STONE & WEBSTER ENGINEERING CORPORATION

CALCULATION TITLE PAGE

CLIENT & PROJECT	PAGE 1 OF 28
Private Fuel Storage LLC / Private Fuel Storage Facility	
CALCULATION TITLE **Accident Dose Calculations at 500m and 3219m Downwind for Canister Leakage Under Hypothetical Accident Conditions for the Holtec MPC-68 and SNC TranStor Canisters**	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-009**	**NA**	**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. To support the response to comments, calculations 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 1) 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

Based on the input information provided for both types of canisters, releases and potential doses to members of the public and radionuclide deposition to soil were estimated using Excel® spreadsheets. Eight spreadsheets were produced for each accident considered (for a total of 16). This report provides a detailed description of the calculations that were performed, including a description of each calculation, the units of each parameter in each equation. This calculation sheet also documents the process used to verify and validate the spreadsheet results that were produced. This calculation is divided into two parts: Development of Doses and Soil Deposition for the Holtec HI-STAR Canister, and Development of Doses and Deposition for the SNC TranStor Storage Canister.

3.0 INPUT - HI-STAR CANISTER

The results for the HI-STAR MPC-68 canister are shown in Tables 1 through 8 in Attachment A at the end of this report. The following discussion provides the input details required in the calculations.

1. In responding to the NRC questions, the information found in Chapter 7 of the HI-STAR TSAR Report HI-941184 (Reference 2) regarding the accident analysis provides initial input for the radionuclides, inventory (Ci/assembly), number of assemblies per canister (68), canister internal volume (5.99 m^3), and canister leak rate (1.58E-5 cm^3/s).

2. The release fractions used are those in Table 4-1 of NUREG-1617 (Reference 3), as described in U.S. NRC in Interim Staff Guidance-5 (Reference 1). This information, and information from Item 1 above, serves as input to the first seven columns of MPC-68 spreadsheet Tables 1, 2, 4, 5, 6, and 8. The input to these columns has been verified against

Chapter 7 of the HI-STAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 (Reference 1) guidance.

3. The canister leakage accident duration is assumed to be 30 days, as defined in the U.S. Nuclear Regulatory Commission Interim Staff Guidance – 5 (Reference 1).

4. Reference 4 and the PFSF Environmental Report (Reference 5) identify two downwind distances of interest to this calculation: 500 m (identified as the nearest distance from a canister to the site owner controlled area fence), and 3,219 m (about 2 miles, identified in the PFSF Environmental Report as the distance to the nearest residence).

5. Atmospheric dispersion factors (X/Qs) at these downwind distances are: 1.94E-3 s/m^3 at 500 m downwind and 9.42E-5 s/m^3 at 3,219 m downwind (Reference 4). These X/Qs are based on a wind speed of 1.0 m/s and atmospheric stability Class F, consistent with the guidance in ISG-5 (Reference 1), with no consideration for plume meander.

6. Inhalation dose conversion factors are obtained from Federal Guidance Report No. 11 (Reference 6) based on NRC guidance found in ISG-5 (Reference 1).

7. External dose conversion factors are obtained from Federal Guidance Report No. 12 (Reference 7) based on NRC guidance found in ISG-5 (Reference 1).

8. A breathing rate of 3.30E-4 m^3/s is used, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

9. Deposition estimates for material in the plume produced by the accident were made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). To estimate deposition, this approach requires that the relative deposition rate be divided by the arc length of the sector at the given downwind distance being considered. The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111 (Reference 8), as 8.0 E-5 m^{-1} at 500 m downwind and as 2.3E-5 m^{-1} at 3,219 m downwind.

4.0 INPUT – TRANSTOR STORAGE CANISTER

The results for the SNC TranStor storage canister are shown in Tables 1a through 8a in Attachment B at the end of this report. The following discussion provides the input details required in the calculations.

1. Information regarding the number of assemblies per BWR canister (61) was obtained from the TranStor Safety Analysis Report (Reference 9). Additional information was provided by Sierra Nuclear Corporation during a telephone conversation with Alan Wells on February 5, 1999, and served as initial input for the radionuclides, inventory (Ci/assembly), canister

internal volume (5.71 m^3), and canister leak rate (1.0E-4 cm^3/s). (Note, this information requires confirmation).

2. The release fractions used are those in Table 4-1 of NUREG-1617 (Reference 3), as described in U.S. NRC in Interim Staff Guidance-5 (Reference 1). This information, and information from Item 1 above, serves as input to the first seven columns of the SNC TranStor spreadsheet Tables 1a, 2a, 4a, 5a, 6a, and 8a. The input to these columns has been verified against the information provided by Alan Wells and the release fractions that are consistent with ISG-5 guidance.

