates

Equation Number	Category	Equation	Reference Section
6-5	Total Body Dose Rate from Noble Gases Released from Stack	$\dot{R}_{tbs}\left(\frac{mrem}{yr}\right) = 0.61\sum_i \dot{Q}_i^{ST} DFB_i$	6.4.1
6-39	Total Body Dose Rate from Noble Gases Released from Ground	$\dot{R}_{tbg}\left(\frac{mrem}{yr}\right) = 6.4\sum_i \dot{Q}_i^{GL} DFB_i$	6.4.1
6-7	Skin Dose Rate from Noble Gases Released from Stack	$\dot{R}_{skins}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{ST} DF'_{is}$	6.5.1
6-38	Skin Dose Rate from Noble Gases Released from Ground	$\dot{R}_{sking}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GL} DF'_{ig}$	6.5.1
6-16	Critical Organ Dose Rate from Stack Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days	$\dot{R}_{cos}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{STP} DFG'_{sico}$	6.6.1
6-40	Critical Organ Dose Rate from Ground Level Release of I-131, I-133, Tritium, and Particulates with $T_{1/2}$ >8 Days	$\dot{R}_{cog}\left(\frac{mrem}{yr}\right) = \sum_i \dot{Q}_i^{GLP} DFG'_{gico}$	6.6.1

TABLE 1.1.5

Summary of Methods to Calculate

Doses to Air from Noble Gases

Equation Number	Category	Equation	Reference Section
6-21	Gamma Dose to Air from Noble Gases Released from Stack	$D^{\gamma}_{airs}(mrad) = 0.019\sum_{i} Q^{ST}_{i} DF^{\gamma}_{i}$	6.7.1
6-41	Gamma Dose to Air from Noble Gases Released from Ground Level	$D^{\gamma}_{airg}(mrad) = 0.20\sum_{i} Q^{GL}_{i} DF^{\gamma}_{i}$	6.7.1
6-23	Beta Dose to Air from Noble Gases Released from Stack	$D^{\beta}_{airs}(mrad) = 0.033\sum_{i} Q^{ST}_{i} DF^{\beta}_{i}$	6.8.1
6-43	Beta Dose to Air from Noble Gases Released from Ground Level	$D^{\beta}_{airg}(mrad) = 1.12\sum_{i} Q^{GL}_{i} DF^{\beta}_{i}$	6.8.1

TABLE 1.1.6

Summary of Methods to Calculate
Dose to an Individual from Tritium, Iodine, and Particulates in
Gas Releases and Direct Radiation

Equation Number	Category	Equation	Reference Section
6-25	Dose to Critical Organ from Stack Release of I-131, I-133, Tritium, and Particulates	$D_{cos}(mrem) = \sum_i Q_i^{STP} DFG_{sico}$	6.9.1
6-44	Dose to Critical Organ from Ground Level Release of I-131, I-133, Tritium, and Particulates	$D_{cog}(mrem) = \sum_i Q_i^{GLP} DFG_{gico}$	6.9.1
	Direct Dose		
6-27	Turbine Building	$D_d(mrem) = K_{N16}(L) \times E$	6.11.1
	North Warehouse		
6-28	Shielded End	$D_s = 0.25 \times \dot{R}_s$	6.11.2
6-29	Unshielded End	$D_u = 0.53 \times \dot{R}_u$	6.11.2
	LLW Storage Pad		
6-30	Direct Line (Module Short Side Out)	$D_{de} = 0.28 \times \dot{R}_d \times f_d$	6.11.3
6-31	Direct Line (Module Long Side Out)	$D_{ds} = 0.39 \times \dot{R}_d \times f_d$	6.11.3
6-32	Skyshine (Resin Liners)	$D_{SKR} = 0.016 \times \dot{R}_{SKR} \times f_{SK}$	6.11.3
6-33	Skyshine (DAW)	$D_{SKD} = 0.015 \times \dot{R}_{SKD} \times f_{SK}$	6.11.3
6-34	Resin Liner Transfer (Unshielded)	$D_{Tran} = 0.0025 \times \dot{R}_{Tran} \times T_{Tran}$	6.11.3
6-35	Intermodular Gap Dose	$D_{Gap} = 2.44E - 2 \times W_{Gap} \times A_{RL} \times f_{Gap}$	6.11.3

TABLE 1.1.7

Summary of Methods for Setpoint Determinations

Equation Number	Category	Equation	Reference Section
8-1	Liquid Effluents:		
	Liquid Radwaste Discharge Monitor (17/350)	$R^{L}_{spt}(cps) = \frac{DF}{DF_{min}} S_l \sum_i C_{mi}$	8.1.1.1
	Gaseous Effluents:		
	Plant Stack (RR-108-1A, RR-108-1B) and AOG Offgas System (3127, 3128) Noble Gas Activity Monitors		
8-9	Total Body	$R^{tb}_{spt}(cpm) = 818 S_g \frac{1}{F} \frac{1}{DFB_c}$	8.2.1.1
8-10	Skin	$R^{skin}_{spt}(cpm) = 3000 S_g \frac{1}{F} \frac{1}{DF'_c}$	8.2.1.1
8-21	SJAE Noble Gas Activity Monitors (17/150A, 17/150B)	$R^{SJAE}_{spt}(mR/hr) = 1.6E+05 S_g \frac{1}{F}$	8.2.2.1

TABLE 1.1.8
Effluent and Environmental Controls Cross-Reference

Control Topic	Original Technical Specification Section	Revised ODCM Control Section
INSTRUMENTATION		
Radioactive Liquid Effluent Instrumentation	3/4.9.A	3/4.1.1
Effluent instrumentation list	Table 3.9.1	Table 3.1.1
Instrument surveillance requirements	Table 4.9.1	Table 4.1.1
Radioactive Gaseous Effluent Instrumentation	3/4.9.B	3/4.1.2
Effluent instrumentation list	Table 3.9.2	Table 3.1.2
Instrumentation requirements	Table 4.9.2	Table 4.1.2
RADIOACTIVE LIQUID EFFLUENTS		
Concentration	3/4.8.A	3/4.2.1
Liquid waste sampling & analysis program	Table 4.8.1	Table 4.2.1
Dose – Liquids	3/4.8.B	3/4.2.2
Liquid Radwaste Treatment	3/4.8.C	3/4.2.3
RADIOACTIVE GASEOUS EFFLUENTS		
Dose Rate	3/4.8.E	3/4.3.1
Gaseous waste sampling & analysis program	Table 4.8.2	Table 4.3.1
Dose from Noble Gases	3/4.8.F	3/4.3.2
Dose from I-131, I-133, Tritium and Radionuclides in Particulate Form	3/4.8.G	3/4.3.3
Gaseous Radwaste Treatment	3/4.8.H	3/4.3.4
Ventilation Exhaust Treatment	3/4.8.I	3/4.3.5
Primary Containment	3/4.8.L	3/4.3.6
Steam Jet Air Ejector	3/4.8.K*	3/4.3.7*
TOTAL DOSE		
Total Dose	3/4.8.M	3/4.4.1
RADIOLOGICAL ENVIRONMENTAL MONITORING		
Radiological Environmental Monitoring Program	3/4.9.C	3/4.5.1
Listing of required monitoring criteria	Table 3.9.3	Table 3.5.1
Reporting levels for radioactivity in samples	Table 3.9.4	Table 3.5.2
Detector capability for environmental analysis	Table 4.9.3	Table 4.5.1
Land Use Census	3/4.9.D	3/4.5.2

* Specification 3/4.8.K remains in plant Technical Specifications and is duplicated in ODCM Control 3/4.3.7.

TABLE 1.1.8
(Continued)

Effluent and Environmental Controls Cross-Reference

Control Topic	Original Technical Specification Section	Revised ODCM Control Section
Intercomparison Program	3/4.9.E	3/4.5.3
EFFLUENT CONTROL BASES	Bases: 3.8 & 3.9	3/4.6
UNIQUE REPORTING REQUIREMENTS		
Annual Radioactive Effluent Release Report	6.7.C.1	10.1
Environmental Radiological Monitoring	6.7.C.3	10.2
Special Reports	6.7.C.2	10.3
Major Changes to Radioactive Liquid, Gaseous, and Solid Waste Treatment Systems	6.14	10.4

TABLE 1.1.9

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TABLE 1.1.10
Dose Factors Specific for Vermont Yankee
for Noble Gas Releases

Radionuclide	Gamma Total Body Dose Factor DFB_i $\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$	Beta Skin Dose Factor DFS_i $\left(\frac{mrem\text{-}m^3}{pCi\text{-}yr}\right)$	Combined Skin Dose Factor (Stack Release) DF'_{is} $\left(\frac{mrem\text{-}sec}{\mu Ci\text{-}yr}\right)$	Beta Air Dose Factor DF_i^β $\left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$	Gamma Air Dose Factor DF_i^γ $\left(\frac{mrad\text{-}m^3}{pCi\text{-}yr}\right)$
Ar-41	8.84E-03*	2.69E-03	9.12E-03	3.28E-03	9.30E-03
Kr-83m	7.56E-08	-----	1.31E-05	2.88E-04	1.93E-05
Kr-85m	1.17E-03	1.46E-03	2.35E-03	1.97E-03	1.23E-03
Kr-85	1.61E-05	1.34E-03	1.41E-03	1.95E-03	1.72E-05
Kr-87	5.92E-03	9.73E-03	1.43E-02	1.03E-02	6.17E-03
Kr-88	1.47E-02	2.37E-03	1.28E-02	2.93E-03	1.52E-02
Kr-89	1.66E-02	1.01E-02	2.23E-02	1.06E-02	1.73E-02
Kr-90	1.56E-02	7.29E-03	1.87E-02	7.83E-03	1.63E-02
Xe-131m	9.15E-05	4.76E-04	6.01E-04	1.11E-03	1.56E-04
Xe-133m	2.51E-04	9.94E-04	1.26E-03	1.48E-03	3.27E-04
Xe-133	2.94E-04	3.06E-04	5.58E-04	1.05E-03	3.53E-04
Xe-135m	3.12E-03	7.11E-04	3.02E-03	7.39E-04	3.36E-03
Xe-135	1.81E-03	1.86E-03	3.24E-03	2.46E-03	1.92E-03
Xe-137	1.42E-03	1.22E-02	1.37E-02	1.27E-02	1.51E-03
Xe-138	8.83E-03	4.13E-03	1.06E-02	4.75E-03	9.21E-03

*8.84E-03 = 8.84×10^{-3}

TABLE 1.1.10A

Combined Skin Dose Factors Specific for Vermont Yankee Ground Level Noble Gas Releases

Radionuclide	$DF'_{ig}\left(\frac{\text{mrem-sec}}{\mu\text{Ci-yr}}\right)$
Ar-41	1.61E-01
Kr-83M	1.38E-04
Kr-85M	6.02E-02
Kr-85	4.73E-02
Kr-87	3.86E-01
Kr-88	1.92E-01
Kr-89	4.79E-01
Kr-90	3.73E-01
Xe-131M	1.79E-02
Xe-133M	3.72E-02
Xe-133	1.33E-02
Xe-135M	4.90E-02
Xe-135	7.92E-02
Xe-137	4.40E-01
Xe-138	2.11E-01

