STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

*SEE INSTRUCTIONS ON REVERSE SIDE

▲ 5010.64 (FRONT)

CLIENT & PROJECT: Private Fuel Storage Limited Liability Corp./Private Fuel Storage Facility

PAGE 1 OF 8

CALCULATION TITLE (Indicative of the Objective): Accident X/Qs for the Private Fuel Storage Facility (PFSF)

QA CATEGORY (✓)
☒ I - NUCLEAR SAFETY RELATED
☐ II ☐ III ☐ _____ OTHER

CALCULATION IDENTIFICATION NUMBER

J. O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.
05996.01	Rad. Protection	UR-1	N.A.	N.A.

* APPROVALS - SIGNATURE & DATE

PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)	REV. NO. OR NEW CALC NO.	SUPERSEDES * CALC. NO. OR REV. NO.	CONFIRMATION *REQUIRED (✓) YES	NO
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CALCULATION SHEET	J.O./W.O./CALCULATION NO. 05996.01-UR-2	REVISION 0	PAGE 2

PREPARER/DATE	REVIEWER/CHECKER/DATE	INDEPENDENT REVIEWER/DATE
Johns / 6/4/97		

SUBJECT/TITLE	QA CATEGORY/CODE CLASS
Accident χ/Qs for the Private Fuel Storage Facility (PFSF)	I

TABLE OF CONTENTS AND HISTORIC DATA
(Revisions, Additions, Deletions, Etc.)

PAGE NO.	DESCRIPTION	REVISION NO.	REVISION DATE	REMARKS
1	Calculation Title Page	0	6/4/97	
2	Table of Contents	0	6/4/97	
3	Calculation Objective	0	6/4/97	
3	Calculation Method/Assumptions	0	6/4/97	
3	References	0	6/4/97	
3	Conclusion	0	6/4/97	
5	Calculation	0	6/4/97	
5	χ/Q Equations and Methodology	0	6/4/97	
6	Calculation Input Parameters	0	6/4/97	
7	Resultant χ/Qs at Distances of Interest	0	6/4/97	
8	χ/Qs for Postulated Instantaneous Releases	0	6/4/97	
8	χ/Qs for Postulated Long Term Releases	0	6/4/97	

CALCULATION IDENTIFICATION NUMBER				PAGE 3
J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-1	OPTIONAL TASK CODE N.A.	

CALCULATION OBJECTIVE

The objective of this calculation is to determine conservative dispersion factors (χ/Qs) at several distances of interest at the Private Fuel Storage Facility (PFSF). The dispersion factors determined in this calculation will be used to calculate doses at the various distances of interest for accidents involving postulated releases of radioactivity.

CALCULATION METHOD / ASSUMPTIONS

χ/Qs are calculated in accordance with the methodology presented in Regulatory Guide 1.145 (Reference 1) for a ground level release. Meteorological conditions of Pasquill Stability Class F (moderately stable) and a 1.0 meter/second (m/sec) wind speed are assumed. χ/Qs are calculated assuming both instantaneous and long term releases.

REFERENCES

1. Regulatory Guide 1.145, Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants, Revision 1, U.S. NRC, 1983.

2. NUREG-1536, Standard Review Plan for Dry Cask Storage Systems, Final Report, January 1997.

CONCLUSION

χ/Qs are calculated for three distances of interest assuming Stability Class F conditions, with 1 m/sec horizontal wind speed:

500 meters - the closest distance from the Canister Transfer Building to the OCA boundary. This represents the nearest distance from a point where a loaded canister could be staged, stored, or handled at the PFSF to the OCA boundary.

150 meters - an arbitrarily selected distance so doses can be calculated at an intervening distance inside the OCA boundary.

3,219 meters equal to 2.0 miles, the distance from a storage pad to the nearest residence.

