ENCERCON *Excellence – Every project Every day*	CALCULATION COVER SHEET	CALC. NO. TXUT-001-FSAR-13.3-CALC-026
		REV. 2
		PAGE NO. 1 of 20
Title:	CPNPP Technical Support Center Accident χ/Q Calculation	Client: Luminant
		Project: MITS003

Item	Cover Sheet Items	Yes	No
1	Does this calculation contain any open assumptions that require confirmation? If **YES**, identify the assumptions. ______	☐	☒
2	Does this calculation serve as an "Alternate Calculation"? If **YES**, identify the design verified calculation. **Design Verified Calculation No.**______	☐	☒
3	Does this calculation supersede an existing calculation? If **YES**, identify the superseded calculation. **Superseded Calculation No.**______	☐	☒

Scope of Revision:

Revision 1 incorporated changes in the distances and directions between the sources and receptors. The elevations of the sources and receptors also changed.

Revision 2 corrects the exponents in two χ/Q values and deletes an unnecessary figure. The US-APWR DCD and Units 3 & 4 FSAR references are also updated to the most current revision.

Revision Impact on Results:

Revision 1 required that the ARCON96 input files be revised and ARCON96 be run again. The results of this calculation were impacted slightly by the changes in distances, directions, and elevations.

Revision 2 changes the exponents in the west main steam relief valve 2-8 hour χ/Q in Table 2-1 and the 0-2 hour cross unit χ/Q for the main steam line in Table 7-3. No ARCON files are re-run and no other results are changed.

Study Calculation	☐	**Final Calculation**	☒
Safety-Related	☐	**Non-Safety Related**	☒

(Print Name and Sign)	
Originator: Jeffrey Head *[signature]*	**Date:** 6-24-2010
Design Verifier: Nathan Jackson *[signature]*	**Date:** 6-24-2010
Approver: Marvin Morris *[signature]*	**Date:** 6/24/2010

CALCULATION REVISION STATUS

REVISION	DATE	DESCRIPTION
0	April 6, 2008	Initial Issue
1	September 23, 2009	Revision to revise source heights, distances, and directions to receptors. Receptor height also changed.
2	June 24, 2010	Revision to correct exponents in two χ/Q values and to delete unnecessary figure.

PAGE REVISION STATUS

PAGE NO.	REVISION	PAGE NO.	REVISION
9, 20	0		
3, 4, 8, 10, 12 - 18	1		
1, 2, 5 – 7, 11, 19	2		

APPENDIX REVISION STATUS

APPENDIX NO.	PAGE NO.	REVISION NO.	APPENDIX NO.	PAGE NO.	REVISION NO.
Appendix 1	1 – 3	0			
Appendix 2	1 – 2	1			
Appendix 3	1	2			
Appendix 4	1 – 3	0			

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1.0 Purpose and Background

The purpose of this calculation is to determine Technical Support Center (TSC) atmospheric relative concentration (χ/Q) values in support of design basis Technical Support Center radiological habitability assessments for the proposed Luminant nuclear plants, Comanche Peak Nuclear Power Plant (CPNPP) Units 3 & 4. This assessment is required to demonstrate compliance with Paragraph IV.E.8 of Appendix E, to 10 CFR Part 50, "Emergency Planning and Preparedness for Production and Utilization Facilities," as it relates to adequate provisions for an onsite technical support center (TSC) from which effective direction can be given and effective control can be exercised during an emergency. Standard Review Plan (SRP)15.0.3 identifies that for Combined Operating License Applications, the NRC staff reviews the dose analysis performed to demonstrate TSC habitability in support of Standard Review Plan 13.3, emergency planning review. SRP 15.0.3 states that the radiation protection design of the TSC is acceptable if the total calculated radiological consequences for the postulated fission product release fall within the exposure acceptance criteria specified for the control room in GDC-19 of Appendix A to 10 CFR Part 50 [Reference 3.4], which is 5 rem TEDE for the duration of the accident. Atmospheric relative concentrations (χ/Q values) are significant inputs in radiological assessments.

The results of this calculation will be used to support the Combined Operating License Application (COLA) for CPNPP to be submitted by Luminant. The CPNPP COLA is being prepared in accordance with Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)" [Reference 3.12]. The TSC must meet the same dose requirements as the Control Room.

This calculation was performed using the ARCON96 computer program [References 3.1 and 3.2], which was developed as a tool for the use of the U.S. Nuclear Regulatory Commission (NRC) staff in their review of licensee submittals related to Control Room habitability. NRC guidance for determining atmospheric relative concentrations for assessing the potential Control Room radiological consequences for a range of postulated accidental releases of radioactive material to the atmosphere is provided in Regulatory Guide 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants" [Reference 3.3]. Regulatory Guide 1.194 procedures are largely based on the ARCON96 code; however, this guide also provides procedures for addressing some aspects of Control Room χ/Q determinations not currently implemented in the ARCON96 code. Refer to Reference 3.1 for the ARCON96 code manual and Reference 3.2 for the Computer Program Certification Package for the ARCON96 program.

The Comanche Peak onsite meteorological measurement program utilizes wind speed sensors, wind direction sensors and temperature sensors from the meteorological tower located at the plant site near the Squaw Creek Reservoir. The hourly meteorological data for the years 2001 through 2004 and the year 2006 was recorded at the 10 m and 60 m levels as provided by Texas Utilities (TXU) and Luminant [References 3.6 and 3.7]. The meteorological data provided by TXU and Luminant was screened and then manually reviewed using criteria recommended in NUREG-0917 [Reference 3.14]. The meteorological data evaluation is documented in TXUT-001-FSAR-2.3-CALC-024 [Reference 3.17]. The screened met data was then formatted for use as input to the ARCON96 code using Microsoft Excel.

This calculation will consider postulated plant releases from the following locations [Figure 4, Reference 3.16]:

1. Containment Shell
2. Main Steam Line (East and West)
3. Main Steam Relief Valves (East and West)
4. Main Steam Safety Valves (East and West)
5. Fuel Handling Area
6. Plant Vent

Per discussion with MHI engineers [Reference 3.18] and Table 3 of Reference 3.16, the TSC HVAC system is completely integrated with the Auxiliary Building HVAC system. Therefore, the receptor locations to be considered are the Auxiliary Building HVAC intakes for each of the two units (see Assumption 4.5). There are two of these HVAC intakes on the southwest section of the Auxiliary Building roof [Figure 4, Reference 3.16].

The distances and directions from the sources to the receptors are taken from Appendix B of Reference 3.16. Since CPNPP Units 3 & 4 are oriented identically and the locations of the releases and receptors for each unit are the same [Reference 3.11 and Figure 4, Reference 3.16], the TSC χ/Q values determined for a postulated accident at one unit, are representative of both units. However, Unit 3 TSC χ/Q values determined for an accident at Unit 4 would be different from those for an accident at Unit 3 and vice versa.

Revision 1 of this calculation revises all release heights, distances, and directions based on Revision 2 of CP34-HKH-001 [Reference 3.16]. The TSC HVAC intake height is also changed based on Revision 2 of CP34-HKH-001 [Reference 3.16].

