Nine Mile Point Unit 1
Alternative Source Term

Calculation H21C076

"X/Qs for Releases from NMP Units 1 & 2 (CNS Calcs NMPAST-01-001 & NMPAST-02-001)"

ORIGINAL

NUCLEAR ENGINEERING	CALCULATION COVER SHEET	Page 1 (Next 2) Total 106 Last 106

Project: NINE MILE POINT NUCLEAR STATION **Unit** (1, 2 or 0=Both) : 0 **Discipline** : ANALYSIS

Title	Calculation No.			
X/QS FOR RELEASES FROM NMP UNITS 1 & 2 (CNS CALCS NMPAST-01-001 & NMPAST-02-001)	H21C076			
	(Sub)system(s)	Building	Floor Elev.	Index No.
	N/A	N/A	N/A	N/A

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Rev	Description	Eval., DER, or Change No.	Prep'd By	Date	Reviewed By	Date	App	Date
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Ref No	Document No.	Doc Type	Index	Sheet	Rev

General Reference(s) :
SEE PAGES 29, 78, 79 & 97

Remarks :
CNS CALCULATION NMPAST-01-001 CALCULATES X/Qs AT THE EAB & LPZ (SEE PAGES 3 THRU 50)
CNS CALCULATION NMPAST-02-001 CALCULATES X/Qs FOR CONTROL ROOMS & TSC (SEE PAGES 51 THRU 90)
THESE CALCULATIONS WERE INDEPENDENTLY REVIEWED, AND VERIFIED IN ACCORDANCE WITH NEP-DES-07, BY NYSIS CORP (N13617) (SEE PAGES 91 THRU 106)
NOTE: PAGES 23, 24 & 81 CONTAIN COLOR PRINTING. NO INFORMATION IS LOST IN BLACK & WHITE.

Confirmation Required (Yes / No) : No See Page(s) : _____	Final Issue Status: APP	Turnover Required (Yes / N/A) : N/A

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Key Words : X/Q, ATMOSPHERIC DISPERSION, EAB, LPZ, CONTROL ROOM, TSC, PAVAN, ARCON96	

Calculation Cover Sheet

Calculation No. NMPAST-01-001 Rev. 2 No. of Pages 45

Title Calculation of X/Qs at the EAB and LPZ from Releases at NMP Units 1 and 2

Rev. 0	Name	Signature	Date
Prepared By	James Heffner		
Checked By	Shane Gardner		
Approved By	Tara Neider		

Rev. 1	Name	Signature	Date
Prepared By	James Heffner		
Checked By	Shane Gardner		
Approved By	Tara Neider		

Description of Changes

- New meteorological (MET) data is incorporated.
  - Rounding errors contributed to minor discrepancies in results of NMPAST-01-001.
  - All calculations were rerun in PAVAN using new MET data.
- The WSW is regarded as a land rather than coastal sector for NMP Unit 2 in this revision.
  - Main Stack distance to EAB was changed from 405 m to 1,615 m.
  - Combined Radwaste/Reactor Building Vent was changed from 747 m to 1,381 m.
- Eliminated coastal sector distances to EAB.
  - W, WNW, NW, NNW, N, NNE , NE, and ENE sectors are considered coastal and are not considered for evaluation in this revision.
  - Coastal sector distances to EAB were substituted with the minimum land sector distances to obtain overall site X/Q values.
- Provided additional calculations for stack releases in each sector to prove that maximum X/Q concentrations do not occur at distances beyond the EAB and LPZ.
  - RG 1.145 Rev. 1 mentions that X/Q values may occur at distances beyond the EAB and LPZ.
  - PAVAN runs were performed at various distances ranging from 100 – 9,000 m for stack releases to prove that maximum X/Qs exist at the EAB and LPZ.

Affected Pages – Sections 5 through 9.

Rev. 2	Name	Signature	Date
Prepared By	Shane Gardner	Shane R Gardner	12/19/03
Checked By	David Matchick	David Matchick	12/29/03
Approved By	Larry Smith	Larry D Smith	12/31/03

Description of Changes

The purpose of this revision is to respond to comments made in a third party review performed by NISYS Corp. at the request of NMPNS. Several comments were made and the reader is referred to the NISYS document NISYS-1169-DV001/R0 for more detail. CNS and NMPNS agreed to a plan to resolve a selection of the NISYS comments (see CNS-03-218, 9/24/03 and electronic correspondence from Timothy M. Kurtz to Shane Gardner, November 6, 2003, "Re: CNS Comments on NISYS Review of X/Q Calculations"). CNS-03-218 provides a description regarding how the comments were addressed and provides the basis for incorporating the comments into this calculation. More specifically, the following comments were addressed:

NISYS Comment No.	Description	Affected Page(s)
1b	include a scale drawing (compass "rose")	Appendix A
1c	statement documenting conformance to Safety Guide 23	3-4, 24 (Ref. 21)
2a	justification of PAVAN variable "A" (building wake area)	6, 24 (Refs. 19 & 20)
3b	correction and review of 28 hand-checked 0.5% X/Q values	16-17, 19-22
3c	provide a basis for intermediate time points	17
5a	add a detailed listing of files on CD be provided	Appendix C

Resolution of NISYS comment 3b resulted in minor changes to the results provided in section 7. More specifically, it was determined that PAVAN outputs were correctly processed internally to the code (ENVLOP routine) and therefore the results in the output files were correct. The results tables in section 7 were updated to reflect this finding. The new results were only slightly different from the results of previous revision 1.

In addition to the changes indicated above, the calculation was further revised to incorporate minor editorial changes

Affected Pages: Calculation Cover Sheet (Title); all pages thereafter

H21C076-00

Calculation Review Checklist

Calculation # NMPAST-01-001 Rev. # 2

Circle, as appropriate, the Yes/No/NA for all items

Correct calculation format ..... Yes/No/NA

Correctness of assumptions ..... Yes/No/NA

Adequacy of assumption basis ..... Yes/No/NA

Correctness of parameters used ..... Yes/No/NA

Appropriate choice of method ..... Yes/No/NA

Adequate documentation of method ..... Yes/No/NA

Correct application of method ..... Yes/No/NA

Correctness of results/conclusions ..... Yes/No/NA

Adequate Reference list ..... Yes/No/NA

If computer software was used to perform the calculation, the following elements shall also be considered:

Proper software verification and verification documentation ..... Yes/No/NA

Correctness of input parameters ..... Yes/No/NA

Correct information in analysis calculation ..... Yes/No/NA

Correct interpretation of results ..... Yes/No/NA

Signature David A. Matchick Date 12-29-03

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1. Objective

The purpose of this calculation is to determine conservative estimates of exclusion area boundary (EAB) and low population zone (LPZ) atmospheric dispersion coefficients (X/Qs) for use in calculations which determine radiation dose consequences associated with postulated design basis accidents occurring at Nine Mile Point Nuclear Station (NMP) Unit 1 and Unit 2.

2. Background

NMP has requested the services of Constellation Nuclear Services (CNS) to evaluate and update offsite and control room atmospheric dispersion coefficients for both Units 1 and 2. The atmospheric dispersion coefficients are needed for a scoping study to determine the feasibility of the use of the Alternative Source Term (AST) methodology for the determination of design basis accident dose consequences and can be applied to other calculations which determine radiation dose consequences at the EAB and LPZ boundaries.

After a postulated accident at the NMP Unit 1 or Unit 2, radioactivity may reach the atmosphere by several pathways. These pathways include the reactor building blowout panel, the turbine building blowout panel and the main stack for Unit 1. For Unit 2, the release pathways include the combined radwaste and reactor building vent, the main steam tunnel, the standby gas treatment system building, the post accident sampling system panel and the main stack. Once the radioactivity reaches the atmosphere, it will create dose consequences at the EAB and the outer boundary of the LPZ. The determination of atmospheric dispersion coefficients provide the amount of radioactivity reaching the EAB and LPZ for a given source for use in the dose consequence determination.

This calculation provides conservative estimates of atmospheric dispersion coefficients at the EAB and LPZ from the following release sources:

- Unit 1 Main Stack
- Unit 1 Reactor Building Blowout Panel
- Unit 1 Turbine Building Blowout Panel
- Unit 2 Main Stack
- Unit 2 Combined Radwaste and Reactor Building Vent
- Unit 2 Main Steam Tunnel
- Unit 2 Standby Gas Treatment System Building
- Unit 2 Post Accident Sampling System Panel

2.1. Applicable Regulations and Commitments

PAVAN is used to determine X/Q values used in the assessment of dose consequences of design basis accidents in nuclear power stations. 10 CFR Part 100 (Reference 6) and 10 CFR Part 50 (Reference 7) require such assessments. PAVAN follows the guidance of R.G. 1.145 (Reference 2) for calculating X/Qs. Meteorological data are hourly averages obtained from

NMP Joint Frequency Distribution Report (JFD) (Reference 9) and the analysis conforms to requirements of R.G. 1.145 (Reference 2) and R.G. 1.23 (Reference 21).

3. Methodology

The PAVAN program uses meteorological data in the form of joint frequency distributions of hourly averages of wind direction and wind speed by atmospheric stability class. Wind direction is distributed into 16 sectors. For each sector a 0.5% X/Q is calculated to represent the 0 – 2 hour X/Q in accordance with R.G. 1.145 (Reference 2). The 0.5% X/Q is the value which is equaled or exceeded 0.5% of the time. PAVAN also calculates a sector annual average X/Q in accordance with R.G. 1.111 (Reference 3). The 0 – 2 hour X/Q value and the annual average X/Q are used to determine sector X/Q values for various intermediate time periods.

In a similar manner, PAVAN also calculates a 5% overall site X/Q value that is independent of wind direction. This is the site value that is not exceeded more than 5% of the time, and is used to represent the 0 – 2 hour X/Q. The overall site annual average X/Q is calculated in accordance with R.G. 1.111 (Reference 3). The 0 – 2 hour X/Q value and the annual average X/Q are used to determine overall site X/Q values for various intermediate time periods.

In addition, PAVAN also calculates short-term sector fumigation X/Qs for both the EAB and LPZ in accordance with R.G. 1.145 (Reference 2) for stack releases. For each sector, the larger of the sector fumigation and the sector non-fumigation X/Q should be used for the 0 – 2 hour time period. The highest X/Q value for the 16 sectors represents the maximum sector X/Q.

The X/Q value for EAB or LPZ evaluations should be the maximum sector X/Q or the 5% overall site X/Q, whichever is higher. A more detailed description on the methodology used by PAVAN to calculate X/Qs is provided in the reference documentation (References 2, 3 and 8).

4. Computer Hardware/Software Usage

4.1. Hardware Used

All PAVAN X/Q calculations were performed on PC CNS-76, operating under the Windows® 98 operating system. PAVAN has been previously verified on CNS-76 in accordance with the CNS QA Program (Reference 15).

4.2. Software Used

The program PAVAN is written in FORTRAN IV computer language and is compatible with a CDC 7600 computer system under the NOS 1.0 operating system. A further description of PAVAN is included in the user's guide (Reference 8).

Microsoft® Excel® was also used for calculation purposes outlined in Sections 5.2.3, 6.1, and 6.2. In accordance with the CNS QA Program (Reference 1), no computer code verification is required for Excel.

5. Inputs and Assumptions

5.1. Design Input

Table 5.1-1 summarizes the design input used to generate the input files for the PAVAN calculations. The actual input files for PAVAN are included in the *Input Files* folder on the enclosed CD. Specific inputs for the meteorological data (Card 9) of the PAVAN input file are indicated in Table 5.1-2. The meteorological data was obtained from the NMP Joint Frequency Distribution Report (JFD) (Reference 9) and appears in the *Revised NMP_60m_JFD_1997-2001 for CNS* file on the enclosed CD. Complete descriptions and proper formats of each data input is included in the PAVAN user's guide (Reference 8). No tables are provided for the following calculations:

- Unit 1 Turbine Building Blowout Panel
- Unit 2 Main Steam Tunnel
- Unit 2 Standby Gas Treatment System Building
- Unit 2 Sampling System Panel

The reason for the omission of these tables is explained in Section 5.2.4.

The design inputs required for calculating the off-site X/Qs using PAVAN were obtained from the following documents:

- Accident X/Q Values for Nine Mile Point Unit 1 Releases from the Main Stack and the Reactor and Turbine Buildings (Reference 10)

- Technical Support Document Nine Mile Point Unit 2 Accident and Long-Term Diffusion Estimates and the Methodology Used in their Calculation (Reference 11)
- NMP Drawing C-26658-C (Reference 12)
- NMP Joint Frequency Distribution Report (JFD) (Reference 9)
- NMP Unit 2 USAR Figures 2.3-43 through 2.3-46 (Reference 13)
- NMP Unit 2 USAR Section 2.3.4.4.2 (Reference 14)
- NMP Drawing C-18713-C (Reference 16)
- NMP Unit 2 USAR Figure 1.2-11 (Reference 17)

5.2. Assumptions

5.2.1. Release Point Distances to the EAB and LPZ

Due to the close proximity of the Unit 1 reactor building blowout panel with the turbine building blowout panel, identical distances to the EAB and LPZ were used for each of these release points.

Due to the close proximities of the Unit 2 combined radwaste and reactor building vent, the main steam tunnel, the standby gas treatment system building and the post accident sampling system panel, identical distances to the EAB and LPZ were used for each of these release points.

5.2.2. Building Wake Correction Factors

For the cases involving ground level releases, the smallest vertical-plane cross-sectional area of the corresponding reactor building, in m^2, was used in accordance with R.G. 1.145 (Reference 2). An area of 2,082 m^2 was used (References 10, 19 and 20) for the Unit 1 releases classified as ground level, and an area of 2844 m^2 was used (Reference 14) for the Unit 2 releases classified as ground level.

5.2.3. Site Topography

For both Units' main stack releases, distances of 3,000 m and 6,000 m were selected for input as distances with terrain data for each sector. Two distances were selected to provide sufficient description of how terrain height varies around the entire site. 6,000 m was selected since it represents roughly the entire distance from the stack releases to the LPZ. 3,000 m was selected since it represents roughly half of the distance from the stack releases to the LPZ. Terrain heights for all 16 sectors were provided in Reference 13 at various distances from the site. A straight-line slope was assumed to exist between the terrain height at the site and the terrain height at various distances from the site. The straight line slopes were used in Microsoft® Excel® to estimate the terrain heights at 3,000 m and 6,000 m. For any terrain height calculated as less than plant grade elevation, a terrain height of zero meters was assumed, since the height above plant grade level is called for in the PAVAN user's guide

(Reference 8). This entire terrain height calculation, and the associated files, are included in the *Terrain Height Estimates* file on the enclosed CD.

Since there are no severe terrain features such as deep valleys or mountains, in the vicinity of NMP, to affect the diffusion of radionuclides releases from the elevated main stacks, the default terrain adjustment factors (TAF=1) were applied.

5.2.4. Identical Data

For the reasons mentioned in Sections 5.2.1 and 5.2.2, several of the PAVAN input files, with the exception of file name, have the same input data and assumptions. For this reason, several of these files are omitted from Table 5.1-1. Input reference files identical to these omitted input files are provided in Table 5.2-1. Likewise, the output files for those mentioned in Table 5.2-1 are also assumed to be identical to their reference output files and are therefore not included in this report. These files, both input and output, are however contained in the respective *Input Files* or *Output Files* folders on the enclosed CD.

5.2.5. Maximum Category 12 Wind Speed

Since the NMP meteorological data (Reference 9) fails to provide a maximum wind speed for category 12 winds, a conservative value of 60.5 m/s was selected. Maximum wind speed is required input for each wind category in PAVAN.

5.2.6. NMP Unit 2 WSW Sector

The NMP Unit 2 WSW sector distance to the EAB may be considered as a land or coastal distance (Reference 11). This calculation uses land distances to the EAB from the Main Stack and Combined Radwaste/Reactor Building of 1,615 m and 1,381 m, respectively.

5.2.7. Coastal Sectors

The following sectors are regarded as coastal and are not considered (Reference 18):

- W
- WNW
- NW
- NNW
- N
- NNE
- NE
- ENE

Because PAVAN requires distance data for 16 sectors in order to calculate X/Q values, minimum land distances were substituted for coastal distances. The land distances substituted for the coastal sectors along with their reasoning are included in Table 5.1.

Table 5.1-1.a PAVAN Input for Unit 1 Main Stack Release

Card Type	Variable Name	Data Input		
1	KOPT(1-4, 6, 8)	0		
	KOPT(7,9-10)	1		
2	TITLD(1-5)	Nine Mile Point		
	TITLD(6-10)	1/01/97 to 12/31/01		
	TITLD(11-15)	Elevated 106.7 meters		
3	TITLD(16-20)	60.7 m		
	TITLD(21-25)	51.2 m		
4	TITLD(26-45)	NMP Joint Frequency Distribution Report (JFD)		
5	TITLD(46-65)	Nine Mile Point Unit 1 Main Stack to EAB/LPZ		
6	NVEL	12 categories		
	NDIS	2 distances		
7	A	0 m^2 (no input needed for stack releases)		
	D	0 m (no input needed for stack releases)		
	HS	106.7 m		
	TOWERH	60.7 m		
8	CALM(J)	0 (for all since KOPT(8)=0)		
9	FREQ(K,I,J)	See Table 5.1-2		
10	UCOR	-1		
	UMAX(I)	I=1: 0.44 m/s I=2: 1.0 m/s I=3: 2.0 m/s I=4: 3.0 m/s I=5: 4.0 m/s I=6: 5.0 m/s	I=7: 6.0 m/s I=8: 8.0 m/s I=9: 10.0 m/s I=10: 13.0 m/s I=11: 18.0 m/s I=12: 60.5 m/s	
11	BDY(K,I)	K	I=1 (m)	I=2 (m)
		S	2,000	6,116
		SSW	1,500	6,116
		SW	1,200	6,116
		WSW	830	6,116
		W[1]	830	6,116
		WNW[1]	830	6,116
		NW[1]	830	6,116
		NNW[1]	830	6,116
		N[1]	830	6,116
		NNE[1]	830	6,116
		NE[1]	830	6,116
		ENE[1]	830	6,116
		E	1,900	6,116
		ESE	1,900	6,116
		SE	2,300	6,116

Card Type	Variable Name	Data Input		
		SSE	2,000	6,116
12	TAF(K,I)	K	I=1	I=2
		All	1.0	1.0
13	DIST(K,I)	K	I=1	I=2
		All	3000 m	6000 m
14	HT(K,I)	K	I=1 (m)	I=2 (m)
		S	28	57
		SSW	19	39
		SW	19	39
		WSW	0	0
		W	0	0
		WNW	0	0
		NW	0	0
		NNW	0	0
		N	0	0
		NNE	0	0
		NE	1	3
		ENE	3	6
		E	14	28
		ESE	16	32
		SE	11	22
		SSE	14	27
1	Represents a coastal sector. The selected distance of 830 m represents the distance from the Unit 1 Main Stack to the EAB in the WSW sector. The WSW sector contains the minimum distance from the Unit 1 Main Stack to the EAB for all land sectors.			

Table 5.1-1.b PAVAN Input for Unit 1 Reactor Building Blowout Panel Release

Card Type	Variable Name	Data Input
1	KOPT(1-4, 6, 8-9)	0
	KOPT(7,10)	1
2	TITLD(1-5)	Nine Mile Point
	TITLD(6-10)	1/01/97 to 12/31/01
	TITLD(11-15)	Ground Level Release
3	TITLD(16-20)	60.7 m
	TITLD(21-25)	51.2 m
4	TITLD(26-45)	NMP Joint Frequency Distribution Report (JFD)
5	TITLD(46-65)	Nine Mile Point Unit 1 Reactor Building Blowout Panel to EAB/LPZ
6	NVEL	12 categories
	NDIS	0 distances
7	A	2082 m^2 (per Reference 19 and 20)
	D	42.2 m

Card Type	Variable Name	Data Input		
	HS	10 m		
	TOWERH	60.7 m		
8	CALM(J)	0 (for all since KOPT(8)=0)		
9	FREQ(K,I,J)	See Table 5.1-2		
10	UCOR	-1		
	UMAX(I)	I=1: 0.44 m/s I=2: 1.0 m/s I=3: 2.0 m/s I=4: 3.0 m/s I=5: 4.0 m/s I=6: 5.0 m/s		I=7: 6.0 m/s I=8: 8.0 m/s I=9: 10.0 m/s I=10: 13.0 m/s I=11: 18.0 m/s I=12: 60.5 m/s
11	BDY(K,I)	K	I=1 (meters)	I=2 (meters)
		S	2,000	6,116
		SSW	1,500	6,116
		SW	1,200	6,116
		WSW	830	6,116
		W[1]	830	6,116
		WNW[1]	830	6,116
		NW[1]	830	6,116
		NNW[1]	830	6,116
		N[1]	830	6,116
		NNE[1]	830	6,116
		NE[1]	830	6,116
		ENE[1]	830	6,116
		E	1,900	6,116
		ESE	1,900	6,116
		SE	2,300	6,116
		SSE	2,000	6,116
12	TAF(K,I)	No input required (KOPT(9)=0)		
13	DIST(K,I)	No input required (ground level release)		
14	HT(K,I)	No input required (ground level release)		

1 Represents a coastal sector. The selected distance of 830 m represents the distance from the Unit 1 Reactor Building Blowout Panel to the EAB in the WSW sector. The WSW sector contains the minimum distance from the Unit 1 Reactor Building Blowout Panel to the EAB for all land sectors.

Table 5.1-1.c PAVAN Input for Unit 2 Main Stack Release

Card Type	Variable Name	Data Input
1	KOPT(1-4, 6,8)	0
	KOPT(7,9-10)	1
2	TITLD(1-5)	Nine Mile Point
	TITLD(6-10)	1/01/97 to 12/31/01
	TITLD(11-15)	Elevated 130.8 meters
3	TITLD(16-20)	60.7 m
	TITLD(21-25)	51.2 m
4	TITLD(26-45)	NMP Joint Frequency Distribution Report (JFD)
5	TITLD(46-65)	Nine Mile Point Unit 2 Main Stack to EAB/LPZ
6	NVEL	12 categories

Card Type	Variable Name	Data Input		
	NDIS	2 distances		
7	A	0 m^2 (no input needed for stack releases)		
	D	0 m (no input needed for stack releases)		
	HS	130.8 m		
	TOWERH	60.7 m		
8	CALM(J)	0 (for all since KOPT(8)=0)		
9	FREQ(K,I,J)	See Table 5.1-2		
10	UCOR	-1		
	UMAX(I)	I=1: 0.44 m/s I=2: 1.0 m/s I=3: 2.0 m/s I=4: 3.0 m/s I=5: 4.0 m/s I=6: 5.0 m/s	I=7: 6.0 m/s I=8: 8.0 m/s I=9: 10.0 m/s I=10: 13.0 m/s I=11: 18.0 m/s I=12: 60.5 m/s	
11	BDY(K,I)	K	I=1 (m)	I=2 (m)
		S	2,256	6,116
		SSW	1,936	6,116
		SW	1,615	6,116
		WSW	1,615	6,116
		W[1]	1,555	6,116
		WNW[1]	1,555	6,116
		NW[1]	1,555	6,116
		NNW[1]	1,555	6,116
		N[1]	1,555	6,116
		NNE[1]	1,555	6,116
		NE[1]	1,555	6,116
		ENE[1]	1,555	6,116
		E	1,555	6,116
		ESE	1,555	6,116
		SE	1,600	6,116
		SSE	2,134	6,116
12	TAF(K,I)	K	I=1	I=2
		All	1.0	1.0
13	DIST(K,I)	K	I=1	I=2
		All	3000 m	6000 m
14	HT(K,I)	K	I=1 (m)	I=2 (m)
		S	28	57
		SSW	19	39
		SW	19	39
		WSW	0	0
		W	0	0
		WNW	0	0
		NW	0	0
		NNW	0	0
		N	0	0
		NNE	0	0
		NE	1	3
		ENE	3	6
		E	14	28
		ESE	16	32

Card Type	Variable Name	Data Input		
		SE	11	22
		SSE	14	27
1	Represents a coastal sector. The selected distance of 1,555 m represents the distance from the Unit 2 Main Stack to the EAB in the E and ESE sectors. The E and ESE sectors contain the minimum distance from the Unit 2 Main Stack to the EAB for all land sectors.			

