Enclosure 4

TAC 16-010

002N4207-NP, "General Electric Nuclear Test Reactor Annual Average Dispersion Factor Adequacy Review," Revision 1

Public Version

This is a non-proprietary version of Enclosure 3, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double brackets, as shown here [[ ]].

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GE Hitachi Nuclear Energy

002N4207-NP
Revision 1
September 2016

Non-Proprietary Information – Class I (Public)

General Electric Nuclear Test Reactor Annual Average Dispersion Factor Adequacy Review

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IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

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REVISION SUMMARY

Rev.	Section Modified	Revision Description
0	All	Initial Issue
1	Multiple	Specific instances of proprietary information identified.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

Item	Short Form	Description
1	AGL	Above Ground Level
2	χ/Q	Chi-Over-Q (Atmospheric Dispersion Factor)
3	D/Q	Deposition Factor
4	E	East
5	GE	General Electric
6	GEH	GE-Hitachi Nuclear Energy
7	JFT	Joint Frequency Table
8	N	North
9	NRC	Nuclear Regulatory Commission
10	NTR	Nuclear Test Reactor
11	NUREG	Nuclear Regulatory (Prefix to Identify a Class of NRC Technical Reports)
12	RG	Regulatory Guide
13	SAR	Safety Analysis Report
14	S	South
15	VNC	Vallecitos Nuclear Center
16	W	West

EXECUTIVE SUMMARY

The adequacy of the General Electric (GE) Nuclear Test Reactor (NTR) annual average atmospheric dispersion factor (χ/Q) has been reviewed for its application to a reduced site area associated with a proposed sale of land at the Vallecitos Nuclear Center (VNC). The proposed land sale will reduce some directional sector distances to the site boundary from the NTR stack which are critical parameters used in the determination of the annual average χ/Q.

The sector results of the adequacy review case for an 8-day decayed release are shown in Table 5-1. The most limiting annual average χ/Q is 2.2E-05 sec/m^3 which occurs in the Southwest (SW) Sector. The adequacy review annual average χ/Q is bounded by the current GE NTR annual average χ/Q of 3.48E-05 sec/m^3 (or 3.48E-11 sec/ml) by approximately 37%.

As shown in Table 5-2, all annual average χ/Qs for distances up to 80467 meters (50 miles) are less than the calculated value of 2.2E-05 sec/m^3 in the adequacy review results for the assumed site boundary. Thus, it is demonstrated that a more limiting annual average χ/Q does not occur beyond the assumed boundary.

Therefore, the NTR Safety Analysis Report (SAR) annual average χ/Q remains bounding and is adequate for continued use as the bases for the stack action levels (as described in Section 6.4 of the NTR SAR) after the land sale occurs if the parcel of land sold does not exceed the minimum distance of 510 meters from the NTR stack in the Northwest (NW) through East-Northeast (ENE) sectors.

1.0 INTRODUCTION

Recently, a proposal has been made to sell a portion of the land on the north side of the GE NTR site located at VNC. The proposed land sale would reduce some sector distances to the site boundary from the NTR stack which are critical parameters used in the determination of the annual average χ/Q. Therefore, the reduction in boundary distances resulting from the potential land sale may impact on the annual average χ/Q used in the licensing basis of the GE NTR SAR [1].

1.1 Purpose

The purpose of this analysis is to calculate a conservative annual average χ/Q for the GE NTR using current methodology for comparison to the existing annual average χ/Q reported in the NTR SAR so that the adequacy of the existing value can be established. If the annual average χ/Q calculated for this adequacy review is bounded by the SAR annual average χ/Q value then no change to the SAR value will be made, otherwise the adequacy review χ/Q will replace the SAR value.

1.2 Scope

Depending on the outcome of the comparison of the annual average χ/Q calculated here to the SAR value, the results of this analysis and subsequent conclusions will be used to support the NTR license in one of the following ways:

1. Direct inclusion of the adequacy review annual average χ/Q in the NTR SAR (if it is not bounded by the SAR value).

   Or

2. Proof outside the NTR SAR that the existing annual average χ/Q is adequate (if the adequacy review annual average χ/Q is bounded by the SAR value).

2.0 METHODOLOGY

The approach used to calculate the NTR SAR average annual χ/Q employed a method that predated current regulatory guidance using a computer code which is no longer available and is described in Reference 2. This method followed the approach in the "For Comment" version of Regulatory Guide (RG) 1.145 annual average dispersion factors [3].