Revision 2 of this calculation corrects exponents copied from the ARCON output files for the west main steam relief valve 2-8 hour χ/Q in Table 2-1 and the 0-2 hour cross unit χ/Q for the main steam line in Table 7-3. Revision 2 also removes the reactor building cross section figure from section 6.3 because it contained out of date information that is no longer necessary. The US-APWR DCD and Units 3 & 4 FSAR references are also updated to the most current revision.

2.0 Summary of Results and Conclusions

There are no specific acceptance criteria or regulatory requirements associated with the atmospheric dispersion factors determined in this calculation. The site specific TSC dispersion values are given in Table 2-1 below. As discussed in Section 7.0, the Unit 3 specific TSC atmospheric dispersion values determined for an accident at Unit 4 and the Unit 4 specific TSC atmospheric dispersion values determined for an accident at Unit 3 are bounded by the values given in Table 2-1.

These TSC atmospheric relative concentration (χ/Q) values were prepared for use in TSC radiological habitability assessments for the proposed Luminant nuclear plants, CPNPP Units 3 & 4. Selection of the appropriately bounding values for use should be carefully evaluated for unit number, release and receptor locations, timing, and accident scenario.

Table 2-1
Technical Support Center Atmospheric Dispersion Factors (χ/Q) in s/m^3 for Accident Dose Analysis

Time Interval	Plant Vent	Main Steam Line (East)	Main Steam Line (West)	Fuel Handling Area	Main Steam Relief Valve (East)
0 – 2 hours	1.1E-03	7.3E-04	1.3E-03	4.4E-04	8.7E-04
2 – 8 hours	6.9E-04	5.5E-04	9.6E-04	2.8E-04	6.1E-04
8 – 24 hours	2.8E-04	2.3E-04	3.9E-04	1.1E-04	2.5E-04
1 – 4 days	2.1E-04	1.8E-04	3.2E-04	8.5E-05	1.7E-04
4 – 30 days	1.3E-04	1.3E-04	2.4E-04	5.0E-05	1.2E-04
Time Interval	**Main Steam Relief Valve (West)**	**Main Steam Safety Valve (East)**	**Main Steam Safety Valve (West)**	**Containment Shell**	
0 – 2 hours	1.3E-03	8.7E-04	1.3E-03	8.0E-04	
2 – 8 hours	9.3E-04	6.3E-04	9.6E-04	5.1E-04	
8 – 24 hours	3.8E-04	2.6E-04	3.9E-04	2.3E-04	
1 – 4 days	2.7E-04	1.8E-04	2.7E-04	1.6E-04	
4 – 30 days	1.9E-04	1.3E-04	2.0E-04	1.1E-04	

3.0 References

3.1 NUREG/CR-6331, "Atmospheric Relative Concentrations in Building Wakes", Revision 1, May 1997

3.2 ENERCON Computer Program Certification: "ARCON96 Computer Code, Atmospheric Relative CONcentrations in Building Wakes (ARCON)", 5/10/2004

3.3 Regulatory Guide 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants", June 2003

3.4 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants"

3.5 10 CFR Part 50.67, "Accident Source Term"

3.6 Dennis Buschbaum (TXU) to Mike Laggart (ENERCON), CPSES-200602398, "Transmittal of Existing CPSES Meteorological Data for Use in COLA at Comanche Peak Units 3 and 4", Nov. 30, 2006 (data is included in electronic files in Appendix 1)

3.7 Matt Weeks (Luminant) to Mike Laggart (ENERCON), CPSES-200701296, "Transmittal MET data (November Thru December 2006) as requested by ENERCON RFI-0067", Aug. 2, 2007(data is included in electronic files in Appendix 1)

3.8 Regulatory Guide 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants", Revision 1, March 2007

3.9 Mitsubishi Heavy Industries, Ltd., "Design Control Document for the United States Advanced Pressurized Water Reactor", Revision 2

3.10 Comanche Peak Steam Electric Station Units 1 & 2 FSAR, Amendment 99, Supp. 7, April 8, 2005

3.11 Comanche Peak Nuclear Power Plant Units 3 and 4 Site Plot Plan, FSAR Figure 2.1-201, Revision 1, (Appendix 3)

3.12 Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)", June 2007

3.13 Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors", Revision 1, July 1977

3.14 Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data, NUREG-0917, July 1982

3.15 Report TXUT-001-PR-001, "Suitability of Existing Meteorological Program for COL Application", Revision 0

3.16 Mitsubishi Heavy Industries, Ltd., CP34-HKH-0001 Revision 2, "Combination of Sources and Receptors for Main Control Room Dose Calculation", August 7, 2009

3.17 Calculation TXUT-001-FSAR-2.3-CALC-024, "CPNPP Control Room Accident χ/Q Calculation", Revision 1

3.18 Email from Seiichi Kudo (MHI) to Joanne Morris and Jared Monroe (ENERCON), "About the Calculation Condition for X/Q", Feb 4, 2008 (Appendix 4)

4.0 Assumptions

4.1 According to Regulatory Guide 1.194 [Reference 3.3], the meteorological data needed for TSC χ/Q calculations should be representative of the overall site conditions and be free from local effects such as building and cooling tower wakes, brush and vegetation, or terrain. In addition, the size of the data set used in the χ/Q assessments should be sufficiently large such that it is representative of long-term meteorological trends at the site. The NRC staff considers five years of hourly observations to be representative of long-term trends at most sites. With sufficient justification of its representativeness, however, the minimum meteorological data set is one complete year (including all four seasons) of hourly observations.

This calculation assumes that the five years of meteorological data used in this calculation (2001 – 2004 and 2006) provided by TXU and Luminant [References 3.6 and 3.7] are representative of the overall site conditions and long-term trends for the CPNPP site. As documented in the Comanche Peak Report on the Suitability of Existing Meteorological Program for COL Application [Reference 3.15], the location of the Comanche Peak meteorological tower is sufficiently removed from any plant structures or significant topographic features to insure that the system provides adequate data to represent onsite meteorological conditions and to describe the local and regional atmospheric transport and diffusion characteristics. The wind and stability characteristics of the Comanche Peak site and the relationship of these parameters to the corresponding parameters at the Mineral Wells Airport are discussed in Section 4 of the Report [Reference 3.15] and are found to be "very similar". Thus, no long term trends were observed which would bias χ/Q estimates.

4.2 The distances and directions from the sources to the receptor locations provided in Table 1 of Reference 3.16 are assumed to be conservatively determined using the closest release point to the receptor and ignoring intervening structures. This is a reasonable assumption based on review of Figure 4 from Reference 3.16 and MHI Power Block General Arrangement Drawings.

4.3 This calculation conservatively assumes all sources are point sources except for the containment shell, which is considered a diffuse area source.

4.4 Per email from Seiichi Kudo (MHI) to Joanne Morris and Jared Monroe (ENERCON) Dated 2/4/08 [Reference 3.18] and Table 3 of Reference 3.16, the TSC HVAC system is integrated completely with the Auxiliary Building HVAC system. Therefore, the atmospheric dispersion values calculated for the TSC are conservatively determined using the distances from each release location to the closer of the two Auxiliary Building HVAC intakes. Only the Auxiliary Building HVAC intakes are analyzed as receptors because they provide the most direct pathway to the TSC. Releases entering the building any other way would disperse throughout the Auxiliary Building before reaching the TSC, thus lowering the χ/Q value (see Section 6.4 for further discussion). This approach is conservative.