TABLE 1.1.11

Dose Factors Specific for Vermont Yankee
for Liquid Releases

Radionuclide	Total Body Dose Factor $DFL_{itb}\left(\frac{mrem}{Ci}\right)$	Maximum Organ Dose Factor $DFL_{imo}\left(\frac{mrem}{Ci}\right)$
H-3	2.06E-04	2.06E-04
Na-24	3.38E-02	3.38E-02
Cr-51	3.10E-04	6.96E-02
Mn-54	2.08E-01	3.00E+00
Mn-56	8.53E-06	5.29E-03
Fe-55	4.18E-02	2.54E-01
Fe-59	2.49E-01	1.84E+00
Co-58	5.97E-02	4.34E-01
Co-60	2.13E-01	1.28E+00
Zn-65	8.06E+00	1.64E+01
Sr-89	2.55E-01	8.91E+00
Sr-90	4.23E+01	1.67E+02
Zr-95	4.21E-04	1.36E-01
Mo-99	4.79E-03	4.51E-02
Tc-99m	5.04E-06	2.33E-04
Ag-110m	6.90E-03	7.02E-01
Sb-124	8.44E-03	2.22E-01
Sb-125	7.52E-03	1.15E-01
I-131	2.57E-02	1.47E+01
I-132	3.10E-06	1.29E-04
I-133	3.31E-03	1.63E+00
I-135	3.16E-04	5.90E-02
Cs-134	1.28E+02	1.60E+02
Cs-137	7.58E+01	1.21E+02
Ba-140	4.08E-03	9.72E-02
Ce-141	2.31E-05	4.10E-02
W-187	1.18E-02	8.90E+00

TABLE 1.1.12

Dose and Dose Rate Factors Specific for Vermont Yankee
for Iodines, Tritium, and Particulate Releases

Radio-nuclide	Stack Release: Critical Organ Dose Factor $DFG_{sico}\left(\frac{mrem}{Ci}\right)$	Stack Release: Critical Organ Dose Rate Factor $DFG'_{sico}\left(\frac{mrem-sec}{yr-\mu Ci}\right)$	Ground Level Release*: Critical Organ Dose Factor $DFG_{gico}\left(\frac{mrem}{Ci}\right)$	Ground Level Release*: Critical Organ Dose Rate Factor $DFG'_{gico}\left(\frac{mrem-sec}{yr-\mu Ci}\right)$
H-3	3.13E-04	9.87E-03	1.06E-02	3.34E-01
C-14	1.90E-01	5.99E+00	6.43E+00	2.03E+02
Cr-51	6.11E-03	2.11E-01	4.16E-02	1.43E+00
Mn-54	7.01E-01	2.77E+01	4.71E+00	1.84E+02
Fe-55	3.17E-01	1.00E+01	2.05E+00	6.47E+01
Fe-59	6.99E-01	2.32E+01	4.60E+00	1.52E+02
Co-57	2.18E-01	8.23E+00	1.41E+00	5.33E+01
Co-58	3.62E-01	1.30E+01	2.39E+00	8.52E+01
Co-60	7.63E+00	3.41E+02	4.99E+01	2.16E+03
Zn-65	3.71E+00	1.20E+02	2.36E+01	7.63E+02
Se-75	2.41E+00	7.76E+01	1.53E+01	4.92E+02
Sn-113	1.03E+00	3.25E+01	6.58E+00	2.08E+02
Sr-89	1.14E+01	3.60E+02	7.27E+01	2.29E+03
Sr-90	4.31E+02	1.36E+04	2.82E+03	8.89E+04
Zr-95	6.91E-01	2.28E+01	4.51E+00	1.49E+02
Sb-124	1.26E+00	4.23E+01	8.35E+00	2.79E+02
Sb-125	1.25E+00	4.89E+01	8.01E+00	3.13E+02
I-131	7.71E+01	2.43E+03	5.02E+02	1.58E+04
I-133	8.22E-01	2.59E+01	8.30E+00	2.62E+02
Cs-134	1.58E+01	5.27E+02	1.02E+02	3.37E+03
Cs-137	1.63E+01	5.55E+02	1.04E+02	3.53E+03
Ba-140	1.13E-01	3.66E+00	2.18E+00	6.94E+01
Ce-141	1.70E-01	5.42E+00	1.19E+00	3.78E+01
Ce-144	3.85E+00	1.22E+02	2.52E+01	7.98E+02

* The release point reference is the North Warehouse. These dose and dose rate factors are conservative for potential release applications associated with ground level effluents from other major facilities (i.e., Turbine Building, Reactor Building, AOG, and CAB).

2.0 DEFINITIONS

This section lists definitions (Table 2.1.1) and dose equation variable names (Table 2.1.2) which are unique to the VY ODCM. Other definitions pertaining to actions and surveillance requirements for the various controls can be found in the Vermont Yankee Technical Specifications, Section 1.0, DEFINITIONS.

TABLE 2.1.1

Definitions

1. Site Boundary – The site boundary is shown in Plant Drawing 5920-6245.

2. Off-Site Dose Calculation Manual (ODCM) – A manual containing the current methodology and parameters used in the calculation of off-site doses due to radioactive gaseous and liquid effluents, in the calculation of gaseous and liquid effluent monitoring alarm/trip setpoints, and in the conduction of the environmental radiological monitoring program. The ODCM shall also contain (1) the Radioactive Effluent Controls (including the Radiological Environmental Monitoring) Program required by Technical Specification 6.7.D, and (2) descriptions of the information that should be included in the annual Radioactive Effluent Release Report and Annual Radiological Environmental Operating Report required by Technical Specifications 6.6.D and 6.6.E, respectively.

3. Gaseous Radwaste Treatment System – The Augmented Off-Gas System (AOG) is the gaseous radwaste treatment system which has been designed and installed to reduce radioactive gaseous effluents by collecting primary coolant system off-gases from the primary system and providing for delay or holdup for the purpose of reducing the total radioactivity prior to release to the environment.

4. Ventilation Exhaust Treatment System – The Radwaste Building and AOG Building ventilation HEPA filters are ventilation exhaust treatment systems which have been designed and installed to reduce radioactive material in particulate form in gaseous effluent by passing ventilation air through HEPA filters for the purpose of removing radioactive particulates from the gaseous exhaust stream prior to release to the environment. Engineered safety feature atmospheric cleanup systems, such as the Standby Gas Treatment (SBGT) System, are not considered to be ventilation exhaust treatment system components.

5. Vent/Purging – Vent/purging is the controlled process of discharging air or gas from the primary containment to control temperature, pressure, humidity, concentration or other operating conditions.

TABLE 2.1.2

Summary of Variables

Variable		Definition	Units
A_{RL}	=	Total gamma activity contained in a resin liner in storage directly in line with a gap between adjacent storage modules.	Ci
C_{li}^{NG}	=	Concentration at point of discharge to an unrestricted area of dissolved and entrained noble gas "i" in liquid pathways from all station sources.	µCi/ml
C_{l}^{NG}	=	Total activity of all dissolved and entrained noble gases in liquid pathways from all station sources.	$\frac{\mu Ci}{ml}$
C_{di}	=	Concentration of radionuclide "i" at the point of liquid discharge to an unrestricted area.	$\frac{\mu Ci}{ml}$
C_i	=	Concentration of radionuclide "i".	$\frac{\mu Ci}{cc}$
C_{pi}	=	Concentration, exclusive of noble gases, of radionuclide "i" from tank "p" at point of discharge to an unrestricted area.	$\frac{\mu Ci}{ml}$
C_{mi}	=	Concentration of radionuclide "i" in mixture at the monitor.	$\frac{\mu Ci}{ml}$
D_{airs}^{β}	=	Beta dose to air from stack release.	mrad
D_{airg}^{β}	=	Beta dose to air from ground level release.	mrad
D_{airs}^{γ}	=	Gamma dose to air from stack release.	mrad
D_{airg}^{γ}	=	Gamma dose to air from ground level release.	mrad
D_{cos}	=	Dose to critical organ from stack release.	mrem
D_{cog}	=	Dose to the critical organ from ground level release.	mrem
D_d	=	Direct dose (Turbine Building).	mrem

TABLE 2.1.2
(Continued)

Summary of Variables

Variable		Definition	Units
$\dot{R}_d$	=	Dose rate at 3 feet from unobstructed side of storage module facing site boundary.	$\frac{mrem}{hr}$
D_{dE}	=	Direct dose at site boundary per unobstructed storage module (short end).	$\frac{mrem}{yr - module}$
D_{ds}	=	Direct dose at site boundary per unobstructed storage module (long side).	$\frac{mrem}{yr - module}$
D^{γ}_{finite}	=	Gamma dose to air, corrected for finite cloud.	mrad
D_{Gap}	=	Intermodular gap dose projected to the maximum site boundary location from resin waste not directly shielded by DAW modules.	$\frac{mrem}{yr}$
D_{mo}	=	Dose to the maximum organ.	mrem
D^S	=	Dose to skin from beta and gamma.	mrem
$\dot{R}_S$	=	Dose rate at 1 meter from source in shielded end of North Warehouse.	$\frac{mrem}{hr}$
D_S	=	Annual dose at site boundary from fixed sources in shielded end of North Warehouse.	$\frac{mrem}{yr}$
$\dot{R}_{SKD}$	=	Maximum dose rate at 3 feet over top of DAW in a storage module.	$\frac{mrem}{hr}$
$\dot{R}_{SKR}$	=	Maximum dose rate at 3 feet over top of each resin liner in a storage module.	$\frac{mrem}{hr}$
D_{SKD}	=	Skyshine dose at the site boundary from DAW in storage modules (unobstructed top surfaces).	$\frac{mrem}{yr - module}$
D_{SKR}	=	Skyshine dose at the site boundary from resin liners in storage modules (unobstructed top surfaces).	$\frac{mrem}{yr - liner}$

TABLE 2.1.2
(Continued)

Summary of Variables

Variable		Definition	Units
D_{tb}	=	Dose to the total body	mrem
$K_{N16}^{(L)}$	=	The direct dose conversion factor for N-16 scatter from the turbine hall to Location (L)	$\frac{mrem}{MW_e h}$
$\dot{R}_{Tran}$	=	Dose rate at contact from the unshielded top surface of resin liner.	$\frac{rad}{hr}$
D_{Tran}	=	Dose at the site boundary from unshielded movement of resin liner between transfer cask and storage module.	mrem
$\dot{R}_U$	=	Dose rate at 1 meter from source in unshielded end of North Warehouse.	$\frac{mrem}{hr}$
D_U	=	The annual dose at the site boundary from fixed sources in the unshielded end of North Warehouse.	$\frac{mrem}{hr}$
DF	=	Dilution factor.	ratio
DF_{min}	=	Minimum allowable dilution factor.	ratio
DF'_c	=	Composite skin dose factor.	$\frac{mrem-sec}{pCi-yr}$
DFB_i	=	Total body gamma dose factor for nuclide "i".	$\frac{mrem-m^3}{pCi-yr}$
DFB_c	=	Composite total body dose factor.	$\frac{mrem-m^3}{pCi-yr}$
DFL_{itb}	=	Site-specific, total body dose factor for a liquid release of nuclide "i".	$\frac{mrem}{Ci}$
DFL_{imo}	=	Site-specific, maximum organ dose factor for a liquid release of nuclide "i".	$\frac{mrem}{Ci}$