The annual average χ/Q calculated for this adequacy review follows the guidance and procedures described in RG 1.111 which is the current methodology employed at commercial nuclear plants in the United States [4].

Because the dispersion factor being reviewed is based on older methods in many cases the terminology used has changed over time. In order to clarify some of these differences it should be recognized that for the purpose of this report and the reference documents cited in this report the terms "dilution factor", "dispersion-dilution coefficient", "dispersion-dilution factor", "χ/Q", "effluent χ/Q", "average annual dispersion factor", "long term χ/Q" , and "normal operation χ/Q" are all referring to an annual average χ/Q and the terms are used interchangeably. This

report does not reference or discuss any short term or accident χ/Q factors (onsite or offsite) and they are not in the scope of this adequacy review.

2.1 GE NTR Methodology

The annual average χ/Q for a release from the NTR stack to the site boundary is described in a report entitled "NTR Stack Release Limits" [2]. As detailed in Reference 2, the RALOC code developed by GE was used for the calculation [5]. The RALOC code manual states that at the time the code was developed (1976) there was no formal guidance issued by the Nuclear Regulatory Commission (NRC) which defined an acceptable method to generate atmospheric dispersion factors, and that the method used in RALOC is based on personal communication with the NRC.

A review of the RALOC code description indicates the following major considerations which are now required by formal regulations were not addressed in the development of the code.

1. Elevated Releases
2. Vent releases from a stack on top of a building
3. The impact of surrounding terrain on dispersion
4. The treatment of calm winds

The methods used for the NTR analysis were less developed than those currently employed.

2.1.1 GE NTR Dispersion Factor

The NTR vents to the environment from a stack on top of the free standing building that houses the NTR (designated VNC Building 105). The annual average χ/Q associated the Building 105 stack is 3.48E-11 sec/ml. As explained in a GEH response to a request for information from the NRC, the single maximum calculated annual average χ/Q value of 3.48E-11 sec/ml was selected from the 16 sector average values [6]. This value occurs in the east-southeast sector at 622 meters from the stack, and is used to determine the NTR stack release limits.

In addition, the following critical assumptions associated with the NTR annual average χ/Q were listed in Reference 2.

1. Wind direction, speed and stability condition for each hour during the year was recorded and used to calculate the χ/Q value in 16 equal sectors (22.5°) at the site boundary.
2. Distances to the 16 sector nearest boundary points, starting at the north sector and proceeding clockwise are (meters): 2302, 2390, 1926, 1615, 955, 622, 522, 510, 515, 597, 756, 636, 622, 634, 749, and 1109.
3. Building 105 cross-sectional area, for building wake effect (square meters) = 281 m^2.
4. Stack height Above Ground Level (AGL, meters): 0 m.
5. Pasquill type meteorological condition designations.
6. The sector average χ/Q values are used instead of centerline values.
7. No plume depletion was accounted for.
8. Continuous release conditions were used.

Typically χ/Qs are reported in units of sec/m^3 so for the purpose of comparing the SAR value to the adequacy review dispersion factor calculated for this report it is converted to 3.48E-05 sec/m^3.

2.2 Adequacy Review χ/Q Methodology

This analysis has been performed in accordance with RG 1.111 [4]. The XOQDOQ computer code, which was developed to implement RG 1.111, is used to perform this analysis [7].

A description of the release conditions, the terrain around the plant, the receptor locations and wind information needed to perform the XOQDOQ evaluation are presented in this report. The *XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations* manual (NUREG/CR-2919) defines all input parameters used in the model [7].

3.0 INPUTS AND ASSUMPTIONS

To the extent possible, the inputs used for the SAR annual average χ/Q have been used for the adequacy review annual average χ/Q. Some assumptions applied in the SAR χ/Q analysis have been changed for the adequacy review χ/Q if allowed by the governing regulatory guidance in RG 1.111 and NUREG/CR-2919.

3.1 Assumptions

The following critical assumptions associated with the adequacy review annual average χ/Q model have been applied.