4.5 NRC guidance on the use of ARCON96 for determining Control Room χ/Q values, Regulatory Guide 1.194 [Reference 3.3], is applied. In accordance with this guidance, a surface roughness of 0.2 is used.

4.6 The averaging sector width constant of 4.3 is used instead of the ARCON96 code default value of 4.0. This is consistent with the guidance of Regulatory Guide 1.194 [Reference 3.3].

4.7 Regulatory Guide 1.194 recommends using the default minimum wind speed of 0.5 m/s. Since the CPNPP anemometer start speed is 0.45 m/s [Reference 3.10], the NRC recommended value of 0.5 m/s will not be used. Use of 0.45 m/s is justified, since the instruments are accurate at this level according to Table 2.3-34 of the CPSES Units 1 & 2 FSAR [Reference 3.10].

5.0 Methodology

The methodology used in this calculation is based on Regulatory Guide 1.194 and the ARCON96 code. Regulatory Guide 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants" [Reference 3.3], provides guidance on the use of ARCON96 for determining atmospheric relative concentrations in building wakes. The model implemented in ARCON96 is structured to address short-term atmospheric dispersion at typical reactor site building complexes. Therefore, the use of ARCON96 for determination of atmospheric dispersion factors for the TSC is appropriate. Verification of the ARCON96 computer code [Reference 3.2] was performed in accordance with the ENERCON corporate procedure for control of computer software.

The basic diffusion model implemented in the ARCON96 code is a straight-line Gaussian model that assumes the release rate is constant for the entire period of release. This assumption is made to permit evaluation of potential effects of accidental releases without having to specify a complete release sequence.

ARCON96 permits evaluation of ground-level, vent, and elevated releases. Building wake effects are considered in the evaluation of relative concentrations from ground-level releases. Vent releases are treated as a mixed ground-level and elevated release. The proportion of the mixture is determined by the ratio between the effluent vertical velocity and the release-height wind speed using Equation 16 from the ARCON96 manual [Reference 3.1]. Further discussion on this method is included in Regulatory Guide 1.111 and the XOQDOQ code. Note that Regulatory Guide 1.194 [Reference 3.3] indicates that the ARCON96 vent release model should not be used for design basis accident calculations. Elevated releases are determined with correction for downwash and differences in terrain elevation between the stack and the TSC intakes. Diffusion coefficients used in ARCON96 have three components. The first component is the diffusion coefficient used in other NRC models; for example, XOQDOQ and PAVAN. The other two components are corrections to account for enhanced dispersion under low wind speed conditions and in building wakes.

ARCON96 calculates relative concentrations using hourly meteorological data. It then combines the hourly averages to estimate concentrations for periods ranging in duration from 2 hours to 30 days. Wind direction is considered as the averages are formed. As a result, the averages account for persistence in both diffusion conditions and wind direction. Cumulative frequency distributions are prepared from the average relative concentrations. Relative concentrations that are exceeded no more than five percent of the time (95th percentile relative concentrations) are determined from the cumulative frequency distributions for each averaging period. Finally, the relative concentrations for five standard averaging periods used in TSC habitability assessments are calculated from the 95th percentile relative concentrations.

6.0 Design Input

6.1 True North and Plant Directions

Based on Appendix A of Reference 3.16, Plant North is 8.54° counter-clockwise of True North. The atmospheric dispersion calculations are based on True North (360 degrees). Therefore, TSC release location directions are determined relative to True North.

6.2 Meteorological Data

ARCON96 uses meteorological data in the form of electronic meteorological data files. The meteorological data files require one record per hour. Each record must include the day of the year, the hour of the day, the stability and the wind direction and wind speed at the lower measurement level. The record may also include a five character location identifier and a wind direction and speed for the upper level. The meteorological data used in this calculation was obtained from the hourly meteorological data for the four years beginning January 1, 2001 and ending December 31, 2004 as well as the data from 2006 beginning January 1, 2006 and ending December 31, 2006 as provided by TXU and Luminant [References 3.6 and 3.7]. The meteorological data provided represents 43,824 total possible hours of data, i.e., (365 x 4 + 366 x 1) x 24. Each year of meteorological data is input into ARCON96 as a separate meteorological file.

The five years of onsite meteorological data is assumed to be a representative data base for χ/Q estimates over an extended period of time. In addition, it is assumed that there are no topographical characteristics in the vicinity of the site for restrictions of horizontal and/or vertical plume spread, channeling, or other changes in airflow trajectories, or other unusual conditions affecting atmospheric transport and diffusion between the source and the receptors (see Assumption 4.1).

The raw met data provided by CPNPP was screened and then manually reviewed using criteria recommended in NUREG-0917 [Reference 3.14]. The screening and evaluation of the meteorological data is documented in calculation TXUT-001-FSAR-2.3-CALC-024 [Reference 3.17]. Four hundred seventy-three hours of bad or missing data were identified and rejected based on the screening and review process. This number of bad or missing data is representative of the number of hours that any of the variables used in the calculation of atmospheric dispersion coefficients, e.g., lower wind speed or direction, upper temperature, and lower temperature, were determined to be bad. If the data for any other parameter was determined to be bad or missing, the bad data was replaced with "999", but all the data for that entire hour was not marked bad.

Regulatory Guide 1.23 [Reference 3.8] recommends that a data recovery goal of 90% be achieved for each year of meteorological data. The meteorological data from 2005 is not included because there are approximately 40 days of missing data from this year. This results in a data recovery of less than the required 90%. Therefore, this year was determined to be unrepresentative of onsite meteorology. The data recoveries for each year used in this calculation are 99.0%, 98.0%, 99.3%, 98.7%, and 99.6%, for 2001 – 2004, and 2006, respectively. The data recovery for the five-year composite data is 98.9%.

The process of formatting the data for use in the ARCON96 code consists of the following:

1. Converting the wind speed from mph to m/s and multiplying by 10
2. Rounding the wind speed and direction to the nearest integer
3. Changing bad data indicator from "-999" or "-999.00" to "999" for wind speed, wind direction and stability class
4. Changing temperature differential (°F/50m) to temperature differential (°C/100m)
5. Changing temperature differential (°C/100m) to stability class using the classification system from Regulatory Guide 1.23 [Reference 3.8]
6. Formatting data in accordance with the ARCON96 manual [Reference 3.1]

The stability classes are based on the classification system given in Table 1 of Regulatory Guide 1.23 [Reference 3.8], as follows:

Regulatory Guide 1.23
Classification of Atmospheric Stability

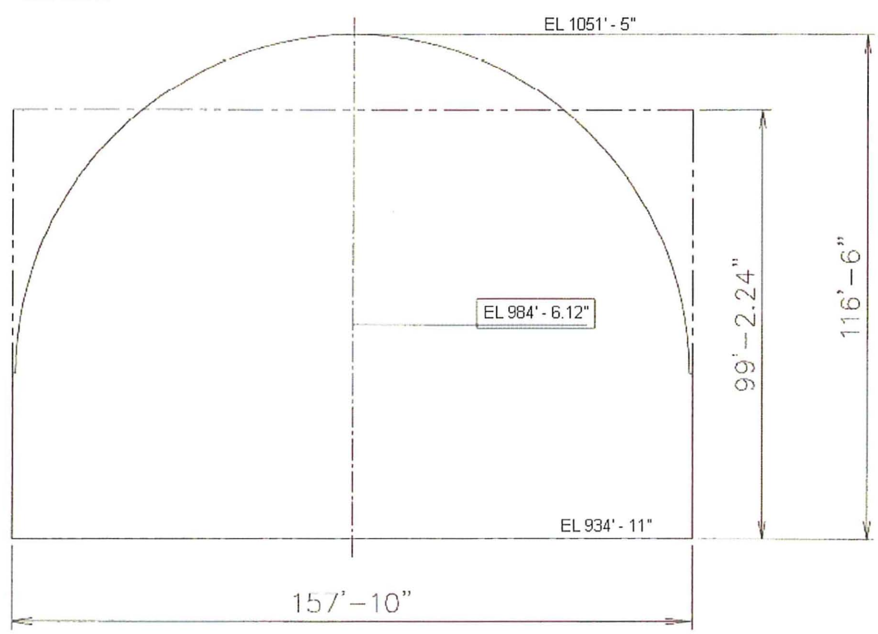
Stability Classification	Pasquill Categories	Temperature change with height (°C/100m)
Extremely unstable	A	$\Delta T \leq -1.9$
Moderately unstable	B	$-1.9 < \Delta T \leq -1.7$
Slightly unstable	C	$-1.7 < \Delta T \leq -1.5$
Neutral	D	$-1.5 < \Delta T \leq -0.5$
Slightly stable	E	$-0.5 < \Delta T \leq 1.5$
Moderately stable	F	$1.5 < \Delta T \leq 4.0$
Extremely stable	G	$\Delta T > 4.0$

6.3 *Building Area*

The ARCON96 code uses the building area in determining the wake diffusion. The building area controls the distance downwind that building-wake effects will be felt. Since the receptor (intake) locations are fixed, the appropriate building area is the area normal to the line between the release location and the intake location. The containment vessel is the tallest building on site and is normal to the lines between the release locations and the intake locations. A smaller cross-sectional area results in less building wake and higher atmospheric dispersion coefficients. Therefore, for conservatism, the cross-sectional area of containment above the roof of the Reactor Building is used in the determination of building-wake effects.

The area of the Reactor Building to be used in the determination of building-wake effects will be conservatively estimated as the cross-sectional area of containment above the Reactor Building roof. The following information was obtained from Figure 5 of Reference 3.16, which is provided below.

$Width_{area\ source}$ = 157 ft = 47.9 m
$Height_{area\ source}$ = 99 ft = 30.2 m



Cross-Sectional Area = Width x Height
= 47.9 m x 30.2 m
= **1,447 m^2**

As discussed above, a smaller cross-sectional area results in a higher atmospheric dispersion coefficient. Therefore, for additional conservatism, a building cross-sectional area of 1,200 m^2 is used.

6.4 Receptor Locations

According to Reference 3.16, the Control Room HVAC intakes, Class 1E Electrical Room HVAC intakes, the Reactor Building Doors, and the Auxiliary Building HVAC intakes are all potential receptors evaluated for Control Room χ/Q values. For evaluating TSC χ/Q values, only the Auxiliary Building HVAC intakes are evaluated as inleakage pathways. The Reactor Building Doors are interior doors and are not evaluated as receptors for the calculation of TSC χ/Q values. Because of the torturous paths from the Control Room and Class 1E Electrical Room HVAC intakes to the TSC, the χ/Q values determined for the Auxiliary Building HVAC intakes clearly bound those calculated for inleakage from any of the other receptors. This is due to the fact that the Auxiliary Building HVAC system is completely integrated with the TSC HVAC system. Therefore, some of the contaminated air entering the Auxiliary Building HVAC system is filtered, then exhausted directly into the TSC; thus, the χ/Q values determined for the Auxiliary Building HVAC intakes are conservative values to use for inleakage into the TSC (see Assumption 4.5). This is in accordance with Section C 3.3 of Regulatory Guide 1.194 [Reference 3.3].

Horizontal distance to the receptor from the release point is used in ARCON96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack releases. The ARCON96 guidance [Reference 3.3] allows calculation of the χ/Q values assuming flow around and over the building for cases where the plume is assumed to flow around a building rather than over it. The χ/Q values calculated assuming flow around and over the building are then to be compared and the higher of the two χ/Q's is to be used. Since consideration of flows around structures would result in increased distances without any significant change in direction, no cases were evaluated which take credit for flow around structures (see Assumption 4.3). This approach is conservative. The minimum source to receptor distances to either the North or South Auxiliary Building HVAC intake from Reference 3.16 are used in this analysis. This approach is also conservative. These distances are reported in Table 6-1 below.

The value of the intake height is used in ARCON96 for calculating the slant range for ground level releases and the off-centerline correction factors for stack release models. The upper and lower elevations of the HVAC intakes from Reference 3.16 are displayed in Table 6-2. For cases where the release height is above the HVAC intake, the upper elevation of the HVAC intake is used. For cases where the release height is below the HVAC intake, the lower elevation of the HVAC intake is used. This approach is conservative as it minimizes the distances from the sources to the receptor.

The direction from the receptor to the source is used to establish which range of wind directions should be used in the assessment of the χ/Q values. The directions from the source to the receptors are given in Reference 3.16. However, the direction must have the same point of reference as the wind directions reported in the meteorological data; therefore, the directions from the receptors to the sources, given relative to Plant North, are corrected for True North (see Section 6.1). These directions are reported below in Table 6-1. Because ARCON96 only accepts degrees input in whole numbers, all directions are rounded up to the nearest degree.

Table 6-1
Auxiliary Building HVAC Intake Distances and Directions

Release Point	Distance (m)	Direction to Source (°)
Plant Vent	55.5	73°
Main Steam Line (East)	93.0	104°
Main Steam Line (West)	70.1	109°
Fuel Handling Area	111.9	63°
Main Steam Relief Valve (East)	78.9	88°
Main Steam Relief Valve (West)	62.5	89°
Main Steam Safety Valve (East)	79.6	92°
Main Steam Safety Valve (West)	63.4	94°
Containment Shell	46.3	83°

Table 6-2
Above Grade Elevations of the Auxiliary Building HVAC Intakes

Receptor	Lower Elevation (m)	Upper Elevation (m)
Auxiliary Building HVAC Intakes	23.3	25.4

6.5 Release Heights

The ARCON96 computer code also requires the height of the release points. The value of the release height is used for three purposes in ARCON96: (1) to adjust wind speeds for differences between the heights of the instrumentation and the release, (2) to determine slant path for ground level releases and (3) to correct off-centerline data for elevated releases. The relevant US-APWR release point heights relative to plant grade [Table 2 - Reference 3.16] are as follows:

Table 6-3
Release Heights

Release Point	Elevation (m)
Plant Vent	69.9
Main Steam Line (East)	12.8
Main Steam Line (West)	26.3
Containment Shell	49.5
Fuel Handling Area	5.9
Main Steam Relief Valve (East)	40.7
Main Steam Relief Valve (West)	40.7
Main Steam Safety Valve (East)	38.8
Main Steam Safety Valve (West)	38.8

6.6 Release Point Data

In ARCON96 vent release calculations, the vertical vent velocity of the vent exhaust is compared with the release height wind speed to determine how much of the exhaust enters the building wake. When the ratio of vertical velocity to wind speed exceeds 5, the exhaust rises above the wake. When the ratio is less than 1, the exhaust is completely trapped in the wake, and at intermediate ratios, part of the exhaust enters the wake. In elevated release calculations, the vertical velocity is used to determine if the stack height should be reduced to account for downwash. Downwash is included in the calculation whenever the ratio of vertical velocity to the release height wind speed is less than 1.5. The vent velocity is calculated based on the vent flow and vent area. For releases through capped vents, the vertical velocity is zero.