3. The canister leakage accident duration is assumed to be 30 days, as defined in the U.S. Nuclear Regulatory Commission Interim Staff Guidance – 5 (Reference 1)

4. Reference 4 and the PFSF Environmental Report (Reference 5) identify two downwind distances of interest to this calculation: 500 m (identified as the nearest distance from a canister to the site owner controlled area fence), and 3,219 m (about 2 miles, identified in the PFSF Environmental Report as the distance to the nearest residence).

5. Atmospheric dispersion factors (X/Qs) at these downwind distances are: 1.94E-3 s/m^3 at 500 m downwind and 9.42E-5 s/m^3 at 3,219 m downwind (Reference 4). These X/Qs are based on a wind speed of 1.0 m/s and atmospheric stability Class F, consistent with the guidance in ISG-5 (Reference 1), with no consideration for plume meander.

6. Inhalation dose conversion factors are obtained from Federal Guidance Report No. 11 (Reference 6) based on NRC guidance found in ISG-5 (Reference 1).

7. External dose conversion factors are obtained from Federal Guidance Report No. 12 (Reference 7) based on NRC guidance found in ISG-5 (Reference 1).

8. A breathing rate of 3.30E-4 m^3/s is used, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

9. Deposition estimates for material in the plume produced by the accident were made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). To estimate the deposition, this approach requires that the relative deposition rate be divided by the arc length of the sector at the given downwind distance being considered. The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111 (Reference 8), as 8.0 E-5 m^{-1} at 500 m downwind and as 2.3E-5 m^{-1} at 3,219 m downwind.

5.0 ASSUMPTIONS

1. The deposition, in units of pCi/g, is calculated to produce input to the RESRAD computer program. It is assumed that the deposited material is mixed in the top 1 cm of soil, and that the soil density is 1.5E+6 g/m^3.

2. It is assumed that the wind blows in the same direction continuously over the entire 30 day duration of the activity release.

3. For inhalation and submersion doses, it is assumed that an individual is continuously present at the locations of interest (nearest point at the owner controlled area fence and nearest residence) over the entire 30 day duration of the activity release.

6.0 CALCULATION/RESULTS - HOLTEC HI-STAR CANISTER ACCIDENT

The following sections describe the calculations that were performed for the 30-day canister leakage accident for the Holtec HI-STAR canister. Details are provided for each of the eight tables of spreadsheet results, on a column-by-column basis.

Table 1 - MPC-68 Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (μCi/m^2) at 500 m Downwind

As previously described, the first seven columns are entered from data contained in Chapter 7 of the HI-STAR TSAR Report (Reference 2)and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 1 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.50E+1 (Ci/Assembly) x 68 (Assemblies) x (1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 1 = 1.17E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 1.

The ninth column of Table 1 contains the X/Q at a distance of 500 m downwind. As previously defined in the Input Section, this value is 1.94E-3 s/m^3. The tenth column of Table 1 contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6). The eleventh column of Table 1 contains the committed effective dose equivalent dose conversion factor from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The twelfth column of Table

1 contains the committed effective dose equivalent dose conversion factor for inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 11 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for Co-60 produces:

5.91E-8 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 2.19E2 mrem/μCi

This value compares to the value calculated for Co-60 in the twelfth column of Table 1.

The exposure duration for this accident is 30 days, in accordance with guidance in ISG-5 (Reference 1), converted to seconds as follows:

30 d x 24 h/d x 3600 s/h = 2.59E6 s

This value compares to the value entered in the thirteenth column of Table 1.

The inhalation committed effective dose equivalent is found as:

CEDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3)
x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for Co-60:

CEDE (mrem/y) = 2.19E+2 (mrem/μCi) x 1.17E-8 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3)
x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 4.2 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 1.

The final two columns of Table 1 contain deposition estimates. As previously described in the Input Section, this estimate was made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111 (Reference 8), as 8.0 E-5 m^{-1} at 500 m downwind. The calculation performed in the next to last column of Table 1 is as follows:

Deposition at 500 m (Ci/m^2) = Relative Deposition (m^{-1}) x Release Rate (Ci/s) x
Accident Exposure Duration (s) / (π x 2 x 500 m)/16)

Substituting values for Co-60:

Deposition at 500 m (Ci/m^2) = 8E-5 m^{-1} x 1.17E-8 (Ci/s) x
2.59E+6 (s) /(196) = 1.23E-8 (Ci/m^2)

This value compares to the value calculated for Co-60 in the next to last column of Table 1.