1. The release from the NTR stack is assumed to be a mixed mode release (a mixture of elevated and ground releases) consistent with requirements of RG 1.111 for an effluent release from a vent at the level of or above adjacent structures.
2. The meteorological data used for the SAR annual average χ/Q is assumed to be applicable to the adequacy review annual average χ/Q. This is a conservative assumption because this wind data [[
]]
3. In accordance with the recommendations in NUREG/CR-2919 Section 3.7, the upper limit to the highest wind speed category is assumed to be 5 units greater than the highest wind speed category in the wind data set ([[ ]] as described in Section 3.2.1).
4. The distances to the site boundary for the directional sectors that may be impacted by the land sale (the NW through ENE sectors) are all assumed to be 510 meters from the NTR stack. This is a conservative assumption because the actual distances to the site boundary for the NW through ENE sectors are all greater than 510 meters (see Table 3-4).
5. The distances to the boundary for all sectors not impacted by the land sale are assumed to be the same as those used in the NTR SAR annual average χ/Q analysis (Reference 2).
6. The NTR stack release is assumed to undergo radioactive decay with a half-life of 8 days with no credit for depletion of the plume consistent with the SAR annual average χ/Q analysis (Reference 2).

3.2 Inputs

3.2.1 Meteorological Data

Meteorological data is formatted for use with the XOQDOQ code as a Joint Frequency Table (JFT), which characterizes the data as a table of annual fractional occurrences during a given time period of a particular combination of stability class, wind direction, and wind speed category.

The XOQDOQ JFT was created from data obtained from the VNC meteorological data collection tower and reported in Reference 8. As stated in Reference 8, the data was collected in accordance with the "Original Issue" of RG 1.23 [9]. Reference 8 indicates that all periods of calm winds (less than 2 mph) are treated as Pasquill stability class G with an assumed windspeed of 1 mph.

This treatment of calm winds is very conservative considering every stability class typically has some calm winds occurring at various times. Distributing all calms into a single stability class drives the JFT to be weighted toward the most limiting Pasquill stability class which drives higher χ/Qs. Conversely, the XOQDOQ methodology would distribute the calms between each stability class as they were recorded.

To ensure the adequacy review case meteorological basis is consistent with the original analysis in Reference 2, the distribution of calms reported in Reference 8 was not changed.

Instrument Height

The instrument height for the VNC meteorological data tower is [[ ]] above the surrounding terrain [10].

Wind Speed Categories

The wind speed categories reported in Reference 8 are shown in Table 3-1. The upper limit of each wind speed category is used in the XOQDOQ model. In accordance with NUREG/CR-2919 Section 3.7, since the highest category is expressed with no upper limit the XOQDOQ code requires that an upper limit must be assumed, and 5 units greater than the largest wind speed is generally acceptable. Thus, the upper limit for the highest wind speed category is assumed to be [[ ]].

Table 3-1 – Wind Speed Categories

Wind Speed Categories	Upper Limit to Category (mph)
[[	
	]]

Joint Frequency Distribution

The JFTs provided in Reference 8 are fractional occurrences of each speed and category for the years 1976 and 1977 which were summed then averaged for use in XOQDOQ as shown in Table 3-2. Thus, the JFT used for the SAR χ/Q has been used to calculate the adequacy review χ/Q.

Table 3-2 – Joint Frequency Distribution

	Direction Sector→ Wind Speed (mph)↓	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
[[																	
																]]

Table 3-2 – Joint Frequency Distribution

	Direction Sector→ Wind Speed (mph)↓	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
	[[																
																	]]

3.2.2 NTR Stack Release Parameters

As described in Reference 2, the SAR annual average χ/Q analysis did not model the NTR stack [2], as that was not an option [[ ]] [5]. Conversely, RG 1.111 includes methods for crediting the stack because most gaseous effluent released from nuclear sites do occur through tall stacks or vents on top of buildings. Therefore, this adequacy review credits the NTR stack which vents to the environment from the top of the free standing building that houses the NTR. The following stack parameters needed for the XOQDOQ model were collected from various VNC documentation.

1. Stack height = 13.7 m [11]
2. Stack Cross Sectional Area = [[ ]] [12]
3. Stack flow rate = 1800 ft^3/minute (cfm) [6].
4. Building Height = [[ ]] [13]
5. Building Wake Area = 281 m^2 [2]

Because VNC Building 105 is not in the zone of influence of taller structures and the release point is above the building itself, this analysis models the release as a "mixed mode" release as allowed by RG 1.111 [4].