The stack flow is used in ARCON96 calculations to ensure that effluent concentrations in the atmosphere are always less than the concentrations at the release point. The closer together the release point and receptor are and the larger the flow, the more important it is to include the flow; however, Regulatory Guide 1.194 indicates that if the stack flow is not maintained during the course of the accident, this parameter should be set to zero. Stack radius is used only in elevated release calculations to determine the maximum stack height reduction during downwash conditions.

6.6.1 Plant Vent

The heating, ventilation, and air conditioning (HVAC) systems serving the plant during normal and emergency conditions, including a station blackout (SBO), are designed to provide suitable environment for plant equipment and personnel. Ventilation zones, air distribution and airflows migration are configured and arranged so that the ventilation air is drawn from the clean areas to areas of potentially greater radioactive contamination to a final filtration and exhaust systems discharging to the Plant Vent stack.

During normal plant operations, the containment air is drawn through the containment low volume purge system penetration by the exhaust filtration unit and discharged to the atmosphere through the Plant Vent stack. The capacity of the containment low volume purge system is sized to maintain acceptably low levels of radioactivity, including noble gases, during normal plant operation.

During refueling operations, the containment air is drawn through the containment high volume purge system penetration by the exhaust filtration unit and discharged to the atmosphere through the Plant Vent stack. The capacity of the containment high volume purge system is sized to maintain acceptably low levels of radioactivity, including noble gases, during refueling operations.

In the event of a LOCA, the annulus emergency exhaust system draws down the penetration and safeguard component areas to a negative pressure with regard to the adjacent areas. Exhaust air is filtered and discharged into the vent stack and the penetration and safeguard component areas remains isolated from the auxiliary building HVAC system.

Regulatory Guide 1.194 [Reference 3.3] states that stack releases are appropriate for releases from standalone stacks that are 2½ times the height of adjacent solid structures. The elevation of the CPNPP Nuclear Plant Vent is 69.9 m above plant grade (see Table 6-3), the same elevation as the top of the containment building. As a result, releases from the Plant Vent cannot be considered as "stack releases". It should also be noted that the NRC guidance states that the use of vent release models is not acceptable for design basis accident applications. Therefore, releases from the Plant Vent will be considered as ground-level releases. If the release type is ground-level, ARCON96 ignores all user inputs related to release velocity and radius; therefore, zero is entered for these values. The stack flow is conservatively set to zero.

6.6.2 Main Steam Line

The main function of the main steam supply system (MSS) is to transport steam from the steam generators to the high-pressure turbine and to the moisture separator reheater over a range of flows and pressures covering the entire operating range from system warmup to valve wide open (VWO) turbine conditions.

The main steam line travels through the Reactor Building and into the turbine building. The piping rooms where the main steam line passes between the PCCV and the turbine building are located on the top floor of this area. The assumed location of a main steam line break is near the point where the main steam line travels from the Reactor Building to the Turbine Building. A ground-level release is conservatively assumed for the main steam line release. If the release type is ground-level, ARCON96 ignores all user inputs related to release velocity and radius; therefore, zero is entered for these values. Since the flow rate from the main steam line is not maintained during the course of the accident, in accordance with Regulatory Guide 1.194 guidance, the stack flow is also set to zero.

6.6.3 Containment Shell

The containment vessel consists of a prestressed, post-tensioned concrete structure with a cylindrical wall, hemispherical dome, and flat reinforced concrete foundation slab. The inside surface of the structure is lined with carbon steel. The US-APWR reactor and reactor coolant system (RCS) are completely enclosed in the prestressed concrete containment vessel (PCCV). The PCCV is designed to assure essentially no leakage of radioactive materials to the environment, even if a major failure of the reactor coolant system were to occur.

The containment shell is modeled as a vertical, diffuse area source. ARCON96 permits specification of initial diffusion coefficients to represent the diffuse area source. The following equations from Regulatory Guide 1.194 [Reference 3.3] are used to determine the horizontal and vertical diffusion coefficients.

$$\vartheta_Y = \frac{Width_{area\ source}}{6} \quad \text{Equation 1}$$

$$\vartheta_Z = \frac{Height_{area\ source}}{6} \quad \text{Equation 2}$$

The height and width of the area source are taken as the maximum vertical and horizontal dimensions of the above grade shield building cross-sectional area perpendicular to the line of sight from the building center to the Auxiliary Building HVAC intake locations. These dimensions are projected onto a vertical plane perpendicular to the line of sight and located at the closest point on the containment building surface relative to the receptor. The release height is set at the vertical center of the projected plane. The source-to-receptor distance is measured from the containment building to the nearest HVAC intake. The vertical projected plane conservatively assumed for the containment shell diffuse area source is shown in Figure 5 of Reference 3.16 (see Section 6.3). Based on the equations above, the vertical and horizontal diffusion coefficients are determined to be 5.0 m (16.5 ft) and 8.0 m (26.2 ft), respectively. According to Table 2 of Reference 3.16, the release height is at an elevation 49.5 m (162.4 ft) above grade. The horizontal distance from the projected plane to the nearest Auxiliary Building HVAC intake is 46.3 m as given in Table 6-1.

6.6.4 Fuel Handling Area

The fuel handling area of the Reactor Building contains the new fuel storage facilities as well as the spent fuel storage facilities. The spent fuel storage facilities are safety related.

Dispersion factors for the fuel handling area are used for the fuel handling accident occurring outside containment and for evaluating the impact of releases associated with spent fuel pool boiling.

The release elevation given in Reference 3.16 for the fuel handling area is 5.9 m above plant grade. A ground-level release is conservatively assumed for a release in the fuel handling area. If the release type is ground-level, ARCON96 ignores all user inputs related to release velocity and radius; therefore, zero is entered for these values. The fuel handling area is conservatively assumed to be a point source.

6.6.5 Safety Valves

The main steam supply system dissipates heat generated by the nuclear steam supply system (NSSS) by means of turbine bypass valves (TBV) to the condenser or to the atmosphere through air operated main steam relief valves (MSRV), the motor operated main steam depressurization valves (MSDV), or the spring-loaded main steam safety valves (MSSV) when either the turbine-generator or condenser is unavailable.

Dispersion factors for the safety valves are used for accident scenarios where there are steam generator releases. There are six MSSVs provided per main steam line. The MSSVs with sufficient rated capacity are provided to prevent the steam pressure from exceeding 110% of the MSS design pressure.