Table 5.1-1.d PAVAN Input for Unit 2 Combined Radwaste and Reactor Building Vent Release

Card Type	Variable Name	Data Input		
1	KOPT(1-4, 6, 8-9)	0		
	KOPT(7,10)	1		
2	TITLD(1-5)	Nine Mile Point		
	TITLD(6-10)	1/01/97 to 12/31/01		
	TITLD(11-15)	Ground Level Release		
3	TITLD(16-20)	60.7 m		
	TITLD(21-25)	51.2 m		
4	TITLD(26-45)	NMP Joint Frequency Distribution Report (JFD)		
5	TITLD(46-65)	Nine Mile Point Unit 2 Combined Radwase/Reactor Building Vent to EAB/LPZ		
6	NVEL	12 categories		
	NDIS	0 distances		
7	A	2844 m^2		
	D	51.9 m		
	HS	10 m		
	TOWERH	60.7 m		
8	CALM(J)	0 (for all since KOPT(8)=0)		
9	FREQ(K,I,J)	See Table 5-2		
10	UCOR	-1		
	UMAX(I)	I=1: 0.44 m/s I=2: 1.0 m/s I=3: 2.0 m/s I=4: 3.0 m/s I=5: 4.0 m/s I=6: 5.0 m/s	I=7: 6.0 m/s I=8: 8.0 m/s I=9: 10.0 m/s I=10: 13.0 m/s I=11: 18.0 m/s I=12: 60.5 m/s	
11	BDY(K,I)	K	I=1 (meters)	I=2 (meters)
		S	1,945	6,116
		SSW	1,695	6,116
		SW	1,381	6,116
		WSW	1,381	6,116
		W[1]	1,381	6,116
		WNW[1]	1,381	6,116
		NW[1]	1,381	6,116
		NNW[1]	1,381	6,116
		N[1]	1,381	6,116
		NNE[1]	1,381	6,116
		NE[1]	1,381	6,116
		ENE[1]	1,381	6,116

Card Type	Variable Name	Data Input		
		E	1,686	6,116
		ESE	1,686	6,116
		SE	1,743	6,116
		SSE	2,094	6,116
12	TAF(K,I)	No input required (KOPT(9)=0)		
13	DIST(K,I)	No input required (ground level release)		
14	HT(K,I)	No input required (ground level release)		
1	Represents a coastal sector. The selected distance of 1,381 m represents the distance from the Unit 2 Combined Radwaste/Reactor Building Vent to the EAB in the SW and WSW sectors. The SW and WSW sectors contain the minimum distance from the Unit 2 Combined Radwaste/Reactor Building Vent to the EAB for all land sectors.			

Table 5.1-2 Card 9 Input

	K=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
J=1	I=1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I=2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
	I=3	7	1	2	0	0	0	2	0	0	3	2	0	4	7	10	25
	I=4	44	18	3	1	1	1	1	3	3	0	1	1	7	33	63	64
	I=5	45	42	14	0	2	6	4	3	6	0	0	10	9	34	64	65
	I=6	43	40	5	0	0	8	16	12	7	3	1	46	18	29	53	53
	I=7	45	28	3	0	0	5	17	11	8	2	1	91	25	19	37	44
	I=8	108	70	5	1	1	5	24	26	3	4	0	172	35	36	71	87
	I=9	85	45	2	0	0	1	19	10	3	0	0	71	21	29	73	80
	I=10	91	48	2	0	0	1	9	5	0	0	0	19	46	69	147	121
	I=11	24	21	0	0	0	0	3	1	0	0	0	36	44	141	95	31
	I=12	7	0	0	0	0	0	0	0	0	0	0	3	16	34	9	0
J=2	I=1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I=2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	I=3	6	4	0	1	1	1	0	1	2	3	1	0	3	1	5	6
	I=4	11	15	11	1	1	2	5	4	1	5	1	4	5	21	11	5
	I=5	17	19	7	3	0	6	8	17	13	4	0	9	23	24	6	9
	I=6	14	16	10	0	1	6	12	15	16	5	2	27	30	26	14	12
	I=7	17	11	1	0	1	7	21	18	10	3	0	36	25	11	27	20
	I=8	56	37	6	1	0	3	21	19	10	0	4	58	44	36	82	50
	I=9	57	45	0	0	0	3	8	6	9	0	1	38	58	36	65	71
	I=10	39	35	0	0	0	0	2	1	3	0	0	33	62	84	95	51
	I=11	15	13	0	0	0	0	0	0	0	0	0	39	83	83	30	9
	I=12	0	0	0	0	0	0	0	0	0	0	0	5	16	5	0	0
J=3	I=1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	I=2	1	0	0	0	0	0	1	0	1	0	0	0	0	3	1	0
	I=3	10	2	1	2	3	2	1	1	2	0	3	3	3	4	11	6
	I=4	10	22	20	2	3	4	8	4	4	8	2	5	20	17	22	13

K=		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	I=5	18	22	15	7	0	19	17	27	22	7	3	16	42	26	11	9
	I=6	11	25	7	0	0	6	16	25	32	8	0	25	47	32	14	15
	I=7	26	17	4	0	1	7	30	27	36	6	3	33	63	21	43	27
	I=8	84	71	12	0	1	7	29	27	21	2	3	69	86	58	84	45
	I=9	54	53	6	0	0	1	21	9	17	3	0	26	80	73	85	57
	I=10	38	57	6	0	0	0	20	5	2	0	5	59	130	84	62	55
	I=11	20	18	0	0	0	0	1	0	0	0	1	62	98	95	19	1
	I=12	0	1	0	0	0	0	0	0	0	0	0	9	12	5	1	0
	I=1	0	1	0	0	1	1	1	1	1	1	2	0	1	0	2	0
	I=2	4	7	9	8	4	4	5	2	6	4	3	6	7	2	6	5
	I=3	36	49	61	44	45	33	25	35	15	24	23	18	33	51	50	40
	I=4	84	101	129	73	51	83	81	63	61	62	38	61	117	82	73	60
	I=5	65	105	181	67	66	97	134	129	132	108	58	99	178	94	70	50
J=4	I=6	94	108	189	37	51	100	185	143	199	172	92	160	181	104	81	87
	I=7	104	134	137	18	45	153	289	175	216	198	144	219	178	131	127	106
	I=8	170	356	185	12	29	179	587	332	412	276	229	443	394	300	231	188
	I=9	100	234	79	1	3	79	303	191	179	40	140	298	376	232	204	119
	I=10	98	161	29	0	1	14	125	67	45	10	49	286	387	251	117	62
	I=11	33	40	1	0	0	2	11	10	3	0	2	195	289	139	23	14
	I=12	0	0	0	0	0	0	0	0	0	0	0	20	24	12	0	0
	I=1	0	0	0	0	1	2	1	2	0	1	1	0	0	0	0	2
	I=2	8	7	6	8	7	8	5	2	5	5	6	8	3	3	11	5
	I=3	27	23	52	34	32	25	16	27	16	20	31	45	29	31	13	20
	I=4	35	42	73	92	57	49	33	46	41	37	51	58	95	56	41	39
	I=5	27	31	93	71	71	63	74	83	52	48	60	102	98	38	29	15
J=5	I=6	21	33	37	28	38	73	116	104	106	108	97	212	102	37	12	18
	I=7	16	23	24	10	16	76	246	170	213	216	139	183	84	22	12	20
	I=8	36	29	17	4	15	67	630	605	614	404	213	349	136	52	30	19
	I=9	24	18	6	0	0	11	235	320	245	58	62	236	105	54	21	11
	I=10	18	23	5	0	1	2	44	62	24	1	7	175	106	54	7	12
	I=11	2	6	0	0	0	1	5	1	0	0	2	56	56	20	5	1
	I=12	0	0	0	0	0	0	0	0	0	0	0	5	4	2	0	0
J=6	I=1	1	0	0	0	1	1	0	0	2	1	0	1	0	2	0	0
	I=2	4	2	4	9	6	3	0	4	2	3	9	4	2	2	1	5
	I=3	13	15	22	26	21	12	16	13	14	14	25	28	21	24	25	12
	I=4	17	19	40	41	30	32	21	18	17	17	30	40	44	34	10	15
	I=5	8	13	17	23	51	21	26	27	18	23	58	80	38	21	12	9
	I=6	9	10	6	16	22	25	36	39	33	31	70	71	39	9	8	11
	I=7	9	11	4	2	18	45	39	52	30	42	85	53	18	3	2	7
	I=8	13	7	5	0	8	24	109	187	158	138	93	50	24	15	3	6
	I=9	8	7	2	0	0	0	8	25	25	17	1	20	26	9	8	9
	I=10	10	4	0	0	0	0	0	0	0	0	0	17	28	7	5	2

K=		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	I=11	0	0	0	0	0	0	0	0	0	0	0	11	5	1	0	0
	I=12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
J=7	I=1	1	1	0	0	3	1	0	4	1	1	1	0	1	1	0	1
	I=2	7	7	8	10	12	6	8	8	14	5	5	7	14	11	7	4
	I=3	21	25	27	33	32	36	23	25	31	28	46	44	33	34	13	26
	I=4	14	15	36	30	49	38	25	27	31	42	58	62	40	21	12	12
	I=5	8	10	3	16	37	30	29	41	26	46	86	81	17	7	3	5
	I=6	5	2	0	3	21	33	35	34	40	52	80	54	12	0	1	3
	I=7	1	4	2	2	7	28	29	54	45	47	63	18	5	1	1	2
	I=8	10	10	1	0	4	19	36	95	90	45	21	14	4	1	3	7
	I=9	14	5	1	0	0	0	3	2	2	0	0	3	7	1	4	8
	I=10	8	9	0	0	0	0	0	0	0	0	0	7	8	1	3	6
	I=11	2	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0
	I=12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

I = Wind Speed Category, J = Stability Category, K = wind Direction

Table 5.2-1 Input References for Similar PAVAN Input Files

PAVAN Input File	Similar PAVAN Input File
Unit 1 Turbine Building Blowout Panel	Unit 1 Reactor Building Blowout Panel
Unit 2 Main Steam Tunnel	Unit 2 Combined Radwaste and Reactor Building Vent
Unit 2 Standby Gas Treatment System Building	Unit 2 Combined Radwaste and Reactor Building Vent
Unit 2 Sampling System Panel	Unit 2 Combined Radwaste and Reactor Building Vent

6. Calculation and Results

6.1. Determination of Distances for Calculations

For stack releases, the maximum ground-level X/Q in a sector may occur at a distance beyond the EAB and LPZ. R.G. 1.145 (Reference 2) recommends making X/Q calculations for each sector at each minimum boundary distance and at various distances beyond the EAB to determine where the maximum concentrations occur. Test cases in PAVAN were performed at both Units for the following distances (in meters):

100	250	500	510	525
535	550	600	650	700
750	850	1000	1250	1500
1750	2000	2500	3000	3500
4500	5000	5500	6000	6500
7000	8000	9000		

Figures 6.1-1 and 6.1-2 show the results of the test cases. For both Units, it was determined that the maximum X/Q values occur at the EAB and LPZ boundaries. All input files, output

files and other files related to the test cases are included in the *Maximum Stack XQ Distances* folder on the enclosed CD.

6.2. ENVLOP Programming Error

As mentioned in the CNS PAVAN Computer Code Verification (Reference 15), the PAVAN ENVLOP subroutine has a programming error or "bug." As a result, 0.5% X/Qs for non-coastal sectors were visually checked in each PAVAN output file. Twenty-eight cases were hand-checked where the 0.5% X/Q was not bounded or near neighboring points. These cases included:

- Unit 1 Main Stack to EAB – SSW Sector
- Unit 1 Main Stack to EAB – E Sector
- Unit 1 Main Stack to EAB – ESE Sector
- Unit 1 Main Stack to EAB – SE Sector
- Unit 1 Main Stack to LPZ – SW Sector
- Unit 1 Main Stack to LPZ – WSW Sector
- Unit 1 Main Stack to LPZ – E Sector
- Unit 1 Main Stack to LPZ – ESE Sector
- Unit 1 Reactor Building Blowout Panel to EAB – SW Sector
- Unit 1 Reactor Building Blowout Panel to EAB – WSW Sector
- Unit 1 Reactor Building Blowout Panel to EAB – E Sector
- Unit 1 Reactor Building Blowout Panel to LPZ – SSW Sector
- Unit 1 Reactor Building Blowout Panel to LPZ – SW Sector
- Unit 1 Reactor Building Blowout Panel to LPZ – SE Sector
- Unit 1 Reactor Building Blowout Panel to LPZ – SSE Sector
- Unit 2 Main Stack to LPZ – S Sector
- Unit 2 Main Stack to LPZ – SW Sector
- Unit 2 Main Stack to LPZ – WSW Sector
- Unit 2 Main Stack to LPZ – ESE Sector
- Unit 2 Main Stack to LPZ – SE Sector
- Unit 2 Main Stack to LPZ – SSE Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to EAB – SW Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to EAB – WSW Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to EAB – SSE Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to LPZ – SSW Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to LPZ – SW Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to LPZ – SE Sector
- Unit 2 Combined Radwaste/Reactor Building Vent to LPZ – SSE Sector

As a result, the X/Q values which were equaled or exceeded 0.5% of the time for these runs and sectors were manually verified in Microsoft® Excel®, based on the upper envelope of the ordered X/Q frequency values extracted from the PAVAN output files. These values represent

the 0 – 2 hour X/Qs for the sector. It was determined that all the 0.5% X/Q values were calculated correctly by PAVAN, and are therefore valid. Hence, the PAVAN output values were extracted and required no additional processing. These calculations are included in the 0.5% *Sector Dependent Calculations* folder on the attached disc.

6.3. ENVLOP Error

According to the PAVAN user's guide (Reference 8), an error occurs in the ENVLOP subroutine when the total number of values in the arrays X and Y used in obtaining upper-enveloping lines exceeds 98. This number overflows arrays X and Y. As a result of this error, the overall site X/Q value which is equaled or exceeded 5.0% of the time was not obtained in six of the PAVAN calculation runs. The six runs included:

- Unit 1 Main Stack to EAB
- Unit 1 Main Stack to LPZ
- Unit 1 Reactor Building Blowout Panel to EAB
- Unit 2 Main Stack to EAB
- Unit 2 Main Stack to LPZ
- Unit 2 Combined Radwaste and Reactor Building Vent to EAB

As a result, the overall site X/Q values which were equaled or exceeded 5.0% of the time for these runs were manually calculated in Microsoft® Excel®, based on the upper envelope of the ordered X/Q frequency values extracted from the PAVAN output files. These values represent the 0 – 2 hour overall site X/Qs. In addition, the intermediate time-period overall site X/Qs were manually calculated using the PAVAN algorithm coded into Excel® spreadsheet form. Intermediate time points of 8, 16, 72 and 624 were utilized in this spreadsheet algorithm, which is replicated from the PAVAN algorithm. These manual calculations were performed using the methodology as described in R.G. 1.145 (Reference 2) and the PAVAN user's guide (Reference 8). These calculations are included in the *5% Site Limit Calculations* folder on the enclosed CD.

6.4. Results

Results of PAVAN calculations are included in Tables 6.4-1 through 6.4-5. The actual PAVAN output files are included in the *Output Files* folder on the enclosed CD. Table 6.4-1 lists the 0.5% sector dependent 0 – 2 hour (non-fumigation) X/Qs along with the fumigation X/Qs calculated with PAVAN for stack releases for non-coastal sectors. Tables 6.4-2 through 6.4-5 lists both the sector dependent and overall site limit X/Qs for non-coastal sectors.

Figure 6.1-1 Unit 1 Main Stack X/Q Versus Distance

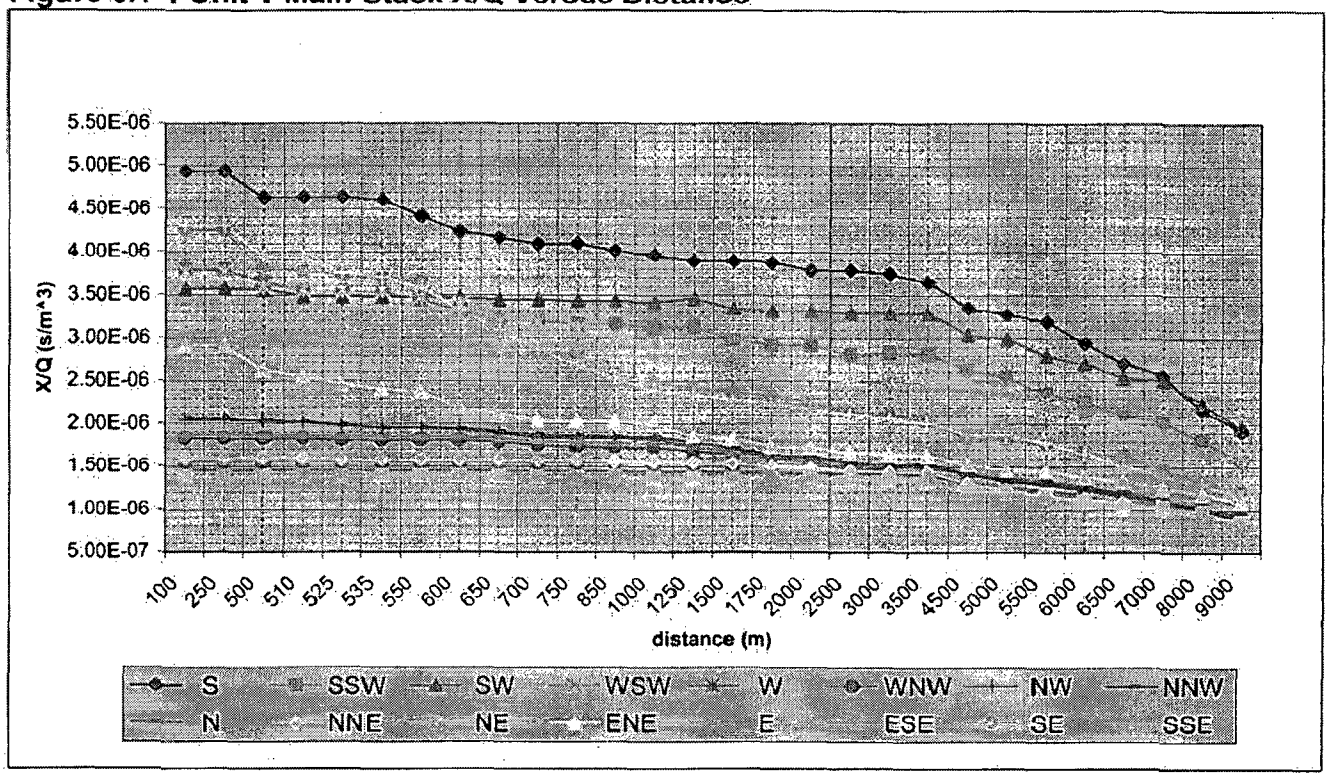


Figure 6.1-2 Unit 2 Main Stack X/Q Versus Distance

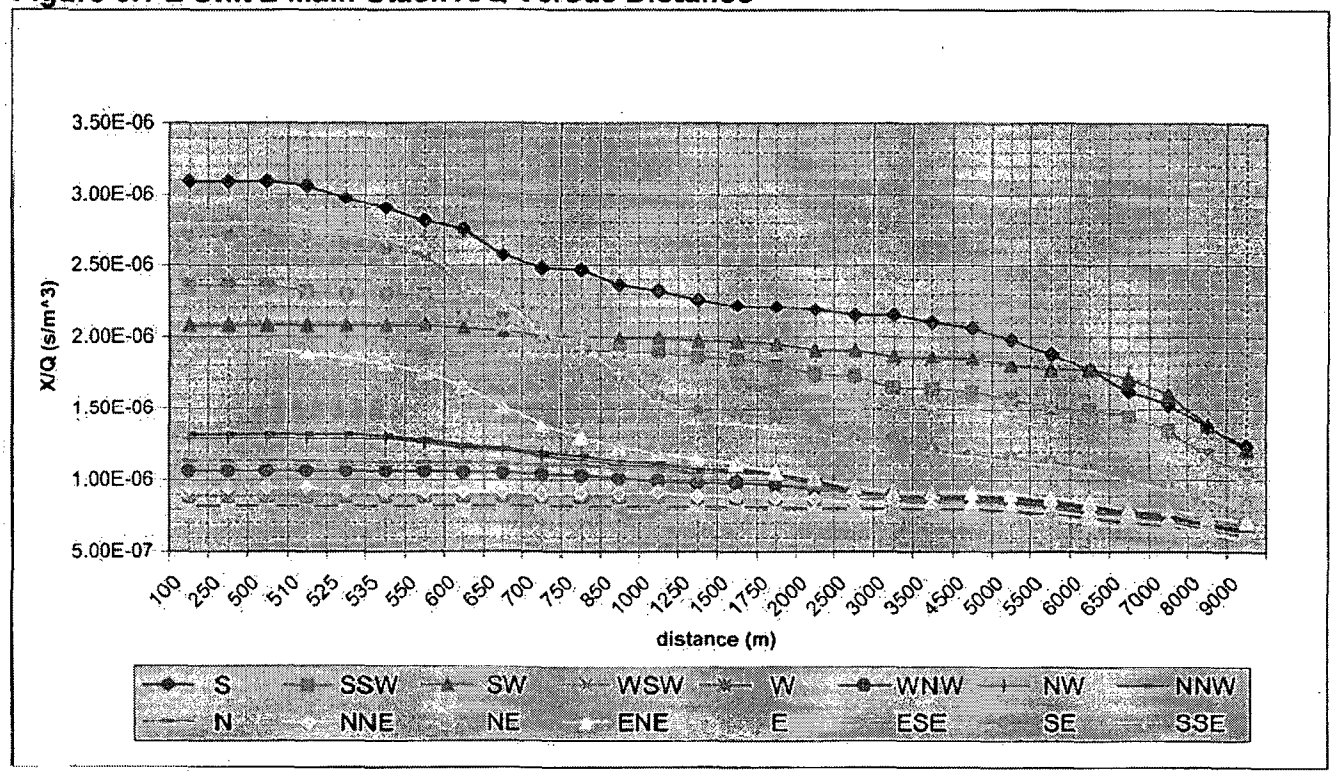


Table 6.4-1 Nine Mile Point 0.5% Sector Dependent Short-Term X/Qs Calculated with PAVAN

Source	Sector	Non-Fumigation 0-2 Hour EAB X/Q (sec/m^3)	Fumigation EAB X/Q (sec/m^3)	Non-Fumigation 0-2 Hour LPZ X/Q (sec/m^3)	Fumigation LPZ X/Q (sec/m^3)
Unit 1 Main Stack	S	3.78E-06	3.28E-05	2.87E-06	2.12E-05
	SSW	2.98E-06[1]	3.85E-05	2.22E-06	1.55E-05
	SW	3.46E-06	4.62E-05	2.66E-06[1]	1.55E-05
	WSW	1.55E-06	5.98E-05	1.25E-06[1]	9.85E-06
	E	2.57E-06[1]	3.09E-05	2.05E-06[1]	1.34E-05
	ESE	2.60E-06[1]	3.13E-05	2.06E-06[1]	1.41E-05
	SE	2.21E-06[1]	2.59E-05	1.67E-06	1.24E-05
	SSE	2.18E-06	2.96E-05	1.61E-06	1.32E-05
Unit 2 Main Stack	S	2.19E-06	2.36E-05	1.73E-06[1]	1.42E-05
	SSW	1.79E-06	2.51E-05	1.49E-06	1.15E-05
	SW	1.97E-06	2.90E-05	1.75E-06[1]	1.15E-05
	WSW	8.82E-07	2.68E-05	7.80E-07[1]	8.04E-06
	E	1.64E-06	2.93E-05	1.43E-06	1.02E-05
	ESE	1.69E-06	2.96E-05	1.28E-06[1]	1.06E-05
	SE	1.44E-06	2.83E-05	1.06E-06[1]	9.66E-06
	SSE	1.31E-06	2.25E-05	1.04E-06[1]	1.01E-05

1 Value manually verified in accordance with Section 6.2.

Table 6.4-2 Unit 1 Main Stack Non-Fumigation X/Q Values

Distance	Sector	X/Q (sec/m^3)					
		0-2 Hours	0-8 Hours	8-24 Hours	1-4 Days	4-30 Days	Annual Average
EAB	S	3.78E-06	1.68E-06	1.12E-06	4.65E-07	1.31E-07	2.80E-08
	SSW[1]	2.98E-06	1.36E-06	9.21E-07	3.94E-07	1.16E-07	2.62E-08
	SW	3.46E-06	1.35E-06	8.40E-07	3.02E-07	6.93E-08	1.15E-08
	WSW	1.55E-06	4.75E-07	2.63E-07	7.30E-08	1.16E-08	1.22E-09
	E[1]	2.57E-06	1.29E-06	9.10E-07	4.30E-07	1.46E-07	3.92E-08
	ESE[1]	2.60E-06	1.24E-06	8.62E-07	3.88E-07	1.23E-07	3.03E-08
	SE[1]	2.21E-06	1.06E-06	7.36E-07	3.32E-07	1.06E-07	2.61E-08
	SSE	2.18E-06	1.01E-06	6.89E-07	2.99E-07	9.02E-08	2.08E-08
	Overall Site[2]	2.61E-06	1.30E-06	9.22E-07	4.34E-07	1.47E-07	3.92E-08
LPZ	S	2.87E-06	1.26E-06	8.40E-07	3.45E-07	9.62E-08	2.02E-08
	SSW	2.22E-06	1.03E-06	6.96E-07	3.01E-07	9.01E-08	2.06E-08
	SW[1]	2.66E-06	1.21E-06	8.13E-07	3.45E-07	1.01E-07	2.24E-08
	WSW[1]	1.25E-06	5.22E-07	3.38E-07	1.31E-07	3.37E-08	6.41E-09
	E[1]	2.05E-06	1.01E-06	7.12E-07	3.32E-07	1.11E-07	2.89E-08
	ESE[1]	2.06E-06	9.59E-07	6.54E-07	2.85E-07	8.66E-08	2.01E-08
	SE	1.67E-06	7.68E-07	5.20E-07	2.23E-07	6.63E-08	1.50E-08
	SSE	1.61E-06	7.25E-07	4.86E-07	2.04E-07	5.88E-08	1.28E-08
	Overall Site[2]	1.90E-06	9.53E-07	6.74E-07	3.18E-07	1.08E-07	2.89E-08

1 With the exception of Annual Average, all values were verified in accordance with Section 6.2.
2 With the exception of Annual Average, all values were calculated in accordance with Section 6.3.