3.2.2.1 Exit Velocity

This analysis credits the initial exit velocity of the release from the NTR stack. As indicated in the SAR χ/Q analysis (Reference 2) the velocity of the NTR stack effluent release was not considered. However, the adequacy review χ/Q analysis will credit the exit velocity of the effluent release as allowed by RG 1.111. The NTR stack average flow rate during operation used for limiting concentrations and calculating measured releases is 1800 cfm (0.850 m^3/sec) [6]. The NTR stack has a cross sectional area of [[ ]] [12], therefore the exit velocity is 7.2 m/sec [equal to (0.850 m^3/sec)/(0.1176 m^2)].

3.2.2.2 Receptor Distances

The land that may potentially be sold is located on the north side of the VNC site. Since the exact distances are not readily available this analysis develops minimum distances in order to bound the potential land sale.

As shown in Section 2.1.1, the distances to the boundary for each the sixteen 22.5° direction sectors were used for the NTR χ/Q analysis. As stated in Reference 2, the distances to the closest boundary point of each sector from the NTR were scaled from drawing number 2l2E239, "Topographic Map". The same drawing appears as Figure 2.4 of Reference 11 and was used to perform basic measurements for this adequacy review as depicted in Figure 3-1. Figure 3-1 contains the following markings:

- The dotted blue line on Figure 3-1 bisects the VNC site from east to west consistent with a typical plot line used for a land sale, and is tangentially as close as possible to the fence line of the GE Test Reactor (GETR) which has been shut down and issued a "possession only" license. Therefore, the area north of the dotted blue line best represents the largest plot of land that could be sold at VNC.

- The dotted black lines depict the sixteen 22.5° direction sectors necessary to perform the dispersion analysis.
- The red measurement markers depict the distances to sector boundaries for sectors not impacted by the land sale. These measurements establish that the SAR analysis and this adequacy review analysis are based on the same site layout (see Table 3-3).
- The green measurement markers depict the distances to sector boundaries for sectors that will be impacted by the land sale. As with the red markers, these measurements demonstrate the Reference 2 distances are based on the same site layout as this adequacy review (see Table 3-3).
- The solid blue measurement markers depict minimum distances that bound the potential land sale for the impacted sectors.