TABLE 2.1.2
(Continued)

Summary of Variables

Variable		Definition	Units
DFG_{sico}	=	Site-specific, critical organ dose factor for a stack gaseous release of nuclide "i".	$\frac{mrem}{Ci}$
DFG'_{sico}	=	Site-specific, critical organ dose rate factor for a stack gaseous release of nuclide "i".	$\frac{mrem-sec}{\mu Ci-yr}$
DFG_{gico}	=	Site-specific, critical organ dose factor for a ground level gaseous release of nuclide "i".	$\frac{mrem}{Ci}$
DFG'_{gico}	=	Site-specific, critical organ dose rate factor for a ground level gaseous release of nuclide "i".	$\frac{mrem-sec}{\mu Ci-yr}$
DFS_i	=	Beta skin dose factor for nuclide "i".	$\frac{mrem-m^3}{\rho Ci-yr}$
DF'_{is}	=	Combined skin dose factor for nuclide "i" from a stack release	$\frac{mrem-sec}{\mu Ci-yr}$
DF'_{ig}	=	Combined skin dose factor for nuclide "i" from a ground level release.	$\frac{mrem-sec}{\mu Ci-yr}$
DF_i^{γ}	=	Gamma air dose factor for nuclide "i".	$\frac{mrad-m^3}{\rho Ci-yr}$
DF_i	=	Beta air dose factor for nuclide "i".	$\frac{mrad-m^3}{\rho Ci-yr}$
$\dot{R}_{cos}$	=	Critical organ dose rate due to iodines and particulates released from stack.	$\frac{mrem}{yr}$
$\dot{R}_{cog}$	=	Critical organ dose rate due to iodines and particulates released from ground.	$\frac{mrem}{yr}$
$\dot{R}_{skins}$	=	Skin dose rate due to stack release of noble gases.	$\frac{mrem}{yr}$
$\dot{R}_{sking}$	=	Skin dose rate due to ground release of noble gases.	$\frac{mrem}{yr}$

TABLE 2.1.2
(Continued)

Summary of Variables

Variable		Definition	Units
$\dot{R}_{tbs}$	=	Total body dose rate due to noble gases from stack release.	$\frac{mrem}{yr}$
$\dot{R}_{tbg}$	=	Total body dose rate due to noble gases from ground level release.	$\frac{mrem}{yr}$
D/Q	=	Deposition factor for dry deposition of elemental radioiodines and other particulates.	$\frac{1}{m^2}$
E	=	Gross electric output over the period of interest.	MW_eh
f_d	=	Fraction of a year that a storage module is in use with an unobstructed side oriented toward west site boundary.	fraction
f_{Gap}	=	Fraction of a year that the intermodular gap is not shielded.	fraction
f_{SK}	=	Fraction of a year that a storage module is in use with an unobstructed top surface.	fraction
F_d	=	Flow rate out of discharge canal.	gpm
F_m	=	Flow rate past liquid radwaste monitor.	gpm
F	=	Flow rate past gaseous radwaste monitor.	$\frac{cc}{sec}$
F_1^{ENG}	=	Sum of the fractions of combined effluent concentrations in liquid pathways (excluding noble gases).	fraction
ECL_i	=	Annual average effluent concentration limit for radionuclide "i" (10CFR20.1001-20.2401, Appendix B, Table 2, Column 2)	$\frac{\mu Ci}{cc}$
Q_i	=	Release for radionuclide "i" from the point of interest.	curies

TABLE 2.1.2
(Continued)

Summary of Variables

Variable		Definition	Units
$\dot{Q}_i$	=	Release rate for radionuclide "i" at the point of interest.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{ST}$	=	The noble gas radionuclide "i" release rate at the plant stack.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{GL}$	=	The noble gas radionuclide "i" release rate from ground level.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{SJAE}$	=	The noble gas radionuclide "i" release rate at the steam jet air ejector.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{AOG}$	=	The noble gas radionuclide "i" release rate at the exhaust of the Advanced Off-Gas System	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{STP}$	=	The iodine, tritium, and particulate radionuclide "i" release rate from the plant stack.	$\frac{\mu Ci}{sec}$
$\dot{Q}_i^{GLP}$	=	The iodine, tritium, and particulate radionuclide "i" release rate from ground level.	$\frac{\mu Ci}{sec}$
Q_i^{ST}	=	The release of noble gas radionuclide "i" from the plant stack.	curies
Q_i^{GL}	=	The release of noble gas radionuclide "i" from ground level.	curies
Q_i^{STP}	=	The release of iodine, tritium, and particulate radionuclide "i" from the plant stack.	curies
Q_i^{GLP}	=	The release of iodine, tritium, and particulate radionuclide "i" from ground level.	curies
R_{spt}^{L}	=	Liquid monitor response for the limiting concentration at the point of discharge.	cps

TABLE 2.1.2
(Continued)

Summary of Variables

Variable	Definition	Units
R_{spt}^{skin}	Response of the noble gas monitor at the limiting skin dose rate.	cpm
R_{spt}^{tb}	Response of the noble gas monitor to limiting total body dose rate.	cpm
S_F	Shielding factor.	Ratio
S_g	Detector counting efficiency from the most recent gas monitor calibration.	$\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$
S_{gi}	Detector counting efficiency for noble gas "i".	$\frac{cpm}{\mu Ci/cc}$ or $\frac{mR/hr}{\mu Ci/cc}$
S_l	Detector counting efficiency from the most recent liquid monitor calibration.	$\frac{cps}{\mu Ci/ml}$
S_{li}	Detector counting efficiency for radionuclide "i".	$\frac{cps}{\mu Ci/ml}$
T_{Tran}	Time that an unshielded resin liner is exposed in the storage pad area.	hours
W_{Gap}	Intermodule gap width between adjacent DAW storage modules which shield resin liner storage modules from the west site boundary.	inches
X/Q_s	Annual or long-term average undepleted atmospheric dispersion factor for stack release.	$\frac{sec}{m^3}$
X/Q_g	Annual or long-term average undepleted atmospheric dispersion factor for ground level release.	$\frac{sec}{m^3}$
$[X/Q]_s^\gamma$	Effective annual or long-term average gamma atmospheric dispersion factor.	$\frac{sec}{m^3}$
$[X/Q]_g^\gamma$	Effective annual or long-term average gamma atmospheric dispersion factor for a ground level release.	$\frac{sec}{m^3}$

3/4.0 EFFLUENT AND ENVIRONMENTAL CONTROLS

This section includes the effluent and environmental controls that were originally part of the Vermont Yankee Technical Specifications. These controls were relocated into the ODCM without any substantial changes, in accordance with NRC Generic Letter 89-01. Text and tables were reformatted to the style of the ODCM. The various controls were renumbered from the original numbering scheme of the Technical Specifications. A cross-reference of the old Technical Specifications section to the new ODCM section is presented in Table 1.1.8.

3/4.1 INSTRUMENTATION

3/4.1.1 Radioactive Liquid Effluent Instrumentation

CONTROLS

3.1.1 The radioactive liquid effluent monitoring instrumentation channel shall be operable in accordance with Control Table 3.1.1 with their alarm setpoints set to ensure that the limits of Control 3.2.1 are not exceeded.

APPLICABILITY:

During periods of release through monitored pathways as listed on Table 3.1.1.

ACTION:

a. With a radioactive liquid effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Control 3.2.1 are met, without delay suspend the release of radioactive liquid effluents monitored by the affected channel or change the setpoint so that it is acceptably conservative or declare the channel inoperable.

b. With one or more radioactive liquid effluent monitoring instrumentation channels inoperable, take the action shown in Table 3.1.1.

SURVEILLANCE REQUIREMENTS

4.1.1.a Each radioactive liquid effluent monitoring instrumentation channel shall be tested and calibrated as indicated in Table 4.1.1.

4.1.1.b The setpoints for monitoring instrumentation shall be determined in accordance with the ODCM (Section 8.1).

TABLE 3.1.1

Liquid Effluent Monitoring Instrumentation

	Minimum Channels Operable	Notes
1. Gross Radioactivity Monitors not Providing Automatic Termination of Release		
a. Liquid Radwaste Discharge Monitor (RM-17-350)	1*	1,4
b. Service Water Discharge Monitor (RM-17-351)	1	2,4
2. Flow Rate Measurement Devices		
a. Liquid Radwaste Discharge Flow Rate Monitor (FIT-20-485/442)	1*	3,4

* During releases via this pathway

TABLE 3.1.1 NOTATION

NOTE 1 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases may continue provided that prior to initiating a release:

a. At least two independent samples are analyzed in accordance with Control 4.2.1, and

b. At least two technically qualified members of the Facility Staff independently verify the release rate calculations and discharge line valving.

Otherwise, suspend release of radioactive effluents via this pathway.

NOTE 2 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided that, at least once per 24 hours, grab samples are collected and analyzed for gross radioactivity (beta or gamma) at a lower limit of detection of at least 10^{-7} microcurie/ml.

NOTE 3 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours during actual releases. Pump performance curves may be used to estimate flow.

NOTE 4 - With the number of channels operable less than required by the minimum channels operable requirement, exert reasonable efforts to return the instrument(s) to operable status prior to the next release.

TABLE 4.1.1

Radioactive Liquid Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Instrument Check	Source Check	Instrument Calibration	Instrument Functional Test
1. Gross Radioactivity Monitors not Providing Automatic Termination of Release				
a. Liquid Radwaste Discharge Monitor (3)	Once each day*	Prior to each release, but no more than once each month	Once each 18 months (1)	Once each quarter (2)
b. Service Water Discharge Monitor (3)	Once each day	Once each month	Once each 18 months (1)	Once each quarter (2)
2. Flow Rate Measurement Devices				
a. Liquid Radwaste Discharge Flow Rate Monitor	Once each day*	Not Applicable	Not Applicable	Once each quarter*

* During releases via this pathway.

TABLE 4.1.1 NOTATION

(1) The Instrument Calibration for radioactivity measurement instrumentation shall include the use of a known (traceable to National Institute for Standards and Technology) liquid radioactive source positioned in a reproducible geometry with respect to the sensor. These standards shall permit calibrating the system over its normal operating range of energy and rate.

(2) The Instrument Functional Test shall also demonstrate the Control Room alarm annunciation occurs if any of the following conditions exists:

(a) Instrument indicate measured levels above the alarm setpoint.

(b) Circuit failure.

(c) Instrument indicates a downscale failure.

(d) Instrument controls not set in operate mode.

(3) The alarm setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the Off-Site Dose Calculation Manual (see Section 8.1).

3/4.1 INSTRUMENTATION

3/4.1.2 Radioactive Gaseous Effluent Instrumentation

CONTROLS

3.1.2 The gaseous process and effluent monitoring instrumentation channels shall be operable in accordance with Control Table 3.1.2 with their alarm/trip setpoints set to ensure that the limits of Controls 3.3.1.a, and Technical Specifications 3.8.J.1 and 3.8.K.1 (Control 3.3.7) are not exceeded.

APPLICABILITY:

As shown in Table 3.1.2.