Table 6.4-3 Unit 1 Reactor Building Blowout Panel X/Q Values

Distance	Sector	X/Q (sec/m^3)					
		0-2 Hours	0-8 Hours	8-24 Hours	1-4 Days	4-30 Days	Annual Average
EAB	S	4.59E-05	2.48E-05	1.83E-05	9.39E-06	3.61E-06	1.12E-06
	SSW	6.34E-05	3.72E-05	2.84E-05	1.59E-05	6.93E-06	2.50E-06
	SW[1]	1.02E-04	6.21E-05	4.84E-05	2.81E-05	1.29E-05	4.99E-06
	WSW[1]	1.58E-04	9.48E-05	7.35E-05	4.24E-05	1.92E-05	7.29E-06
	E[1]	7.42E-05	4.26E-05	3.22E-05	1.76E-05	7.43E-06	2.58E-06
	ESE	5.44E-05	3.08E-05	2.32E-05	1.25E-05	5.14E-06	1.73E-06
	SE	2.97E-05	1.62E-05	1.20E-05	6.21E-06	2.41E-06	7.60E-07
	SSE	4.11E-05	2.23E-05	1.64E-05	8.43E-06	3.24E-06	1.01E-06
	Overall Site[2]	1.90E-04	1.28E-04	1.05E-04	6.80E-05	3.67E-05	1.72E-05
LPZ	S	1.31E-05	5.96E-06	4.03E-06	1.72E-06	5.05E-07	1.13E-07
	SSW[1]	1.33E-05	6.17E-06	4.20E-06	1.82E-06	5.51E-07	1.27E-07
	SW[1]	1.81E-05	8.19E-06	5.52E-06	2.34E-06	6.82E-07	1.51E-07

Distance	Sector	X/Q (sec/m^3)					
		0-2 Hours	0-8 Hours	8-24 Hours	1-4 Days	4-30 Days	Annual Average
	WSW	2.07E-05	8.99E-06	5.93E-06	2.40E-06	6.57E-07	1.34E-07
	E	2.31E-05	1.08E-05	7.35E-06	3.21E-06	9.80E-07	2.29E-07
	ESE	1.59E-05	7.40E-06	5.05E-06	2.20E-06	6.68E-07	1.55E-07
	SE[1]	9.24E-06	4.38E-06	3.01E-06	1.34E-06	4.19E-07	1.01E-07
	SSE[1]	1.10E-05	5.09E-06	3.45E-06	1.49E-06	4.46E-07	1.02E-07
	Overall Site	3.58E-05	1.63E-05	1.10E-05	4.67E-06	1.37E-06	3.04E-07

1 With the exception of Annual Average, all values were verified in accordance with Section 6.2.
2 With the exception of Annual Average, all values were calculated in accordance with Section 6.3.

Table 6.4-4 Unit 2 Main Stack Non- Fumigation X/Q Values

Distance	Sector	X/Q (sec/m^3)					
		0-2 Hours	0-8 Hours	8-24 Hours	1-4 Days	4-30 Days	Annual Average
EAB	S	2.19E-06	9.70E-07	6.45E-07	2.67E-07	7.49E-08	1.59E-08
	SSW	1.79E-06	8.10E-07	5.46E-07	2.31E-07	6.75E-08	1.50E-08
	SW	1.97E-06	7.71E-07	4.83E-07	1.75E-07	4.06E-08	6.80E-09
	WSW	8.82E-07	3.01E-07	1.76E-07	5.50E-08	1.03E-08	1.33E-09
	E	1.64E-06	7.81E-07	5.40E-07	2.42E-07	7.64E-08	1.87E-08
	ESE	1.69E-06	7.84E-07	5.34E-07	2.32E-07	7.02E-08	1.63E-08
	SE	1.44E-06	6.86E-07	4.73E-07	2.11E-07	6.65E-08	1.62E-08
	SSE	1.31E-06	6.05E-07	4.11E-07	1.77E-07	5.29E-08	1.21E-08
	Overall Site[2]	1.56E-06	7.53E-07	5.22E-07	2.36E-07	7.54E-08	1.87E-08
LPZ	S[1]	1.73E-06	7.79E-07	5.22E-07	2.20E-07	6.33E-08	1.38E-08
	SSW	1.49E-06	6.94E-07	4.75E-07	2.08E-07	6.35E-08	1.49E-08
	SW[1]	1.75E-06	8.01E-07	5.41E-07	2.31E-07	6.82E-08	1.53E-08
	WSW[1]	7.80E-07	3.25E-07	2.09E-07	8.09E-08	2.06E-08	3.88E-09
	E	1.43E-06	7.05E-07	4.95E-07	2.30E-07	7.65E-08	1.99E-08
	ESE[1]	1.28E-06	6.08E-07	4.19E-07	1.87E-07	5.85E-08	1.41E-08
	SE[1]	1.06E-06	4.98E-07	3.41E-07	1.50E-07	4.62E-08	1.09E-08
	SSE[1]	1.04E-06	4.76E-07	3.22E-07	1.37E-07	4.06E-08	9.13E-09
	Overall Site[2]	1.20E-06	6.10E-07	4.34E-07	2.08E-07	7.24E-08	1.99E-08

1 With the exception of Annual Average, all values were verified in accordance with Section 6.2.
2 With the exception of Annual Average, all values were calculated in accordance with Section 6.3.

Table 6.4-5 Unit 2 Combined Radwaste/Reactor Building Vent X/Q Values

Distance	Sector	X/Q (sec/m^3)					
		0-2 Hours	0-8 Hours	8-24 Hours	1-4 Days	4-30 Days	Annual Average
EAB	S	4.65E-05	2.51E-05	1.85E-05	9.46E-06	3.62E-06	1.12E-06
	SSW	5.47E-05	3.10E-05	2.34E-05	1.27E-05	5.25E-06	1.79E-06
	SW[1]	8.75E-05	5.12E-05	3.91E-05	2.18E-05	9.46E-06	3.40E-06
	WSW[1]	9.14E-05	5.13E-05	3.85E-05	2.06E-05	8.38E-06	2.79E-06
	E	8.00E-05	4.70E-05	3.60E-05	2.03E-05	8.85E-06	3.22E-06
	ESE	6.22E-05	3.57E-05	2.70E-05	1.48E-05	6.23E-06	2.16E-06
	SE	4.07E-05	2.32E-05	1.75E-05	9.54E-06	3.98E-06	1.36E-06
	SSE[1]	3.85E-05	2.05E-05	1.50E-05	7.56E-06	2.84E-06	8.54E-07
	Overall Site[2]	1.19E-04	7.37E-05	5.80E-05	3.45E-05	1.64E-05	6.56E-06
LPZ	S	1.30E-05	5.90E-06	3.98E-06	1.69E-06	4.92E-07	1.09E-07
	SSW[1]	1.32E-05	6.11E-06	4.15E-06	1.79E-06	5.37E-07	1.23E-07
	SW[1]	1.81E-05	8.15E-06	5.47E-06	2.30E-06	6.66E-07	1.46E-07
	WSW	2.07E-05	8.92E-06	5.86E-06	2.36E-06	6.37E-07	1.29E-07
	E	2.31E-05	1.07E-05	7.28E-06	3.16E-06	9.56E-07	2.21E-07
	ESE	1.58E-05	7.32E-06	4.98E-06	2.16E-06	6.50E-07	1.50E-07
	SE[1]	9.24E-06	4.36E-06	2.99E-06	1.32E-06	4.11E-07	9.80E-08
	SSE[1]	1.10E-05	5.06E-06	3.42E-06	1.47E-06	4.35E-07	9.83E-08
	Overall Site	3.58E-05	1.62E-05	1.09E-05	4.59E-06	1.33E-06	2.93E-07

1 With the exception of Annual Average, all values were verified in accordance with Section 6.2.
2 With the exception of Annual Average, all values were calculated in accordance with Section 6.3.

7. Conclusions

Tables 7-1 and 7-2 provide conservative atmospheric dispersion coefficients (X/Qs) to be used to perform calculations to assess radiation exposure at the EAB and LPZ due to postulated accidents occurring at NMP Unit 1 and Unit 2. Ground-level releases include releases from the Unit 1 Reactor Building Blowout Panel, Unit 1 Turbine Building Blowout Panel, Unit 2 Combined Radwaste/Reactor Building Vent, Unit 2 Main Steam Tunnel, Unit 2 Standby Gas Treatment System Building and Unit 2 Post Accident Sampling System Panel. Elevated releases include releases from the Unit 1 Main Stack and Unit 2 Main Stack.

For the EAB, 0 – 2 hour X/Qs selected for EAB evaluation are assumed to last for the duration of the accident. X/Q values selected for evaluation at the LPZ represent the maximum of sector dependent and overall site X/Qs for each time interval. Fumigation X/Qs are considered for elevated releases only and are conservatively assumed to exist for 0 – 8 hours at the LPZ. All X/Qs selected for evaluation are consistent with the guidelines presented in R.G. 1.145 (Reference 2).

Table 7-1 Ground-Level Release X/Qs Selected for Evaluation at NMP

Unit	Boundary	X/Q (sec/m^3)				
		0 – 2 Hours	0 – 8 Hours	8 – 24 Hours	1 – 4 Days	4 – 30 Days
1	EAB[1]	1.90E-04[3]				
	LPZ[2]		1.63E-05[3]	1.10E-05[3]	4.67E-06[3]	1.37E-06[3]
2	EAB[1]	1.19E-04[3]				
	LPZ[2]		1.62E-05[3]	1.09E-05[3]	4.59E-06[3]	1.33E-06[3]

1 0-2 Hour X/Qs at the EAB are conservatively assumed to exist for the duration of the accident.
2 X/Q values for each time interval at the LPZ represent the maximum of the sector dependent and overall site values.
3 Overall Site X/Q Value.

Table 7-2 Elevated Release X/Q Selected for Evaluation at NMP

Unit	Boundary	X/Q (sec/m^3)				
		0 – 2 Hours	0 – 8 Hours	8 – 24 Hours	1 – 4 Days	4 – 30 Days
1	EAB[1]	5.98E-05[3]				
	LPZ[2]		2.12E-05[5]	8.40E-07[6]	3.45E-07[6]	1.11E-07[8]
2	EAB[1]	2.96E-05[4]				
	LPZ[2]		1.42E-05[5]	5.41E-07[7]	2.31E-07[7]	7.65E-08[8]

1 0-2 Hour X/Qs at the EAB are conservatively assumed to exist for the duration of the accident.
2 X/Q values for each time interval at the LPZ represent the maximum of the sector dependent and overall site values. Short-term fumigation X/Qs are conservatively assumed to exist for the first 8 hours of the accident.
3 WSW sector short-term fumigation value.
4 ESE sector short-term fumigation value.
5 S sector short-term fumigation value.
6 S sector X/Q value.
7 SW sector X/Q value.
8 E sector X/Q value.

8. References

1. CNS Quality Assurance Program, Rev. 4, December 1, 2002.
2. Regulatory Guide 1.145, Rev. 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants", February 1983.
3. Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", July 1977.
4. NMP Purchase Order No. 02-40502, May 22, 2002.
5. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", July 2000.
6. 10 CFR Part 100, "Reactor Site Criteria", December 1996.
7. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities", August 1991.
8. NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations", November 1982.
9. E-mail from Tom Galletta to Shane Gardner and James Heffner (Subject: 5 year JFD's), Attachment: "NMP_60m_JFD_1997-2001 for CNS", July 25, 2002.
10. Meteorological Evaluation Services, Inc. "Accident X/Q Values for Nine Mile Point Unit 1 Releases from the Main Stack and the Reactor and Turbine Buildings", August 7, 1990.
11. Meteorological Evaluation Services, Inc. "Technical Support Document Nine Mile Point Unit 2 Accident and Long-Term Diffusion Estimates and the Methodology Used in their Calculation", December 1985.
12. NMP Drawing C-26658-C, Rev. 4, July 1974.
13. NMP Unit 2 USAR Figures 2.3-43 through 2.3-46, Amendment 3, June 1983.
14. NMP Unit 2 USAR Section 2.3.4.4.2, Rev. 10, November 1998.
15. CNS PAVAN Computer Code Verification, Rev. 1, June 24, 2002.
16. NMP Drawing C-18713-C, Rev. 9, May 1974.
17. NMP Unit 2 USAR Figure 1.2-11, Rev. 0, April 1989.
18. Teleconference with NMP (Ted Kulczycky, Al Moisan, Glen Stinson, Tara Neider-CNS, Shane Gardner-CNS, James Heffner-CNS), Subject: Exclusion of NMP coastal sectors from evaluation, August 8, 2002.
19. Teleconference with NMP (Ted Kulczycky, Al Moisan, Glen Stinson, Tara Neider-CNS, Shane Gardner-CNS, David Matchick-CNS, Timothy Kurtz), September 10, 2003.
20. Memorandum CNS-03-218, "Comments on NISYS Review of CNS Calculations NMPAST-01-001 and NMPAST-02-001," Shane R. Gardner, September 24, 2003.
21. Regulatory Guide 1.23, "Onsite Meteorological Programs," February, 1972.

Appendices

Appendix A - Figures: EAB and LPZ Regions Showing Associated X/Q Directions
Appendix B - PAVAN Output
Appendix C - Listing of Files on DATA CD-ROM for Calculation NMPAST-01-001

Appendix A - Figures: EAB and LPZ Regions Showing Associated X/Q Directions

Figure A-1 EAB and Associated X/Q Directions

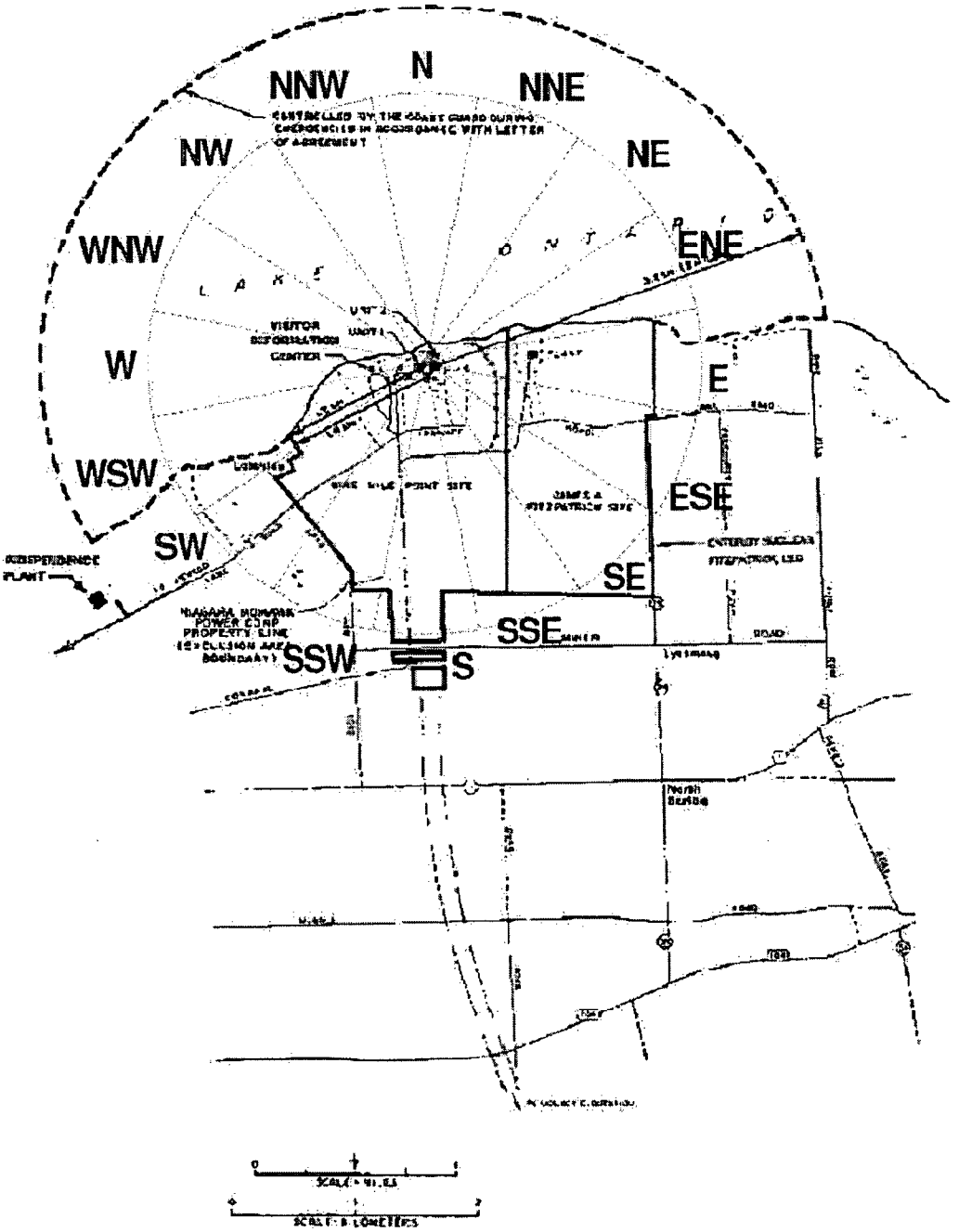
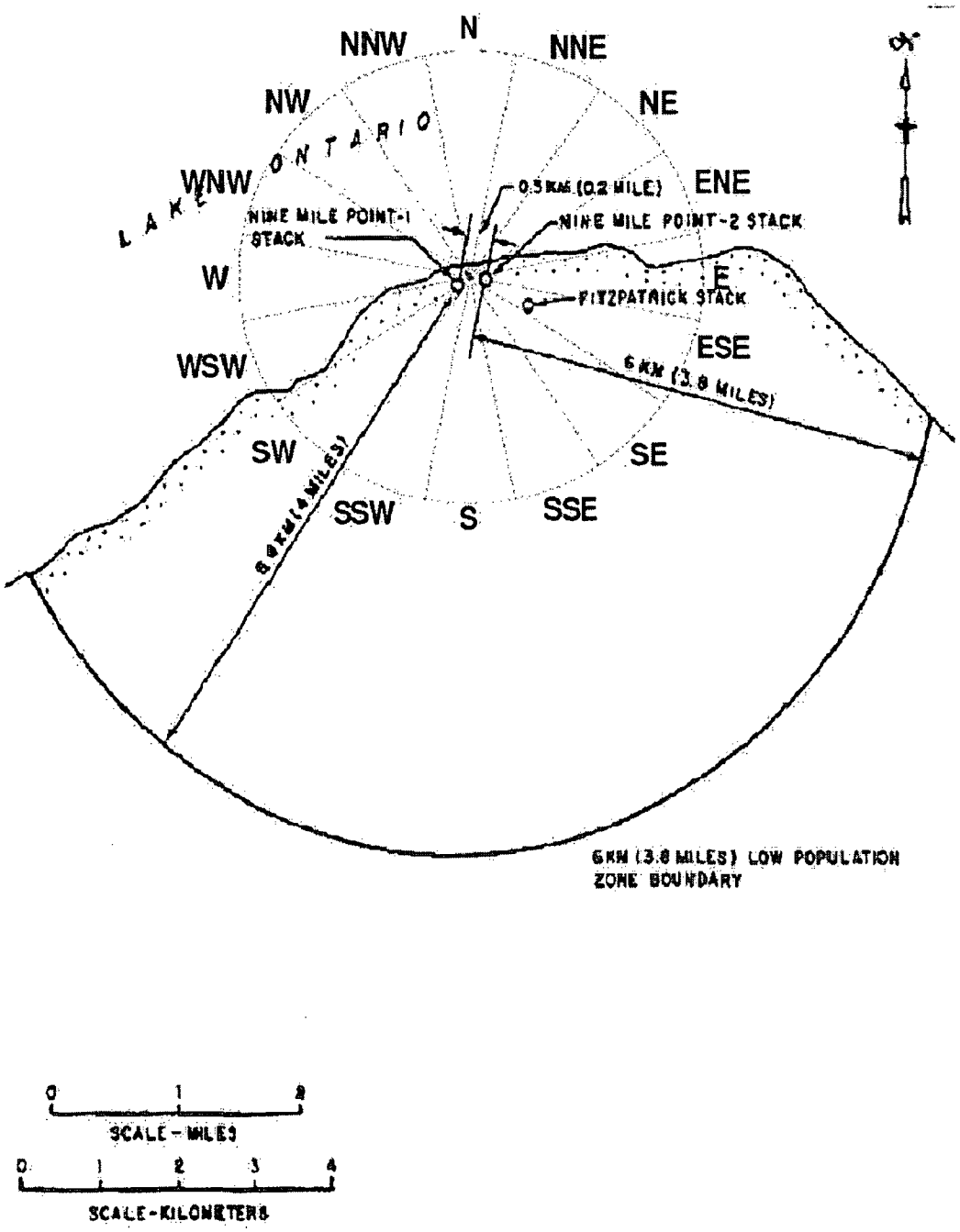


Figure A-2 LPZ and Associated X/Q Directions



Appendix B - PAVAN Output

1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: ELEVATED 106.7 METER DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 1 MAIN STACK TO EAB/LPZ
PROGRAM: PAVAN, 10/76, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	2000.	3.78E-05	1.68E-06	1.12E-06	4.65E-07	1.31E-07	2.80E-08	43.7	S
SSW	1500.	2.98E-05	1.36E-06	9.21E-07	3.94E-07	1.16E-07	2.62E-08	22.3	SSW
SW	1200.	3.46E-05	1.35E-06	8.40E-07	3.02E-07	6.93E-08	1.15E-08	35.2	SW
WSW	830.	1.55E-05	4.75E-07	2.63E-07	7.30E-08	1.16E-08	1.22E-09	5.9	WSW
W	830.	1.43E-05	4.36E-07	2.41E-07	6.62E-08	1.04E-08	1.07E-09	6.3	W
WNW	830.	1.72E-05	6.46E-07	3.96E-07	1.37E-07	2.98E-08	4.61E-09	4.5	WNW
NW	830.	1.83E-05	7.72E-07	5.02E-07	1.97E-07	5.15E-08	9.96E-09	5.8	NW
NNW	830.	1.85E-05	7.79E-07	5.05E-07	1.97E-07	5.09E-08	9.74E-09	6.5	NNW
N	830.	1.77E-05	7.31E-07	4.69E-07	1.79E-07	4.51E-08	8.34E-09	5.6	N
NNE	830.	1.56E-05	5.73E-07	3.47E-07	1.17E-07	2.44E-08	3.60E-09	5.5	NNE
NE	830.	1.38E-05	4.56E-07	2.62E-07	7.85E-08	1.39E-08	1.68E-09	5.1	NE
ENE	830.	2.01E-05	9.76E-07	6.79E-07	3.09E-07	9.99E-08	2.51E-08	5.4	ENE
E	1900.	2.57E-05	1.29E-06	9.10E-07	4.30E-07	1.46E-07	3.92E-08	17.5	E
ESE	1900.	2.60E-05	1.24E-06	8.62E-07	3.88E-07	1.23E-07	3.03E-08	16.1	ESE
SE	2300.	2.21E-05	1.06E-06	7.36E-07	3.32E-07	1.06E-07	2.61E-08	14.8	SE
SSE	2000.	2.18E-05	1.01E-06	6.89E-07	2.99E-07	9.02E-08	2.08E-08	13.5	SSE
MAX X/Q		3.78E-05				TOTAL HOURS AROUND SITE:		213.7	
SRP 2.3.4	830.	4.82E-05	2.17E-05	1.46E-05	6.16E-07	1.78E-07	3.92E-08		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.92E-08		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.
0X/Q VALUES (SEC/CUBIC METER) FOR FUMIGATION AT THE BOUNDARY:

DOWNWIND SECTOR	DISTANCE (METERS)	FUMIGATION X/Q
S	2000.	3.28E-05
SSW	1500.	3.85E-05
SW	1200.	4.62E-05
WSW	830.	5.98E-05
W	830.	5.98E-05
WNW	830.	5.98E-05
NW	830.	5.98E-05
NNW	830.	5.98E-05
N	830.	5.98E-05
NNE	830.	5.98E-05
NE	830.	6.00E-05
ENE	830.	6.03E-05
E	1900.	3.09E-05
ESE	1900.	3.13E-05

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SE	2300.	2.59E-05
SSE	2000.	2.96E-05

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: ELEVATED 106.7 METER DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 1 MAIN STACK TO EAB/LPZ
PROGRAM: PAVAN, 10/76, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	6116.	2.87E-06	1.26E-06	8.40E-07	3.45E-07	9.62E-08	2.02E-08	43.7	S
SSW	6116.	2.22E-06	1.03E-06	6.96E-07	3.01E-07	9.01E-08	2.06E-08	23.8	SSW
SW	6116.	2.66E-06	1.21E-06	8.13E-07	3.45E-07	1.01E-07	2.24E-08	35.4	SW
WSW	6116.	1.25E-06	5.22E-07	3.38E-07	1.31E-07	3.37E-08	6.41E-09	4.7	WSW
W	6116.	1.14E-06	4.84E-07	3.15E-07	1.24E-07	3.25E-08	6.31E-09	5.3	W
WNW	6116.	1.23E-06	5.53E-07	3.72E-07	1.57E-07	4.54E-08	9.96E-09	6.9	WNW
NW	6116.	1.20E-06	6.05E-07	4.29E-07	2.04E-07	6.98E-08	1.88E-08	5.7	NW
NNW	6116.	1.23E-06	5.99E-07	4.17E-07	1.90E-07	6.16E-08	1.55E-08	6.9	NNW
N	6116.	1.11E-06	5.48E-07	3.86E-07	1.80E-07	6.00E-08	1.57E-08	4.3	N
NNE	6116.	1.13E-06	5.36E-07	3.69E-07	1.63E-07	5.09E-08	1.22E-08	5.3	NNE
NE	6116.	1.08E-06	5.01E-07	3.42E-07	1.49E-07	4.55E-08	1.06E-08	6.6	NE
ENE	6116.	1.37E-06	6.83E-07	4.83E-07	2.28E-07	7.74E-08	2.07E-08	6.8	ENE
E	6116.	2.05E-06	1.01E-06	7.12E-07	3.32E-07	1.11E-07	2.89E-08	18.4	E
ESE	6116.	2.06E-06	9.59E-07	6.54E-07	2.85E-07	8.66E-08	2.01E-08	20.5	ESE
SE	6116.	1.67E-06	7.68E-07	5.20E-07	2.23E-07	6.63E-08	1.50E-08	14.2	SE
SSE	6116.	1.61E-06	7.25E-07	4.86E-07	2.04E-07	5.88E-08	1.28E-08	15.1	SSE
MAX X/Q		2.87E-06				TOTAL HOURS AROUND SITE:		223.7	
SRP 2.3.4	6116.	3.89E-06	1.73E-06	1.15E-06	4.79E-07	1.35E-07	2.89E-08		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.89E-08		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.
0X/Q VALUES (SEC/CUBIC METER) FOR FUMIGATION AT THE BOUNDARY:

DOWNWIND SECTOR	DISTANCE (METERS)	FUMIGATION X/Q
S	6116.	2.12E-05
SSW	6116.	1.55E-05
SW	6116.	1.55E-05
WSW	6116.	9.85E-06
W	6116.	9.85E-06
WNW	6116.	9.85E-06
NW	6116.	9.85E-06
NNW	6116.	9.85E-06
N	6116.	9.85E-06
NNE	6116.	9.85E-06
NE	6116.	1.01E-05
ENE	6116.	1.04E-05
E	6116.	1.34E-05
ESE	6116.	1.41E-05

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SE	6116.	1.24E-05
SSE	6116.	1.32E-05

H21C076-00

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: GROUND LEVEL RELEASE DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 1 REACTOR BUILDING BLOWOUT PANEL TO EAB/LPZ
PROGRAM: PAVAN, 10/76, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0

RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	2000.	4.59E-05	2.48E-05	1.83E-05	9.39E-06	3.61E-06	1.12E-06	4.3	S
SSW	1500.	6.34E-05	3.72E-05	2.84E-05	1.59E-05	6.93E-06	2.50E-06	6.8	SSW
SW	1200.	1.02E-04	6.21E-05	4.84E-05	2.81E-05	1.29E-05	4.99E-06	12.5	SW
WSW	830.	1.58E-04	9.48E-05	7.35E-05	4.24E-05	1.92E-05	7.29E-06	28.0	WSW
W	830.	1.87E-04	1.13E-04	8.77E-05	5.07E-05	2.30E-05	8.78E-06	32.8	W
WNW	830.	1.83E-04	1.12E-04	8.78E-05	5.16E-05	2.40E-05	9.44E-06	28.4	WNW
NW	830.	1.71E-04	1.13E-04	9.15E-05	5.83E-05	3.05E-05	1.38E-05	23.0	NW
NNW	830.	2.01E-04	1.31E-04	1.06E-04	6.63E-05	3.40E-05	1.50E-05	27.3	NNW
N	830.	2.10E-04	1.35E-04	1.08E-04	6.65E-05	3.33E-05	1.43E-05	36.5	N
NNE	830.	1.95E-04	1.23E-04	9.76E-05	5.92E-05	2.89E-05	1.20E-05	28.7	NNE
NE	830.	2.34E-04	1.46E-04	1.15E-04	6.89E-05	3.30E-05	1.34E-05	43.7	NE
ENE	830.	2.26E-04	1.48E-04	1.19E-04	7.51E-05	3.87E-05	1.72E-05	41.0	ENE
E	1900.	7.42E-05	4.26E-05	3.22E-05	1.76E-05	7.43E-06	2.58E-06	7.3	E
ESE	1900.	5.44E-05	3.08E-05	2.32E-05	1.25E-05	5.14E-06	1.73E-06	6.9	ESE
SE	2300.	2.97E-05	1.62E-05	1.20E-05	6.21E-06	2.41E-06	7.60E-07	2.7	SE
SSE	2000.	4.11E-05	2.23E-05	1.64E-05	8.43E-06	3.24E-06	1.01E-06	4.4	SSE
MAX X/Q		2.34E-04				TOTAL HOURS AROUND SITE:		334.4	
SRP 2.3.4	830.	4.44E-04	2.59E-04	1.98E-04	1.10E-04	4.78E-05	1.72E-05		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.72E-05		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.

H21C076-000

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: GROUND LEVEL RELEASE DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 1 REACTOR BUILDING BLOWOUT PANEL TO EAB/LPZ
PROGRAM: PAVAN, 10/76, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	6116.	1.31E-05	5.96E-06	4.03E-06	1.72E-06	5.05E-07	1.13E-07	14.3	S
SSW	6116.	1.33E-05	6.17E-06	4.20E-06	1.82E-06	5.51E-07	1.27E-07	392.7	SSW
SW	6116.	1.81E-05	8.19E-06	5.52E-06	2.34E-06	6.82E-07	1.51E-07	19.7	SW
WSW	6116.	2.07E-05	8.99E-06	5.93E-06	2.40E-06	6.57E-07	1.34E-07	24.1	WSW
W	6116.	2.74E-05	1.18E-05	7.70E-06	3.08E-06	8.27E-07	1.65E-07	30.1	W
WNW	6116.	2.76E-05	1.19E-05	7.81E-06	3.13E-06	8.44E-07	1.70E-07	26.3	WNW
NW	6116.	2.54E-05	1.17E-05	7.96E-06	3.44E-06	1.03E-06	2.36E-07	20.5	NW
NNW	6116.	2.92E-05	1.35E-05	9.12E-06	3.93E-06	1.17E-06	2.67E-07	23.1	NNW
N	6116.	2.78E-05	1.28E-05	8.68E-06	3.73E-06	1.11E-06	2.53E-07	27.7	N
NNE	6116.	3.03E-05	1.34E-05	8.89E-06	3.66E-06	1.03E-06	2.16E-07	27.9	NNE
NE	6116.	3.85E-05	1.68E-05	1.11E-05	4.49E-06	1.23E-06	2.51E-07	43.7	NE
ENE	6116.	3.71E-05	1.68E-05	1.13E-05	4.76E-06	1.38E-06	3.04E-07	40.6	ENE
E	6116.	2.31E-05	1.08E-05	7.35E-06	3.21E-06	9.80E-07	2.29E-07	24.2	E
ESE	6116.	1.59E-05	7.40E-06	5.05E-06	2.20E-06	6.68E-07	1.55E-07	19.7	ESE
SE	6116.	9.24E-06	4.38E-06	3.01E-06	1.34E-06	4.19E-07	1.01E-07	12.8	SE
SSE	6116.	1.10E-05	5.09E-06	3.45E-06	1.49E-06	4.46E-07	1.02E-07	13.8	SSE
MAX X/Q		3.85E-05				TOTAL HOURS AROUND SITE:		761.7	
SRP 2.3.4	6116.	5.06E-05	2.17E-05	1.42E-05	5.69E-06	1.52E-06	3.04E-07		
SITE LIMIT		3.58E-05	1.63E-05	1.10E-05	4.67E-06	1.37E-06	3.04E-07		

0THE FIVE-PERCENT-FOR-THE-ENTIRE-SITE X/Q IS LIMITING.

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: ELEVATED 130.8 METER DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 2 MAIN STACK TO EAB/LPZ
PROGRAM: PAVAN, 10/76, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	2256.	2.19E-06	9.70E-07	6.45E-07	2.67E-07	7.49E-08	1.59E-08	43.7	S
SSW	1936.	1.79E-06	8.10E-07	5.46E-07	2.31E-07	6.75E-08	1.50E-08	22.3	SSW
SW	1615.	1.97E-06	7.71E-07	4.83E-07	1.75E-07	4.06E-08	6.80E-09	32.1	SW
WSW	1615.	8.82E-07	3.01E-07	1.76E-07	5.50E-08	1.03E-08	1.33E-09	6.0	WSW
W	1555.	8.17E-07	2.75E-07	1.60E-07	4.91E-08	9.02E-09	1.14E-09	6.1	W
WNW	1555.	9.81E-07	3.82E-07	2.38E-07	8.55E-08	1.96E-08	3.25E-09	6.3	WNW
NW	1555.	1.05E-06	4.56E-07	3.00E-07	1.21E-07	3.27E-08	6.62E-09	6.7	NW
NNW	1555.	1.07E-06	4.57E-07	2.98E-07	1.18E-07	3.11E-08	6.10E-09	7.0	NNW
N	1555.	1.06E-06	4.50E-07	2.94E-07	1.16E-07	3.07E-08	6.03E-09	6.1	N
NNE	1555.	8.92E-07	3.45E-07	2.15E-07	7.67E-08	1.75E-08	2.86E-09	5.5	NNE
NE	1555.	7.76E-07	2.84E-07	1.71E-07	5.75E-08	1.20E-08	1.76E-09	5.3	NE
ENE	1555.	1.09E-06	5.13E-07	3.53E-07	1.56E-07	4.87E-08	1.17E-08	6.1	ENE
E	1555.	1.64E-06	7.81E-07	5.40E-07	2.42E-07	7.64E-08	1.87E-08	16.6	E
ESE	1555.	1.69E-06	7.84E-07	5.34E-07	2.32E-07	7.02E-08	1.63E-08	21.9	ESE
SE	1600.	1.44E-06	6.86E-07	4.73E-07	2.11E-07	6.65E-08	1.62E-08	20.6	SE
SSE	2134.	1.31E-06	6.05E-07	4.11E-07	1.77E-07	5.29E-08	1.21E-08	13.6	SSE
MAX X/Q		2.19E-06				TOTAL HOURS AROUND SITE:		225.9	
SRP 2.3.4	1555.	2.43E-06	1.09E-06	7.26E-07	3.03E-07	8.65E-08	1.87E-08		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E-08		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.
0X/Q VALUES (SEC/CUBIC METER) FOR FUMIGATION AT THE BOUNDARY:

DOWNWIND SECTOR	DISTANCE (METERS)	FUMIGATION X/Q
S	2256.	2.36E-05
SSW	1936.	2.51E-05
SW	1615.	2.90E-05
WSW	1615.	2.68E-05
W	1555.	2.77E-05
WNW	1555.	2.77E-05
NW	1555.	2.77E-05
NNW	1555.	2.77E-05
N	1555.	2.77E-05
NNE	1555.	2.77E-05
NE	1555.	2.78E-05
ENE	1555.	2.80E-05
E	1555.	2.93E-05
ESE	1555.	2.96E-05

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SE	1600.	2.83E-05
SSE	2134.	2.25E-05

H21 C076-00

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: ELEVATED 130.8 METER DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 2 MAIN STACK TO EAB/LPZ
PROGRAM: PAVAN, 10/75, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	6116.	1.73E-06	7.79E-07	5.22E-07	2.20E-07	6.33E-08	1.38E-08	42.5	S
SSW	6116.	1.49E-06	6.94E-07	4.75E-07	2.08E-07	6.35E-08	1.49E-08	30.1	SSW
SW	6116.	1.75E-06	8.01E-07	5.41E-07	2.31E-07	6.82E-08	1.53E-08	43.7	SW
WSW	6116.	7.80E-07	3.25E-07	2.09E-07	8.09E-08	2.06E-08	3.88E-09	7.3	WSW
W	6116.	7.30E-07	3.07E-07	1.99E-07	7.75E-08	2.01E-08	3.84E-09	7.8	W
WNW	6116.	7.98E-07	3.59E-07	2.41E-07	1.01E-07	2.92E-08	6.38E-09	7.6	WNW
NW	6116.	8.15E-07	4.06E-07	2.86E-07	1.34E-07	4.53E-08	1.20E-08	7.8	NW
NNW	6116.	8.10E-07	3.88E-07	2.69E-07	1.21E-07	3.86E-08	9.52E-09	7.7	NNW
N	6116.	7.74E-07	3.76E-07	2.62E-07	1.20E-07	3.89E-08	9.84E-09	7.2	N
NNE	6116.	7.54E-07	3.52E-07	2.41E-07	1.05E-07	3.21E-08	7.53E-09	7.0	NNE
NE	6116.	6.93E-07	3.19E-07	2.17E-07	9.36E-08	2.80E-08	6.40E-09	7.7	NE
ENE	6116.	8.37E-07	4.21E-07	2.99E-07	1.42E-07	4.86E-08	1.31E-08	6.7	ENE
E	6116.	1.43E-06	7.05E-07	4.95E-07	2.30E-07	7.65E-08	1.99E-08	26.8	E
ESE	6116.	1.28E-06	6.08E-07	4.19E-07	1.87E-07	5.85E-08	1.41E-08	19.6	ESE
SE	6116.	1.06E-06	4.98E-07	3.41E-07	1.50E-07	4.62E-08	1.09E-08	16.7	SE
SSE	6116.	1.04E-06	4.76E-07	3.22E-07	1.37E-07	4.06E-08	9.13E-09	15.3	SSE
MAX X/Q		1.75E-06				TOTAL HOURS AROUND SITE:		261.7	
SRP 2.3.4	6116.	2.19E-06	1.01E-06	6.83E-07	2.94E-07	8.76E-08	1.99E-08		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-08		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.
0X/Q VALUES (SEC/CUBIC METER) FOR FUMIGATION AT THE BOUNDARY:

DOWNWIND SECTOR	DISTANCE (METERS)	FUMIGATION X/Q
S	6116.	1.42E-05
SSW	6116.	1.15E-05
SW	6116.	1.15E-05
WSW	6116.	8.04E-06
W	6116.	8.04E-06
WNW	6116.	8.04E-06
NW	6116.	8.04E-06
NNW	6116.	8.04E-06
N	6116.	8.04E-06
NNE	6116.	8.04E-06
NE	6116.	8.23E-06
ENE	6116.	8.42E-06
E	6116.	1.02E-05
ESE	6116.	1.06E-05

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SE	6116.	9.66E-06
SSE	6116.	1.01E-05

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: GROUND LEVEL RELEASE DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 2 COMBINED RADWASTE/REACTOR BUILDING VENT TO EAB/LPZ
PROGRAM: PAVAN, 10/75, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)
VERSUS
AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	1945.	4.65E-05	2.51E-05	1.85E-05	9.46E-06	3.62E-06	1.12E-06	10.3	S
SSW	1695.	5.47E-05	3.10E-05	2.34E-05	1.27E-05	5.25E-06	1.79E-06	13.1	SSW
SW	1381.	8.75E-05	5.12E-05	3.91E-05	2.18E-05	9.46E-06	3.40E-06	24.4	SW
WSW	1381.	9.14E-05	5.13E-05	3.85E-05	2.06E-05	8.38E-06	2.79E-06	27.1	WSW
W	1381.	1.10E-04	6.16E-05	4.61E-05	2.46E-05	1.00E-05	3.33E-06	31.7	W
WNW	1381.	1.10E-04	6.25E-05	4.71E-05	2.55E-05	1.06E-05	3.59E-06	28.1	WNW
NW	1381.	1.02E-04	6.28E-05	4.91E-05	2.89E-05	1.35E-05	5.31E-06	21.8	NW
NNW	1381.	1.16E-04	7.06E-05	5.50E-05	3.21E-05	1.48E-05	5.73E-06	21.4	NNW
N	1381.	1.24E-04	7.38E-05	5.70E-05	3.26E-05	1.46E-05	5.46E-06	34.9	N
NNE	1381.	1.17E-04	6.86E-05	5.25E-05	2.94E-05	1.27E-05	4.59E-06	27.5	NNE
NE	1381.	1.42E-04	8.18E-05	6.22E-05	3.42E-05	1.45E-05	5.10E-06	43.7	NE
ENE	1381.	1.34E-04	8.13E-05	6.34E-05	3.69E-05	1.70E-05	6.56E-06	39.2	ENE
E	1686.	8.00E-05	4.70E-05	3.60E-05	2.03E-05	8.85E-06	3.22E-06	20.6	E
ESE	1686.	6.22E-05	3.57E-05	2.70E-05	1.48E-05	6.23E-06	2.16E-06	17.9	ESE
SE	1743.	4.07E-05	2.32E-05	1.75E-05	9.54E-06	3.98E-06	1.36E-06	11.8	SE
SSE	2094.	3.85E-05	2.05E-05	1.50E-05	7.56E-06	2.84E-06	8.54E-07	9.9	SSE
MAX X/Q		1.42E-04				TOTAL HOURS	AROUND SITE:	383.5	
SRP 2.3.4	1381.	2.45E-04	1.34E-04	9.97E-05	5.21E-05	2.05E-05	6.56E-06		
SITE LIMIT		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.56E-06		

00.5 PERCENT X/Q TO AN INDIVIDUAL IS LIMITING.

H21C0076-00

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1USNRC COMPUTER CODE-PAVAN, VERSION 2.0 RUN DATE: 09-03-02

/PLANT NAME: NINE MILE POINT METEOROLOGICAL INSTRUMENTATION
DATA PERIOD: 1/01/97 TO 12/31/01 WIND SENSORS HEIGHT: 60.7 METER
TYPE OF RELEASE: GROUND LEVEL RELEASE DELTA-T HEIGHTS: 51.2 METER
SOURCE OF DATA: JOINT FREQUENCY DISTRIBUTION REPORT (JFD) NINE MILE POINT NUCLEAR STATION
COMMENTS: NINE MILE POINT UNIT 2 COMBINED RADWASTE/REACTOR BUILDING VENT TO EAB/LPZ
PROGRAM: PAVAN, 10/75, 8/79 REVISION, IMPLEMENTATION OF REGULATORY GUIDE 1.145
0 RELATIVE CONCENTRATION (X/Q) VALUES (SEC/CUBIC METER)

VERSUS AVERAGING TIME

DOWNWIND SECTOR	DISTANCE (METERS)	0-2 HOURS	0-8 HOURS	8-24 HOURS	1-4 DAYS	4-30 DAYS	ANNUAL AVERAGE	HOURS PER YEAR MAX 0-2 HR X/Q IS EXCEEDED IN SECTOR	DOWNWIND SECTOR
S	6116.	1.30E-05	5.90E-06	3.98E-06	1.69E-06	4.92E-07	1.09E-07	14.3	S
SSW	6116.	1.32E-05	6.11E-06	4.15E-06	1.79E-06	5.37E-07	1.23E-07	392.7	SSW
SW	6116.	1.81E-05	8.15E-06	5.47E-06	2.30E-06	6.66E-07	1.46E-07	19.7	SW
WSW	6116.	2.07E-05	8.92E-06	5.86E-06	2.36E-06	6.37E-07	1.29E-07	24.1	WSW
W	6116.	2.74E-05	1.17E-05	7.61E-06	3.02E-06	7.59E-07	1.57E-07	30.1	W
WNW	6116.	2.76E-05	1.18E-05	7.72E-06	3.07E-06	8.19E-07	1.63E-07	26.8	WNW
NW	6116.	2.54E-05	1.17E-05	7.89E-06	3.39E-06	1.01E-06	2.29E-07	20.5	NW
NNW	6116.	2.92E-05	1.34E-05	9.03E-06	3.86E-06	1.14E-06	2.57E-07	23.1	NNW
N	6116.	2.78E-05	1.27E-05	8.59E-06	3.67E-06	1.08E-06	2.43E-07	27.7	N
NNE	6116.	3.03E-05	1.33E-05	8.80E-06	3.60E-06	9.98E-07	2.08E-07	27.9	NNE
NE	6116.	3.85E-05	1.66E-05	1.09E-05	4.39E-06	1.19E-06	2.40E-07	43.7	NE
ENE	6116.	3.71E-05	1.67E-05	1.12E-05	4.68E-06	1.35E-06	2.93E-07	40.6	ENE
E	6116.	2.31E-05	1.07E-05	7.28E-06	3.16E-06	9.56E-07	2.21E-07	24.2	E
ESE	6116.	1.58E-05	7.32E-06	4.98E-06	2.16E-06	6.50E-07	1.50E-07	19.7	ESE
SE	6116.	9.24E-06	4.36E-06	2.99E-06	1.32E-06	4.11E-07	9.80E-08	12.8	SE
SSE	6116.	1.10E-05	5.06E-06	3.42E-06	1.47E-06	4.35E-07	9.83E-08	13.8	SSE
MAX X/Q		3.85E-05				TOTAL HOURS AROUND SITE:		761.6	
SRP 2.3.4	6116.	4.99E-05	2.13E-05	1.40E-05	5.55E-06	1.48E-06	2.93E-07		
SITE LIMIT		3.58E-05	1.62E-05	1.09E-05	4.59E-06	1.33E-06	2.93E-07		

0THE FIVE-PERCENT-FOR-THE-ENTIRE-SITE X/Q IS LIMITING.

