STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

CLIENT & PROJECT				PAGE 1 OF 4	
Private Fuel Storage LLC / Private Fuel Storage Facility					
CALCULATION TITLE **RESRAD Pathway Analysis Following Deposition of Radioactive Material From the Accident Plumes**				QA CATEGORY I	
CALCULATION IDENTIFICATION NUMBER					
J.O. OR W.O. NO.	DIVISION & GROUP	CURRENT CALC. NO.	OPTIONAL TASK CODE	OPTIONAL WORK PACKAGE NO.	
05996.02	**Radiation Protection**	**UR-010**	**NA**	**NA**	

APPROVALS - SIGNATURE & DATE			REV. NO. OR NEW CALC. NO	SUPERSEDES CALC. NO. OR REV. NO.	CONFIRMATION REQUIRED (X)	
PREPARER(S)/DATE(S)	REVIEWER(S)/DATE(S)	INDEPENDENT REVIEWER(S)/DATE(S)			YES	NO
W.E. Kennedy (Dade Moeller & Associates) W.E. Kennedy 02/09/99	C.Y. Smith (Dade Moeller & Associates) Cheryl Y. Smith 2.9.99	J.R. Johns J.R. Johns 2-10-99	0	NA	X (See page 3)	

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05996.02	Radiation Protection	UR-010	NA	

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1.0 OBJECTIVE

At the request of Private Fuel Storage, LLC, Dade Moeller & Associates, Inc. was requested to perform calculations necessary to respond to questions raised by the U.S. Nuclear Regulatory Commission (NRC) during the licensing process for the Private Fuel Storage Facility proposed to be built in Tooele County, Utah. Specifically, the questions were associated with the accident analysis and the development of an estimate of the dose to members of the public from environmental pathways following deposition of radioactive material from the plume created by the accidental release of radioactive materials to the air. The objective of this calculation is to estimate the potential radiation doses that result from material deposited from the plume created by accidents involving nuclear fuel canisters stored at the Private Fuel Storage Facility. Previous calculations (Reference 1) were performed using the Excel® spreadsheet software. Two sets of 30-day canister leakage accidents, as defined in the U.S. Nuclear Regulatory Commission Interim Staff Guidance – 5 (ISG-5, Reference 2) were performed: 1) for the Holtec HI-STAR Canister, and 2) for the Sierra Nuclear Corporation (SNC) TranStor storage canister. Both accident analyses involve BWR fuel, providing the largest inventory (and therefore producing the largest source term), to obtain bounding dose estimates.

2.0 METHOD

As an evaluation of the potential doses from environmental pathways following deposition of material in the plume, a pathway analysis using the RESRAD computer program was conducted. The first step of this evaluation was to estimate the amount of material deposited on the ground from the plume. This estimate was made in a previous Calculation (Reference 1). These values were in units of pCi/g to match the input requirements of the RESRAD computer program. (NOTE: correct operation of the RESRAD software for the scenarios considered requires confirmation.)

3.0 INPUT

The primary input to the calculations is the deposition, in pCi/g, for each radionuclide, for each accident, at each location downwind. These values are found in Tables 1 and 5 of Attachment A of Reference 1 for the Holtec HI-STAR canister, and in Tables 1a and 5a of Attachment B of Reference 1 for the SNC TranStor storage canister.

4.0 ASSUMPTIONS

The exposure scenario considered in the RESRAD analysis includes direct exposure to contaminated ground, inhalation of resuspended radioactive material, ingestion of milk and beef following grazing, and ingestion of soil. This scenario is considered to be consistent with the land use conditions and environment of the land surrounding the proposed Private Fuel Storage Facility. Since the 500 m downwind location is considered to be along the OCA fence line, it is not possible for an individual to continuously occupy this location. Therefore, for purposes of

calculation, an exposure duration of 2,000 h/y is assumed at 500 m downwind. Although natural vegetation at the facility is quite sparse, it is conservatively assumed that the RESRAD default values for fodder intake are met both for the dairy and beef cattle. Default values for human consumption shown in RESRAD for air, milk, beef, and soil were assumed. The default values include inhalation of 1,918 m^3 of air (over 2,000 h/y) with a mass loading factor for air of 2.0E-4 g/m^3, ingestion of 92 L/y of milk, ingestion of 63 kg/y of beef, and ingestion of 36.5 g/y of soil. The same scenario is evaluated at a downwind distance of 3,219 m, except that continuous exposure (8760 h/y) is assumed since this is the location of the nearest resident.

5.0 CALCULATION/RESULTS

The calculations were conducted using RESRAD and a summary of the output for the cases considered is included in the Attachment . The resulting Total Committed Effective Dose Equivalents for these accident cases were: 1) 0.49 mrem/y at 500 m downwind, and 0.095 mrem/y at 3,219 m downwind for the HI-STAR canister, and 2) 2.67 mrem/y at 500 m downwind, and 0.522 mrem/y at 3,219 m downwind.