ACTION:

a. With a gaseous process or effluent monitoring instrumentation channel alarm/trip setpoint less conservative than a value which will ensure that the limits of Control 3.3.1.a and Technical Specification 3.8.K.1 are met, immediately take actions to suspend the release of radioactive gaseous effluents monitored by the affected channel, or declare the channel inoperable, or change the setpoint so it is acceptably conservative..

b. With less than the minimum number of radioactive gaseous effluent monitoring instrumentation channels operable, take actions noted in Table 3.1.2.

SURVEILLANCE REQUIREMENTS

4.1.2.a Each gaseous process or effluent monitoring instrumentation channel shall be tested and calibrated as indicated in Table 4.1.2.

4.1.2.b The setpoints for monitoring instrumentation shall be determined in accordance with the ODCM (Section 8.2).

TABLE 3.1.2

Gaseous Effluent Monitoring Instrumentation

Instrument	Minimum Channels Operable	Notes
1. Steam Jet Air Ejector (SJAE)		
a. Noble Gas Activity Monitor * (RM-17-150A/B)	1	7, 8, 9
2. Augmented Off-Gas System		
a. Noble Gas Activity Monitor Between the Charcoal Bed System and the Plant Stack (Providing Alarm and Automatic Termination of Release) (RAN-OG-3127, RAN-OG-3128)	1	2, 5, 6, 7
b. Flow Rate Monitor (FI-OG-2002, FI-OG-2004, FI-OG-2008)	1	1, 5, 6
c. Hydrogen Monitor (H2AN-OG-2921A/B, H2AN-OG-2922A/B)	1	3, 5, 6
3. Plant Stack		
a. Noble Gas Activity Monitor (RM-17-156, RM-17-157)	1	5, 7, 10
b. Iodine Sampler Cartridge	1	4, 5
c. Particulate Sampler Filter	1	4, 5
d. Sampler Flow Integrator (FI-17-156/157)	1	1, 5
e. Stack Flow Rate Monitor (FI-108-22)	1	1, 5

* This instrumentation channel(s) is required to support compliance with Technical Specification 3.8.K.

TABLE 3.1.2 NOTATION

NOTE 1 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided the flow rate is estimated at least once per 4 hours.

NOTE 2 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue for a period of up to 7 days provided that at least one of the stack monitoring systems is operable and off-gas system temperature and pressure are measured continuously.

NOTE 3 - With the number of channels operable less than required by the minimum channels operable requirement, operation of the AOG System may continue provided gas samples are collected at least once per 24 hours and analyzed within the following 4 hours, or an orderly transfer of the off-gas effluents from the operating recombiner to the standby recombiner shall be made.

NOTE 4 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via the affected pathway may continue provided samples are continuously collected with auxiliary sampling equipment.

NOTE 5 - With the number of channels operable less than required by the minimum channels operable requirement, exert reasonable efforts to return the instrument(s) to operable status within 30 days.

NOTE 6 - During releases via this pathway.

NOTE 7 - The alarm/trip setpoints of these channels shall be determined and adjusted in accordance with the methodology and parameters in the Off-Site Dose Calculation Manual (ODCM).

NOTE 8 - Minimum channels operable required only during operation of the Steam Jet Air Ejector.

NOTE 9 - With the number of channels operable less than required by the minimum channels operable requirement, gases from the SJAE may be released to the environment for up to 72 hours provided:

1. The AOG System is not bypassed; and
2. The AOG System noble gas activity monitor is operable.

NOTE 10 - With the number of channels operable less than required by the minimum channels operable requirement, effluent releases via this pathway may continue provided grab samples are taken at least once per 12 hours and these samples are analyzed for gross activity within 24 hours.

TABLE 4.1.2

Gaseous Effluent Monitoring Instrumentation Surveillance Requirements

Instrument	Instrument Check	Source Check	Instrument Calibration	Instrument Functional Test
1. Steam Jet Air Ejector (SJAE)				
a. Noble Gas Activity Monitor +	Once each day**	Once each month	Once each 18 months (3)	Once each quarter (2)
2. Augmented Off-Gas System				
a. Noble Gas Activity Monitor	Once each day*	Once each month	Once each 18 months (3)	Once each quarter (1)
b. Flow Rate Monitor	Once each day*	Not Applicable	Once each 18 months	Not Applicable
c. Hydrogen Monitor ++	Once each day*	Not Applicable	Once each quarter (4)	Once each month
3. Plant Stack				
a. Noble Gas Activity Monitor	Once each day	Once each month	Once each 18 months (3)	Once each quarter (2)
b. Sampler Flow Integrator	Once each week	Not Applicable	Once each 18 months	Not Applicable
c. System Flow Rate Monitor	Once each day	Not Applicable	R[a]	Once each quarter

* During releases via this pathway.

** During operation of main condenser SJAE.

\+ This instrumentation channel(s) is required to support compliance with Technical Specification 3.8.K (same as Control 3.3.7).

++ This instrumentation channel(s) is required to support compliance with Technical Specification 3.8.J.

(a) R = once each refueling cycle.

TABLE 4.1.2 NOTATION

(1) The Instrument Functional Test shall demonstrate that the instrument will provide an isolation signal to the system logic under the following conditions:

(a) Instrument indicates measured levels above the alarm setpoint.

(b) Circuit failure.

(c) Instrument indicates a downscale failure.

(d) Instrument controls not set in operate mode.

(2) The Instrument Functional Test shall also demonstrate that Control Room alarm annunciation occurs when any of the following conditions exist:

(a) Instrument indicates measured levels above the alarm setpoint.

(b) Circuit failure.

(c) Instrument indicates a downscale failure.

(d) Instrument controls are not set in operate mode.

(3) The Instrument Calibration for radioactivity measurement instrumentation shall include the use of a known (traceable to National Institute for Standards and Technology) radioactive source positioned in a reproducible geometry with respect to the sensor. These standards should permit calibrating the system over its normal operating range of rate capabilities.

(4) The Instrument Calibration shall include the use of standard gas samples (high range and low range) containing suitable concentrations, hydrogen balance air, for the detection range of interest per Technical Specification 3.8.J.1.

3/4.2 RADIOACTIVE LIQUID EFFLUENTS

3/4.2.1 Liquid Effluent Concentration

CONTROLS

3.2.1 The concentration of radioactive material in liquid effluents released to Unrestricted Areas shall be limited to 10 times the concentrations specified in Appendix B to 10CFR Part 20.1001 – 20.2401, Table 2, Column 2 for radionuclides other than noble gases and 2×10^{-4} uCi/ml total activity concentration for all dissolved or entrained noble gases.

APPLICABILITY:

At all times.

ACTION:

With the concentration of radioactive material in liquid effluents released to Unrestricted Areas exceeding the limits of Control 3.2.1, immediately take action to decrease the release rate of radioactive materials and/or increase the dilution flow rate to restore the concentration to within the above limits.

SURVEILLANCE REQUIREMENTS

4.2.1.a Radioactive material in liquid waste shall be sampled and analyzed in accordance with requirements of Table 4.2.1.

4.2.1.b The results of the analyses shall be used in accordance with the methods in the ODCM to assure that the concentrations at the point of release to Unrestricted Areas are limited to the values in Control 3.2.1.

TABLE 4.2.1

Radioactive Liquid Waste Sampling and Analysis Program

Liquid Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml)a
Batch Waste Release Tanks[b]	Prior to each release Each Batch	Prior to each release Each Batch	Principal Gamma Emitters[d]	5×10^{-7}
			I-131	1×10^{-6}
	One Batch per month sampled prior to a release	Once per month	Dissolved and Entrained Gases (Gamma Emitters)	1×10^{-5}
	Prior to each release Each Batch	Once per month Composite[c]	H-3	1×10^{-5}
			Gross Alpha	1×10^{-7}
	Prior to each release Each Batch	Once per quarter Composite[c]	Sr-89, Sr-90	5×10^{-8}
			Fe-55	1×10^{-6}

TABLE 4.2.1 NOTATION

a. The LLD is the smallest concentration of radioactive material in a sample that will yield a net count, above system background, that will be detected with 95% probability with only 5% probability of falsely concluding that a blank observation represents a "real" signal.

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

$$LLD = \frac{4.66 * S_b}{E * V * K * Y * e^{-\lambda * \Delta t}}$$

where:

LLD= the lower limit of detection as defined above (microcuries or picocuries/unit mass or volume)

S_b = the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts/minute)

E = the counting efficiency (counts/disintegration)

V = the sample size (units of mass or volume)

K = 2.22×10^6 disintegrations/minute/microcurie or 2.22 disintegration/minute/picocurie as applicable

Y = the fractional radiochemical yield (when applicable)

λ = the radioactive decay constant for the particular radionuclide (/minute)

Δt = the elapsed time between sample collection and analysis (minutes)

Typical values of E, V, Y and Δt can be used in the calculation. 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.

Analysis 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 interfering nuclides, or other uncontrollable circumstances may render these LLDs unavailable.

It should be recognized that the LLD is defined as a "before the fact" limit representing the capability of a measurement system and not as an "after the fact" limit for a particular measurement. This does not preclude the calculation of an "after the fact" LLD for a particular measurement based upon the actual parameters for the sample in question and appropriate decay correction parameters such as decay while sampling and during analysis.

b. A batch release is the discharge of liquid wastes of a discrete volume. Prior to sampling for analysis, each batch shall be isolated and then thoroughly mixed to assure representative sampling.

TABLE 4.2.1 NOTATION
(Cont'd)

c. A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen which is representative of the liquids released. 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.

d. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141, and Ce-144. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD level, but as "not detected". When unusual circumstances result in LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.

3/4.2 RADIOACTIVE LIQUID EFFLUENTS

3/4.2.2 Dose - Liquids

CONTROLS

3.2.2 The dose or dose commitment to a member of the public from radioactive materials in liquid effluents released to Unrestricted Areas shall be limited to the following:

a. During any calendar quarter:

less than or equal to 1.5 mrem to the total body, and
less than or equal to 5 mrem to any organ, and

b. During any calendar year:

less than or equal to 3 mrem to the total body, and
less than or equal to 10 mrem to any organ.

APPLICABILITY:

At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to ODCM Section 10, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.2.2 Cumulative dose contributions shall be determined in accordance with the methods in the ODCM at least once per month if releases during the period have occurred.

3/4.2 RADIOACTIVE LIQUID EFFLUENTS

3/4.2.3 Liquid Radwaste Treatment

CONTROLS

3.2.3 The liquid radwaste treatment system shall be used in its designed modes of operation to reduce the radioactive materials in the liquid waste prior to its discharge when the estimated doses due to the liquid effluents released to Unrestricted Areas, when averaged with all other liquid releases over the last month, would exceed 0.06 mrem to the total body, or 0.2 mrem to any organ.

APPLICABILITY:

At all times.

ACTION:

With radioactive liquid waste being discharged without treatment and in excess of the above limits and any portion of the Liquid Radwaste Treatment System not in operation, prepare and submit to the Commission within 30 days, a Special Report that includes the information detailed in ODCM Section 10.3.1.

SURVEILLANCE REQUIREMENTS

4.2.3.a See Control 4.2.2.