H21 C076-000

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Appendix C - Listing of Files on DATA CD-ROM for Calculation NMPAST-01-001

Note: This directory listing does not include the calculation document, cover page and review checklist files.

```
Directory of D:\

08/05/2002  11:04 AM            20,992 Terrain Height Estimates.xls
08/23/2002  11:15 AM            58,368 Revised NMP_60m_JFD_1997-2001 for CNS.doc

Directory of D:\0.5% Sector Dependent Calculations

12/19/2003  05:00 PM    <DIR>          .
12/19/2003  05:00 PM    <DIR>          ..
08/29/2002  08:34 AM           331,264 U1 Main Stack to EAB   E.xls
08/28/2002  07:54 PM           332,288 U1 Main Stack to EAB - ESE.xls
09/06/2002  10:03 AM           331,264 U1 Main Stack to EAB - SE.xls
08/28/2002  07:56 PM           331,264 U1 Main Stack to EAB - SSW.xls
12/19/2003  01:55 PM           332,288 U1 Main Stack to LPZ - E.xls
08/28/2002  08:10 PM           331,776 U1 Main Stack to LPZ - ESE.xls
08/28/2002  08:14 PM           331,264 U1 Main Stack to LPZ - SW.xls
08/28/2002  08:15 PM           329,728 U1 Main Stack to LPZ - WSW.xls
12/19/2003  03:48 PM           333,312 U1 Reactor BLDG Blowout Panel to EAB - E.xls
08/28/2002  08:18 PM           331,264 U1 Reactor BLDG Blowout Panel to EAB - SW.xls
12/19/2003  03:43 PM           330,752 U1 Reactor BLDG Blowout Panel to EAB - WSW.xls
08/28/2002  08:21 PM           332,288 U1 Reactor BLDG Blowout Panel to LPZ - SE.xls
09/06/2002  10:40 AM           332,288 U1 Reactor BLDG Blowout Panel to LPZ - SSE.xls
08/28/2002  08:23 PM           332,288 U1 Reactor BLDG Blowout Panel to LPZ - SSW.xls
08/28/2002  08:25 PM           331,264 U1 Reactor BLDG Blowout Panel to LPZ - SW.xls
08/28/2002  08:34 PM           332,288 U2 Combined Radwaste and Reactor BLDG Vent to EAB - SSE.xls
08/28/2002  08:35 PM           331,264 U2 Combined Radwaste and Reactor BLDG Vent to EAB - SW.xls
12/19/2003  01:55 PM           332,288 U2 Combined Radwaste and Reactor BLDG Vent to EAB - WSW.xls
08/28/2002  08:37 PM           332,288 U2 Combined Radwaste and Reactor BLDG Vent to LPZ - SE.xls
08/28/2002  08:39 PM           332,800 U2 Combined Radwaste and Reactor BLDG Vent to LPZ - SSE.xls
08/28/2002  08:40 PM           332,288 U2 Combined Radwaste and Reactor BLDG Vent to LPZ - SSW.xls
08/28/2002  08:42 PM           331,264 U2 Combined Radwaste and Reactor BLDG Vent to LPZ - SW.xls
09/06/2002  10:53 AM           332,288 U2 Main Stack to LPZ - ESE.xls
08/28/2002  08:28 PM           331,776 U2 Main Stack to LPZ - S.xls
08/28/2002  08:29 PM           331,776 U2 Main Stack to LPZ - SE.xls
08/28/2002  08:30 PM           331,264 U2 Main Stack to LPZ - SSE.xls
08/28/2002  08:31 PM           331,264 U2 Main Stack to LPZ - SW.xls
08/28/2002  08:33 PM           329,728 U2 Main Stack to LPZ - WSW.xls
               28 File(s)    9,287,168 bytes

 Directory of D:\5% Site Limit Calculations

12/19/2003  04:32 PM    <DIR>          .
12/19/2003  04:32 PM    <DIR>          ..
12/19/2003  04:21 PM         3,603,456 5% Envelopes.xls
12/19/2003  04:32 PM            16,384 Intermediate Time Calculations.xls
12/19/2003  04:19 PM           359,936 Unit 1 Main Stack to EAB.xls
12/19/2003  04:19 PM           367,616 Unit 1 Main Stack to LPZ.xls
12/19/2003  04:20 PM           354,304 Unit 1 Reactor BLDG Blowout Panel to EAB.xls
12/19/2003  04:20 PM           355,840 Unit 2 Combined Radwaste and Reactor BLDG Vent to EAB.xls
12/19/2003  04:20 PM           372,736 Unit 2 Main Stack to EAB.xls
12/19/2003  04:20 PM           369,664 Unit 2 Main Stack to LPZ.xls
                8 File(s)    5,799,936 bytes

 Directory of D:\Input Files

11/18/2003  02:24 PM    <DIR>          .
11/18/2003  02:24 PM    <DIR>          ..
08/26/2002  10:04 AM             7,913 Unit 1 Main Stack to EAB and LPZ.inp
08/26/2002  10:04 AM             7,441 Unit 1 Reactor Bldg Blowout Panel to EAB and LPZ.inp
08/26/2002  10:04 AM             7,441 Unit 1 Turbine Bldg Blowout Panel to EAB and LPZ.inp
09/03/2002  09:44 AM             7,913 Unit 2 Main Stack to EAB and LPZ.inp
08/26/2002  10:04 AM             7,442 Unit 2 Main Steam Tunnel to EAB and LPZ.inp
08/26/2002  10:04 AM             7,444 Unit 2 Post Accident Samp to EAB and LPZ.inp
```

```
08/26/2002  10:04 AM              7,450 Unit 2 Reactor Bldg to EAB and LPZ.inp
08/26/2002  10:04 AM              7,448 Unit 2 Stby Gas Bldg to EAB and LPZ.inp
               8 File(s)         60,492 bytes

 Directory of D:\Maximum Stack XQ Distance

11/18/2003  02:24 PM    <DIR>          .
11/18/2003  02:24 PM    <DIR>          ..
11/18/2003  02:24 PM    <DIR>          Unit 1
11/18/2003  02:24 PM    <DIR>          Unit 2
               0 File(s)              0 bytes

 Directory of D:\Maximum Stack XQ Distance\Unit 1

11/18/2003  02:24 PM    <DIR>          .
11/18/2003  02:24 PM    <DIR>          ..
08/27/2002  03:10 PM              7,913 100 and 250.inp
08/27/2002  03:10 PM              7,913 1000 and 1250.inp
08/27/2002  03:20 PM            602,588 1000AN~1.out
08/27/2002  03:20 PM            598,239 100AND~1.out
08/27/2002  03:10 PM              7,913 1500 and 1750.inp
08/27/2002  03:20 PM            604,359 1500AN~1.out
08/27/2002  03:10 PM              7,913 2000 and 2500.inp
08/27/2002  03:20 PM            605,411 2000AN~1.out
08/27/2002  03:10 PM              7,913 3000 and 3500.inp
08/27/2002  03:20 PM            609,698 3000AN~1.out
08/27/2002  03:10 PM              7,913 4500 and 5000.inp
08/27/2002  03:20 PM            615,621 4500AN~1.out
08/27/2002  03:10 PM              7,913 500 and 750.inp
08/27/2002  03:20 PM            597,141 500AND~1.out
08/27/2002  03:10 PM              7,913 510 and 535.inp
08/27/2002  03:20 PM            596,977 510AND~1.out
08/27/2002  03:10 PM              7,913 525 and 550.inp
08/27/2002  03:20 PM            596,679 525AND~1.out
08/27/2002  03:10 PM              7,913 5500 and 6000.inp
08/27/2002  03:20 PM            615,867 5500AN~1.out
08/27/2002  03:10 PM              7,913 600 and 650.inp
08/27/2002  03:20 PM            595,555 600AND~1.out
08/27/2002  03:10 PM              7,913 6500 and 7000.inp
08/27/2002  03:20 PM            617,663 6500AN~1.out
08/27/2002  03:10 PM              7,913 700 and 850.inp
08/27/2002  03:20 PM            597,491 700AND~1.out
08/27/2002  03:10 PM              7,913 8000 and 9000.inp
08/27/2002  03:20 PM            602,625 8000AN~1.out
08/27/2002  02:07 PM                224 run_unit1.bat
08/27/2002  04:51 PM            129,536 Unit1 Max Stack XQ (Scoping).xls
              30 File(s)      8,696,456 bytes

 Directory of D:\Maximum Stack XQ Distance\Unit 2

11/18/2003  02:24 PM    <DIR>          .
11/18/2003  02:24 PM    <DIR>          ..
08/27/2002  02:46 PM              7,913 100 and 250.inp
08/27/2002  02:48 PM              7,913 1000 and 1250.inp
08/27/2002  03:21 PM            602,399 1000AN~1.out
08/27/2002  03:21 PM            597,841 100AND~1.out
08/27/2002  02:49 PM              7,913 1500 and 1750.inp
08/27/2002  03:21 PM            605,037 1500AN~1.out
08/27/2002  02:53 PM              7,913 2000 and 2500.inp
08/27/2002  03:21 PM            606,903 2000AN~1.out
08/27/2002  02:55 PM              7,913 3000 and 3500.inp
08/27/2002  03:21 PM            610,393 3000AN~1.out
08/27/2002  02:56 PM              7,913 4500 and 5000.inp
08/27/2002  03:21 PM            613,827 4500AN~1.out
08/27/2002  02:57 PM              7,913 500 and 750.inp
08/27/2002  03:20 PM            597,739 500AND~1.out
08/27/2002  02:58 PM              7,913 510 and 535.inp
08/27/2002  03:20 PM            597,841 510AND~1.out
```

```
08/27/2002  02:59 PM            7,913 525 and 550.inp
08/27/2002  03:21 PM          598,435 525AND~1.out
08/27/2002  03:00 PM            7,913 5500 and 6000.inp
08/27/2002  03:21 PM          616,055 5500AN~1.out
08/27/2002  03:02 PM            7,913 600 and 650.inp
08/27/2002  03:21 PM          598,117 600AND~1.out
08/27/2002  03:02 PM            7,913 6500 and 7000.inp
08/27/2002  03:21 PM          617,883 6500AN~1.out
08/27/2002  03:03 PM            7,913 700 and 850.inp
08/27/2002  03:21 PM          597,689 700AND~1.out
08/27/2002  03:04 PM            7,913 8000 and 9000.inp
08/27/2002  03:21 PM          607,754 8000AN~1.out
08/27/2002  02:07 PM              224 run_unit2.bat
08/27/2002  05:51 PM          130,048 Unit 2 Max Stack XQ (Scoping).xls
              30 File(s)    8,708,967 bytes

 Directory of D:\Output Files

11/18/2003  02:24 PM    <DIR>          .
11/18/2003  02:24 PM    <DIR>          ..
09/03/2002  09:58 AM          609,639 UNIT1M~1.out
09/03/2002  09:58 AM          571,812 UNIT1R~1.out
09/03/2002  09:58 AM          571,812 UNIT1T~1.out
09/03/2002  09:58 AM          612,897 UNIT2M~1.out
09/03/2002  09:58 AM          571,256 UNIT2M~2.out
09/03/2002  09:58 AM          571,256 UNIT2P~1.out
09/03/2002  09:58 AM          571,256 UNIT2R~1.out
09/03/2002  09:58 AM          571,256 UNIT2S~1.out
               8 File(s)    4,651,184 bytes
```

H21C076-00

Calculation Cover Sheet

Calculation No. NMPAST-02-001 Rev. 2 No. of Pages 37

Title Calculation of Atmospheric Dispersion Coefficients (X/Qs) at the NMP Unit 1 Technical Support Center and Units 1 and 2 Control Room Intakes for All Releases

Rev. 0	Name	Signature	Date
Prepared By	Shane Gardner		
Checked By	James Heffner		
Approved By	Tara Neider		

Rev. 1	Name	Signature	Date
Prepared By	Shane Gardner		
Checked By	James Heffner		
Approved By	Tara Neider		

Description of Changes
This calculation revision is in response to the availability of revised meteorological data from NMP. This revision incorporates the results of the revised meteorological data into the body of the calculation, i.e. the X/Q results in Tables 3.3.3 and 3.3.4 have been recalculated with the new meteorological data. Also, this revision adds the calculation of X/Q values at the Unit 1 Technical Support Center. This revision further includes changes to resolve minor editorial issues.

Affected Pages: Calculation Cover Sheet (Title); all pages thereafter

Rev. 2	Name	Signature	Date
Prepared By	Shane Gardner	Shane R Gardner	12/22/03
Checked By	David Matchick	David Matchick	12/30/03
Approved By	Larry Smith	Larry D Smith	12/31/03

Description of Changes

The purpose of this revision is to respond to comments made in a third party review performed by NISYS Corp. at the request of NMPNS. Several comments were made and the reader is referred to the NISYS document NISYS-1169-DV001/R0 for more detail. CNS and NMPNS agreed to a plan to resolve a selection of the NISYS comments (see CNS-03-218, 9/24/03 and electronic correspondence from Timothy M. Kurtz to Shane Gardner, November 6, 2003, "Re: CNS Comments on NISYS Review of X/Q Calculations"). CNS-03-218 provides a description regarding how the comments were addressed and provides the basis for incorporating the comments into this calculation. More specifically, the following comments were addressed:

NISYS

Comment No.	Description	Affected Page(s)
1a	include a scale drawing (compass "rose")	Appendix A
1b	statement documenting conformance to Safety Guide 23	4, 26 (Refs. 29 &30)
2a	first part only; justification of assumptions	8-10

4a	incorrect conversions from English to metric units	6, 8, 16-19, 22-24
5a	add a detailed listing of files on CD be provided	Appendix D

Only comment 4a impacted the results of the calculation. This comment changed building wake area input parameters for several of the ARCON96 computer runs and therefore impacted the X/Q estimates. The revised results were compared against the previous results from revision 1 of this calculation. It was determined that the previous revision 1 results were conservative and bounding with respect to the revised results. Most of the changes in the X/Q values occurred for X/Qs at the Unit 1 Control Room intake. The following is a catalogue of the changes in the X/Q values:

Release Point	Receptor Point	Average Change in X/Q (%)
Unit 1 Reactor Bldg.	Unit 1 Control Room	-4.1
Unit 1 Turbine Bldg.	Unit 1 Control Room	-2.6
Unit 1 Main Stack	Unit 1 Control Room	-11.4
Unit 2 Combined Radwaste/Rx Vent	Unit 1 Control Room	-4.4
Unit 2 PASS Panel	Unit 1 Control Room	-1.8
Unit 2 SGTS Bldg.	Unit 1 Control Room	-0.6
Unit 2 Main Steam Tunnel	Unit 1 Control Room	-0.9
Unit 2 Main Stack	Unit 1 Control Room	-3.8
Unit 2 Main Stack	Unit 1 Tech. Support Center	-0.3
Unit 2 PASS Panel	Unit 2 Control Room	-0.2
Unit 2 SGTS Bldg.	Unit 2 Control Room	-0.1
Unit 2 Main Stack	Unit 2 Control Room	-0.3

In addition to the changes indicated above, the calculation was further revised to incorporate minor editorial changes.

Affected Pages: Calculation Cover Sheet (Title); all pages thereafter

Calculation Review Checklist

Calculation # NMPAST-02-001 Rev. # 2

Circle, as appropriate, the Yes/No/NA for all items

Correct calculation format ..... Yes/No/NA

Correctness of assumptions ..... Yes/No/NA

Adequacy of assumption basis ..... Yes/No/NA

Correctness of parameters used ..... Yes/No/NA

Appropriate choice of method ..... Yes/No/NA

Adequate documentation of method ..... Yes/No/NA

Correct application of method ..... Yes/No/NA

Correctness of results/conclusions ..... Yes/No/NA

Adequate Reference list ..... Yes/No/NA

If computer software was used to perform the calculation, the following elements shall also be considered:

Proper software verification and verification documentation ..... Yes/No/NA

Correctness of input parameters ..... Yes/No/NA

Correct information in analysis calculation ..... Yes/No/NA

Correct interpretation of results ..... Yes/No/NA

Signature David Matchick Date 12-30-03

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1. Objective

The purpose of this calculation is to determine conservative estimates of atmospheric dispersion coefficients (X/Q) for the Nine Mile Point Unit 1 and 2 Nuclear Station control room air intakes for release points defined herein.

2. Background

Nine Mile Point Nuclear Station (NMP) has requested the services of Constellation Nuclear Services (CNS) to evaluate and update offsite and control room atmospheric dispersion coefficients for Units 1 and 2. The atmospheric dispersion coefficients (X/Q) are needed for a scoping study to determine the feasibility of the use of Alternative Source Term (AST) methodology for the determination of design basis accident dose consequences and can be applied to other calculations which determine radiation dose consequences at the Unit 1 and 2 Control Rooms.

2.1. Applicable Regulations and Commitments

This calculation employs the ARCON96 computer code (Ref. 2) to calculate X/Q values. The Regulatory Guides (RG) 1.145 (Ref. 3) and 1.183 (Ref. 4) are utilized to perform the analyses herein. Other regulatory guidance on atmospheric relative concentrations for Control Room radiological habitability assessments (Ref. 5) has been implemented as necessary. The regulatory guidance for analyses associated with the use of AST is found in RG 1.183 (Ref. 4). Meteorological data are hourly averages obtained from NMP Joint Frequency Distribution Report (JFD) (Ref. 29) and the analysis conforms to the requirements of R.G. 1.23 (Ref.30).

3. Methodology

Recently published guidance (Ref. 4 and 5) has outlined acceptable procedures for calculation of X/Q values with the computer code system ARCON96. ARCON96 employs a straight-line Gaussian dispersion model to calculate X/Q values based on hourly meteorological data. The X/Q values calculated are hourly, normalized concentrations. These values are then averaged to provide X/Q values for time periods ranging from 0 to 720 hours. A more complete discussion, including details on the methods, input guide and programmer's guide, are provided in the user's guide (Ref. 2).

The ARCON96 computer code was utilized to calculate conservative estimates of the X/Q values for all releases to each of the NMP Unit 1 and 2 Control Room intakes and the Unit 1 Technical Support Center. The recently published guidance (Ref. 5) was reviewed and used as appropriate. Moreover, the details pertaining to the use of ground level, vent and stack releases, calculation of building wake correction factors, appropriate ARCON96 default input and the use of diffuse area sources were considered for inclusion.

4. Computer Hardware/Software Usage

4.1. Description of Hardware Used

All computer calculations were performed on Windows® 98 and Windows® 2000 personal computers. The computer identification of the PCs used are CNS-115 and CNS-112.

4.2. Description of Software Used

The ARCON96 computer code system was used to calculate control room X/Q values. ARCON96 is an NRC affiliated computer code which implements a straight-line Gaussian dispersion model to estimate downwind X/Q values. The X/Q values are determined from hourly meteorological data. ARCON96 has the capability to calculate ground-level, vent or stack release scenarios. A complete description of the code, including its capabilities, technical basis and programmer's guide can be found in the user's guide (Ref. 2).

Microsoft® Excel® was utilized to calculate distances and directions for release/intake scenarios not readily available by reference.

4.2.1. Software Verification

ARCON96 has been verified and validated (Ref. 6) in accordance with Quality Assurance procedures (Ref. 7). Microsoft® Excel® is classified as Category 3 Software per section 3.2.3 of the CNS Computer Code Verification 3.5 (Ref. 7) and does not require initial verification. The results obtained from use of Microsoft® Excel® were verified in the same manner as technical reports (Ref. 7).

5. Inputs

5.1. Meteorological Input

1. Upper level wind measurement height = 199' = 60.66 meters (Ref. 8).
2. Lower level wind measurement height = 31' = 9.45 meters (Ref. 8).
3. Meteorological input data provided in ARCON96 MET file "NMP 1997-2001 ARCON96 Rev 1.txt" (Ref. 27). This data is a revision to previously used data (Ref. 9). This file has been renamed "NMP_R1.MET" and is included on the attached disk.

5.2. Release/Intake Distances and Directions

Distances and sector bearings for the various releases for both Units 1 and 2 are provided in several previous calculations performed by Meteorological Evaluation Services (MES), Inc. Table 5.2.1 summarizes this input data.

5.3. Release/Intake Elevations

Elevations for the release and intake points are provided in various MES calculations, USAR and drawings. Table 5.3.1 summarizes the elevations of the release and intake points. Unless otherwise indicated, the elevations listed are above plant grade.

5.4. Building Dimensions Related Pertinent to Wake Area Calculations

Unit 1 Turbine Building

1. Building height above grade = 369' 3 1/2" – 261' = 108' 3 1/2" = 33 meters (Ref. 10).

Unit 2 Turbine Building

1. East-west dimension = 338' = 103.02 meters (Ref. 11).
2. North-south dimension = 140' = 42.67 meters (Ref. 11).
3. Building height above grade = 120' = 36.58 meters (Ref. 12).

Unit 2 Reactor Building

1. Outer radius = 85' 6" = 26.06 meters. (Ref. 13)
2. Maximum wall height above grade (top of parapet) = 430' 1 1/2" – 261' = 169' 1 1/2" = 51.55 meters (Ref. 14).

Table 5.2.1. Release/Intake Distances and Directions

Release/Intake	Distance (ft.)	Distance (m)	Sector Bearing[1]	Reference
Releases to Unit 1 Control Room Intake				
Unit 1 Reactor Building Blowout Panel[2] / Unit 1 Control Room Intake	340	103.6	149^0 SSE	Table 1 Ref. 18
Unit 1 Turbine Building Blowout Panel[2] / Unit 1 Control Room Intake	236	71.9	117^0 ESE	Table 1 Ref. 18
Unit 1 Main Stack / Unit 1 Control Room Intake	400	121.9	166^0 SSE	Table 1 Ref. 18
Unit 2 Combined Radwaste & Reactor Building Vent / Unit 1 Control Room	615	187	246^0 WSW	Page 2 Ref. 17
Unit 2 Main Steam Tunnel / Unit 1 Control Room	595	181	246^0 WSW	Page 2 Ref. 17
Unit 2 Standby Gas Treatment System Building / Unit 1 Control Room	800	244	242^0 WSW	Page 2 Ref. 17
Unit 2 Post-Accident Sampling System Panel / Unit 1 Control Room	660	201	230^0 SW	Page 2 Ref. 17

Release/Intake	Distance (ft.)	Distance (m)	Sector Bearing[1]	Reference
Unit 2 Main Stack / Unit 1 Control Room	1355	413	233° SW	Page 2 Ref. 17
Releases to Unit 1 Technical Support Center				
Unit 1 Reactor Building Blowout Panel[2] / Unit 1 Technical Support Center	343	104.5	86° ESE	Table 1 Ref. 18
Unit 1 Turbine Building Blowout Panel[2] / Unit 1 Technical Support Center	328	100.0	86° E	Table 1 Ref. 18
Unit 1 Main Stack / Unit 1 Technical Support Center	330	100.6	140° SE	Table 1 Ref. 18
Releases to Unit 2 Control Room Intakes				
Unit 1 Main Stack / Unit 2 Control Room West-High	740	225.6	121.5° ESE	Table 1 Ref. 18
Unit 1 Main Stack / Unit 2 Control Room West-Low	720	219.5	119.5° ESE	Table 1 Ref. 18
Unit 1 Main Stack / Unit 2 Control Room East-High	800	243.8	115° ESE	Table 1 Ref. 18
Unit 1 Main Stack / Unit 2 Control Room East-Low	800	243.8	115° ESE	Table 1 Ref. 18
Unit 2 Main Stack / Unit 2 Control Room West-High	937	286	225° SW	Table 4 Ref. 16
Unit 2 Main Stack / Unit 2 Control Room West-Low	919	280	225° SW	Table 4 Ref. 16
Unit 2 Main Stack / Unit 2 Control Room East-High	843	257	202.5° SSW	Table 4 Ref. 16
Unit 2 Main Stack / Unit 2 Control Room East-Low	846	258	202.5° SSW	Table 4 Ref. 16

Notes.
1. Sector bearing in degree is measured relative to true north.
2. Distance and directions from midpoint of blowout panel.

Table 5.3.1. Release/Intake Elevations

Point of Interest	Elevation (ft)	Elevation (m)	Reference
Unit 1 Main Stack	350	106.7	Page II-35, Ref. 15
Unit 1 Reactor Building Blowout Panel[1]	78.9	24.0	Ref. 10
Unit 1 Turbine Building Blowout Panel[1]	72.4	22.1	Ref. 10
Unit 2 Main Stack	429	130.8	Table 1, Ref. 16
Unit 2 Combined Radwaste & Reactor Building Vent	187	57	Section 11.3.3.1, Ref. 19
Unit 2 Main Steam Tunnel[2]	45.08	13.7	Ref. 20
Unit 2 Standby Gas Treatment System Building[2]	23.5	7.2	Ref. 21
Unit 2 Control Room Intake West-High[3]	36	11	Ref. 22
Unit 2 Control Room Intake West-Low[3]	15.5	4.7	Ref. 22
Unit 2 Control Room Intake East-High[3]	52.75	16.1	Ref. 22
Unit 2 Control Room Intake East-Low[3]	19	5.8	Ref. 22

Notes:
1. Elevation relative to bottom of blowout panel.
2. Elevation relative to bottom of louvered exhaust.
3. Elevation relative to bottom of intake.

6. Assumptions

1. North-south dimension of Unit 1 Turbine Building = 116' 5" = 35.48 meters (Ref. 23). This assumption is taken to approximate the dimension of the Unit 1 Turbine Building for the purposes of calculating the building wake area.

2. East-west dimension of Unit 1 Turbine Building = 2x(23' 6") + 14x20' = 327' = 99.67 meters (Ref. 23). This assumption is taken to approximate the dimension of the Unit 1 Turbine Building for the purposes of calculating the building wake area.

3. Unit 1 Control Room intake height above grade = 333' – 261' = 72' = 21.95 meters. (Ref. 24) Assumes the intake height is equal to roof elevation. This assumption is taken to approximate the height of the intake as it is not apparent from the references.

4. PASS Panel Vent release height above grade = 339' + 4' (curb) – 261' = 82' = 25 meters. (Ref. 25) Assumed to include 4' high concrete curb surrounding the vent location. This assumption is taken to approximate the vent release height as it is not apparent from the references.

5. Unit 1 releases to Unit 1 Control room intake building wake area is conservatively assumed to be equal to one half of the east-west Unit 1 Turbine Generator Building cross-sectional area. This assumption is to account for the complexity of the dense building cluster at the NMP site for which it is difficult to accurately characterize the building wake area. This assumption conservatively results in higher X/Q values.

6. Unit 1 releases to Unit 2 Control Room intakes building wake area is conservatively assumed to be equal to north-south cross sectional area of the Unit 2 Turbine Building. As the building wake area is difficult to accurately characterize, this assumed area is a best estimate. The actual cross sectional area from the release point to the receptor may be slightly greater than the value determined from this assumption. Therefore, this assumption conservatively results in higher X/Q values.