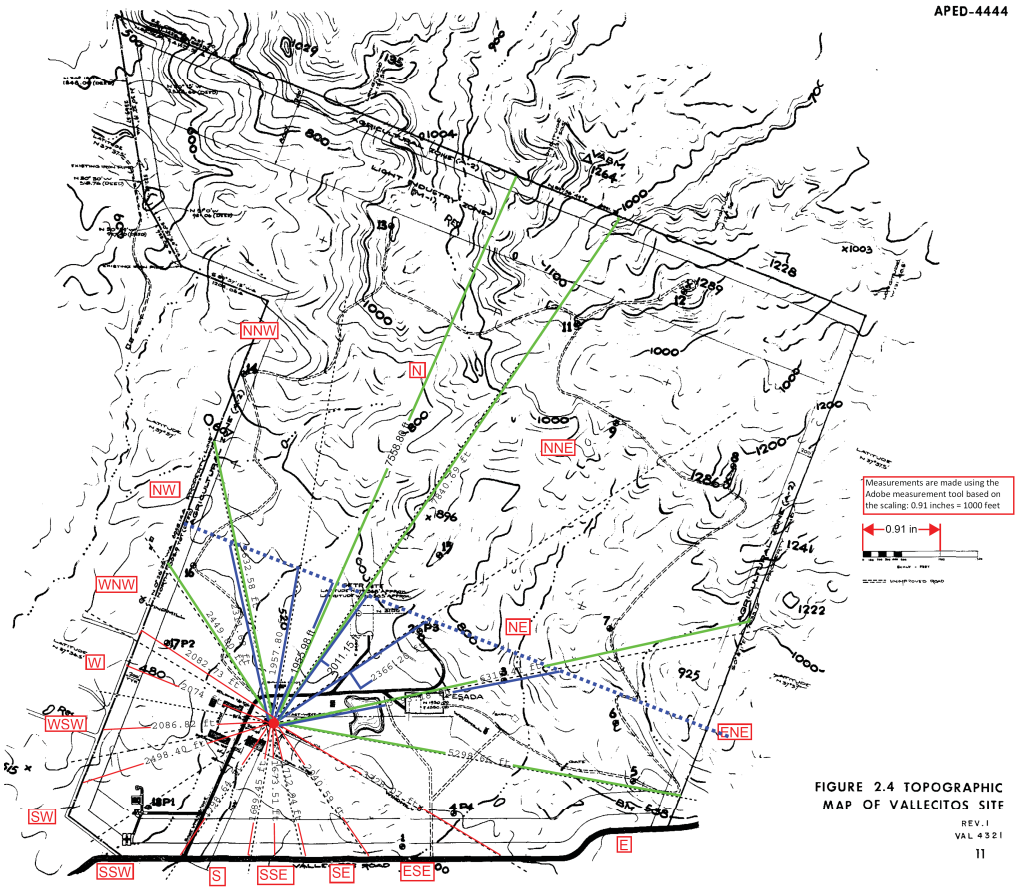

Figure 3-1: NTR Boundary Distances

First, to ensure the accuracy of measurements made using Figure 3-1, the boundary distances for each sector used in Reference 2 were recreated. As shown in Table 3-3, the boundary distances measured using Figure 3-1 were in close agreement with those used in Reference 2.

Table 3-3 –NTR χ/Q Analysis Boundary Distances

Sector	Reference 2 Boundary (m)	Measured from Figure 3-1 Boundary (ft)	Measured from Figure 3-1 Boundary (m)	% Δ From Reference 2
S	515	1689	515	0.00%
SSW	597	1999	609	2.01%
SW	756	2498	762	0.79%
WSW	636	2087	636	0.00%
W	622	2074	632	1.61%
WNW	634	2083	635	0.16%
NW	749	2450	747	-0.27%
NNW	1109	3633	1107	-0.18%
N	2302	7559	2304	0.09%
NNE	2390	7841	2390	0.00%
NE	1926	6319	1926	0.00%
ENE	1615	5299	1615	0.00%
E	955	3328	1014	6.18%
ESE	622	2041	622	0.00%
SE	522	1713	522	0.00%
SSE	510	1674	510	0.00%

For consistency with Reference 2, the distances to the site boundary for those sectors not impacted by the land sale are unchanged in the adequacy review case. As depicted in Figure 3-1, only 6 sectors will potentially be reduced by the land sale from the NW sector sweeping clockwise to the ENE sector. New boundary distances for the impacted sectors were measured as shown in Figure 3-1 and listed in Table 3-4 under the heading "New Boundary Distance".

While the revised distances would likely bound those of any land sale at VNC, for further conservatism the NW through ENE sector distances are assumed to be only 510 meters from the NTR stack which is the shortest of all the distances used in Reference 2. Therefore, the final distances used in the adequacy review case model are those shown in Table 3-4 under the heading "Assumed Boundary Distance".

Table 3-4 – Adequacy Review χ/Q Analysis Boundary Distances

Sector	Reference 2	New Boundary Distance (ft)	New Boundary Distance (m)	% Δ From Reference 2	Assumed Boundary Distance (m)
S	515	No change	No change	N/A	515

Table 3-4 – Adequacy Review χ/Q Analysis Boundary Distances

Sector	Reference 2	New Boundary Distance (ft)	New Boundary Distance (m)	% Δ From Reference 2	Assumed Boundary Distance (m)
SSW	597	No change	No change	N/A	597
SW	756	No change	No change	N/A	756
WSW	636	No change	No change	N/A	636
W	622	No change	No change	N/A	622
WNW	634	No change	No change	N/A	634
NW	**749**	**2311.62**	**705**	**-5.87%**	**510**
NNW	**1109**	**1957.80**	**597**	**-46.17%**	**510**
N	**2302**	**1955.98**	**596**	**-74.11%**	**510**
NNE	**2390**	**2011.15**	**613**	**-74.35%**	**510**
NE	**1926**	**2366.20**	**721**	**-62.56%**	**510**
ENE	**1615**	**3693.18**	**1126**	**-30.28%**	**510**
E	955	No change	No change	N/A	955
ESE	622	No change	No change	N/A	622
SE	522	No change	No change	N/A	522
SSE	510	No change	No change	N/A	510

3.2.2.3 Terrain Correction Factors

Because terrain factors for the NTR site were not developed for Reference 2 open terrain correction factors described in RG 1.111 and implemented by the XOQDOQ code have been applied in the adequacy review χ/Q model [4, 7]. As shown in Figure 3.2 of Reference 7, for all boundary distances less than 1 km the open terrain correction factor will multiply the resulting χ/Q by a factor of 4. Because all of the distances used are less than 1 km this is a very conservative application of the open terrain correction factors.