6.0 CONCLUSION

All of the dose results are quite small compared to the 0.05 Sv (5 rem) accident limit imposed by 10 CFR 72.106(b). The dominant exposure pathway is external exposure to contaminated land and the radionuclide with the largest contribution to the dose is Co-60. From this analysis, it is concluded that these doses are sufficiently small compared to the inhalation TEDEs from plume passage shown in Attachments A an B of Reference 1 (about 4% at 500 m and about 14% at 3,219 m) that they can justifiably be ignored in the accident analysis.

7.0 REFERENCES

1. Stone & Webster Calculation 05996.02-UR-009, February 9, 1999.

2. Interim Staff Guidance – 5. *Normal, off-normal, and hypothetical accident dose estimate calculations for the whole body, thyroid, and skin.* Spent fuel Project Office, U.S. Nuclear Regulatory Commission, Washington, D.C. October 6, 1998.

Attachment 1

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.01 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	8.400E-05
Ce-144	9.300E-04
Cm-244	3.500E-04
Co-60	8.220E-01
Cs-134	1.820E-02
Cs-137	5.790E-02
Eu-154	4.100E-04
Eu-155	1.300E-04
H-3	3.310E-01
I-129	2.900E-05
Pm-147	3.370E-03
Pu-238	2.800E-04
Pu-239	2.300E-05
Pu-240	4.800E-05
Pu-241	7.970E-03
Ru-106	1.050E-02
Sb-125	2.400E-04
Sr-90	3.840E-02

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit =5000 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

(years):	0.000E+00	1.000E+00	2.000E+01	5.000E+01
TDOSE(t):	4.878E-01	4.245E-01	3.517E-02	2.458E-03
M(t):	9.755E-05	8.490E-05	7.034E-06	4.917E-07

Maximum TDOSE(t): 4.878E-01 mrem/yr at t = 0.000E+00 years

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.01 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	3.700E-06
Ce-144	4.200E-05
Cm-244	1.600E-05
Co-60	3.670E-02
Cs-134	8.100E-04
Cs-137	2.580E-03
Eu-154	1.800E-05
Eu-155	5.900E-06
H-3	1.480E-02
I-129	1.300E-06
Pm-147	1.500E-04
Pu-238	1.300E-05
Pu-239	1.000E-06
Pu-240	2.100E-06
Pu-241	3.600E-04
Ru-106	4.700E-04
Sb-125	1.100E-05
Sr-90	1.710E-03

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit =5000 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

(years):	0.000E+00	1.000E+00	2.000E+01	5.000E+01
DOSE(t):	9.515E-02	8.282E-02	6.848E-03	4.717E-04
M(t):	1.903E-05	1.656E-05	1.370E-06	9.433E-08

Maximum TDOSE(t): 9.515E-02 mrem/yr at t = 0.000E+00 years

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.01 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	5.400E-04
Ce-144	1.300E-04
Cm-244	1.960E-03
Co-60	4.520E+00
Cs-134	7.190E-02
Cs-137	3.310E-01
Eu-154	2.030E-03
Eu-155	6.600E-04
H-3	1.800E+00
I-129	1.700E-04
Pm-147	1.440E-02
Pu-238	1.610E-03
Pu-239	1.300E-04
Pu-241	4.180E-02
Ru-106	2.790E-02
Sb-125	1.140E-03
Sr-90	2.200E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit =5000 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	1.000E+01	3.000E+01
TDOSE(t):	2.672E+00	2.278E+00	5.621E-01	3.295E-02
M(t):	5.343E-04	4.556E-04	1.124E-04	6.589E-06

Maximum TDOSE(t): 2.672E+00 mrem/yr at t = 0.000E+00 years

check: $\frac{\text{Snc (mrem/y)}}{\text{Snc (pCi/g)}}$ (MPC pCi/g) ≡ MPC (mrem/y)

$\left(\frac{2.672 \text{ mrem/y}}{4.52 \text{ pCi/g}}\right)$ (0.822 pCi/g) = 0.486

agrees with p. 17 of MPC!

W. E. Kennedy, J. 2/5/99

Contaminated Zone Dimensions

Area:	10000.00 square meters
Thickness:	0.01 meters
Cover Depth:	0.00 meters

Initial Soil Concentrations, pCi/g

Am-241	2.400E-05
Ce-144	8.400E-05
Cm-244	8.700E-05
Co-60	2.020E-01
Cs-134	3.200E-03
Cs-137	1.480E-02
Eu-154	9.100E-05
Eu-155	3.000E-05
H-3	8.200E-02
I-129	7.700E-06
Pm-147	6.400E-04
Pu-238	7.700E-05
Pu-239	5.600E-06
Pu-240	1.200E-05
Pu-241	1.860E-03
Ru-106	1.240E-03
Sb-125	5.100E-05
Sr-90	9.810E-03

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 30 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

(years):	0.000E+00	1.000E+00	1.000E+01	3.000E+01
TDOSE(t):	5.217E-01	4.451E-01	1.098E-01	6.405E-03
M(t):	1.739E-02	1.484E-02	3.661E-03	2.135E-04

Maximum TDOSE(t): 5.217E-01 mrem/yr at t = 0.000E+00 years