4.2.3.b The liquid radwaste treatment system schematic is shown in ODCM Figure 9.1.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.1 Gaseous Effluents Dose Rate

CONTROLS

3.3.1 The dose rate due to radioactive materials released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

a. For noble gases; less than or equal to 500 mrem/yr to the total body and less than or equal to 3,000 mrem/yr to the skin, and

b. For Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days; less than or equal to 1,500 mrem/yr to any organ.

APPLICABILITY:

At all times.

ACTION:

With the dose rate(s) exceeding the above limits, immediately take action to decrease the release rate to within the limits of Control 3.3.1.

SURVEILLANCE REQUIREMENTS

4.3.1.a The dose rate due to noble gases in gaseous effluents shall be determined to be within the limits of Control 3.3.1 in accordance with the methods in the ODCM.

4.3.1.b The dose rate due to Iodine-131, Iodine-133, tritium and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents shall be determined to be within the limits of Control 3.3.1 in accordance with the methods in the ODCM by obtaining representative samples and performing analyses in accordance with the sampling and analysis program specified in Table 4.3.1.

TABLE 4.3.1

Radioactive Gaseous Waste Sampling And Analysis Program

Gaseous Release Type	Sampling Frequency	Minimum Analysis Frequency	Type of Activity Analysis	Lower Limit of Detection (LLD) (uCi/ml)a
A. Steam Jet Air Ejector	Once per week Grab Sample	Once per week	Xe-138, Xe-135, Xe-133, Kr-88, Kr-87, Kr-85M	1×10^{-4}
B. Containment Purge	Prior to each release/ Each Purge Grab Sample for Particulates	Prior to each release/ Each Purge	Principal Gamma Emitters[d,g] and I-131	1×10^{-9} (g)
C. Main Plant Stack	Once per month[c] Grab Sample	Once per month[c]	Principal Gamma Emitters[d]	1×10^{-4}
			H-3	1×10^{-6}
	Continuous[e]	Once per week[b] Charcoal Sample	I-131[f]	1×10^{-12}
	Continuous[e]	Once per week[b] Particulate Sample	Principal Gamma Emitters[d,g] and I-131	1×10^{-11}
	Continuous[e]	Once per month Composite Particulate Sample	Gross Alpha	1×10^{-11}
	Continuous[e]	Once per quarter Composite Particulate Sample	Sr-89, Sr-90	1×10^{-11}
	Continuous	Noble Gas Monitor	Noble Gases Gross Beta or Gamma	1×10^{-5}

TABLE 4.3.1 NOTATION

a. See footnote a. of Table 4.8.1.

b. Samples shall be changed at least once per 7 days and analyses shall be completed within 48 hours after removal from samplers. Sampling shall also be performed at least once per 24 hours for at least 7 days following each shutdown, startup or thermal power change exceeding 25% of rated thermal power in one hour, and analyses shall be completed within 48 hours of changing the samples. When samples collected for 24 hours are analyzed, the corresponding LLDs may be increased by a factor of 10. This requirement to sample at least once per 24 hours for 7 days applies only if: (1) analysis shows that the dose equivalent I-131 concentration in the primary coolant has increased more than a factor of 3 and the resultant concentration is at least 1 x 10-1 μCi/ml; and (2) the noble gas monitor shows that effluent activity has increased more than a factor of 3.

c. Sampling and analyses shall also be performed following shutdown, startup, or a thermal power change exceeding 25% of rated thermal power per hour unless: (a) analysis shows that the dose equivalent I-131 concentration in the primary coolant has not increased more than a factor of 3 and the resultant concentration is at least 1 x 10-1 μCi/ml; and (2) the noble gas monitor shows that effluent activity has not increased more than a factor of 3.

d. The principal gamma emitters for which the LLD specification will apply are exclusively the following radionuclides: Kr-87, Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 for gaseous emissions, and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141 and Ce-144 for particulate emissions. This list does not mean that only these nuclides are to be detected and reported. Other peaks which are measurable and identifiable, together with the above nuclides, shall also be identified and reported. Nuclides which are below LLD for the analyses should not be reported as being present at the LLD level for that nuclide, but as "not detected". When unusual circumstances result in LLDs higher than required, the reasons shall be documented in the Radioactive Effluent Release Report.

e. The ratio of the sample flow rate to the sampled stream flow rate shall be known for the time period covered by each dose or dose rate calculation made in accordance with Controls 3.3.1, 3.3.2, and 3.3.3.

f. The gaseous waste sampling and analysis program does not explicitly require sampling and analysis at a specified LLD to determine the I-133 release. Estimates of I-133 releases shall be determined by counting the weekly charcoal sample for I-133 (as well as I-131) and assume a constant release rate for the release period.

g. Lower Limit of Detection (LLD) applies only to particulate form radionuclides identified in Table Notation d. above.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.2 Dose – Noble Gases

CONTROLS

3.3.2 The air dose due to noble gases released in gaseous effluents from the site to areas at and beyond the site boundary shall be limited to the following:

a. During any calendar quarter:

less than or equal to 5 mrad for gamma radiation, and
less than or equal to 10 mrad for beta radiation, and

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.

APPLICABILITY:

At all times.

ACTION:

With the calculated air dose from radioactive noble gases in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to ODCM Section 10.3.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.3.2 Cumulative dose contributions for the total time period shall be determined in accordance with the methods in the ODCM at least once every month.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.3 Dose – Iodine-131, Iodine-133, Radioactive Material in Particulate Form, and Tritium

CONTROLS

3.3.3 The dose to a member of the public from Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days in gaseous effluents released from the site to areas at and beyond the site boundary 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.

APPLICABILITY:

At all times.

ACTION:

With the calculated dose from the release of Iodine-131, Iodine-133, tritium, and radionuclides in particulate form with half-lives greater than 8 days, in gaseous effluents exceeding any of the above limits, prepare and submit to the Commission within 30 days, pursuant to ODCM Section 10.3.2, a Special Report that identifies the cause(s) for exceeding the limit(s) and defines the corrective actions that have been taken to reduce the releases and the proposed corrective actions to be taken to assure that subsequent releases will be in compliance with the above limits.

SURVEILLANCE REQUIREMENTS

4.3.3 Cumulative dose contributions for the total time period shall be determined in accordance with the methods in the ODCM at least once every month.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.4 Gaseous Radwaste Treatment

CONTROLS

3.3.4 The Augmented Off-Gas System (AOG) shall be used in its designed mode of operation to reduce noble gases in gaseous waste prior to their discharge whenever the main condenser steam jet air ejector (SJAE) is in operation.

APPLICABILITY:

At all times.

ACTION:

With gaseous radwaste from the main condenser air ejector system being discharged without treatment for more than 7 days, prepare and submit to the Commission within 30 days, a Special Report that includes the information detailed in ODCM Section 10.3.2.

SURVEILLANCE REQUIREMENTS

4.3.4.a The readings of the relevant instrument shall be checked every 12 hours when the main condenser SJAE is in use to ensure that the AOG is functioning.

4.3.4.b The gaseous effluent treatment system schematic is shown in ODCM Figure 9.2.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.5 Ventilation Exhaust Treatment

CONTROLS

3.3.5 The AOG and Radwaste Building Ventilation Filter (HEPA) Systems shall be used to reduce particulate materials in gaseous waste prior to their discharge from those buildings when the estimated doses due to gaseous effluent releases from the site to areas at and beyond the site boundary would exceed 0.3 mrem to any organ over one month.

APPLICABILITY:

At all times.

ACTION:

With gaseous radwaste being discharged without processing through appropriate treatment systems as noted above, and in excess of the limits of Control 3.3.5, prepare and submit to the Commission within 30 days, a Special Report that includes the information detailed in ODCM Section 10.3.2.

SURVEILLANCE REQUIREMENTS

4.3.5 See Control 4.3.2 for surveillance related to AOG and Radwaste Building ventilation filter system operation.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.6 Primary Containment

CONTROLS

3.3.6 When the primary containment is to be Vented/Purged, it shall be Vented/Purged through the Standby Gas Treatment System whenever the airborne radioactivity levels in containment of Iodine-131, Iodine-133 or radionuclides in particulate form with half-lives greater than 8 days exceed the levels specified in Appendix B to 10CFR20.1001 - 20.2401, Table 1, Column 3.

APPLICABILITY:

At all times.

ACTION:

a. With the requirements of Control 3.3.6 not satisfied, immediately suspend all Venting/Purging of the containment.

b. During normal refueling and maintenance outages when primary containment is no longer required, then Control 3.3.3 shall supersede Control 3.3.6.

SURVEILLANCE REQUIREMENTS

4.3.6 The primary containment shall be sampled prior to venting/purging per Table 4.3.1, and if the results indicate radioactivity levels in excess of the limits of Control 3.3.6, the containment shall be aligned for venting/purging through the Standby Gas Treatment System. No sampling shall be required if the venting/purging is through the Standby Gas Treatment (SBGT) System.

3/4.3 RADIOACTIVE GASEOUS EFFLUENTS

3/4.3.7 Steam Jet Air Ejector (SJAE) [Duplication of Technical Specification 3/4.8.K.)

CONTROLS

3.3.7 Gross radioactivity release rate from the SJAE shall be limited to less than or equal to 0.16 Ci/sec (after 30 minutes decay).

APPLICABILITY:

At all times.

ACTION:

a. With the gross radioactivity release rate at the SJAE exceeding the above limit, restore the gross radioactivity release rate to within its limit within 72 hours or be in at least Hot Standby within the subsequent 12 hours.

b. With the gross radioactivity release rate at the SJAE greater than or equal to 1.5 Ci/sec (after 30-minute decay), restore the gross radioactivity release rate to less than 1.5 Ci/sec (after 30-minute decay), or be in Hot Standby within 12 hours.

SURVEILLANCE REQUIREMENTS

4.3.7 a. The gross radioactivity release rate shall be continuously monitored in accordance with Control 3.1.2

b. The gross radioactivity release rate of noble gases from the SJAE shall be determined to be within the limit of Control 3.3.7 at the following frequencies by performing an isotopic analysis (for Xe-138, Xe-135, Xe-133, Kr-88, Kr-85m, Kr-87) on a representative sample of gases taken at the discharge.

1. Once per week.
2. Within the 4 hours following an increase of 25% or 5000 microcuries/sec, whichever is greater, in steady-state activity levels during steady-state reactor operation, as indicated by the SJAE monitor.

3/4.4 TOTAL DOSE

3/4.4.1 Total Dose (40 CFR 190)

CONTROLS

3.4.1 The dose or dose commitment to a member of the public** in areas at and beyond the Site Boundary from all station sources is limited to less than or equal to 25 mrem to the total body or any organ (except the thyroid, which is limited to less than or equal to 75 mrem) over a calendar year.

APPLICABILITY:

At all times.

ACTION:

With the calculated dose from the release of radioactive materials in liquid or gaseous effluents exceeding twice the limits of Controls 3.2.2.a, 3.2.2.b, 3.3.2.a, 3.3.2.b, 3.3.3.a, or 3.3.3.b, calculations should be made, including direct radiation contributions from the station to determine whether the above limits of Control 3.4.1 have been exceeded. If such is the case, prepare and submit to the Commission within 30 days a Special Report that includes the information detailed in ODCM Section 10.3.3.