Finally, the deposition in units of pCi/g is calculated to produce input to the RESRAD computer program. For this calculation, it is assumed that the deposited activity is mixed in the top 1 cm of soil, with an assumed soil density of 1.5E+6 g/m^3. This calculation is in the last column of Table 1 and is as follows:

Deposition at 500 m (pCi/g) = Deposition at 500 m (Ci/m^2) x Unit Conversion (pCi/Ci) / (Effective Soil Depth (m) x soil density (g/m^3))

Substituting values for Co-60:

Deposition at 500 m (pCi/g) = 1.23E-8 (Ci/m2) x 1E12 pCi/Ci / ((0.01 m x 1.5E6 g/m^3))
= 8.2E-1pCi/g

This value compares to the value calculated for Co-60 in the last column of Table 1, completing the verification of the spreadsheet calculations used to produce Table 1.

Table 2 - MPC-68 Accident Conditions: Effective Dose - External Exposure from Submersion at 500 m Downwind

Again, the first seven columns of Table 2 are entered from data contained in Chapter 7 of the HI-STAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 guidance. The eighth column of Table 2 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.50E+1 (Ci/Assembly) x 68 (Assemblies) x 1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 1 = 1.17E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 2.

The ninth column of Table 2 shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for Co-60 produces:

Release (Ci) = 1.17E-08 (Ci/s) x 2.59E+6 (s) = 3.03E-2 Ci

This value compares to the calculated value for Co-60 in the ninth column of Table 2.

The tenth column of Table 2 contains the X/Q at a distance of 500 m downwind. This value is 1.94E-3 s/m^3. The eleventh column of Table 2 contains the exposure duration for this accident, 30 days, as expressed in seconds as follows:

30 d x 24 h/d x 3600 s/h = 2.59E6 s

The twelfth column of Table 2 contains the effective dose equivalent factor from submersion in the plume, expressed in units of (Sv m^3/Bq s). This information was obtained from Federal Guidance Report No. 12 (Reference 7). The thirteenth column of Table 2 contains the effective dose equivalent factor for submersion in the plume, in units of (mrem m^3/μCi s), and is obtained as the product of the entry in Column 12 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 12 (Reference 7). A check of this calculation for Co-60 produces:

1.26E-13 (Sv m^3/Bq s) x 3.7E9 mrem/μCi per Sv/Bq = 4.66E-4 (mrem m^3/μCi s)

This value compares to the value calculated for Co-60 in the thirteenth column of Table 2.

The effective dose equivalent from submersion in the plume is found in the fourteenth column of Table 2 as:

EDE (mrem/y) = DCF (mrem m^3/μCi s) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x 1E6 μCi/Ci

Substituting the values for Co-60:

EDE (mrem/y) = 4.66E-4 (mrem m^3/μCi s) x 1.17E-8 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3) x 1E6 μCi/Ci = 2.73E-2 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 2, completing the verification of the spreadsheet calculations used to produce Table 2.

Table 3 - MPC-68 Accident Total Effective Dose Equivalent at 500 m Downwind

Table 3 contains the total effective dose equivalent for the accident involving the MPC-68 Cask at a distance of 500 m downwind, and is calculated using the following equation:

Total Effective Dose Equivalent (mrem/y) = Effective Dose Equivalent from Submersion in the Plume Totaled over all Radionuclides in the Plume (mrem/y) + Inhalation Committed

Effective Dose Equivalent Totaled over all Radionuclides in the Plume (mrem/y)

The dose results are obtained from Tables 1 and 2 and inserted in Columns 1 and 3 of Table 3. Substituting the values for Inhalation Committed Effective Dose Equivalent and the Effective Dose Equivalent from Submersion for this accident at 500 m in the equation above:

2.79E-2 (mrem/y) + 1.34E+1 (mrem/y) = 1.34E+1 (mrem/y)

This value compares to the value calculated for this accident at 500 m shown in the last column of Table 3, completing the verification of the spreadsheet calculations used to produce Table 3.

Table 4 - MPC-68 Accident Thyroid Dose at 500 m Downwind

Thyroid doses for I-129 are calculated next. As previously described, the first seven columns of Table 4 are entered from data contained in Chapter 7 of the HI-STAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 4 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for I-129 produces:

7.72E-3 (Ci/Assembly) x 68 (Assemblies) x (1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 0.3 = 4.1E-13 (Ci/s)

This value compares to the value calculated for I-129 shown in the eighth column of Table 4.