7. Unit 2 releases to Unit 1 Control Room intake and Unit 1 Technical Support Center, with the exception of the Unit 2 Main Stack release, building wake area is conservatively assumed to be equal to north-south cross-sectional area of the Unit 2 Turbine Building. As the building wake area is difficult to accurately characterize, this assumed area is a best estimate. The actual cross sectional area from the release point to the receptor may be slightly greater than the value determined from this assumption. Therefore, this assumption conservatively results in higher X/Q values.

8. Unit 2 Standby Gas Treatment System Building and Unit 2 Main Stack releases to Unit 2 Control Room intakes building wake area is conservatively assumed to be equal to the Unit 2 Reactor Building cross-sectional area. This assumption is taken since the Unit 2 Reactor Building is the dominant structure between the release point and the receptor location. This assumption is conservative because the actual building wake area may be larger due to neighboring structures.

9. Unit 2 Combined Radwaste & Reactor Building Vent and Main Steam Tunnel releases to Unit 2 Control room intakes building wake area is assumed to be 0.01 m^2 (Ref. 5) for a zero wake term. This assumption is made because the Combined Radwaste & Reactor Building Vent and Main Steam Tunnel release points are in close proximity to the intakes. In this configuration it is difficult to characterize the building wake area and assure a conservative X/Q estimate. A zero wake term assumption conservatively results in higher X/Q values.

10. Unit 2 PASS Panel Vent release to Unit 2 Control room intakes building wake area is conservatively assumed to be equal to one half of the Unit 2 Reactor Building cross-sectional area. This assumption is to account for the complexity of the dense building cluster at the NMP site for which it is difficult to accurately characterize the building wake area. This assumption conservatively results in higher X/Q values.

11. Unit 2 Main Stack release is assumed to be a ground-level release as opposed to a stack release in ARCON96. This assumption is made because the NMP stacks are generally located in close proximity to the site building cluster. The height of the stacks

are close to or below 2.5 times the height of the site building structures. Also, regulatory guidance documents (Ref. 5) indicate that proper qualification of stack configurations must be made in order to assume a stack release. Therefore, to alleviate the regulatory risk and to assure conservative X/Q estimates, this assumption has been made. The X/Q results from this assumption will be conservatively higher than those calculated as stack release.

12. Unit 1 Turbine Building Blowout panel release to Unit 1 Technical Support Center building wake area is conservatively assumed to be equal to the north-south Unit 1 Turbine Building Generator Building cross-sectional area. As the building wake area is difficult to accurately characterize, this assumed area is a best estimate. The actual cross sectional area from the release point to the receptor may be slightly greater than the value determined from this assumption. Therefore, this assumption conservatively results in higher X/Q values.

13. Unit 1 Main Stack and Reactor Building Blowout Panel releases to Unit 1 Technical Support Center building wake area is assumed to be 0.01 m^2 (Ref. 5) for a zero wake term. This assumption is made because the release points are in close proximity to the intakes. In this configuration it is difficult to characterize the building wake area. A zero wake term assumption conservatively results in higher X/Q values.

14. Elevation change from the mid-point of the Unit 1 Turbine Building Blowout Panel to Unit 1 Technical Support Center is 62' or 18.9 meter (Ref. 18). The elevation of the mid-point of the Unit 1 Turbine Building Blowout Panel is approximately (354' + 334') / 2 – 261' = 83' according to Reference 10 . Therefore, the elevation of the Unit 1 Technical Support Center is assumed to be 83 – 62' = 21' = 6.4 m. This assumption is taken in lieu of a clear reference showing the height of the Unit 1 Technical Support Center intake structure.

7. Calculations and Results

7.1. Release/Intake Distances and Directions Calculations

Table 5.2.1 lists the distances and directions provided in the X/Q calculations performed previously by MES. These MES calculations fail to provide the distances and sector bearings for the following releases to the Unit 2 Control Room intakes: (1) Unit 1 Reactor Building blowout panel, (2) Unit 1 Turbine Building blowout panel, (3) Unit 2 Main Steam Tunnel, (4) Unit 2 Combined Radwaste & Reactor Building Vent, (5) Unit 2 PASS Panel vent and (6) Unit 2 Standby Gas Treatment Building vent. Furthermore, the MES calculations also fail to disclose the distances and bearings for the Unit 2 releases to the Unit 1 Technical Support Center. The data listed in Table 5.2.1 was used to calculate the distances and directions for the above release/intake combinations by developing a coordinate system. The Unit 2 Main Stack release point was defined as the origin. Figure 7.1.1 shows a schematic depicting the coordinate system used. The coordinate axes, x and y, were respectively aligned with the "true north" and "true east."

The calculations were performed using standard geometry and a Microsoft® Excel® spreadsheet. The unknown distances and directions were calculated in four basic steps: (1) coordinates of the Unit 1 Control Room intake were calculated, (2) the Unit 1 Control Room intake coordinates were used to calculate the coordinates of the six release points listed above and also the Unit 1 Main Stack, (3) the Unit 1 Main Stack coordinates were used to calculate the Unit 2 Control Room intake coordinates and (4) the coordinates of the Unit 2 Control Room intakes and the six releases points listed above were used to calculate the distances and directions. A procedure analogous to the above was used to calculate the distances and directions to the Unit 1 Technical Support Center for the following Unit 2 releases: (1) Main Steam Tunnel, (2) Combined Radwaste & Reactor Building Vent, (3) PASS Panel and (4) Standby Gas Treatment System Building. The simple geometry formulations listed below were implemented:

$$\Delta x = d \cdot \sin(\theta),$$
$$\Delta y = d \cdot \cos(\theta) \text{ and}$$
$$\alpha = \tan^{-1}\left(\frac{\Delta x}{\Delta y}\right) \quad \theta = \alpha + 180^0,$$

where, Δx is the change in the x coordinate, Δy is the change in the y coordinate, θ is the angle relative to "true north," α is the angle relative to the negative y-axis (180 degree or south) and d is the distance between two points. Table 7.1.1 shows the coordinates calculated for the various release/intake locations previously listed. Table 7.1.2 shows the calculated distances and directions for various releases to the Unit 2 Control Room intakes. Table 7.1.3 shows the calculated distances and directions for various releases to the Unit 1 Technical Support Center.

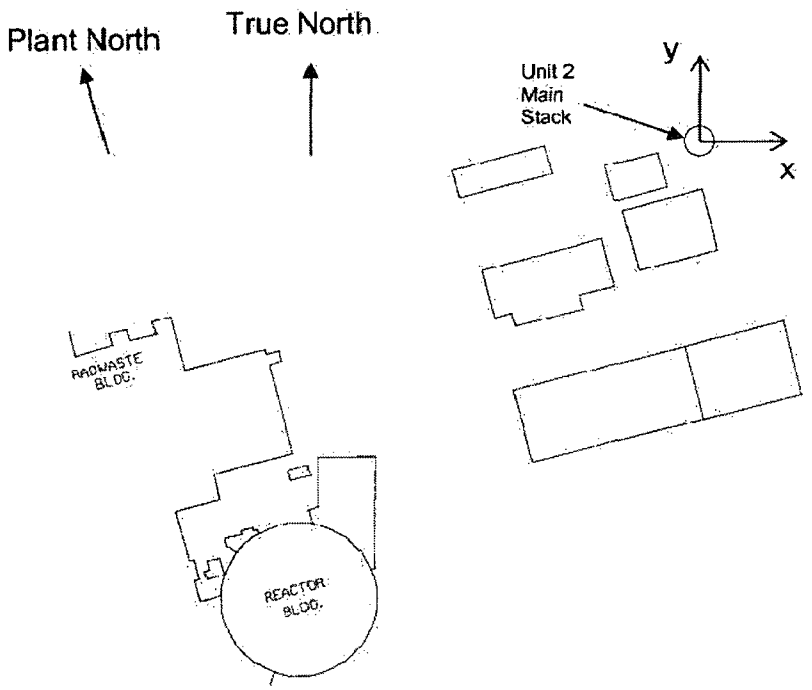

Figure 7.1.1. Schematic of Coordinate Used In Calculating Release/Intake Distances and Directions

Table 7.1.1. Summary Table of Calculated Coordinates of Release/Intake Locations for Units 1 and 2

							Coordinates		
FROM	TO	Δx (ft)	Δy (ft)	d (ft)	d (m)	θ (deg)	x (ft)	y (ft)	Location
Unit 2 Main Stack	Unit 1 Control Room Intake	-1082.15	-815.46	1355	413	233	-1082.15	-815.46	Unit 1 Control Room Intake
Unit 1 Rx Bldg. Blowout Panel	Unit 1 Control Room Intake	175.11	-291.44	340	103.6	149	-1257.26	-524.02	Unit 1 Rx Bldg. Blowout Panel
Unit 1 Turbine Bldg. Blowout Panel		210.28	-107.14	236	71.9	117	-1292.43	-708.32	Unit 1 Turbine Bldg. Blowout Panel
Unit 2 Main Steam Tunnel		-543.56	-242.01	595	181	246	-538.59	-573.45	Unit 2 Main Steam Tunnel
Unit 2 Combined Rx/Rw Vent		-561.83	-250.14	615	187	246	-520.32	-565.32	Unit 2 Combined Rx/Rw Vent
Unit 2 PASS		-505.59	-424.24	660	201	230	-576.56	-391.22	Unit 2 PASS
Unit 2 Standby Gas		-706.36	-375.58	800	244	242	-375.79	-439.88	Unit 2 Standby Gas
Unit 1 Main Stack	Unit 1 Control Room Intake	96.77	-388.12	400	121.9	166	-1178.92	-427.34	Unit 1 Main Stack
Unit 1 Main Stack	Unit 1 Technical Support Center	212.12	-252.79	330	100.6	140	-966.80	-680.14	Unit 1 Technical Support Center
Unit 1 Main Stack	Unit 2 Control Room - West High	630.95	-386.65	740	225.6	121.5	-547.97	-813.99	Unit 2 Control Room - West High
	Unit 2 Control Room - West Low	626.66	-354.54	720	219.5	119.5	-552.26	-781.89	Unit 2 Control Room - West Low
	Unit 2 Control Room - East High	725.05	-338.09	800	243.8	115	-453.87	-765.44	Unit 2 Control Room - East High
	Unit 2 Control Room - East Low	725.05	-338.09	800	243.8	115	-453.87	-765.44	Unit 2 Control Room - East Low

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Table 7.1.2. Summary Table of Distances and Directions for Various Releases to Unit 2 Control Room Intakes

FROM	TO	Δx (ft)	Δy (ft)	d (ft)	d (m)	θ (deg)
Unit 1 Rx Bldg. Blowout Panel	Unit 2 Control Room - West High	709.30	-289.97	766.28	233.56	112.24
	Unit 2 Control Room - West Low	705.00	-257.86	750.68	228.81	110.09
	Unit 2 Control Room - East High	803.39	-241.41	838.88	255.69	106.73
	Unit 2 Control Room - East Low	803.39	-241.41	838.88	255.69	106.73
Unit 1 Turbine Bldg. Blowout Panel	Unit 2 Control Room - West High	744.46	-105.67	751.92	229.19	98.08
	Unit 2 Control Room - West Low	740.16	-73.57	743.81	226.71	95.68
	Unit 2 Control Room - East High	838.56	-57.12	840.50	256.18	93.90
	Unit 2 Control Room - East Low	838.56	-57.12	840.50	256.18	93.90
Unit 2 Main Steam Tunnel	Unit 2 Control Room - West High	-9.37	-240.54	240.72	73.37	182.23
	Unit 2 Control Room - West Low	-13.67	-208.43	208.88	63.67	183.75
	Unit 2 Control Room - East High	84.72	-191.98	209.85	63.96	156.19
	Unit 2 Control Room - East Low	84.72	-191.98	209.85	63.96	156.19
Unit 2 Combined Rx/Rw Vent	Unit 2 Control Room - West High	-27.65	-248.67	250.21	76.26	186.34
	Unit 2 Control Room - West Low	-31.94	-216.57	218.91	66.72	188.39
	Unit 2 Control Room - East High	66.45	-200.12	210.86	64.27	161.63
	Unit 2 Control Room - East Low	66.45	-200.12	210.86	64.27	161.63
Unit 2 PASS	Unit 2 Control Room - West High	28.60	-422.77	423.74	129.15	176.13
	Unit 2 Control Room - West Low	24.30	-390.67	391.42	119.31	176.44
	Unit 2 Control Room - East High	122.69	-374.22	393.81	120.03	161.85
	Unit 2 Control Room - East Low	122.69	-374.22	393.81	120.03	161.85
Unit 2 Standby Gas	Unit 2 Control Room - West High	-172.17	-374.11	411.83	125.52	204.71
	Unit 2 Control Room - West Low	-176.47	-342.00	384.85	117.30	207.29
	Unit 2 Control Room - East High	-78.08	-325.55	334.79	102.04	193.49
	Unit 2 Control Room - East Low	-78.08	-325.55	334.79	102.04	193.49

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Table 7.1.3. Summary Table of Distances and Directions of Unit 2 Releases to the Unit 1 Technical Support Center

FROM	TO	Δx (ft)	Δy (ft)	d (ft)	d (m)	θ (deg)
Unit 2 Main Steam Tunnel	Unit 1 Technical Support Center	-428.21	-106.68	441.30	134.51	256.01
Unit 2 Combined Rx/Rw Vent	Unit 1 Technical Support Center	-446.48	-114.82	461.01	140.51	255.58
Unit 2 PASS	Unit 1 Technical Support Center	-390.24	-288.92	485.55	148.00	233.49
Unit 2 Standby Gas	Unit 1 Technical Support Center	-591.01	-240.25	637.97	194.45	247.88

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7.2. Building Wake Areas

Due to the complexity of the geometry of the structural buildings for both Units 1 and 2, conservative building wake areas were calculated. The conservative assumptions taken to calculate the wake areas are stated in 5 through 10, 12 and 13 of Section 6.1. The calculations for determining building wake areas are as follows:

Unit 1 Releases to Unit 1 Control Room Intake

Per assumption 5 of Section 6.1, the contributing building area is conservatively assumed to be one half of the east-west cross-sectional area of the Unit 1 Turbine Generator Building.

Effective Height of Unit 1 Turbine Generator Building = Height of Generator Building – Height of Unit 1 Control Room Intake = 33 m – 21.95 m = 11 m.

One half east-west length of Unit 1 Turbine Generator Building = 0.5 x 99.67 m = 49.8m

Wake Area for All Unit 1 Releases to Unit 1 Control Room Intake = 11 m x 49.8 m = 550 m^2

Unit 1 Releases to Unit 2 Control Room Intakes

Per assumption 6 of Section 6.1, the contributing building area is conservatively assumed to be the north-south cross-sectional area of the Unit 2 Turbine Building. The height of the intakes is assumed to be the maximum of all four Control Room intakes.

Effective height of Unit 2 Turbine Building = Height of Turbine Building – Max Height of Control Room Intakes = 36.58 m – 16.1 m = 20.4 m

North-south length of Unit 2 Turbine Building = 42.67 m

Wake Area for All Unit 1 Releases to Unit 2 Control Room Intakes = 20.4 m x 42.67 m = 870 m^2

Unit 2 Releases to Unit 1 Control Room Intakes (Excluding Unit 2 Main Stack Release)

Per assumption 7 of Section 6.1, the contributing building area is conservatively assumed to be the north-south cross-sectional area of the Unit 2 Turbine Building.

Effective height of Unit 2 Turbine Building = Height of Turbine Building – Height of Unit 1 Control Room Intake = 36.58 m – 21.95 m = 14.6 m

North-south length of Unit 2 Turbine Building = 42.67 m

Wake Area for All Unit 2 Releases (Excluding Unit 2 Main Stack) to Unit 1 Control Room Intakes = 14.6 m x 42.67 m = 623 m^2

Unit 2 Releases to Unit 1 Technical Support Center (Excluding Unit 2 Main Stack Release)

Per assumption 7 of Section 6.1, the contributing building area is conservatively assumed to be the north-south cross-sectional area of the Unit 2 Turbine Building.

Effective height of Unit 2 Turbine Building = Height of Turbine Building – Height of Unit 1 Technical Support Center = 36.58 m – 6.4 m = 30.18 m

North-south length of Unit 2 Turbine Building = 42.67 m

Wake Area for All Unit 2 Releases (Excluding Unit 2 Main Stack) to Unit 1 Technical Support Center = 30.18 m x 42.67 m = 1287 m^2

Unit 2 Main Stack Release to Unit 1 Control Room Intake

The Unit 2 Main Stack displacement from the Unit 2 Reactor and Turbine building is sufficient such that the building wake area for the Unit 2 Main Stack to the Unit 1 Control Room intake includes both the entire area of the Unit 2 Reactor Building and the north-south cross-sectional area of the Unit 2 Turbine Building.

Effective height of Unit 2 Turbine Building = Height of Turbine Building – Height of Unit 1 Control Room Intake = 36.58 m – 21.95 m = 14.6 m

Effective height of Unit 2 Reactor Building = Height of Reactor Building – Height of Unit 1 Control Room Intake = 51.55 m – 21.95 m = 29.6 m

North-south length of Unit 2 Turbine Building = 42.67 m

Diameter of Unit 2 Reactor Building = 2 x 26.06 m = 52.1m

Wake Area of Unit 2 Turbine Building = 14.6 m x 42.67 m = 623 m^2
Wake Area of Unit 2 Reactor Building = 29.6 m x 52.1 m = 1542 m^2

Wake Area for Unit 2 Main Stack Release to Unit 1 Control Room Intake = 623 m^2 + 1542 m^2 = 2165 m^2

Unit 2 Main Stack Release to Unit 1 Technical Support Center

The Unit 2 Main Stack displacement from the Unit 2 Reactor and Turbine building is sufficient such that the building wake area for the Unit 2 Main Stack to the Unit 1 Technical Support

Center includes both the entire area of the Unit 2 Reactor Building and the north-south cross-sectional area of the Unit 2 Turbine Building.

Effective height of Unit 2 Turbine Building = Height of Turbine Building – Height of Unit 1 Technical Support Center = 36.58 m – 6.4 m = 30.18 m

Effective height of Unit 2 Reactor Building = Height of Reactor Building – Height of Unit 1 Technical Support Center = 51.55 m – 6.4 m = 45.15 m

North-south length of Unit 2 Turbine Building = 42.67 m

Diameter of Unit 2 Reactor Building = 2 x 26.06 m = 52.12 m

Wake Area of Unit 2 Turbine Building = 30.18 m x 42.67 m = 1287 m^2
Wake Area of Unit 2 Reactor Building = 45.15 m x 52.12 m = 2353 m^2

Wake Area for Unit 2 Main Stack Release to Unit 1 Control Room Intake = 1287 m^2 + 2353 m^2 = 3639 m^2

Unit 2 Standby Gas System Building and Unit 2 Main Stack Releases to Unit 2 Control Room Intakes

Per assumptions 8 of Section 6.1, the contributing building area is conservatively assumed to be the cross-sectional area of the Unit 2 Reactor Building. The height of the intakes is assumed to be the maximum of all four Control Room intakes.

Effective height of Unit 2 Reactor Building = Height of Turbine Building – Max Height of Control Room Intakes = 51.55 m – 16.1 m = 35.4 m

Diameter of Unit 2 Reactor Building = 2 x 26.06 m = 52.1 m

Wake Area for Unit 2 Standby Gas System Building and Unit 2 Main Stack Releases to Unit 2 Control Room Intakes = 35.4 m x 52.1 m = 1844 m^2

Unit 2 PASS Panel Vent Release to Unit 2 Control Room Intakes

Per assumption 10 of Section 6.1, the contributing building area is conservatively assumed to be one half the cross-sectional area of the Unit 2 Reactor Building. The height of the intakes is assumed to be the maximum of all four Control Room intakes.

Effective height of Unit 2 Reactor Building = Height of Reactor Building – Max Height of Control Room Intakes = 51.55 m – 16.1 m = 35.4 m

Diameter of Unit 2 Reactor Building = 2 x 26.06 m = 52.1 m

Wake Area for Unit 2 PASS Panel Vent Release to Unit 2 Control Room Intakes = 0.5 x 35.4 m^2 x 52.1 m = 922 m^2

Unit 1 Turbine Building Blowout Panel Release to Unit 1 Technical Support Center

Per assumption 12 of Section 6.1, the contributing building area is conservatively assumed to be the north-south cross-sectional area of the Unit 1 Turbine Building.

Effective Height of Unit 1 Turbine Generator Building = Height of Turbine Building – Height of Unit 1 Technical Support Center = 33 m – 6.4 m = 26.6 m.

North-south Length of the Unit 1 Turbine Building = 35.48 m

Wake Area for Unit 1 Turbine Building Blowout Panel Release to Unit 1 Technical Support Center = 26.6 m x 35.48 m = 943 m^2

Table 7.2.1 summarizes the building wake areas calculated above.

Table 7.2.1. Calculated Building Wake Areas

Release	Intake	Area (m^2)
Unit 1 – All	Unit 1 CR	550
Unit 1 – Main Stack Unit 1 – Reactor Building Blowout Panel	Unit 1 TSC	0.01 [1]
Unit 1 – Turbine Building Blowout Panel	Unit 1 TSC	943
Unit 1 – All	Unit 2 CR – All	870
Unit 2 – All Except Main Stack	Unit 1 CR	623
Unit 2 – All Except Main Stack	Unit 1 TSC	1287
Unit 2 – Main Stack	Unit 1 CR	2165
Unit 2 – Main Stack	Unit 1 TSC	3639
Unit 2 – Standby Gas Building Unit 2 – Main Stack	Unit 2 CR – All	1844
Unit 2 – PASS Panel Vent	Unit 2 CR – All	922
Unit 2 – Combined Radwaste/Reactor Building Vent Unit 2 – Main Steam Tunnel	Unit 2 CR – All	0.01[1]

1. In accordance with assumptions 9 and 13 of section 6.1.

7.3. X/Q Values

The ARCON96 input is comprised of release/intake specific data and some default input parameters. The ARCON96 user's guide (Ref. 2) provides the details of the default input data. All releases have been treated as ground-level releases, including both stack releases. Regulatory guidance (Ref. 5) suggests the use of stack release mode in ARCON96 when the release point is greater than 2.5 times the height of adjacent buildings. Following this specification the Unit 1 stack release is clearly considered a ground-level release. The Unit 2 Main Stack is only slightly greater then 2.5 times the Unit 2 Reactor Building. Since this guidance (Ref. 5) suggests that ARCON96 can calculate non-conservative X/Q values in stack release mode and given the consideration that the Unit 2 Main Stack is very close to 2.5 times the Unit 2 Reactor Building height, the mode of release provided in the ARCON96 for all Unit 2 Stack releases is ground-level. This is consistent with assumption 11 above in Section 6.

The diffuse area source as described in the regulatory guidance (Ref. 5) was also considered for the Unit 1 Turbine Building and Reactor Building blowout panel release scenarios. ARCON96 runs were performed using the diffuse area source input for ARCON96 (as described in Ref. 5). The results suggest that the values calculated with the diffuse area source are slightly less conservative than the values calculated by considering the blowout panels as a finite point. Therefore, no diffuse area sources have been implemented in the ARCON96 runs.

ARCON96 requires the direction data for each release/receptor to be input as the direction from the intake to the release. To this point, the directions listed above in Tables 5.2.1 and 7.1.2 were inverted by 180 degrees. The final distances and directions are provided in Table 7.3.1.

The input common to all runs is comprised mainly of default data. The regulatory guidance (Ref. 5) also provides guidance on values of default input data. The values specified in the regulatory guidance (Ref. 5) were used instead of those provided in the ARCON96 user's manual (Ref. 2). Table 7.3.2 lists the ARCON96 common or default input that was used and the reference for that input data.

A representative input file is included in Appendix A. Due to the number of computer runs performed the input and output files have been provided on the enclosed CD. Appendix C provides a list of computer runs and Appendix D provides a listing of all files on the enclosed CD.

Table 7.3.3-1 provides tabular results of the X/Q values for all releases to the Unit 1 Control Room and Table 7.3.3-2 provides results of the X/Q values for all releases to the Unit 1 Technical Support Center. Table 7.3.4 provides tabular results of the X/Q values for all releases to the Unit 2 Control Room.

The results presented in Tables 7.3.3-1 through 7.3.4 are based on revised meteorological data (Refs. 27 and 28).