SURVEILLANCE REQUIREMENTS

4.4.1.a Cumulative dose contributions from liquid and gaseous effluents shall be determined in accordance with Controls 4.2.2, 4.3.2, and 4.3.3.

4.4.1.b Cumulative dose contributions from direct radiation from plant sources shall be determined in accordance with the methods in the ODCM. This requirement is applicable only under conditions set forth in Control 3.4.1 Action Statement.

* Note: For this Control, a member of the public may be taken as a real individual accounting for his actual activities.

3/4.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.5.1 Environmental Monitoring Program

CONTROLS

3.5.1 The radiological environmental monitoring program shall be conducted as specified in Table 3.5.1.

APPLICABILITY:

At all times.

ACTION:

a. With the radiological environmental monitoring program not being conducted as specified in Tables 3.5.1 or 4.5.1, prepare and submit to the Commission, in the Annual Radiological Environmental Monitoring Report (per ODCM Section 10.2), a description of the reasons for not conducting the program as required and the plans for preventing a recurrence.

b. With the level of radioactivity as the result of plant effluents in an environmental sampling media at one or more locations specified in Control Table 3.5.1 exceeding the reporting levels of Control Table 3.5.2, prepare and submit to the Commission a Special Report within 30 days from receipt of the laboratory analysis (per ODCM Section 10.3.4).

SURVEILLANCE REQUIREMENTS

4.5.1 The radiological environmental monitoring samples shall be collected pursuant to Table 3.5.1 from the locations given in the ODCM and shall be analyzed pursuant to the requirements of Table 3.5.1 and the detection capabilities required by Table 4.5.1.

TABLE 3.5.1

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Radioiodine and Particulates	Samples from 5 locations: 1 sample from up valley, within 4 miles of Site Boundary. (major wind direction) 1 sample from down valley, within 4 miles of Site Boundary. (major wind direction) 1 sample each from the vicinity of two nearby communities, within 10 miles of Site Boundary. 1 sample from a control location.	Continuous operation of sampler with sample collection semimonthly or more frequently as required by dust loading or plant effluent releases.[h]	Radioiodine canister: Analyze each sample for I-131. Particulate sampler: Gross beta radioactivity analysis on each sample following filter change.[c] Composite (by location) for gamma isotopic[d] at least once per quarter.

TABLE 3.5.1
(Cont'd)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
2. DIRECT RADIATION[b]	40 routine monitoring stations as follows: 16 incident response stations (one in each meteorological sector) within a range of 0 to 4 km[g]; 16 incident response stations (one in each meteorological sector) within a range of 2 to 8 km[g]; the balance of the stations to be placed in special interest areas and control station areas.	Quarterly.	Gamma dose, at least once per quarter. Incident response TLDs in the outer monitoring locations, de-dose only quarterly unless gaseous release Controls were exceeded in period.

TABLE 3.5.1
(Cont'd)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface[e]	1 sample upstream.	Monthly grab sample.	Gamma isotopic analysis[d] of each sample. Tritium analysis of composite sample at least once per quarter.
	1 sample downstream.	Composite sample collected over a period of one month[f].	
b. Ground	1 sample from within 8 km distance.	Quarterly.	Gamma isotopic[d] and tritium analyses of each sample.
	1 sample from a control location.	Quarterly.	
c. Sediment from Shoreline	1 sample from downstream area with existing or potential recreational value.	Semiannually.	Gamma isotopic analysis[d] of each sample.
	1 sample from north storm drain outfall.	As specified in the ODCM.	

TABLE 3.5.1
(Cont'd)

Radiological Environmental Monitoring Program

Exposure Pathway and/or Sample	Number of Sample Locations[a]	Sampling and Collection Frequency	Type and Frequency of Analysis
4. INGESTION			
a. Milk	Samples from milking animals in 3 locations within 5 km distance having the highest dose potential. If there are less than 3 primary locations available then 1 or more secondary sample from milking animals in each of 3 areas between 5 to 8 km distance where doses are calculated to be greater than 1 mrem per year.	Semimonthly if milking animals are identified on pasture; at least once per month at other times.	Gamma isotopic[d] and I-131 analysis of each sample.
	1 sample from milking animals in a control location.		
b. Fish	1 sample of two recreationally important species in vicinity of plant discharge area.	Semiannually.	Gamma isotopic analysis[d] on edible portions.
	1 sample (preferably of same species) in areas not influenced by plant discharge.		
c.	1 grass sample at each air sampling station.	Quarterly when available.	Gamma isotopic analysis[d] of each sample.
	1 silage sample at each milk sampling station (as available).	At time of harvest.	Gamma isotopic analysis[d] of each sample.

TABLE 3.5.1 NOTATION

a Specific parameters of distance and direction sector from the centerline of the reactor and additional descriptions where pertinent, shall be provided for each and every sample location in Table 3.5.1 in a table and figure(s) in the ODCM (Section 7). Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons. If specimens are unobtainable due to sampling equipment malfunction, every reasonable effort shall be made to complete corrective action prior to the end of the next sampling period. All deviations from the sampling schedule shall be documented in the Annual Radiological Environmental Operating Report pursuant to ODCM Section 10.2. It is recognized that, at times, it may not be possible or practicable to continue to obtain samples of the media of choice at the most desired location or time. In these instances, suitable alternative media and locations may be chosen for the particular pathway in question and appropriate substitutions made within 30 days in the radiological environmental monitoring program. In lieu of a Licensee Event Report and pursuant to ODCM Section 10.1, identify the cause of the unavailability of samples for that pathway and identify the new location(s) for obtaining replacement samples in the next Radioactive Effluent Release Report and also include in the report a revised figure(s) and table for the ODCM reflecting the new location(s).

b One or more instruments, such as a pressurized ion chamber, for measuring and recording dose rate continuously may be used in place of, or in addition to, integrating dosimeters. For the purposes of this table, a Thermoluminescent Dosimeter (TLD) is considered to be one phosphor; two or more phosphors in a packet are considered as two or more dosimeters. Film badges shall not be used as dosimeters for measuring direct radiation. The 40 stations is not an absolute number. The frequency of analysis or readout for TLD systems will depend upon the characteristics of the specific system used and should be selected to obtain optimum dose information with minimal fading.

c Airborne particulate sample filters shall be analyzed for gross beta radioactivity 24 hours or more after sampling to allow for radon and thoron daughter decay. If gross beta activity in air particulate samples is greater than ten times the yearly mean of control samples, gamma isotopic analysis shall be performed on the individual samples.

d Gamma isotopic analysis means the identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents from the facility.

e The "upstream sample" shall be taken at a distance beyond significant influence of the discharge. The "downstream" sample shall be taken in an area beyond but near the mixing zone.

f Composite sample aliquots shall be collected at time intervals that are very short (e.g., hourly) relative to the compositing period (e.g., monthly) in order to assure obtaining a representative sample.

g Each meteorological sector shall have an established "inner" and an "outer" monitoring location based on ease of recovery (i.e., response time) and year-round accessibility.

h Sample collection will be performed weekly whenever the main plant stack effluent release rate of I-131, as determined by the sampling and analysis program of Table 4.3.1, is equal to or greater than 1 x 10-1 uCi/sec. Sample collection will revert back to semimonthly no sooner than at least two weeks after the plant stack effluent release rate of I-131 falls and remains below 1 x 10-1 uCi/sec.

TABLE 3.5.2

Reporting Levels For Radioactivity Concentrations In Environmental Samples[a]

Reporting Levels

Analysis	Water (pCi/1)	Airborne Particulate or Gases (pCi/m3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Vegetation (pCi/Kg, wet)	Sediment (pCi/Kg, dry)
H-3	2×10^{4} [b]					
Mn-54	1×10^3		3×10^4			
Fe-59	4×10^2		1×10^4			
Co-58	1×10^3		3×10^4			
Co-60	3×10^2		1×10^4			3×10^{3} [c]
Zn-65	3×10^2		2×10^4			
Zr-Nb-95	4×10^2					
I-131		0.9		3	1×10^2	
Cs-134	30	10	1×10^3	60	1×10^3	
Cs-137	50	20	2×10^3	70	2×10^3	
Ba-La-140	2×10^2			3×10^2		

(a) Reporting levels may be averaged over a calendar quarter. When more than one of the radionuclides in Table 3.5.2 are detected in the sampling medium, the unique reporting requirements are not exercised if the following condition holds:

$$\frac{\text{concentration (1)}}{\text{reporting level (1)}} + \frac{\text{concentration (2)}}{\text{reporting level (2)}} + \ldots < 1.0$$

When radionuclides other than those in Table 3.5.2 are detected and are the result of plant effluents, the potential annual dose to a member of the public must be less than or equal to the calendar year limits of Controls 3.2.2, 3.3.1, and 3.3.2.

(b) Reporting level for drinking water pathways. For nondrinking water pathways, a value of 3×10^4 pCi/l may be used.

(c) Reporting level for individual grab samples taken at North Storm Drain Outfall only.

TABLE 4.5.1

Detection Capabilities For Environmental Sample Analysis[a][c][f]

Analysis[d]	Water (pCi/1)	Airborne Particulate or Gas (pCi/m3)	Fish (pCi/Kg, wet)	Milk (pCi/l)	Vegetation (pCi/Kg, wet)	Sediment (pCi/Kg, dry)
Gross beta	4	0.01				
H-3	3000					
Mn-54	15		130			
Fe-59	30		260			
Co-58, 60	15		130			
Zn-65	30		260			
Zr-Nb-95	15[b]					
I-131		0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15[b][e]			15[b][e]		

TABLE 4.5.1 NOTATION

(a) See Footnote (a) of Table 4.3.1.

(b) Parent only.

(c) If the measured concentration minus the 5 sigma counting statistics is found to exceed the specified LLD, the sample does not have to be analyzed to meet the specified LLD.

(d) This list does not mean that only these nuclides are to be considered. Other peaks that are identifiable, together with those of the listed nuclides, shall also be analyzed and reported in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 6.6.E and ODCM Section 10.2.

(e) The Ba-140 LLD and concentration can be determined by the analysis of its short-lived daughter product La-140 subsequent to an 8 day period following collection. The calculation shall be predicted on the normal ingrowth equations for a parent-daughter situation and the assumption that any unsupported La-140 in the sample would have decayed to an insignificant amount (at least 3.6 percent of its original value). The ingrowth equations will assume that the supported La-140 activity at the time of the collection is zero.

(f) Nuclides which are below the LLD for the analyses should not be reported as being present at the LLD, but as "not detected". For purposes of averaging, the LLD will be assumed to be zero.

3/4.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.5.2 Land Use Census

CONTROLS

3.5.2 A land use census shall be conducted to identify the location of the nearest milk animal and the nearest residence in each of the 16 meteorological sectors within a distance of five miles. The survey shall also identify the nearest milk animal (within 3 miles of the plant) to the point of predicted highest annual average D/Q value in each of the three major meteorological sectors due to elevated releases from the plant stack.

APPLICABILITY:

At all times.