The ninth column of Table 4 shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for I-129 produces:

Release (Ci) = 4.14E-13 (Ci/s) x 2.59E+6 (s) = 1.07E-6 Ci

This value compares to the calculated value for I-129 in the ninth column of Table 4.

The tenth column of Table 4 contains the X/Q at a distance of 500 m downwind. This value is 1.94E-3 s/m^3. The eleventh column of Table 4 contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

The twelfth column of Table 4 contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The thirteenth column of Table 4 contains the thyroid committed dose equivalent dose conversion factor for I-129 from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The fourteenth column of Table 4 contains the committed dose equivalent dose conversion factor for I-129 from inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 13 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for I-129 produces:

1.56E-6 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 5.77E+3 mrem/μCi

This value compares to the value calculated for I-128 in the fourteenth column of Table 4.

The inhalation thyroid committed dose equivalent from I-129 is found as:

Thyroid CDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for I-129:

Thyroid CDE (mrem/y) = 5.77E+3 (mrem/μCi) x 4.14E-13 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 3.96E-3 mrem/y

This value compares to the value calculated for I-129 in the fifteenth column of Table 4, completing the verification of the spreadsheet calculations used to produce Table 4.

Table 5 - MPC-68 Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (μCi/m^2) at 3,219 m Downwind

As previously described, the first seven columns are entered from data contained in Chapter 7 of the HI-STAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 5 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.50E+1 (Ci/Assembly) x 68 (Assemblies) x
(1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 1 = 1.17E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 5.

The ninth column of Table 5 contains the X/Q at a distance of 500 m downwind. This value is 9.42E-5 s/m^3. The tenth column of Table 5 contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6). The eleventh column of Table 5 contains the committed effective dose equivalent dose conversion factor from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The twelfth column of Table 5 contains the committed effective dose equivalent dose conversion factor for inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 11 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for Co-60 produces:

5.91E-8 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 2.19E2 mrem/μCi

This value compares to the value calculated for Co-60 in the twelfth column of Table 5.

The exposure duration for this accident is entered into the thirteenth column of Table 5 as 30 days, converted to seconds: 2.59E6 s.

The inhalation committed effective dose equivalent is found as:

CEDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3)
x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for Co-60:

CEDE (mrem/y) = 2.19E+2 (mrem/μCi) x 1.17E-8 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3)
x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 2.06E-1 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 5.

The final two columns of Table 5 contain deposition estimates. As described in the Input Section, this estimate was made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111 as 2.3E-5 m^{-1} at 3,219 m downwind. The calculation performed in the next to last column of Table 5 is as follows:

Deposition at 3,219 m (Ci/m^2) = Relative Deposition (m^{-1}) x Release Rate (Ci/s) x Accident Duration (s) / (π x 2 x 3,219 m)/16

Substituting values for Co-60:

Deposition at 3,219 m (Ci/m^2) = 2.3E-5 m^{-1} x 1.17E-8 (Ci/s) x 2.59E+6 (s) / (1264) = 5.51E-10 (Ci/m^2)

This value compares to the value calculated for Co-60 in the next to last column of Table 5.

Finally, the deposition in units of pCi/g is calculated to produce input to the RESRAD computer program. It is assumed that the deposited radioactive material is mixed in the top 1 cm of soil and that the soil density is 1.5E+6 g/m^3. This calculation is in the last column of Table 5 and is as follows:

Deposition at 3,219 m (pCi/g) = Deposition at 3,219 m (Ci/m^2) x Unit Conversion (pCi/Ci) / (Effective Soil Depth (m) x soil density (g/m^3))

Substituting values for Co-60:

Deposition at 3,219 m (pCi/g) = 5.51E-10 (Ci/m2) x 1E12 pCi/Ci / (0.01 (m) x 1.5E6 (g/m^3)) = 3.68E-2 pCi/g

This value compares to the value calculated for Co-60 in the last column of Table 5, completing the verification of the spreadsheet calculations used to produce Table 5.

Table 6 - MPC-68 Accident Conditions: Effective Dose - External Exposure from Submersion at 3,219 m Downwind

Again, the first seven columns of Table 6 are entered from data contained in Chapter 7 of the HI-SAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 6 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction

An independent calculation for Co-60 produces:

6.50E+1 (Ci/Assembly) x 68 (Assemblies) x (1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 1 = 1.17E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 6.