The main steam safety valves are located on the main steam line which travels through the Reactor Building and Turbine Building. A ground-level release is conservatively assumed for a steam generator release through the main steam safety valves. If the release type is ground-level, ARCON96 ignores all user inputs related to release velocity and radius; therefore, zero is entered for these values. The MSSVs are conservatively assumed to be point sources. In accordance with Regulatory Guide 1.194 guidance, since the MSSV flow is not maintained during the course of the accident, the stack flow is also set to zero. The distances used for the safety valves to the HVAC intake locations are obtained from Table 1 of Reference 3.16 and are assumed to be measured from the safety valve closest to the receptors (see Assumption 4.3).

6.6.6 Relief Valves

Dispersion factors for the air operated main steam relief valves (MSRV) are used for accident scenarios where there are steam generator releases. There is one MSRV installed on each of the four MSS lines from the steam generators. The primary function of the MSRVs is to prevent an unnecessary lifting of the MSSVs.

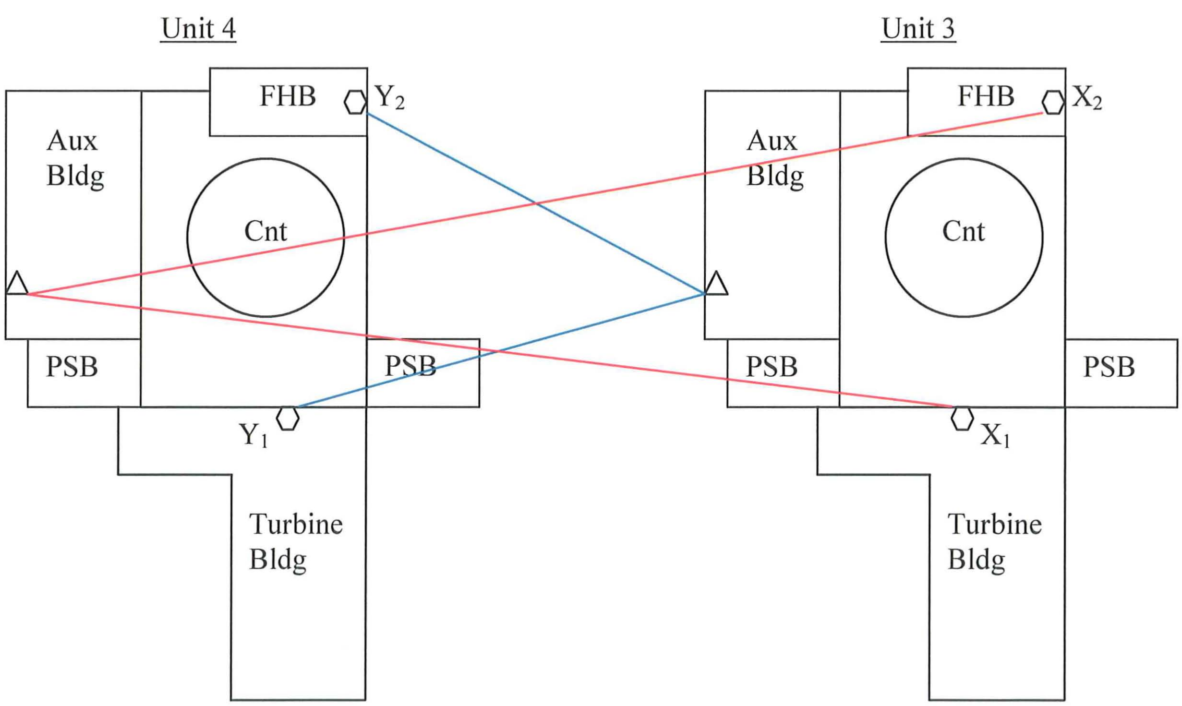
The relief valves are 40.7 m above ground elevation. A ground-level release is conservatively assumed for a steam generator release through the MSRV. If the release type is ground-level, ARCON96 ignores all user inputs related to release velocity and radius; therefore, zero is entered for these values. The relief valves are conservatively assumed to be point sources. The distances used for the relief valves to the HVAC intake locations are obtained from Figure B-1 of drawing Reference 3.16 and are assumed to be measured from the relief valve closest to the receptors (see Assumption 4.2).

7.0 Calculations

This calculation determines the Technical Support Center atmospheric relative concentration (χ/Q) values for evaluation of the radiological dose to TSC operators for various accidents using the ARCON96 code. The atmospheric dispersion estimates discussed previously are determined for the Auxiliary Building HVAC intakes assuming the postulated accident occurs at the same unit. These atmospheric dispersion calculations are based on 2001 – 2004 and 2006 met data and consider release and receptor locations identified in the US-APWR Design Control Document [Reference 3.9]. Results are summarized in Section 2.0. ACRON96 output files are provided in Appendix 2.

Since CPNPP Units 3 & 4 are oriented identically and the locations of the releases and receptors for each unit are the same [References 3.11 and 3.16], the TSC χ/Q values determined for a postulated accident at the same unit are representative of both units. However, Unit 3 TSC χ/Q values determined for an accident at Unit 4 would be different from the Unit 4 TSC χ/Q values determined for an accident at Unit 3. It is clear from a review of the Site Plan drawing [Reference 3.11] that, given the distance between the units, the χ/Q values determined for one TSC for an accident at the other unit would be bounded by the values determined for an accident at the same unit. Revision 0 of this calculation performed a sensitivity study and confirmed this assumption. The slight changes in source and receptor locations in Revision 1 of this calculation do not change the conclusions of the sensitivity study, which are presented below.

Atmospheric dispersion estimates are determined at the Unit 3 and Unit 4 Auxiliary Building HVAC intakes for the Fuel Handling Area and Main Steam Line release locations of each unit, designated in the figure below as X_1 and X_2 for Unit 3 and Y_1 and Y_2 for Unit 4, respectively. The locations were selected to maximize the range of the direction from source to receptor. The following figure is not to scale.



For simplicity, only the releases from the fuel handling area and main steam line break to one Auxiliary Building HVAC intake on the opposite unit is evaluated for each unit. The releases are modeled as ground-level, point source, and the release height is assumed to be equal to the height of the midpoint of the Auxiliary Building HVAC intake. The distances and directions used for this sensitivity study are determined from the Site Plan drawing [Reference 3.11] and are given in Tables 7-1 and 7-2. The results are given in Tables 7-3 and 7-4.

The results in Tables 7-3 and 7-4 show that, at a given unit's HVAC intake there is minimal variation in the χ/Q values from one release location to another. This is because the separation between the plants minimizes the difference in the distance and direction to the source from one release location to another. The difference between the results for the Unit 3 TSC verses the Unit 4 TSC is a function of distances and the met data. Winds blowing in an easterly direction affect the Unit 3 TSC χ/Q values most significantly while winds blowing in a westerly direction affect the Unit 4 TSC χ/Q values most significantly.

Comparing the results given in Tables 7-3 and 7-4 with the results given in Table 2-1, it can be seen that the χ/Q values determined for one TSC assuming a postulated accident at the other unit are bounded by the values determined for an accident at the same unit.