4.0 XOQDOQ MODEL

The XOQDOQ code reads input files with the extension "dat", and generates standard output files entitled "XOQ_OUT.DAT" when a given case is executed. To ensure that the adequacy review case can easily be recreated in the future, all entries made in the model are explicitly stated in the following section.

Card 1

Card 1 is an array (KOPT) options, such that 1 = do, 0 = bypass. All XOQDOQ variables used for Card 1 are shown in Table 4-1.

Table 4-1 – XOQDOQ Input Data Card 1

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
KOPT (1)	[[		
KOPT (2)			]]
KOPT (3)	1	Option to compute a sector spread for comparison with centerline value in a purge calculation. (Normally = 1)	The default value of 1 has been used.
KOPT (4)	0	Option to plot short term χ/Q values versus probability of occurrence. (Normally = 0)	The default value of 0 has been used.
KOPT (5)	1	Option to use cubic spline in lieu of least square function for fitting intermittent release distribution. (Normally = 1)	The default value of 1 has been used.
KOPT (6)	1	Option to punch radial segment X/Q and D/Q values.	The default value of 1 has been used.
KOPT (7)	1	Option to punch output of χ/Q and D/Q values of the points of interest.	Setting this value to 1 allows the programs to generate results for the points of interests [receptors].
KOPT (8)	1	Option to correct χ/Q and D/Q values for open terrain recirculation.	This option applies a correction for recirculation and stagnation at downwind distances (See Section 3.2.2.3).
KOPT (9)	0	Option to correct χ/Q and D/Q values using site-specific terrain recirculation data.	No site-specific diffusion data is available.
KOPT (10)	0	Option to use desert sigma curves. (Normally = 0)	The NTR site is not in the desert.
KOPT (11)	0	Option to use 30 degree sectors for north, south, east, and west with 20 degree sectors in all other directions. (Normally = 0)	The joint frequency data is based on 22.5° sectors as stated in Reference 2.

Card 2

Card 2 is the main title card for the input file and is printed at the beginning of the output file. The Card 2 has been populated with the phrase “General Electric Nuclear Test Reactor 2015”.

Card 3

All XOQDOQ variables used for Card 3 are shown in Table 4-2.

Table 4-2 – XOQDOQ Input Data Card 3

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
NVEL	[[ ]]	Number of velocity (wind speed) categories.	Joint frequency data is based on [[ ]] wind speed categories.
NSTA	7	Number of stability categories.	The meteorological data is based on the Pasquill stability classes (A – G) in accordance with Reference 4.
NDIS	0	Number of distances with terrain data for each sector.	The open terrain correction factor has been used as described in Section 3.2.2.3.
INC	15	The increment in percent for which plotted results are printed out. (Normally = 15)	XOQDOQ Default value as described in Reference 7.
NPTYPE	1	The number of titles of receptor types (cow, garden, etc.). Maximum of eight.	The only receptor modeled is the site boundary.
NEXIT	1	The number of release exit points.	The NTR stack is one release location.
NCOR	0	The number of distances of site-specific correction factors for recirculation. (Maximum of 10)	No site-specific diffusion data is available. This data would typically be determined by experiments or comparison to results from a variable trajectory model. Note that if NCOR is set to 0 the resulting output file will include the tag "VRDIST, VRCR NOT INPUTTED" indicating the parameters describing diffusion data have not been used.

Card 4

All XOQDOQ variables used for Card 4 are shown in Table 4-3.

Table 4-3 – XOQDOQ Input Data Card 4

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
PLEV	[[ ]]	The height AGL in meters of the measured wind presented in the joint frequency data. (See Section 4.17 of NUREG/CR-2919 [7])	See Section 3.2.2.
DECAYS (I) [=], 3	1 = 101 2 = 2.26 3 = 8	For each I: The half-life (days) used in the χ/Q calculations: if DECAYS>100, no decay will occur; if DECYS <0, depletion factor will be used in the χ/Q calculations.	Per Reference 7, an overall half-life of 2.26 days is acceptable for short-lived noble gases and 8 days for all iodines released to the atmosphere. Reference 2 also applied a decay factor of 8 days.
PLGRAD	0	Plant grade elevation (feet above sea level).	All parameters have been normalized to plant grade. No further adjustment is required.