ACTION:

a. With a land use census identifying one or more locations which yield a calculated dose or dose commitment (via the same exposure pathway) at least 20 percent greater than at a location from which samples are currently being obtained in accordance with Control 3.5.1, add the new location(s) to the radiological environmental monitoring program within 30 days if permission from the owner to collect samples can be obtained, and sufficient sample volume is available. The sampling location(s), excluding the control station location, having the lowest calculated dose or dose commitment (via the same exposure pathway) may be deleted from this monitoring program after October 31 of the year in which this land use census was conducted.

b. With the land census not being conducted as required above, prepare and submit to the Commission within 30 days a Special Report that includes information detailed in ODCM Section 10.3.5.

SURVEILLANCE REQUIREMENTS

4.5.2 The land use census shall be conducted at least once per year between the dates of June 1 and October 1 by either a door-to-door survey, aerial survey, or by consulting local agricultural authorities. The results of the land use census shall be included in the Annual Radiological Environmental Operating Report pursuant to Technical Specification 6.6.E and ODCM Section 10.2.

3/4.5 RADIOLOGICAL ENVIRONMENTAL MONITORING

3/4.5.3 Intercomparison Program

CONTROLS

3.5.3 Analyses shall be performed on referenced radioactive materials supplied as part of an Intercomparison Program which has been approved by NRC.

APPLICABILITY:

At all times.

ACTION:

With analysis not being performed as required above, report the corrective actions taken to prevent a recurrence to the Commission in the Annual Radiological Environmental Operating Report pursuant to ODCM Section 10.2

SURVEILLANCE REQUIREMENTS

4.5.3 A summary of the results of analyses performed as part of the above required Intercomparison Program shall be included in the Annual Radiological Environmental Operating Report. The identification of the NRC approved Intercomparison Program which is being participated in shall be stated in the ODCM.

3/4.6 EFFLUENT AND ENVIRONMENTAL CONTROL BASES

INSTRUMENTATION

Liquid Effluent Instrumentation (3.1.1)

The radioactive liquid effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in liquid effluents during actual or potential releases of liquid effluents. The alarm setpoints for these instruments are to ensure that the alarm will occur prior to exceeding 10 times the concentration limits of Appendix B to 10CFR20.1001-20.2401, Table 2, Column 2, values.

Automatic isolation function is not provided on the liquid radwaste discharge line due to the infrequent nature of batch, discrete volume, liquid discharges (on the order of once per year or less), and the administrative controls provided to ensure that conservative discharge flow rates/dilution flows are set such that the probability of exceeding the above concentration limits are low, and the potential off-site dose consequences are also low.

Gaseous Effluent Instrumentation (3.1.2)

The radioactive gaseous effluent instrumentation is provided to monitor and control, as applicable, the releases of radioactive materials in gaseous effluents during actual or potential releases of gaseous effluents. The alarm/trip setpoints for these instruments are provided to ensure that the alarm/trip will occur prior to exceeding design bases dose rates identified in Control 3.3.1.

RADIOACTIVE EFFLUENTS

Liquid Effluents: Concentration (3.2.1)

This Control is provided to ensure that at any time the concentration of radioactive materials released in liquid waste effluents from the site above background (Unrestricted Area for liquids is at the point of discharge from the plant discharge into Connecticut River) will not exceed 10 times the concentration levels specified in 10CFR Part 20.1001-20.2401, Appendix B, Table 2, Column 2. These requirements

provide operational flexibility, compatible with considerations of health and safety, which may temporarily result in releases higher than the absolute value of the concentration numbers in Appendix B, but still within the annual average limitation of the Regulation. Compliance with the design objective doses of Section II.A of Appendix I to 10CFR Part 50 assure that doses are maintained ALARA, and that annual concentration limits of Appendix B to 10CFR20.1001-20.2401 will not be exceeded.

The concentration limit for noble gases is based upon the assumption that Xe-135 is the controlling radionuclide and that an effluent concentration in air (submersion dose equal to 500 mrem/yr) was converted to an equivalent concentration in water.

Liquid Effluents: Dose (3.2.2)

This Control is provided to implement the requirements of Sections II.A, III.A, and IV.A of Appendix I, 10CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.A of Appendix I. The requirements provide operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in liquid effluents will be kept "as low as is reasonably achievable". The Surveillance Requirements implement the requirements in Section III.A of Appendix I, i.e., that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of an individual through appropriate pathways is unlikely to be substantially underestimated. In addition, there is reasonable assurance that the operation of the facility will not result in radionuclide concentrations in potable drinking water that are in excess of the requirements of 40CFR 141. No drinking water supplies drawn from the Connecticut River below the plant have been identified. The appropriate dose equations for implementation through requirements of the Specification are described in the Vermont Yankee Off-Site Dose Calculation Manual. The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive materials in liquid effluents were developed from the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I", Revision 1, April 1977.

Liquid Radwaste Treatment (3.2.3)

The requirement that the appropriate portions of this system as indicated in the ODCM be used, when specified, provides assurance that the releases of radioactive materials in liquid effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10CFR Part 50.36a and the design objective given in Section II.D of Appendix I to 10CFR Part 50. The specified limits governing the use of appropriate portions of the liquid radwaste treatment system were specified as a suitable fraction of the dose design objectives set forth in Section II.A of Appendix I, 10CFR Part 50, for liquid effluents.

Gaseous Effluents: Dose Rate (3.3.1)

The specified limits as determined by the methodology in the ODCM, restrict, at all times, the corresponding gamma and beta dose rates above background to a member of the public at or beyond the site boundary to (500) mrem/year to the total body or to (3,000) mrem/year to the skin. This instantaneous dose rate limit allows for operational flexibility when off normal occurrences may temporarily increase gaseous effluent release rates from the plant, while still providing controls to ensure that licensee meets the dose objectives of Appendix I to 10CFR50.

Control 3.3.1.b also restricts, at all times, comparable with the length of the sampling periods of Table 4.8.2 the corresponding thyroid dose rate above background to an infant via the cow-milk-infant pathway to 1500 mrem/year for the highest impacted cow.

Gaseous Effluents: Dose from Noble Gases (3.3.2)

This Control is provided to implement the requirements of Sections II.B, III.A, and IV.A of Appendix I, 10CFR Part 50. The Limiting Condition for Operation implements the guides set forth in Section II.B of Appendix I. The requirements provide operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive material in gaseous effluents will be kept "as low as is reasonably achievable". The Surveillance Requirements implement the requirements in Section III.A of Appendix I, i.e., that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of any member of the public through appropriate pathways is unlikely to be substantially underestimated. The

appropriate dose equations are specified in the ODCM for calculating the doses due to the actual releases of radioactive noble gases in gaseous effluents. The ODCM also provides for determining the air doses at the site boundary based upon the historical average atmospheric conditions.

The equations specified in the ODCM for calculating the doses due to the actual release rates of radioactive noble gases in gaseous effluents were developed from the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977.

Gaseous Effluents: Dose from Iodine-131, Iodine-133, Tritium, and Radionuclides in Particulate Form (3.3.3)

This Control is provided to implement the requirements of Section II.C, III.A, and IV.A of Appendix I, 10CFR Part 50. The Limiting Condition for Operation are the guides set forth in Section II.C of Appendix I. The requirements provide operating flexibility and at the same time implement the guides set forth in Section IV.A of Appendix I to assure that the releases of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". The Surveillance Requirements implement the requirements in Section III.A of Appendix I that conformance with the guides of Appendix I be shown by calculational procedures based on models and data such that the actual exposure of a member of the public through appropriate pathways is unlikely to be substantially underestimated. The equations specified in the ODCM for calculating the doses due to the actual release rates of the subject materials were also developed using the methodology provided in Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10CFR Part 50, Appendix I", Revision 1, October 1977 and Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," Revision 1, July 1977. These equations also provide for determining the actual doses based upon the historical average atmospheric conditions. The release rate specifications for Iodine 131, Iodine-133, tritium, and radionuclides

in particulate form with half-lives greater than 8 days are dependent on the existing radionuclide pathways to man, in areas at and beyond its site boundary. The pathways which were examined in the development of these specifications were: 1) individual inhalation of airborne radionuclides, 2) deposition of radionuclides onto green leafy vegetation with subsequent consumption by man, 3) deposition onto grassy areas where milk animals and meat producing animals graze with consumption of the milk and meat by man, and 4) deposition on the ground with subsequent exposure of man.

Gaseous Radwaste Treatment (3.3.4)

The requirement that the appropriate portions of the Augmented Off-Gas (AOG) System be used whenever the SJAE is in operation provides reasonable assurance that the releases of radioactive materials in gaseous effluents will be kept "a low as is reasonably achievable". This specification implements the requirements of 10CFR Part 50.36a and the design objectives of Appendix I to 10CFR Part 50.

Ventilation Exhaust Treatment (3.3.5)

The requirement that the AOG Building and Radwaste Building HEPA filters be used when specified provides reasonable assurance that the release of radioactive materials in gaseous effluents will be kept "as low as is reasonably achievable". This specification implements the requirements of 10CFR Part 50.36a and the design objective of Appendix I to 10CFR Part 50. The requirements governing the use of the appropriate portions of the gaseous radwaste filter systems were specified by the NRC in NUREG-0473, Revision 2 (July 1979) as a suitable fraction of the guide set forth in Sections II.B and II.C of Appendix I, 10CFR Part 50, for gaseous effluents.

Primary Containment (MARK I) (3.3.6)

This Control provides reasonable assurance that releases from containment purging/venting operations will be filtered through the Standby Gas Treatment System (SBGT) so that the annual dose limits of 10CFR Part 20 for Members of the Public in areas at and beyond the Site Boundary will not be exceeded. The dose objectives of Control 3.3.3 restrict purge/venting operations when the Standby Gas Treatment System is not in use and gives reasonable assurance that all releases from the plant will

be kept "as low as is reasonably achievable". The specification requires the use of SBGT only when Iodine-131, Iodine-133 or radionuclides in particulate form with half-lives greater than 8 days in containment exceeds the levels in Table 1, Column 3, to Appendix B of 10CFR 20.1001-20.2401 since the filter system is not considered effective in reducing noble gas radioactivity from gas streams.

The use of the 18" purge and vent flow path isolation valves AC-7A (16-19-7A), AC-7B (16-19-7B), AC-8 (16-19-8), AC-10 (16-19-10) has been restricted to 90 hours per year. Normal plant operations (other than inerting and de-inerting) will have AC-8 and AC-10 closed and nitrogen will be supplied to the drywell via the 1" nitrogen makeup supply. The differential pressure maintained between the drywell and torus will allow the nitrogen to "bubble over" into the suppression chamber. A normally open AC-6B (3") allows for venting. A normally closed AC-6A (3") is periodically opened for performance of surveillances such as monthly torus to drywell vacuum breaker tests. Procedurally, when AC-6A is open, AC-6 and AC-7 are closed to prevent overpressurization of the SBGT system or the reactor building ductwork, should a LOCA occur. For this and similar analyses performed, a spurious opening of AC-6 or AC-7 (one of the closed containment isolation valves) is not assumed as a failure simultaneous with a postulated LOCA. Analyses demonstrate that for normal plant operation system alignments, including surveillances such as those described above, that SBGT integrity would be maintained if a LOCA was postulated. Therefore, during normal plant operations, the 90 hour clock does not apply. Accordingly, opening of the 18 inch atmospheric control isolation valves AC-7A, AC-7B, AC-8 and AC-10 will be limited to 90 hours per calendar year (except for performance of the subject valve stroke time surveillances - in which case the appropriate corresponding valves are closed to protect equipment should a LOCA occur). This restriction will apply whenever primary containment integrity is required. The 90 hour clock will apply anytime purge and vent evolutions can not assure the integrity of the SBGT trains or related equipment.