Table 7-1
ARCON96 Input Parameters for χ/Q Sensitivity Study
Unit 3 Technical Support Center HVAC Intake (El. 25.2 m)/ Unit 4 Release Locations

Source Location	Distance to Source (m)	Direction to Source
Fuel Handling Area	214	275.5°
Main Steam Line	238	251.5°

Table 7-2
ARCON96 Input Parameters for χ/Q Sensitivity Study
Unit 4 Technical Support Center HVAC Intake (El. 25.2 m)/ Unit 3 Release Locations

Source Location	Distance to Source (m)	Direction to Source
Fuel Handling Area	405	74.5°
Main Steam Line	365	87.5°

Table 7-3
Technical Support Center Atmospheric Dispersion Factors (χ/Q) in s/m^3 for Accident Dose Analysis at Unit 3 HVAC Intake / Unit 4 Releases

Time Interval	Fuel Handling Area	Main Steam Line
0 – 2 hours	1.4E-04	1.1E-04
2 – 8 hours	8.0E-05	5.9E-05
8 – 24 hours	3.3E-05	2.2E-05
1 – 4 days	2.1E-05	1.7E-05
4 – 30 days	1.9E-05	1.3E-05

Table 7-4
Technical Support Center Atmospheric Dispersion Factors (χ/Q) in s/m^3 for Accident Dose Analysis at Unit 4 HVAC Intake / Unit 3 Releases

Time Interval	Fuel Handling Area	Main Steam Line
0 – 2 hours	4.8E-05	5.7E-05
2 – 8 hours	2.9E-05	3.9E-05
8 – 24 hours	1.2E-05	1.6E-05
1 – 4 days	8.7E-06	1.2E-05
4 – 30 days	5.9E-06	8.4E-06

Appendix 1
Comanche Peak Site 2001 – 2006 Meteorological Data Files

TXU Power

'XU Power
:omanche Peak
;team Electric Station
'.O. Box 1002
ilen Rose, TX 76043
el: 254 897 5851
ax: 254 897 6573
buschb1@txu.com

Dennis Buschbaum
Licensing Basis Manager

CPSES-200602398
November 30, 2006

Mr. Mike Laggart
Project Manager
Enercon
400 Valley Road
Suite 301
Mt. Arlington, NJ 07856

SUBJECT: Transmittal of Existing CPSES Meteorological Data for Use in COLA at Comanche Peak Units 3 and 4

Dear Mike,

Transmitted with this letter is a disk containing Comanche Peak's meteorological records from January 1, 2000 through November 8, 2006. The disk contains seven files as described below.

Should you have any questions or need further information, please contact me at 254-897-5851.

Thank You,

Denny Buschbaum – A08

File Description:	Size	Date
2000 METSYS DATA.DMP	2,277 KB	11/20/2006 11:32 AM
2001 METSYS DATA.DMP	2,270 KB	11/20/2006 11:33 AM
2002 METSYS DATA.DMP	2,270 KB	11/20/2006 11:33 AM
2003 METSYS DATA.DMP	2,270 KB	11/20/2006 11:33 AM
2004 METSYS DATA.DMP	2,277 KB	11/20/2006 11:33 AM
2005 METSYS DATA.DMP	2,270 KB	11/20/2006 11:33 AM
2006 METSYS DATA_THRU 11082006.DMP	1,947 KB	11/20/2006 11:33 AM

Appendix 1 (Continued)
Comanche Peak Site 2001 – 2006 Meteorological Data Files

Luminant

Matt Weeks
Principal Engineer, NuBuild
Matt.weeks@luminant.com

Luminant Power
PO BOX 1002
6322 FM 56 N
Glen Rose, TX 76043

T 254.897.5183
C 817.975.2051
F 254.897.6890

CPSES-200701296

August 2, 2007

Mike Laggart
Project Manager, CP 3 & 4
ENERCON
400 Valley Rd. Suite 301
Mt. Arlington, NJ 07856

SUBJECT: Transmittal MET data (November Thru December 2006) as requested by ENERCON RFI-0067

Mike,
Attached to this letter is a hard copy of the MET data transmitted electronically on August 2, 2007. The specific data transmitted is Comanche Peak's meteorological records from November 1, 2006 through December 31, 2006. The data transmitted represents the balance of the CPSES MET data required for COLA development ENERCON as requested by in RFI-0067. The file information associated with the previously transmitted electronic data is as described below.

If you should have any questions or need further information, please contact me at 254-897-5183.

File Description: Size Date
Nov-1 thru Dec 31 2006_EDM903A.DMP 379 KB 08/02/2007 11:49 AM

Sincerely,

Matt Weeks
Principal Engineer, NuBuild

CC: Craig Hill
Tim Gilder
Denny Buschbaum
Marvin Morris

Attachments: Attachment 1 Listing of Data transmitted electronically (Total of 123 pages)

Appendix 1 (Continued)
Comanche Peak Site 2001 – 2006 Meteorological Data Files

CD: Comanche Peak Met Data:
2001 METSYS DATA.DMP
2002 METSYS DATA.DMP
2003 METSYS DATA.DMP
2004 METSYS DATA.DMP
2006 METSYS DATA_THRU 11082006.DMP
Nov-1 thru Dec 31 2006_EDM903A.DMP

The 2005 met data file is excluded as it was not used in this calculation.

Appendix 2
Comanche Peak ARCON96 Output Files

The ARCON96 program was utilized to calculate the Technical Support Center (TSC) atmospheric dispersion, χ/Q, values for the proposed Comanche Peak Nuclear Power Plants Units 3 & 4. These values were calculated for the preparation of the Comanche Peak COLA. The inputs used for ARCON96 are discussed in the body of the calculation. All output files used in this calculation are provided on the CD attached on the next page. The naming convention used for the output files consists of identifying the Auxiliary Building HVAC intake as the receptor (AB) followed by an abbreviation of the source. For example, "AB_MSL_E.LOG" refers to the χ/Q values at the Auxiliary Building HVAC intake closest to the east Main Steam Line break location. The naming convention used for the cross-unit files consists of identifying the unit and intake followed by the unit and release location. For example, "3AB_4FHA.LOG" refers to the χ/Q values from the Unit 4 Fuel Handling Area to the Unit 3 Auxiliary Building HVAC intake.