Cards 5 and 6

Card 5 consists of the calm wind for each stability category, and Card 6 consists of the JFT shown in Table 3-2. Because the calms were distributed into the lowest wind speed category in stability class G, Card 5 is a blank line per Section 3.8 of Reference 7.

Card 7

All XOQDOQ variables used for Card 7 are shown in Table 4-4.

Table 4-4 – XOQDOQ Input Data Card 7

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
UCOR	101	A unit correction factor applied to wind speed classes. If UCOR<0: no corrections will be made. If UCOR>100: the wind speed classes will be converted from miles per hour to meters per second.	The wind speed categories are in units of miles per hour.
UMAX (I)	[[ ]]	The maximum wind speed in each wind-speed class, in either miles/hour or meters/second.	The wind speed categories for the evaluation were taken directly from Reference 8.

Cards 8 through 11

Because site specific terrain factors were not applied there are no entries for Cards 8 through 11.

Cards 12, 13, and 14

The Card types 12, 13, and 14 of the XOQDOQ input deck are shown in Table 4-5.

Table 4-5 – XOQDOQ Input Data Cards 12, 13, and 14

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
Card 12 NPOINT (I) I = 1, NTYPE	16	The number of receptor locations for a particular receptor type (such as number of cows, gardens, or site boundaries)	See Section 3.2.2.2.
Card 13 TITLPT (I, J)	Boundary	The title of the receptor type for the receptor locations.	The site boundary.

Table 4-5 – XOQDOQ Input Data Cards 12, 13, and 14

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
Card 14 KDIR (I, N) PTDIST (I, N) N=1, NPOINT (I)	Values shown in Table 3-4.	The receptor direction and distance. KDIR is the direction of interest, such that 1 = S, 2 = SSW,…, 16 = SSE. PTDIST is the distance, in meters, to the receptor location.	See Section 3.2.2.2

Card 15

Card 15 is the title card for the release point which has been entered as "NTR Stack 105".

Card 16

The Card type 16 of the XOQDOQ input deck is shown in Table 4-6.

Table 4-6 – XOQDOQ Input Data Card 16

XOQDOQ Variable	NTR Value	Parameter Description	Source / Basis
EXIT (I)	[[	The exit velocity of the release point in meters per second.	See Section 3.2.2.1.
DIAMTR		The inside diameter of the vent or stack in meters.	See Section 3.2.2.1.
HSTACK		The release height (meters AGL). If the release is 100% elevated then input is the negative of the height.	See Section 3.2.2
HBLDG		Height of the vent's building (meters AGL).	See Section 3.2.2
CRSEC (I)		The minimum cross-sectional area for the vent's building (in m^2).	See Section 3.2.2
SLEV (I)	]]	The wind height used for the elevated vent release (meters AGL).	See Section 3.2.1
HEATR (I)	0	The vent heat emission rate (cal/sec).	This analysis conservatively neglects the effects of buoyancy.

Card 17

Card 17 is for use with intermittent releases and requires a single letter identifier followed by 3 numeric purge parameters. Since no intermittent releases are being modeled, these parameters were entered an "A" followed by three "0" values.

5.0 RESULTS AND CONCLUSIONS

The sector results of the adequacy review case for an 8-day decayed release are shown in Table 5-1. The most limiting annual average χ/Q is 2.2E-05 sec/m^3 which occurs in the SW Sector. This result is bounded by the NTR annual average χ/Q of 3.48E-05 sec/m^3 (or 3.48E-11 sec/ml) by approximately 37%, thus, the NTR annual average χ/Q is judged to be adequate if the parcel of land sold does not exceed the minimum distance of 510 meters from the NTR stack in the NW through ENE sectors.