Steam Jet Air Ejector (SJAE) (3.3.7)

Restricting the gross radioactivity release rate of gases from the main condenser SJAE provides reasonable assurance that the total body exposure to an individual at the exclusion area boundary will not exceed a small fraction of the limits of 10CFR Part 100 in the even this effluent in inadvertently discharged directly to the environment without treatment. This specification implements the requirements of General Design Criteria 60 and 64 of Appendix A to 10CFR Part 50. (This basis is a duplicate of that for plant Technical Specification 3.8.K.)

Total Dose (40CFR190) (3.4.1)

This Control is provided to meet the dose limitations of 40CFR Part 190 to Members of the Public in areas at and beyond the Site Boundary. The specification requires the preparation and submittal of a Specific Report whenever the calculated doses from plant radioactive effluents exceed twice the design objective doses of Appendix I. For sites containing up to 4 reactors, it is highly unlikely that the resultant dose to a Member of the Public will exceed the dose limits of 40CFR Part 190 if the individual reactors remain within the reporting requirement level. The Special Report will describe a course of action that should result in the limitation of the annual dose to a Member of the Public to within the 40CFR Part 190 limits. For the purposes of the Special Report, it may be assumed that the dose commitment to the Member of the Public is estimated to exceed the requirements of 40CFR Part 190, the Special Report with a request for a variance (provided the release conditions resulting in violation of 40CFR Part 190 have not already been corrected), in accordance with the provisions of 40CFR Part 190.11 and 10CFR Part 20.2203(a)(4), is considered to be a timely request and fulfills the requirements of 40CFR Part 190 until NRC staff action is completed. The variance only relates to the limits of 40CFR Part 190, and does not apply in any way to the other requirements for dose limitation of 10CFR Part 20. An individual is not considered a Member of the Public during any period in which he/she is engaged in carrying out any operation that subjects them to occupational exposures. For individuals in controlled areas who are considered Members of the Public per 10CFR20, the dose limits of 10CFR20.1301 apply since the licensee has the authority to control and limit access to these areas.

Radiological Environmental Monitoring Program (3.5.1)

The radiological monitoring program required by this Control provides measurements of radiation and of radioactive materials in those exposure pathways and for those radionuclides which lead to the highest potential radiation exposures of member(s) of the public resulting from the station operation. This monitoring program implements Section IV.B.2 of Appendix I to 10 CFR Part 50 and thereby supplements the radiological effluent monitoring program by verifying that the measurable concentrations of radioactive materials and levels of radiation are not higher than expected on the basis of the effluent measurements and modeling of the environmental exposure pathways.

Ten years of plant operation, including the years prior to the implementation of the Augmented Off-Gas System, have amply demonstrated via routine effluent and

environmental reports that plant effluent measurements and modeling of environmental pathways are adequately conservative. In all cases, environmental sample results have been two to three orders of magnitude less than expected by the model employed, thereby representing small percentages of the ALARA and environmental reporting levels. This radiological environmental monitoring program has therefore been significantly modified as provided for by Regulatory Guide 4.1 (C.2.b), Revision 1, April 1975. Specifically, the air particulate and radioiodine air sampling periods have been increased to semimonthly, based on plant effluent and environmental air sampling data for the previous ten years of operation. An I-131 release rate trigger value of 1 x 10-1 uCi/sec from the plant stack will require that air sample collection be increased to weekly. The 1 x 10-1 uCi/sec I-131 value corresponds to the LLD air concentration of 0.07 pCi/m3 at the maximum predicted air monitoring station, which exhibits a maximum quarterly X/Q value of 2 x 10-7 sec/m3. A factor of 3.5 below the LLD value has also been included in the stack release rate value to account for meteorological fluctuations in X/Q. Due to the large local population of cows and the ready availability of milk samples, food product sampling has been eliminated from the program in lieu of milk sampling. Since milking cows in the area spend very little time on pasture, silage and grass sampling have been instituted as an indicator of radionuclide deposition.

The detection capabilities required by Table 4.5.1 are considered optimum for routine environmental measurements in industrial laboratories. It should be recognized that the LLD is defined as a before-the-fact limit representing the capability of a measurement system and not as an after-the-fact limit for a particular measurement. This does not preclude the calculation of an after-the-fact LLD for a particular measurement based upon the actual parameters for the sample in question.

Land Use Census (3.5.2)

This Control is provided to ensure that changes in the use of areas at and beyond the site boundaries are identified and that modifications to the monitoring program are made if required by the results of this census. This census satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR Part 50. The requirement of a garden census has been eliminated along with the food product monitoring requirement due to the substantial and widespread occurrence of dairy farming in the surrounding area which dominates the food uptake pathway.

The addition of new sampling locations to Control 3.5.1, based on the land use census, is limited to those locations which yield a calculated dose or dose commitment greater than 20 percent of the calculated dose or dose commitment at any location currently being sampled. This eliminates the unnecessary changing of the environmental radiation monitoring program for new locations which, within the accuracy of the calculation, contributes essentially the same to the dose or dose commitment as the location already sampled. The substitution of a new sampling point for one already sampled when the calculated difference in dose is less than 20 percent, would not be expected to result in a significant increase in the ability to detect plant effluent related nuclides.

Intercomparison Program (3.5.3)

The requirement for participation in an intercomparison program is provided to ensure that independent checks on the precision and accuracy of the measurements of radioactive material in environmental sample matrices are performed as part of a quality assurance program for environmental monitoring in order to demonstrate that the results are reasonably valid for the purposes of Section IV.B.2 of Appendix I to 10 CFR Part 50.

5.0 METHOD TO CALCULATE OFF-SITE LIQUID CONCENTRATIONS

Chapter 5 contains the basis for plant procedures that the plant operator requires to meet ODCM Control 3.2.1 which limits the total fraction of combined effluent concentration in liquid pathways, excluding noble gases, denoted here as, F_1^{ENG} at the point of discharge at any time (see Figure 9-1). F_1^{ENG} is limited to less than or equal to ten, i.e.,

$$F_1^{ENG} \leq 10$$

The total concentration of all dissolved and entrained noble gases at the point of discharge from all station sources, denoted C_l^{NG}, is limited to 2E-04 μCi/ml, i.e.,

$$C_1^{NG} \leq 2E-04\ \mu Ci/ml.$$

Evaluation of F_1^{ENG} and C_1^{NG} is required concurrent with the sampling and analysis program in Control Table 4.2.1.

5.1 Method to Determine F_1^{ENG} and C_1^{NG}

Determine the total fraction of combined effluent concentrations at the point of discharge in liquid pathways (excluding noble gases), denoted F_1^{ENG}, and determine the total concentration at the point of discharge of all dissolved and entrained noble gases in liquid pathways from all station sources, denoted C_l^{NG}, as follows:

$$F_1^{ENG} = \sum_i \frac{C_{pi}}{ECL_i} \leq 10 \qquad (5\text{-}1)$$

$$\left(\frac{\mu Ci/ml}{\mu Ci/ml}\right)$$

and:

$$C_l^{NG} = \sum_i C_{li}^{NG} \leq 2E\text{-}04 \qquad (5\text{-}2)$$

(μ Ci/ml) (μ Ci/ml) (μ Ci/ml)

where:

F_1^{ENG} = Total sum of the fractions of each radionuclide concentration in liquid effluents (excluding noble gases) at the point of discharge to an unrestricted area, divided by each radionuclide's ECL value.

C_{pi} = Concentration at point of discharge to an unrestricted area of radionuclide "i", except for dissolved and entrained noble gases, from any tank or other significant source, p, from which a discharge may be made (including the floor drain sample tank, the waste sample tanks, the detergent waste tank and any other significant source from which a discharge can be made) (μCi/ml). This concentration can be calculated from: $C_{pi} = C_{TKi}$ x $F_{TK}/[F_{DIL} + F_{TK}]$ where: C_{TKi} equals the concentration of radionuclide i in the tank to be discharged (μCi/ml); F_{DIL} is equal to the dilution flow provided by the liquid radioactive waste dilution pumps (20,000 gpm); F_{TK} equals the liquid waste discharge pump flow rate which regulates the rate at which liquid from a waste collection tank is discharged (gpm).

ECL_i = Annual average effluent concentration limits of radionuclide "i", except for dissolved and entrained noble gases, from 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2 (μCi/ml).

C_l^{NG} = Total concentration at point of discharge to an unrestricted area of all dissolved and entrained noble gases in liquid pathways from all station sources (μCi/ml).

C_{li}^{NG} = Concentration at point of discharge to an unrestricted area of dissolved and entrained noble gas "i" in liquid pathways from all station sources (μCi/ml).

5.2 Method to Determine Radionuclide Concentration for Each Liquid Effluent Pathway

5.2.1 Sample Tanks Pathways

C_{pi} is determined for each radionuclide above LLD from the activity in a representative grab sample of any of the sample tanks and the predicted flow at the point of discharge to an unrestricted area.

Most periodic batch releases are made from the two 10,000-gallon capacity waste sample tanks. These tanks serve to hold all the high purity liquid wastes after they have been filtered through the waste collector and processed by ion exchange in the fuel pool and waste demineralizers. Other periodic batch releases may also come from the detergent waste tank or the floor drain sample tank.

The tanks are sampled from the radwaste sample sink and the contents analyzed for water quality and radioactivity. If the sample meets all the high purity requirements, the contents of the tank may be re-used in the nuclear system. If the sample does not meet all the high purity requirements, the contents are recycled through the radwaste system or discharged.

Prior to discharge each sample tank is analyzed for tritium, dissolved noble gases and dissolved and suspended gamma emitters.

5.2.2 Service Water Pathway

The service water pathway shown on Figure 9-1, flows from the intake structure through the heat exchangers and the discharge structure. Under normal operating conditions, the water in this line is not radioactive. For this reason, the service water line is not sampled routinely but it is continuously monitored with the service water discharge monitor (No. 17/351).

The alarm setpoint on the service water discharge monitor is set at a level which is three times the background of the instrument. The service water is sampled if the monitor is out of service or if the alarm sounds.

Under expected or anticipated operating conditions, the concentration at any time of radionuclides at the point of discharge from the service water effluent pathway to an unrestricted area will not exceed ten times the effluent concentration values of 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2.

5.2.3 Circulating Water Pathway

The circulating water pathway shown on Figure 9-1, flows from the intake structure through the condenser and the discharge structure. Under normal operating conditions, the water in this line is not radioactive. For this reason, the circulating water line is not sampled routinely but it is monitored continuously by the discharge process monitor (No. 17/359) located in the discharge structure.

The alarm setpoint on the discharge process monitor is set at a level which is three times the background of the instrument. The circulating water is sampled if the monitor is out of service or if the alarm sounds.

Under normal operating conditions, the average concentration of radionuclides at the point of discharge from the circulating water pathway to an unrestricted area will not exceed the annual effluent concentration limits in 10CFR20.1001-20.2401, Appendix B, Table 2, Column 2.