Following are the calculated χ/Qs:

χ/Qs for Postulated Instantaneous Releases

150 meters	1.40 E-2 sec/m^3
500 meters	1.94 E-3 sec/m^3
3,219 meters (2.0 miles)	9.42 E-5 sec/m^3

χ/Qs for Postulated Long Term Releases

150 meters	3.51 E-3 sec/m^3
500 meters	4.85 E-4 sec/m^3
3,219 meters (2.0 miles)	5.14 E-5 sec/m^3

CALCULATION IDENTIFICATION NUMBER				PAGE 5
J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-1	OPTIONAL TASK CODE N.A.	

CALCULATION

χ/Q Equations and Methodology

χ/Q values are calculated in accordance with U.S. NRC Regulatory Guide 1.145 (Reference 1). The three equations used to calculate χ/Qs at a boundary some distance from a ground-level release point from Section C.1.3.1 of this Regulatory Guide are as follows:

$$\chi/Q = \frac{1}{\mu_{10}\,(\pi\sigma_y\sigma_z + A/2)} \qquad \text{(Equation 1)}$$

$$\chi/Q = \frac{1}{\mu_{10}\,(3\pi\sigma_y\sigma_z)} \qquad \text{(Equation 2)}$$

$$\chi/Q = \frac{1}{\mu_{10}\,\pi\Sigma_y\sigma_z} \qquad \text{(Equation 3)}$$

where:

χ/Q is the relative concentration (sec/m^3)
μ_{10} is the horizontal wind speed (m/sec) at 10 meters above grade
σ_y and σ_z are the horizontal and vertical dispersion coefficients (m)
Σ_y is the lateral plume spread(m), a function of atmospheric stability and distance
$\Sigma_y = M\sigma_y$ for distances less than or equal to 800 m, and
$\Sigma_y = (M-1)\sigma_{y800m} + \sigma_y$ for distances greater than 800 m
M is the plume meander factor from Figure 3 of Reg. Guide 1.145
A is the cross sectional building area (m^2)

Per Section C.1.3.1.a of Reg. Guide 1.145, horizontal plume meander may be considered provided that atmospheric stability conditions are neutral (Class D) or stable (Classes E, F, and G) and wind speed at the 10 meter level is less than 6 m/sec. The χ/Q with horizontal plume meander considered is given in Equation 3. Section C.1.3.1.b of Reg. Guide 1.145 states that during all other meteorological conditions, plume meander should not be considered.

CALCULATION IDENTIFICATION NUMBER				PAGE 6
J.O. OR W.O. NO. 05996.01	DIVISION & GROUP Rad. Protection	CALCULATION NO. UR-1	OPTIONAL TASK CODE N.A.	

When plume meander is a consideration, then the χ/Q value is calculated by:

- Calculating the χ/Q values using Equations 1, 2, and 3;
- Comparing the values from Equations 1 and 2 and selecting the higher value,
- Comparing this value to the χ/Q calculated by Equation 3, and selecting the lower of these two values as the final χ/Q.

When plume meander is not a consideration, then the χ/Q value is calculated by:

- Calculating the χ/Q values using Equations 1 and 2, and
- Comparing the values from Equations 1 and 2 and selecting the higher value as the final χ/Q.

In reference to the hypothetical loss of canister confinement accident, Section 7.V.4.c of NUREG-1536 (Reference 2) states "Because the leak is assumed to be instantaneous, the plume meandering factor of Regulatory Guide 1.145 is not typically applied." Section 7.V.4.b of NUREG-1536 indicates that the NRC staff accepts consideration of plume meander when the radioactivity release takes place over a substantial period of time.

This calculation computes χ/Qs for both instantaneous releases, which do not consider plume meander, and releases over time, which do take credit for plume meander.

Calculation Input Parameters

A. Horizontal Wind Speed (μ) - For purposes of this calculation, a horizontal wind speed of 1.0 m/sec is utilized coupled with a Pasquill F (moderately stable) stability class.
B. Cross Sectional Building Area - The PFSF includes storage casks mounted on concrete slabs in an open area, with the Canister Transfer Building and the Security and Health Physics Building by the southeast corner of the pads, and the Operations and Maintenance Building and Administration Building further to the southwest of the pads. No credit is taken for building wake effects, and building area is conservatively assumed to be 0 m^2.
C. Meander Correction Factor (M) - For a wind speed of 1.0 m/sec and Stability Class F, Figure 3 of Reg. Guide 1.145 gives a meander correction factor of 4.0.