Table 7.3.1 ARCON96 Distances and Directions Input

FROM	TO	Distance (m)	Direction (degrees)
Unit 1 Control Room Intake	Unit 1 Reactor Building Blowout Panel	103.6	329
	Unit 1 Turbine Building Blowout Panel	71.9	297
	Unit 1 Main Stack	121.9	346
	Unit 2 Combined Radwaste & Reactor Building Vent	187	66
	Unit 2 Main Steam Tunnel	181	66
	Unit 2 Standby Gas Treatment System Building	244	62
	Unit 2 Post Accident Sampling System Panel	201	50
	Unit 2 Main Stack	413	53
Unit 1 Technical Support Center	Unit 1 Reactor Building Blowout Panel	104.5	266
	Unit 1 Turbine Building Blowout Panel	100.0	266
	Unit 1 Main Stack	100.6	320
	Unit 2 Combined Radwaste & Reactor Building Vent	140.51	75.58
	Unit 2 Main Steam Tunnel	134.51	76.01
	Unit 2 Standby Gas Treatment System Building	194.45	67.88
	Unit 2 Post Accident Sampling System Panel	148.00	53.49
	Unit 2 Main Stack	360.29	54.87
Unit 2 Control Room Intake West – High	Unit 1 Reactor Building Blowout Panel	233.56	292.24
Unit 2 Control Room Intake West – Low		228.81	290.09
Unit 2 Control Room Intake East – High		255.69	286.73
Unit 2 Control Room Intake East – Low		255.69	286.73
Unit 2 Control Room Intake West – High	Unit 1 Turbine Building Blowout Panel	229.19	278.08
Unit 2 Control Room Intake West – Low		226.71	275.68
Unit 2 Control Room Intake East – High		256.18	273.90
Unit 2 Control Room Intake East – Low		256.18	273.90
Unit 2 Control Room Intake West – High	Unit 1 Main Stack	225.6	301.5
Unit 2 Control Room Intake West – Low		219.5	299.5
Unit 2 Control Room Intake East – High		243.8	295
Unit 2 Control Room Intake East – Low		243.8	295
Unit 2 Control Room Intake West – High	Unit 2 Combined Radwaste & Reactor Building Vent	76.26	6.34
Unit 2 Control Room Intake West – Low		66.72	8.39
Unit 2 Control Room Intake East – High		64.27	341.63
Unit 2 Control Room Intake East – Low		64.27	341.63
Unit 2 Control Room Intake West – High	Unit 2 Main Steam Tunnel	73.37	2.23
Unit 2 Control Room Intake West – Low		63.67	3.75
Unit 2 Control Room Intake East – High		63.96	336.19
Unit 2 Control Room Intake East – Low		63.96	336.19
Unit 2 Control Room Intake West – High	Unit 2 Standby Gas Treatment System Building	125.52	24.71
Unit 2 Control Room Intake West – Low		117.30	27.29

FROM	TO	Distance (m)	Direction (degrees)
Unit 2 Control Room Intake East – High		102.04	13.49
Unit 2 Control Room Intake East – Low		102.04	13.49
Unit 2 Control Room Intake West – High	Unit 2 Post Accident Sampling System Panel	129.15	356.13
Unit 2 Control Room Intake West – Low		119.31	356.44
Unit 2 Control Room Intake East – High		120.03	341.85
Unit 2 Control Room Intake East – Low		120.03	341.85
Unit 2 Control Room Intake West – High	Unit 2 Main Stack	286	45
Unit 2 Control Room Intake West – Low		280	45
Unit 2 Control Room Intake East – High		257	22.5
Unit 2 Control Room Intake East – Low		258	22.5

Table 7.3.2. List of Common/Default Input Data to ARCON96

Input Parameter	Value Used	Reference
Lower Wind Measurement Height	9.45 m	Ref. 8
Upper Wind Measurement Height	60.66 m	Ref. 8
Wind Speed Units	2 (mph)	Ref. 26
Release Type	1 (ground release)	Assumption 11
Stack Velocity	0	Assumption 11
Stack Flow	0	Assumption 11
Stack Radius	0	Assumption 11
Elevation Difference	0	Ref. 5
Surface Roughness	0.2 m	Ref. 5
Wind Direction Window	90 degrees	Code Default
Minimum Wind Speed	0.5 m/s	Code Default
Averaging Sector Width Constant	4.3	Ref. 5
Initial Diffusion Coefficients	0	Code Default
Hours in Averages	see user's guide (Ref. 2)	Code Default
Minimum Number of Hours	see user's guide (Ref. 2)	Code Default
Expanded Output	n	Code Default

Table 7.3.3-1. X/Q Values for the Unit 1 Control Room

	X/Q Dispersion Coefficients (s / m^3)				
Release Point	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**
U1 Reactor Bldg. Blowout Panel	4.82E-04	2.61E-04	9.25E-05	6.70E-05	4.93E-05
U1 Turbine Bldg. Blowout Panel	1.03E-03	5.85E-04	2.07E-04	1.75E-04	1.52E-04
U1 Main Stack	2.27E-04	1.26E-04	4.30E-05	3.58E-05	2.59E-05
U2 Combined Radwaste & Reactor Vent	1.77E-04	1.09E-04	3.92E-05	2.48E-05	1.85E-05
U2 Post Accident Sampling Sys. Panel	1.59E-04	1.13E-04	4.19E-05	2.48E-05	2.00E-05
U2 Standby Gas Treatment Sys. Building	1.11E-04	8.09E-05	2.91E-05	1.82E-05	1.45E-05
U2 Main Steam Tunnel	1.90E-04	1.37E-04	4.93E-05	3.12E-05	2.56E-05
U2 Main Stack	4.18E-05	2.30E-05	8.94E-06	5.62E-06	4.31E-06

Table 7.3.3-2. X/Q Values for the Unit 1 Technical Support Center

	X/Q Dispersion Coefficients (s / m^3)				
Release Point	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**
U1 Reactor Bldg. Blowout Panel	7.09E-04	5.60E-04	2.34E-04	1.71E-04	1.41E-04
U1 Turbine Bldg. Blowout Panel	5.91E-04	4.26E-04	1.63E-04	1.35E-04	1.16E-04
U1 Main Stack	3.47E-04	2.42E-04	8.22E-05	6.06E-05	5.00E-05
U2 Combined Radwaste & Reactor Vent	2.70E-04	1.64E-04	5.41E-05	3.86E-05	2.86E-05
U2 Post Accident Sampling Sys. Panel	2.69E-04	1.91E-04	7.19E-05	4.22E-05	3.40E-05
U2 Standby Gas Treatment Sys. Building	1.62E-04	1.19E-04	4.28E-05	2.72E-05	2.24E-05
U2 Main Steam Tunnel	3.27E-04	2.41E-04	8.38E-05	5.95E-05	4.76E-05
U2 Main Stack	4.95E-05	2.69E-05	1.03E-05	6.67E-06	4.85E-06

Table 7.3.4. X/Q Values for the Unit 2 Control Room

	U2 Control Room Intake - Upper West					U2 Control Room Intake - Upper East				
	X/Q Dispersion Coefficients (s / m^3)					X/Q Dispersion Coefficients (s / m^3)				
Release Point	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**
U1 Reactor Bldg. Blowout Panel	1.23E-04	7.21E-05	2.57E-05	2.28E-05	2.05E-05	1.06E-04	6.70E-05	2.39E-05	2.17E-05	1.96E-05
U1 Turbine Bldg. Blowout Panel	1.30E-04	9.03E-05	3.45E-05	2.92E-05	2.56E-05	1.09E-04	7.73E-05	2.95E-05	2.45E-05	2.14E-05
U1 Main Stack	1.06E-04	5.90E-05	2.23E-05	1.73E-05	1.43E-05	9.83E-05	5.81E-05	2.22E-05	1.83E-05	1.57E-05
U2 Combined Radwaste & Reactor Vent	8.24E-04	6.29E-04	2.28E-04	1.56E-04	1.26E-04	1.09E-03	7.23E-04	2.46E-04	1.92E-04	1.47E-04
U2 Post Accident Sampling Sys. Panel	3.36E-04	2.00E-04	7.31E-05	5.53E-05	4.04E-05	3.74E-04	2.05E-04	7.08E-05	5.41E-05	3.88E-05
U2 Standby Gas Treatment Sys. Building	3.62E-04	2.59E-04	9.48E-05	6.16E-05	4.42E-05	5.31E-04	3.70E-04	1.35E-04	9.16E-05	6.70E-05
U2 Main Steam Tunnel	1.13E-03	7.49E-04	2.76E-04	1.90E-04	1.49E-04	1.47E-03	8.80E-04	3.32E-04	2.26E-04	1.68E-04
U2 Main Stack	7.04E-05	3.95E-05	1.49E-05	9.96E-06	7.46E-06	8.03E-05	4.48E-05	1.68E-05	1.20E-05	8.83E-06

	U2 Control Room Intake - Lower West					U2 Control Room Intake - Lower East				
	X/Q Dispersion Coefficients (s / m^3)					X/Q Dispersion Coefficients (s / m^3)				
Release Point	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**	**0-2 hrs**	**2-8 hrs**	**8-24 hrs**	**1-4 days**	**4-30 days**
U1 Reactor Bldg. Blowout Panel	1.26E-04	7.73E-05	2.74E-05	2.45E-05	2.23E-05	1.06E-04	6.68E-05	2.39E-05	2.16E-05	1.95E-05
U1 Turbine Bldg. Blowout Panel	1.31E-04	9.42E-05	3.59E-05	3.01E-05	2.63E-05	1.08E-04	7.69E-05	2.96E-05	2.44E-05	2.14E-05
U1 Main Stack	1.10E-04	6.16E-05	2.31E-05	1.85E-05	1.54E-05	9.54E-05	5.68E-05	2.15E-05	1.79E-05	1.54E-05
U2 Combined Radwaste & Reactor Vent	9.03E-04	6.93E-04	2.50E-04	1.71E-04	1.36E-04	9.43E-04	6.34E-04	2.13E-04	1.67E-04	1.29E-04
U2 Post Accident Sampling Sys. Panel	3.84E-04	2.28E-04	8.23E-05	6.28E-05	4.57E-05	3.67E-04	2.01E-04	6.95E-05	5.32E-05	3.83E-05
U2 Standby Gas Treatment Sys. Building	4.05E-04	2.95E-04	1.08E-04	6.98E-05	5.00E-05	5.33E-04	3.72E-04	1.36E-04	9.17E-05	6.72E-05
U2 Main Steam Tunnel	1.46E-03	9.74E-04	3.63E-04	2.45E-04	1.90E-04	1.46E-03	8.70E-04	3.32E-04	2.23E-04	1.68E-04
U2 Main Stack	7.15E-05	4.01E-05	1.52E-05	1.01E-05	7.55E-06	7.78E-05	4.31E-05	1.64E-05	1.16E-05	8.61E-06

8. Conclusions

Atmospheric dispersion coefficients (X/Q) values have been calculated at the control room intakes at both Units 1 and 2 and the Unit 1 Technical Support Center due to all postulated release scenarios. Tables 7.3.3-1, 7.3.3-2 and 7.3.4 provide conservative X/Q values for the scenarios listed above.

9. References

1. NMP Purchase Order, No. 02-40502, May 22, 2002.
2. NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes," May 1997.
3. Regulatory Guide 1.145, Rev. 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," February 1983.
4. Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluation Design Basis Accidents at Nuclear Power Reactors," July 2000.
5. Draft Regulatory Guide DG-1111 and Regulatory Guide 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants," U.S. NRC Office of Nuclear Regulatory Research, December 2001 and June 2003.
6. CNS ARCON96 Computer Code Verification, Rev. 1, June 24, 2002.
7. CNS Quality Assurance Program, Rev. 4, December 1, 2002.
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10. NMP Unit 1 Drawing, C-18713-C, Sht. 2, Rev. 9, 5/22/74.
11. NMP Unit 2 Drawing, EA-1A-7, Rev. 7, 5/31/83.
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13. NMP Unit 2 Drawing, ES-52A-7, Rev. 7, 11/24/82
14. NMP Unit 2 USAR Figure 1.2-11, Sht. 2, Rev. 0, April 1989.
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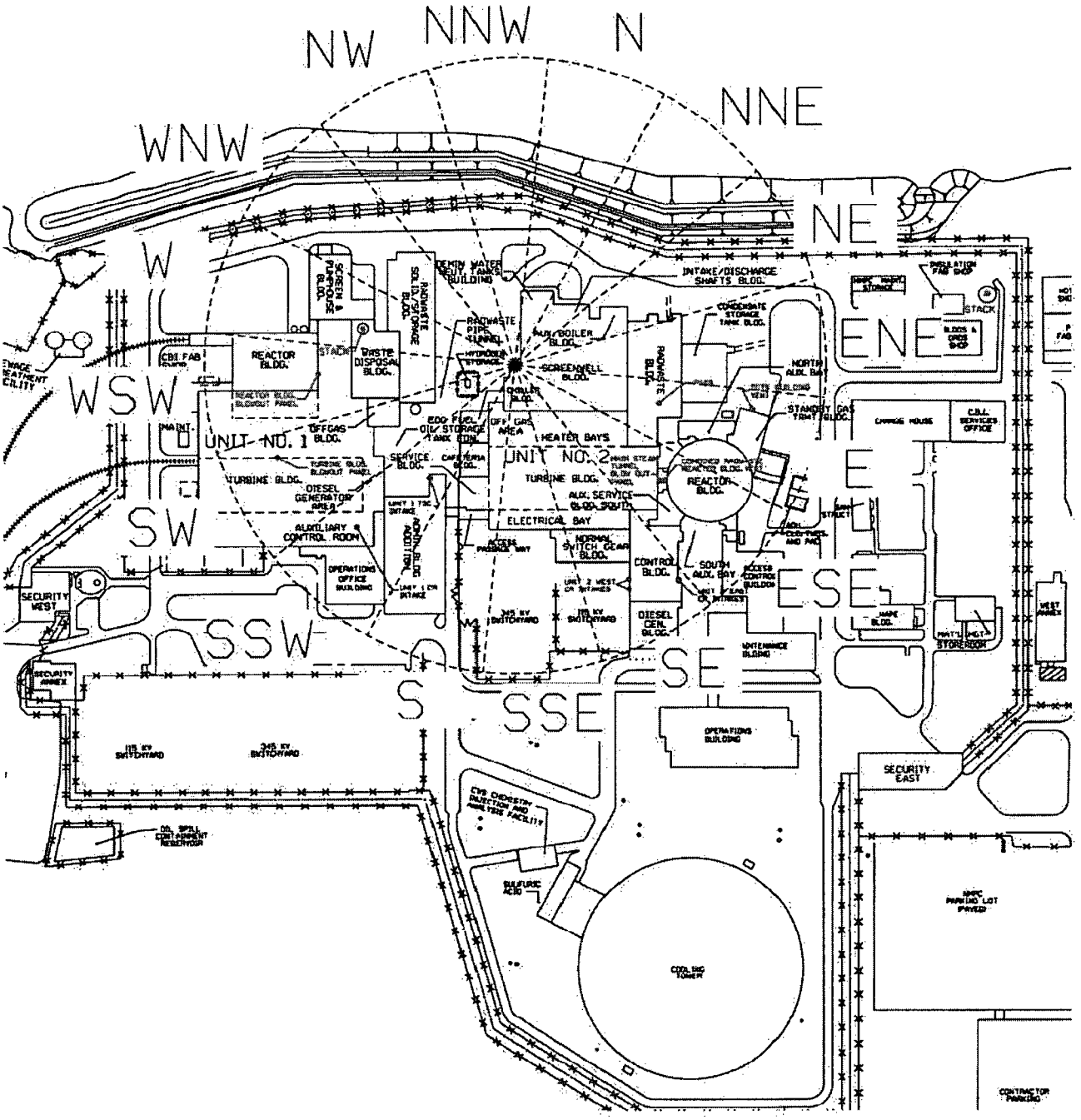
17. MES Calculation, 4/6/89, "X/Q Values at the NMP Unit 1 Control Room Air Intake and Emergency Operations Facility for All NMP Unit 2 Release-Building Scenarios."
18. MES Calculation, 8/7/90, "Accident X/Q Values for Nine Mile Point Unit 1 Releases from the Main Stack and the Reactor Buildings."
19. NMP Unit 2 USAR, Rev. 14, February 2001.
20. NMP Unit 2 Drawing, EV-202E-2, Rev. 2, 3/23/84.
21. NMP Unit 2 Drawing, EA-56B-5, Rev. 5, 5/31/83.
22. NMP Unit 2 Drawing, EA-46D-5, Rev. 5, 5/24/84.
23. NMP Unit 1 Drawing, C-15350-C, Rev 5, 2/29/68.
24. NMP Unit 1 Drawing, C-18717-C, Rev 21, 6/19/01.

25. NMP Unit 2 Drawing, EA-41A-6, Rev. 6, 4/30/91.
26. E-mail Ltr. From Thomas Galletta (NMP) to Shane Gardner (CNS), 7/23/02, "5 year JFD's".
27. E-mail Ltr. From Thomas Galletta (NMP) to Shane Gardner (CNS), 8/1/02, "ARCON96 Data – Rev. 1".
28. CNS Calculation No. NMPAST-01-001, "Calculation of X/Qs at the EAB and LPZ from Releases at NMP Units 1 and 2", 7/31/02, Rev. 0.
29. E-mail from Tom Galletta to Shane Gardner and James Heffner (Subject: 5 year JFD's), Attachment: "NMP_60m_JFD_1997-2001 for CNS", July 25, 2002.
30. Regulatory Guide 1.23, "Onsite Meteorological Programs," February, 1972.

Appendices

Appendix A – Site Plan Showing Associated X/Q Directions
Appendix B – Representative ARCON96 Input File
Appendix C – List of Computer Runs
Appendix D – List of Files On CDROM

Appendix A – Site Plan Showing Associated X/Q Directions



Appendix B – Representative ARCON96 Input File

The following is a copy of the ARCON96 input file for the Unit 1 Main Stack release to the Unit 1 Control Room intake. Additional input files are provided on the attached disk.

```
1
C:\NMP_CR_XO\NMP_R1.MET
     9.45
    60.66
   2
   1
   106.70
   550.00
     0.00
     0.00
     0.00
 346  90
   121.90
    21.95
     0.00
U1MS_U1.log
U1MS_U1.CFD
 .2
     0.50
     4.30
   1   2   4   8  12  24  96 168 360 720
   1   2   4   8  11  22  87 152 324 648
     0.00      0.00
n
```

Appendix C – List of Computer Runs

The ARCON96 computer run identifier and corresponding release/intake scenario are summarized in the list below. The computer run identifier, in conjunction with the appropriate file extension, defines the input and output files for each run. The ARCON96 input file extension is ".RSF" and the output file extensions are ".log" and ".CFD." The input and output files are included in the attached disk.

Table C-1. List of Computer Runs

Computer Run Identifier	Release	Intake
U2STG_U2UW	Unit 2 Standby Gas Treatment System Building	Unit 2 CR – Upper West
U2STG_U2UE		Unit 2 CR – Upper East
U2STG_U2LW		Unit 2 CR – Lower West
U2STG_U2LE		Unit 2 CR – Lower East
U2STG_U1		Unit 1 CR
U2STG_U1TSC		Unit 1 TSC
U2PASSV_U2UW	Unit 2 Post Accident Sampling System Panel	Unit 2 CR – Upper West
U2PASSV_U2UE		Unit 2 CR – Upper East
U2PASSV_U2LW		Unit 2 CR – Lower West
U2PASSV_U2LE		Unit 2 CR – Lower East
U2PASSV_U1		Unit 1 CR
U2PASSV_U1TSC		Unit 1 TSC
U2MST_U2UW	Unit 2 Main Steam Tunnel	Unit 2 CR – Upper West
U2MST_U2UE		Unit 2 CR – Upper East
U2MST_U2LW		Unit 2 CR – Lower West
U2MST_U2LE		Unit 2 CR – Lower East
U2MST_U1		Unit 1 CR
U2MST_U1TSC		Unit 1 TSC
U2MS_U2UW	Unit 2 Main Stack	Unit 2 CR – Upper West
U2MS_U2UE		Unit 2 CR – Upper East
U2MS_U2LW		Unit 2 CR – Lower West
U2MS_U2LE		Unit 2 CR – Lower East
U2MS_U1		Unit 1 CR
U2MS_U1TSC		Unit 1 TSC
U2CRRV_U2UW	Unit 2 Combined Radwaste & Reactor Building Vent	Unit 2 CR – Upper West
U2CRRV_U2UE		Unit 2 CR – Upper East
U2CRRV_U2LW		Unit 2 CR – Lower West
U2CRRV_U2LE		Unit 2 CR – Lower East
U2CRRV_U1		Unit 1 CR
U2CRRV_U1TSC		Unit 1 TSC
U1T_U2UW	Unit 1 Turbine Building Blowout Panel	Unit 2 CR – Upper West
U1T_U2UE		Unit 2 CR – Upper East
U1T_U2LW		Unit 2 CR – Lower West
U1T_U2LE		Unit 2 CR – Lower East
U1T_U1		Unit 1 CR
U1T_U1TSC		Unit 1 TSC
U1R_U2UW	Unit 1 Reactor Building Blowout Panel	Unit 2 CR – Upper West
U1R_U2UE		Unit 2 CR – Upper East
U1R_U2LW		Unit 2 CR – Lower West
U1R_U2LE		Unit 2 CR – Lower East

Computer Run Identifier	Release	Intake
U1R_U1		Unit 1 CR
U1R_U1TSC		Unit 1 TSC
U1MS_U2UW	Unit 1 Main Stack	Unit 2 CR – Upper West
U1MS_U2UE		Unit 2 CR – Upper East
U1MS_U2LW		Unit 2 CR – Lower West
U1MS_U2LE		Unit 2 CR – Lower East
U1MS_U1		Unit 1 CR
U1MS_U1TSC		Unit 1 TSC