Appendix 2 (Continued)
Comanche Peak ARCON96 Output Files

CD: Comanche Peak ARCON Output Files:

The following files are same-unit files:

AB_CS.LOG
AB_FHA.LOG
AB_MSL_E.LOG
AB_MSL_W.LOG
AB_PV.LOG
AB_RV_E.LOG
AB_RV_W.LOG
AB_SV_E.LOG
AB_SV_W.LOG

The following files are cross-unit files:

3AB_4FHA.LOG
3AB_4MSL.LOG
4AB_3FHA.LOG
4AB_3MSL.LOG

Appendix 3
Comanche Peak Units 3 & 4 Site Plot Plan, FSAR Figure 2.1-201

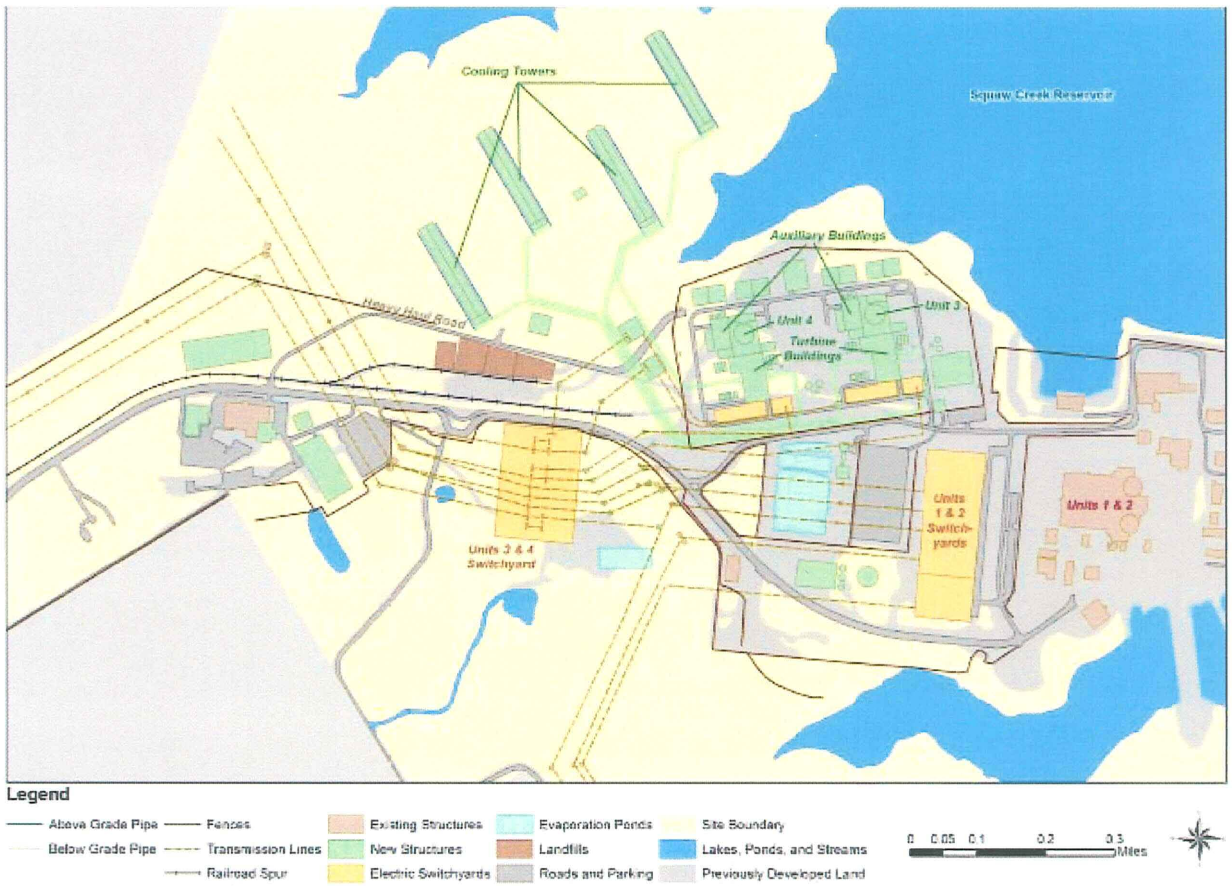


Figure 2.1-201 Site Plot Plan

Appendix 4
MHI Clarification of Assumptions

Email from Seiichi Kudo (MHI) to Joanne Morris (Enercon) Dated 2/1/08

From: 工藤 清一 [sei_kudo@mhi.co.jp]
Sent: Fri 2/1/2008 1:52 PM
To: jmorris@enercon.com; jmonroe@enercon.com
Cc: 河合 勝則; 西野 博雅; 堀 英一; 武智 義典; mlaggart@enercon.com
Subject: about the calculation condition for X/Q

Dear Joanne Morris
Jared Monroe
(cc: Michael Laggart)

Thank you very much for meeting on 30.Jan.

About the X/Q calculation conditions, I send you a file in which fixed data at the present time are mentioned.

Please check the data.

And if there are any other data which you need to calculate X/Q for MCR, please return me mail with the parameters which you need.

I answer to your questions as follows:

(1) We have been considering the location of 4 main steam lines.

The difference of horizontal and vertical distances between the Ease and the West are due to the difference of piping layout of main steam lines. (Please see Figure 4 added in the attached file.)

(2) The reactor building doors, the air locks and the E/H are interior doors. But we made the distances conservatively with presuming that these doors are exterior doors.

(3) The direction angle of the recepter is clockwise angle from plant north line with the release point centered. Please see Figure A-1 added in the attached file.)

(4) AB duct and MCR duct are separated. But we assumed that in-leaked air from AB door into AB may reach to MCR. This assumtion is unrelated to the air duct.

Next, there are some important data as follows:

(1) Relation of Plant north and actual north.

(2) Latest vertical location of CP-3/4.

We must reconfirm those data to our layout section people, but they are now in the plane to Japan.

Then I will inform by mail beginning of next week.

About X/Q for TSC,

MHI is discussing partially modification of the layout and the system design for COL.

X/Q calculation points for TSC may be containing the points for MCR.

If above situation will be finaly determined, X/Q calculation become to needless.

Appendix 4 (Continued)
MHI Clarification of Assumptions

I will inform you after I confirm the design principle for COL.

Could you please stop your action of X/Q forTSC until I will give information to you.

Thank you for your chechking of the calculation condisions.

Best regards

Seiichi Kudo (MHI : Radiation Protection Section)

See attached file: CP34-HKH-0001R0_US-APWR Sources and Receptors for MCR_d3.doc)

Appendix 4 (Continued)
MHI Clarification of Assumptions

Email from Seiichi Kudo (MHI) to Joanne Morris (Enercon) Dated 2/4/08

From: 工藤 清一 [sei_kudo@mhi.co.jp]
Sent: Mon 2/4/2008 12:44 PM
To: jmorris@enercon.com; jmonroe@enercon.com
Cc: 河合 勝則; 西野 博雅; 堀 英一; 武智 義典; mlaggart@enercon.com; 川中子 信司; 田中 敏夫; 山浦 良久
Subject: About the calculation conditions for X/Q

Dear Joanne Morris

Jared Monroe

(cc: Michael Laggart)

We are glad to check the calculation conditions for X/Q by you.

I send a file reviewed with your comments and requests.

We added some informations as follows:

(1) The EL of the grand level is 822'-0' (822 feets)

The vertical distances in Table 1 are shown the relative values from the grand level.

(Please see Table 2, Table 3 and Figure 3 (pp14-15))

(2) The true north is 8.5 degree as clockwise from the plant north.

(Please see Appendix A and Figure A-1)

(3) The modified informations are pointed out with red word or red line from the last file which I sended last Fridar.

Could you please check and start calculation of X/Q for MCR?

Then the X/Qs for TSC are needless because the X/Qs for TSC HVAC intake are inegrated with AB HVAC intake completely.

(See attached file: CP34-HKH-0001R0_US-APWR Sources and Receptors for MCR_d6.pdf)

We hope to your quick responce and thank you for your efforts.

Best regards,

S.Kudo (MHI : Radiation protection Section)