Table 5-1 – Adequacy Review Case Results (sec/m^3)

S	7.00E-06
SSW	1.30E-05
SW	**2.20E-05**
WSW	2.10E-05
W	7.90E-06
WNW	5.10E-06
NW	2.10E-06
NNW	2.20E-06
N	2.50E-06
NNE	3.20E-06
NE	5.90E-06
ENE	4.10E-06
E	4.40E-06
ESE	1.70E-06
SE	6.60E-07
SSE	1.60E-06

Because the distance to the boundary of 510 meters in the NW through ENE sectors was assumed to be the shortest boundary distance from the prior analysis (shown in Reference 6), Table 5-2 is provided from the same XOQDOQ output to demonstrates that a more limiting annual average χ/Q does not occur beyond the assumed boundary. As shown in Table 5-2, all annual average χ/Qs for distances up to 80467 meters (50 miles) are less than the calculated value of 2.2E-05 sec/m^3 in the final adequacy review results for the assumed site boundary.

Table 5-2 – Annual Average χ/Qs for Downwind Distances from the NTR Stack (sec/m^3)

Distance from the NTR Stack → Sector ↓	0.5-1 (miles) 805-1609 (meters)	1-2 (miles) 1609-3219 (meters)	2-3 (miles) 3219-4828 (meters)	3-4 (miles) 4828-6437 (meters)	4-5 (miles) 6437-8047 (meters)	5-10 (miles) 8047-16093 (meters)	10-20 (miles) 16093-32187 (meters)	20-30 (miles) 32187-48280 (meters)	30-40 (miles) 48280-64374 (meters)	40-50 (miles) 64374-80467 (meters)
S	9.46E-06	5.32E-06	2.42E-06	1.41E-06	9.48E-07	4.69E-07	1.93E-07	1.02E-07	6.66E-08	4.80E-08
SSW	9.72E-06	4.37E-06	1.87E-06	1.07E-06	7.13E-07	3.49E-07	1.42E-07	7.49E-08	4.88E-08	3.52E-08
SW	1.45E-05	5.17E-06	2.04E-06	1.14E-06	7.48E-07	3.60E-07	1.44E-07	7.52E-08	4.88E-08	3.52E-08
WSW	1.32E-05	5.37E-06	2.22E-06	1.26E-06	8.35E-07	4.06E-07	1.64E-07	8.60E-08	5.59E-08	4.03E-08
W	1.10E-05	6.09E-06	2.76E-06	1.60E-06	1.08E-06	5.33E-07	2.19E-07	1.16E-07	7.56E-08	5.45E-08
WNW	8.76E-06	4.98E-06	2.27E-06	1.32E-06	8.89E-07	4.40E-07	1.81E-07	9.59E-08	6.26E-08	4.52E-08
NW	1.38E-06	6.04E-07	2.54E-07	1.44E-07	9.61E-08	4.69E-08	1.90E-08	1.01E-08	6.56E-09	4.75E-09
NNW	1.60E-06	7.76E-07	3.39E-07	1.95E-07	1.31E-07	6.42E-08	2.62E-08	1.39E-08	9.05E-09	6.53E-09
N	1.89E-06	9.29E-07	4.08E-07	2.35E-07	1.58E-07	7.76E-08	3.18E-08	1.68E-08	1.10E-08	7.91E-09
NNE	1.09E-06	3.16E-07	1.11E-07	5.93E-08	3.81E-08	1.78E-08	6.85E-09	3.52E-09	2.27E-09	1.63E-09
NE	1.72E-06	4.11E-07	1.28E-07	6.48E-08	4.05E-08	1.82E-08	6.66E-09	3.34E-09	2.14E-09	1.54E-09
ENE	1.23E-06	3.08E-07	9.91E-08	5.12E-08	3.24E-08	1.48E-08	5.57E-09	2.85E-09	1.85E-09	1.34E-09
E	3.95E-06	1.79E-06	7.62E-07	4.35E-07	2.91E-07	1.42E-07	5.79E-08	3.06E-08	2.00E-08	1.45E-08
ESE	3.95E-06	2.33E-06	1.07E-06	6.22E-07	4.20E-07	2.08E-07	8.56E-08	4.54E-08	2.96E-08	2.14E-08
SE	4.62E-07	2.13E-07	9.12E-08	5.21E-08	3.48E-08	1.70E-08	6.93E-09	3.66E-09	2.39E-09	1.72E-09
SSE	2.62E-06	1.51E-06	6.87E-07	4.00E-07	2.70E-07	1.34E-07	5.49E-08	2.91E-08	1.90E-08	1.37E-08

6.0 REFERENCES

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