Appendix D – List of Files On CDROM

Note: This directory listing does not include the calculation document, cover page and review checklist files.

```
Directory of D:\

12/22/2003  05:02 PM    <DIR>          .
12/22/2003  05:02 PM    <DIR>          ..
09/09/2002  02:42 PM            28,672 Distances Calculations.xls
12/22/2003  03:15 PM    <DIR>          Inputs and Outputs
08/02/2002  10:56 AM         1,621,488 NMP_R1.MET
12/22/2003  03:07 PM            30,208 Results Summary (MET DATA Rev 1).xls
11/18/2003  02:27 PM    <DIR>          SCOPING
               6 File(s)      4,359,152 bytes

 Directory of D:\Inputs and Outputs

12/22/2003  03:15 PM    <DIR>          .
12/22/2003  03:15 PM    <DIR>          ..
12/22/2003  11:12 AM             1,544 run_revision2.bat
11/18/2003  02:27 PM    <DIR>          UNIT1
11/18/2003  02:27 PM    <DIR>          UNIT1-TSC
12/22/2003  08:05 AM    <DIR>          UNIT2
               1 File(s)          1,544 bytes

 Directory of D:\Inputs and Outputs\UNIT1

11/18/2003  02:27 PM    <DIR>          .
11/18/2003  02:27 PM    <DIR>          ..
05/09/1997  03:00 PM            14,620 ARCHELP.TXT
06/27/1997  12:41 PM           380,928 ARCON96F.EXE
05/09/1997  03:00 PM           143,612 ARCONVB2.EXE
12/22/2003  03:09 PM    <DIR>          CFD
01/11/1994  12:00 AM           393,942 DOSXMSF.EXE
12/22/2003  03:11 PM    <DIR>          log
07/29/2002  01:21 PM               545 run_allrelease_ulcr.bat
12/22/2003  01:57 PM               401 U1MS_U1.RSF
12/22/2003  01:57 PM               381 U1R_U1.RSF
12/22/2003  01:57 PM               381 U1T_U1.RSF
12/22/2003  01:57 PM               387 U2CRRV_U1.RSF
12/22/2003  01:57 PM               385 U2MST_U1.RSF
12/22/2003  01:57 PM               383 U2MS_U1.RSF
12/22/2003  01:57 PM               389 U2PASSV_U1.RSF
12/22/2003  01:57 PM               385 U2STG_U1.RSF
              13 File(s)        936,739 bytes

 Directory of D:\Inputs and Outputs\UNIT1\CFD

12/22/2003  03:09 PM    <DIR>          .
12/22/2003  03:09 PM    <DIR>          ..
12/22/2003  02:53 PM            11,168 U1MS_U1.CFD
12/22/2003  02:53 PM            11,168 U1R_U1.CFD
12/22/2003  02:53 PM            11,168 U1T_U1.CFD
12/22/2003  02:53 PM            11,168 U2CRRV_U1.CFD
12/22/2003  02:53 PM            11,168 U2MST_U1.CFD
12/22/2003  02:53 PM            11,168 U2MS_U1.CFD
12/22/2003  02:53 PM            11,168 U2PASSV_U1.CFD
12/22/2003  02:53 PM            11,168 U2STG_U1.CFD
```

```
               8 File(s)         89,344 bytes

 Directory of D:\Inputs and Outputs\UNIT1\log

12/22/2003  03:11 PM    <DIR>          .
12/22/2003  03:11 PM    <DIR>          ..
12/22/2003  02:53 PM             4,838 U1MS_U1.log
12/22/2003  02:53 PM             4,838 U1R_U1.log
12/22/2003  02:53 PM             4,838 U1T_U1.log
12/22/2003  02:53 PM             4,838 U2CRRV_U1.log
12/22/2003  02:53 PM             4,838 U2MST_U1.log
12/22/2003  02:53 PM             4,838 U2MS_U1.log
12/22/2003  02:53 PM             4,838 U2PASSV_U1.log
12/22/2003  02:53 PM             4,838 U2STG_U1.log
               8 File(s)         38,704 bytes

 Directory of D:\Inputs and Outputs\UNIT1-TSC

11/18/2003  02:27 PM    <DIR>          .
11/18/2003  02:27 PM    <DIR>          ..
05/09/1997  03:00 PM            14,620 ARCHELP.TXT
06/27/1997  12:41 PM           380,928 ARCON96F.EXE
05/09/1997  03:00 PM           143,612 ARCONVB2.EXE
12/22/2003  03:11 PM    <DIR>          CFD
01/11/1994  12:00 AM           393,942 DOSXMSF.EXE
12/22/2003  03:11 PM    <DIR>          log
09/09/2002  01:09 PM               617 run_allrelease_u1tsc.bat
09/09/2002  01:06 PM               407 U1MS_U1TSC.RSF
09/09/2002  01:24 PM               387 U1R_U1TSC.RSF
09/09/2002  01:06 PM               387 U1T_U1TSC.RSF
09/09/2002  01:06 PM               393 U2CRRV_U1TSC.RSF
09/09/2002  01:06 PM               391 U2MST_U1TSC.RSF
12/22/2003  08:09 AM               389 U2MS_U1TSC.RSF
09/09/2002  01:06 PM               395 U2PASSV_U1TSC.RSF
09/09/2002  01:06 PM               391 U2STG_U1TSC.RSF
              13 File(s)        936,859 bytes

 Directory of D:\Inputs and Outputs\UNIT1-TSC\CFD

12/22/2003  03:11 PM    <DIR>          .
12/22/2003  03:11 PM    <DIR>          ..
09/09/2002  01:09 PM            11,168 U1MS_U1TSC.CFD
09/09/2002  01:09 PM            11,168 U1R_U1TSCTSC.CFD
09/09/2002  01:09 PM            11,168 U1T_U1TSC.CFD
09/09/2002  01:09 PM            11,168 U2CRRV_U1TSC.CFD
09/09/2002  01:09 PM            11,168 U2MST_U1TSC.CFD
12/22/2003  02:53 PM            11,168 U2MS_U1TSC.CFD
09/09/2002  01:09 PM            11,168 U2PASSV_U1TSC.CFD
09/09/2002  01:09 PM            11,168 U2STG_U1TSC.CFD
               8 File(s)         89,344 bytes

 Directory of D:\Inputs and Outputs\UNIT1-TSC\log

12/22/2003  03:11 PM    <DIR>          .
12/22/2003  03:11 PM    <DIR>          ..
09/09/2002  01:09 PM             4,838 U1MS_U1TSC.log
09/09/2002  01:09 PM             4,838 U1R_U1TSCTSC.log
09/09/2002  01:09 PM             4,838 U1T_U1TSC.log
09/09/2002  01:09 PM             4,838 U2CRRV_U1TSC.log
09/09/2002  01:09 PM             4,838 U2MST_U1TSC.log
12/22/2003  02:53 PM             4,838 U2MS_U1TSC.log
```

```
09/09/2002  01:09 PM              4,838 U2PASSV_U1TSC.log
09/09/2002  01:09 PM              4,838 U2STG_U1TSC.log
               8 File(s)         38,704 bytes

 Directory of D:\Inputs and Outputs\UNIT2

12/22/2003  08:05 AM    <DIR>           .
12/22/2003  08:05 AM    <DIR>           ..
05/09/1997  03:00 PM             14,620 ARCHELP.TXT
06/27/1997  12:41 PM            380,928 ARCON96F.EXE
05/09/1997  03:00 PM            143,612 ARCONVB2.EXE
12/22/2003  03:10 PM    <DIR>           CFD
01/11/1994  12:00 AM            393,942 DOSXMSF.EXE
12/22/2003  03:12 PM    <DIR>           log
07/29/2002  01:20 PM              2,128 run_allrelease_u2cr.bat
09/09/2002  01:06 PM                387 U1MS_U2LE.RSF
09/09/2002  01:06 PM                387 U1MS_U2LW.RSF
09/09/2002  01:06 PM                387 U1MS_U2UE.RSF
09/09/2002  01:06 PM                387 U1MS_U2UW.RSF
09/09/2002  01:06 PM                385 U1R_U2LE.RSF
09/09/2002  01:06 PM                385 U1R_U2LW.RSF
09/09/2002  01:06 PM                385 U1R_U2UE.RSF
09/09/2002  01:06 PM                385 U1R_U2UW.RSF
09/09/2002  01:06 PM                385 U1T_U2LE.RSF
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H21C076-00 91

NISYS CORPORATION

NISYS-1169-DV001/R0

Nine Mile Point Nuclear Station

DESIGN VERIFICATION OF CALCULATIONS NMPAST-01-001 AND NMPAST-02-001

August 2003

Prepared by

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Lycoming, NY

H21C076-00 92

NISYS CORPORATION

APPROVALS

Duane T. Nakahata — 8/25/03

Prepared by Duane T. Nakahata, PhD. PE — Date

T. M. Carroll — 8/25/03

Reviewed by T. M. Carroll — Date

John P. Durham — 8/25/03

Approved by John P. Durham, PE — Date

Revision History	
Revision Level	Summary of Change(s)
0	Initial Issue

APPROVALS

Duane T Nakahata 8/25/03

Prepared by Duane T. Nakahata, PhD, PE Date

T M Carroll 8/25/03

Reviewed by T. M. Carroll Date

Approved by John P. Durham, PE Date

Revision History	
Revision Level	**Summary of Change(s)**
0	Initial Issue

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2.0 METHOD AND EXTENT OF DESIGN VERIFICATION 5

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ATTACHMENTS

ATT No.	Description	No. of Pages
1	Design Verification Criteria (NMPAST-01-001)	1
2	Design Verification Criteria (NMPAST-02-001)	1
3	Certificate of Conformance	1

1.0 OBJECTIVE

The objective of this report is to perform a design verification of Nine Mile Point Nuclear Station (NMP) calculations NMPAST-01-001, Rev. 1 (Ref. 1) and NMPAST-02-001, Rev. 1 (Ref. 2).

Using the PAVAN computer program (Ref. 3), calculation NMPAST-01-001 determines the atmospheric dispersion coefficients (X/Q values) at the exclusion area boundary (EAB) and low population zone (LPZ) boundary, due to releases from specified Unit 1 and Unit 2 sources. Calculation NMPAST-02-001 uses the ARCON96 program (Ref. 4) to determine the X/Q values for the NMP Unit 1 and Unit 2 fresh air intakes, due to releases from specified Unit 1 and Unit 2 sources. Atmospheric dispersion coefficients are needed to perform Alternative Source Term scoping calculations, which are documented elsewhere.

2.0 METHOD AND EXTENT OF DESIGN VERIFICATION

The design verification process is described in NMP's Design Verification procedure (Ref. 5), and in NISYS Corporation's Project Instruction (Ref. 6). The design review method, as defined in Reference 5, will be used to perform the verification of calculations NMPAST-01-001 and NMPAST-02-001.

The extent of the design review will include identification of the design input, calculation process, and output for the subject calculations. The design review will also evaluate the appropriate use of the PAVAN and ARCON96 software to accurately determine the X/Q values. In addition, the following questions will be addressed (as required by References 6 and 7) to ensure that relevant items are considered in the verification effort:

1. Were the inputs correctly stated?
2. Are the assumptions necessary to perform the calculations adequately described and reasonable?
3. Was an appropriate method used?
4. Were the inputs correctly incorporated into the calculations?
5. Are the outputs reasonable compared to the inputs?
6. Do the calculations conform to USNRC Regulatory Guides 1.145 and 1.194?

The results of the design review are discussed in Section 4.0. Completed design verification criteria sheets as required by Reference 6 are provided as Attachments 1 and 2. As required by Reference 7, a Certificate of Conformance, signed by NISYS Corporation's Quality Assurance Manager is provided as Attachment 3.

3.0 REFERENCES

1. Calculation NMPAST-01-001, Revision 1, Calculation of X/Qs at the EAB and LPZ from Releases at NMP Units 1 and 2.
2. Calculation NMPAST-02-001, Revision 1, Calculation of Atmospheric Dispersion Coefficients (X/Qs) at the NMP Unit 1 Technical Support Center and Units 1 and 2 Control Room Intakes for All Releases.
3. CCC-445, RSIC Computer Code Collection – PAVAN, NUREG/CR-2858 (November 1982), PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations.
4. CCC-664, RSICC Computer Code Collection – ARCON96, NUREG/CR-6331, Revision 1 (May 1997), Atmospheric Relative Concentrations in Building Wakes.
5. Nine Mile Point Procedure NEP-DES-07, Revision 4, Design Verification.
6. NISYS Corporation Project Instruction, NISYS-1169-PI001/RO, Performing Design Verification of Atmospheric Dispersion Calculations.
7. Nine Mile Point Purchase Order No. 03-45612, Independent Verification of Calculations NMPAST-01-001 and NMPAST-02-001, dated 7/1/2003.
8. U.S. NRC Regulatory Guide 1.145, Revision 1 (February 1983), Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants.
9. U.S. NRC Regulatory Guide 1.194 (June 2003), Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants.
10. NMPAST-01-001-CD (9/6/2002), CD-R compact disc containing computer files for NMPAST-01-001, Revision 1.
11. NMPAST-02-001-CD (9/6/2002), CD-R compact disc containing computer files for NMPAST-02-001, Revision 1
12. NMP Unit 2 USAR Figure 2.1-2, Revision 15 (October 2003), Site Boundaries and Transportation Routes.
13. NMP Unit 2 USAR Figure 2.1-4, Revision 6 (April 1994), Low Population Zone Boundary.
14. NMP Unit 1 USAR Figure III-10, Revision 14 (June 1996), Reactor Building and Turbine Building Cross-Section.

4.0 RESULTS

Design Verification Checklist

Document: NMPAST-01-001, Rev. 1, Calculation of X/Qs at the EAB and LPZ from Releases at NMP Units 1 and 2

Design Verifier's Name: Duane T. Nakahata

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
1. Were the inputs correctly selected?		X	
1a. In NMPAST-01-001, the EAB distances from Unit 1 and Unit 2 for the E, ESE, and SE sectors may be in error, since, as defined below, the Exclusion Area should include NMP-controlled property only. These distances appear to be measured to the eastern boundary of the neighboring Fitzpatrick site (1.9 and 1.6 km for Units 1 and 2, respectively for the E sector), rather than to the eastern boundary of the NMP site (approximately 0.7 km for Unit 1 (Ref. 12)). Per 10CFR100.3, Exclusion area is defined as "that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result."			
1b. Although the values used for design inputs are referenced (in Section 5.1 of the calculation), for clarity of the geographic relationships it is recommended that the calculation include a scale drawing that shows a compass "rose" superimposed upon an outline of the extent of the EAB and LPZ. Alternatively, it is recommended that the appropriate figures from the references be included as attachments to the calculation.			
1c. The source of the meteorological inputs is clearly specified in Section 5.1 of the calculation. However, the method used to obtain these inputs from the raw data is not stated. Section 1.1 of Regulatory Guide 1.145 requires that meteorological data represent hourly averages, and are categorized into atmospheric stability classes according to Regulatory Guide 1.23 (now Safety Guide 23), "Onsite Meteorological Programs". It is recommended that a statement documenting conformance to Safety Guide 23 be included.			

Document: NMPAST-01-001, Rev. 1

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
2. Are the assumptions necessary to perform the calculations adequately described and reasonable?		X	
2a. In Section 5.2.2 of NMPAST-01-001, the value used for the variable A, the minimum vertical cross-sectional area of the Unit 1 containment structure (2082 m^2), could not be verified. As a check, the height of the Unit 1 Reactor building is 42.2 m (Table 5.1-1.b of NMPAST-01-001); and the horizontal dimension of the U1 RB-TB complex (east-west) is 99.67 m (Sect. 6 of NMPAST-02-001), yielding a cross-sectional area of approx. 4186 m^2. The inputs for this assumption and a justification should be clearly stated. (For example, "Although the actual cross-sectional area is __ m^2, found by multiplying a height of __ m by length of __ m, a smaller area is assumed because the reactor building is connected to other buildings and this conservatively results in higher X/Q values.)			
3. Was an appropriate method used?	X		
3a. In Section 6.2 of NMPAST-01-001, the reason for hand-checking 28 sector 0.5% X/Q values is not clear. (Recommend that an example be provided to clarify the screening process.) Of these 28 cases, 26 resulted in 0.5% X/Q values identical to the PAVAN output. However, the X/Q values subsequently calculated for the intermediate time intervals differ from the PAVAN output. The differences are small (on the order of 1%) and are apparently due to calculating the intermediate time intervals using 3 significant digits (hand-check values) instead of 4 (PAVAN values).			
3b. Of the 28 hand-checked cases discussed in Section 6.2 of NMPAST-01-001, two cases resulted in a change to the reported value (from 2.048E-6 to 2.08E-6 for Unit 1 Main Stack to LPZ-E, and from 9.140E-5 to 9.58E-5 for Unit 2 Combined Vent to EAB-WSW). These modifications, which are conservative, appear to be due to differences between PAVAN and the hand-check procedures that derive the upper envelope of the X/Q values versus their cumulative frequency of occurrence. For the PAVAN approach, Section 4.6 of NUREG/CR-2858 states, "Starting with the highest X/Q value, [subroutine] ENVLOP compares the slope of the line drawn from this point to every other point within an increment containing ten X/Q values." The FORTRAN listing was checked to verify that ENVLOP uses only ten points in each increment, thereby calculating the slopes of nine lines. In contrast, the EXCEL spreadsheets that document the manual procedure use eleven points per increment, resulting in ten slopes.			
3c. In Sections 6.2 and 6.3 of NMPAST-01-001, when calculating the intermediate time-period X/Qs using logarithmic interpolation, it is recommended that the basis for using the selected time points of 8, 16, 72 and 624 hours (as shown in the Intermediate Time Calculations spreadsheets), be stated.			

Document: NMPAST-01-001, Rev. 1

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
4. Were the inputs correctly incorporated into the calculations?	X		
5. Are the outputs reasonable compared to the inputs? 5a. Although the PAVAN computer input files, output files and Excel worksheets that are described in the each of the calculations are provided on a read-only CD (Ref. 10), it is recommended that a detailed listing of the files be provided. This will assure that the files available on hand and those discussed in the calculation are identical.	X		
6. Does the calculation conform to USNRC Regulatory Guide (RG) 1.145?	X		

Design Verification Checklist

Document: NMPAST-02-001, Rev. 1, Calculation of Atmospheric Dispersion Coefficients (X/Qs) at the NMP Unit 1 Technical Support Center and Units 1 and 2 Control Room Intakes for All Releases

Design Verifier's Name: Duane T. Nakahata

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
1. Were the inputs correctly selected? 1a. Although the values used for design inputs are referenced (in Sections 5.2 and 7.1 of the calculation), for clarity of the geographic relationships it is recommended that the calculation include a scale drawing that shows a compass "rose" superimposed upon an outline of the Unit 1 and Unit 2 showing the release points and intakes. Addtionally, it is recommended that the appropriate tables and figures from the references be included as attachments to the calculation. 1b. The source of the meteorological inputs is clearly specified in Section 5.1 of the calculation. However, the method used to obtain these inputs from the raw data is not stated. Section 3.1 of Regulatory Guide 1.194 requires that meteorological data represent hourly averages, and are categorized into atmospheric stability classes according to Safety Guide 23 (formerly Regulatory Guide 1.23), "Onsite Meteorological Programs". It is recommended that a statement documenting conformance to Safety Guide 23 be included.	X		
2. Are the assumptions necessary to perform the calculations adequately described and reasonable? 2a. In Section 6, the justification for all assumptions should be clearly stated. For example, "Unit 1 releases to U1 CR intake building wake area is assumed to be one-half of the E-W U1 TB cross-sectional area because [give reason] and this conservatively results in higher X/Q values." As another example, "U2 Main Stack release is assumed to be a ground-level release in ARCON96 because [give reason], as described in Section 7.3."		X	
3. Was an appropriate method used?	X		

Document: NMPAST-02-001, Rev. 1

Items Addressed with Basis of Review Answer	Review Check		
	Yes	No	N/A
4. Were the inputs correctly incorporated into the calculations?		X	
4a. In NMPAST-02-001, three conversions from English into metric units are incorrect. In Section 5.4, the Unit 2 RB outer radius (85' 6") should be 26.06 m (not 25.06 m). In Section 6, the Unit 1 TB E-W dimension (327') should be 99.67 m (not 111.86 m), and the Unit 1 CR intake height above grade (72') should be 21.95 m (not 29.95 m). These errors are carried forward into Section 7.2, resulting in six errors in the Table 7.2.1 Building Wake Areas: Unit 1 (all) to Unit 1 CR should be 550 not 167 m^2. U 2 (all except stack) to U1 CR should be 623 not 281 m^2. U2 stack to U1 CR should be 2165 not 1363 m^2. U2 stack to U1 TSC should be 3639 not 3549 m^2. U2 stack & SGB to U2 CR (all) should be 1844 not 1773 m^2. U2 PASS to U2 CR (all) should be 922 not 886 m^2. The errors were carried forward into the ARCON96 computer runs.			
5. Are the outputs reasonable compared to the inputs?	X		
5a. Although the ARCON96 computer input files, output files and Excel worksheets that are described in the each of the calculations are provided on a read-only CD (Ref. 11), it is recommended that a detailed listing of the files be provided. This will assure that the files available on hand and those discussed in the calculation are identical.			
6. Does the calculation conform to USNRC Regulatory Guide (RG) 1.194?	X		

5.0 RECOMMENDATIONS

1. Correct or address the errors discussed in Item 1a (for NMPAST-01-001) and Item 4a (for NMPAST-02-001) of Section 4. Correct the affected computer input files and rerun them.

2. Improve the justification for assumptions used in the calculations, as described in Item 2 (for both calculations) of Section 4.

3. Evaluate the recommendations discussed in Items 1b, 1c, 3a, 3c, and 5 (for NMPAST-01-001), and Items 1a, 1b, and 5 (for NMPAST-02-001) of Section 4.

4. Review the results of the hand checks described in Item 3b (for NMPAST-01-001) of Section 4. Revise the hand checks to remove conservatisms, if desired.

5. Revise NMPAST-01-001 and NMPAST-02-001, incorporating changes due to the recommendations stated above.

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DESIGN VERIFICATION CRITERIA

NISYS CORPORATION

Attachment 1

NISYS-1169-DV001/R0

- ☒ 1. Originator followed defined procedures.
- ☒ 2. Title, purpose, and function of the work checked are adequately described.
- ☒ 3. Work method is clearly stated and appropriate.
- ☒ 4. Assumptions are identified. Open items are flagged for subsequent verification where necessary. *See Item 2 of Section 4.0*
- ☒ 5. Technical bases and references are current and are correctly selected and incorporated.
- ☐ 6. Design inputs are properly selected and adequately identified. Any specific inputs to be excluded are adequately identified. *See Item 1 of Section 4.0*
- ☒ 7. Applicable codes, standards, and regulatory requirements are identified and properly used.
- ☒ 8. Analytical steps can be verified without recourse to originator.
- ☒ 9. Each page of the work is identified and traceable to originator, date, and project or equivalent control number.
- ☒ 10. All markings are legible and identifiable.
- ☐ 11. Work clearly references any final supporting computer runs. *Calc. needs index of computer files*
- ☒ 12. Final computer runs or documents being checked include input listing. Correct inputs are used. Where input is not listed on output, alternate methods are used by the checker.
- ☒ 13. Final computer runs are uniquely identified.
- ☒ 14. Results are consistent with inputs, technical procedures, and other project criteria.
- ☒ 15. Results are reasonable.
- ☒ 16. Revisions are clearly documented.
- ☒ 17. Technical interface requirements in the Project Plan have been satisfied.
- ☒ 18. Appropriate QA requirements are specified.
- ☐ 19. Applicable construction and operating experience has been considered. *N/A*
- ☐ 20. Specified parts, equipment, and processes are suitable for required application. *N/A*
- ☐ 21. Specified materials are compatible with each other and the design environmental conditions to which the material will be exposed. *N/A*
- ☐ 22. Adequate maintenance features and requirements are specified. *N/A*
- ☐ 23. Accessibility and other design provisions are adequate for performance of needed maintenance and repair. *N/A*
- ☐ 24. Adequate accessibility is provided to perform the in-service inspection expected to be required during plant life. *N/A*
- ☐ 25. Design properly considered radiation exposure to the public and plant personnel. *N/A*
- ☐ 26. Acceptance criteria incorporated into the design documents are sufficient to allow verification that design requirements have been satisfactorily accomplished. *N/A*
- ☐ 27. Adequate handling, storage, cleaning, and shipping requirements are specified. *N/A*
- ☐ 28. Adequate identification requirements are specified. *N/A*

Design Verified: Calculation NMPAST-01-001 Revision: 1

Verifier: Mam T Nakaketa Date: 8/25/03

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DESIGN VERIFICATION CRITERIA

NISYS CORPORATION

Attachment 2

NISYS-1169-DV001/R0

☒ 1. Originator followed defined procedures.
☒ 2. Title, purpose, and function of the work checked are adequately described.
☒ 3. Work method is clearly stated and appropriate.
☒ 4. Assumptions are identified. Open items are flagged for subsequent verification where necessary. *See Item 2 of Section 4.0*
☒ 5. Technical bases and references are current and are correctly selected and incorporated.
☐ 6. Design inputs are properly selected and adequately identified. Any specific inputs to be excluded are adequately identified. *See Item 4 of Section 4.0*
☒ 7. Applicable codes, standards, and regulatory requirements are identified and properly used.
☒ 8. Analytical steps can be verified without recourse to originator.
☒ 9. Each page of the work is identified and traceable to originator, date, and project or equivalent control number.
☒ 10. All markings are legible and identifiable.
☐ 11. Work clearly references any final supporting computer runs. *Calc. needs index of computer files*
☒ 12. Final computer runs or documents being checked include input listing. Correct inputs are used. Where input is not listed on output, alternate methods are used by the checker.
☒ 13. Final computer runs are uniquely identified.
☒ 14. Results are consistent with inputs, technical procedures, and other project criteria.
☒ 15. Results are reasonable.
☒ 16. Revisions are clearly documented.
☒ 17. Technical interface requirements in the Project Plan have been satisfied.
☒ 18. Appropriate QA requirements are specified.
☐ 19. Applicable construction and operating experience has been considered. *N/A*
☐ 20. Specified parts, equipment, and processes are suitable for required application. *N/A*
☐ 21. Specified materials are compatible with each other and the design environmental conditions to which the material will be exposed. *N/A*
☐ 22. Adequate maintenance features and requirements are specified. *N/A*
☐ 23. Accessibility and other design provisions are adequate for performance of needed maintenance and repair. *N/A*
☐ 24. Adequate accessibility is provided to perform the in-service inspection expected to be required during plant life. *N/A*
☐ 25. Design properly considered radiation exposure to the public and plant personnel. *N/A*
☐ 26. Acceptance criteria incorporated into the design documents are sufficient to allow verification that design requirements have been satisfactorily accomplished. *N/A*
☐ 27. Adequate handling, storage, cleaning, and shipping requirements are specified. *N/A*
☐ 28. Adequate identification requirements are specified. *N/A*

Design Verified: Calculation NMPAST-02-001 Revision: 1

Verifier: [illegible] Date: 8/25/03

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CERTIFICATE OF CONFORMANCE

NISYS CORPORATION

Attachment 3
NISYS-1169-DV001/R0

COC Number: COC1169-001 **Date: 8/25/2003**

Client: Nine Mile Point Nuclear Station, LLC
NISYS Project No.: 1169
NISYS Project Title: Nine Mile Point Calculation Design Verification
Contract No./Date: 00750 / R11/07/01
P.O. No./Date: 03-45612 / 07/01/03
Supplier: NISYS Corporation

NISYS Corporation certifies that the materials and products listed below were furnished to CLIENT in conformance with the requirements of Purchase Order 03-45612.

Customer Item No.	NISYS Item No.	Quantity	Item / Service Description
001	NISYS-1169-DV-001/R0	1	Design Verification of Calculations NMPAST-01-001 and NMPAST-02-001

	Printed / Typed Name and Title	Signature	Date
Prepared by: (First, MI, Last)	Duane T. Nakahata, PhD, PE Project Engineer	Duane T Nakahata	8/25/03
NISYS QA Manager (First, MI, Last)	Mark R. Winsor, PE	Mark Winsor	8/25/2003