D. Distances to the OCA Boundary From Cask Storage and Transfer Locations Nearest the Boundary - Distances to the OCA from various locations at the PFSF are scaled from SWEC Drawing No. 0599601-EY-1-E, "Site & Access Road Location Plan." Following are distances from the OCA boundary to points of interest:

1. From east side of storage pads to east OCA fence: 689 m
2. From south side of storage pads to south OCA fence: 705 m
3. From west side of storage pads to west OCA fence: 646 m
4. From north side of storage pads to north OCA fence: 646 m
5. From east side of Canister Transfer Building to OCA fence: 500 m
6. From south side of Canister Transfer Building to south OCA fence: 662 m
7. From rail (shipping cask staging area on the west of Canister Transfer Building) south to OCA fence: 654 m

E. Horizontal and Vertical Dispersion Coefficients and Lateral Plume Spread for the nearest residence (2.0 miles = 3,219 m), the nearest distance from canister storage, staging, and handling operations to the OCA fence, and an arbitrary intermediate distance of 150m.

σ_y is obtained from Reg. Guide 1.145, Figure 1, assuming Stability Class F
σ_z is obtained from Reg. Guide 1.145, Figure 2, assuming Stability Class F
$\sum_y$ is obtained from the Reg. Guide 1.145 equation, $\sum_y = M\sigma_y$ for distances less than or equal to 800 m, and $\sum_y = (M-1)\sigma_{y800m} + \sigma_y$ for distances greater than 800 m, where M is from Reg. Guide 1.145, Figure 3. σ_{y800m} is found to be 31.3 from Reg. Guide 1.145, Figure 1.

Distance	σ_y	σ_z	M	$\sum_y$
150 meters	6.9	3.29	4.0	27.6
500 meters	20.0	8.20	4.0	80.0
3,219 meters (2.0 miles)	113	29.9	4.0	207

Resultant χ/Qs at Distances of Interest

The above coefficients for horizontal and vertical dispersion and lateral plume spread are inserted into Equations 1, 2 and 3, provided in Section C.1.3.1 of Reg. Guide 1.145 and shown above, to calculate χ/Qs for distances of interest. The value of μ_{10} in all three equations, the horizontal wind speed, is assumed to be 1.0 m/sec.

Distance	Equation 1 (sec/m^3)	Equation 2 (sec/m^3)	Equation 3 (sec/m^3)
150 meters	1.40 E-2	4.67 E-3	3.51 E-3
500 meters	1.94 E-3	6.47 E-4	4.85 E-4
3,219 meters (2.0 miles)	9.42 E-5	3.14 E-5	5.14 E-5

χ/Qs for Postulated Instantaneous Releases

For postulated instantaneous releases during Stability Class F conditions, with 1 m/sec horizontal wind speed and no credit for plume meander, the χ/Q value is calculated to be the higher of Equations 1 and 2, resulting in the following:

150 meters	1.40 E-2 sec/m^3
500 meters	1.94 E-3 sec/m^3
3,219 meters (2.0 miles)	9.42 E-5 sec/m^3

χ/Qs for Postulated Long Term Releases

For releases postulated to occur over a long period of time during Stability Class F conditions, with 1 m/sec horizontal wind speed, plume meander is a consideration and the χ/Q value is calculated by: selecting the higher value of Equations 1 and 2, then comparing this value with the χ/Q value calculated by Equation 3, and taking the lower of these two values as the final χ/Q.

150 meters	3.51 E-3 sec/m^3
500 meters	4.85 E-4 sec/m^3
3,219 meters (2.0 miles)	5.14 E-5 sec/m^3