The ninth column of Table 6 shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for Co-60 produces:

Release (Ci) = 1.17E-08 (Ci/s) x 2.59E+6 (s) = 3.03E-2 Ci

This value compares to the calculated value for Co-60 in the ninth column of Table 6.

The tenth column of Table 6 contains the X/Q at a distance of 3,219 m downwind. This value is 9.42E-5 s/m^3. The eleventh column of Table 6 contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The twelfth column of Table 6 contains the effective dose equivalent dose conversion factor from submersion in the plume, expressed in units of (Sv m^3/Bq s). This information was obtained from Federal Guidance Report No. 12 (Reference 7). The thirteenth column of Table 6 contains the effective dose equivalent dose conversion factor for submersion in the plume, in units of (mrem m^3/μCi s), and is obtained as the product of the entry in Column 12 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 12 (Reference 7). A check of this calculation for Co-60 produces:

1.26E-13 (Sv m^3/Bq s) x 3.7E9 mrem/μCi per Sv/Bq = 4.66E-4 (mrem m^3/μCi s)

This value compares to the value calculated for Co-60 in the thirteenth column of Table 6.

The effective dose equivalent from submersion in the plume is found as:

EDE (mrem/y) = DCF (mrem m^3/μCi s) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x 1E6 μCi/Ci

Substituting the values for Co-60:

EDE (mrem/y) = 4.66E-4 (mrem m^3/μCi s) x 1.17E-8 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3) x 1E6 μCi/Ci = 1.33E-3 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 6, completing the verification of the spreadsheet calculations used to produce Table 6.

Table 7 - MPC-68 Accident Total Effective Dose Equivalent at 3,219 m Downwind

Table 7 contains the total effective dose equivalent for the accident involving the MPC-68 Cask at a distance of 3,219 m downwind, and is calculated using the following equation:

Total Effective Dose Equivalent (mrem/y) = Effective Dose Equivalent from Submersion in the Plume Totaled over all Radionuclides in the Plume (mrem/y) + Inhalation Committed Effective Dose Equivalent Totaled over all Radionuclides in the Plume (mrem/y)

The dose results are obtained from Tables 5 and 6 and inserted in Columns 1 and 3 of Table 7. Substituting the values for Inhalation Committed Effective Dose Equivalent and the Effective Dose Equivalent from Submersion for this accident at 500 m in the equation above:

1.36E-3 (mrem/y) + 6.52E-1 (mrem/y) = 6.53E-1 (mrem/y)

This value compares to the value calculated for this accident at 3,219 m shown in the last column of Table 7, completing the verification of the spreadsheet calculations used to produce Table 7.

Table 8 - MPC-68 Accident Thyroid Dose at 3,219 m Downwind

Thyroid doses for I-129 are calculated next. As previously described, the first seven columns of Table 8 are entered from data contained in Chapter 7 of the HI-STAR TSAR Report (Reference 2) and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 8 contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for I-129 produces:

7.72E-3 (Ci/Assembly) x 68 (Assemblies) x
(1.58E-5 (cm^3/s)/ 5.99E+6 (cm^3)) x 0.3 = 4.1E-13 (Ci/s)

This value compares to the value calculated for I-129 shown in the eighth column of Table 8.

The ninth column of Table 8 shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for I-129 produces:

Release (Ci) = 4.14E-13 (Ci/s) x 2.59E+6 (s) = 1.07E-6 Ci

This value compares to the calculated value for I-129 in the ninth column of Table 8.

The tenth column of Table 8 contains the X/Q at a distance of 500 m downwind. This value is 9.42E-5 s/m^3. The eleventh column of Table 8 contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

The twelfth column of Table 8 contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The thirteenth column of Table 8 contains the thyroid committed dose equivalent dose conversion factor for I-129 from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The fourteenth column of Table 8 contains the committed dose equivalent dose conversion factor for I-129 from inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 13 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for I-129 produces:

1.56E-6 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 5.77E+3 mrem/μCi

This value compares to the value calculated for I-129 in the fourteenth column of Table 8.

The inhalation thyroid committed dose equivalent from I-129 is found in the fifteenth column of Table 8 as:

Thyroid CDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for I-129:

Thyroid CDE (mrem/y) = 5.77E+3 (mrem/μCi) x 4.14E-13 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 1.92E-4 mrem/y

This value compares to the value calculated for I-129 in the fifteenth column of Table 8, completing the verification of the spreadsheet calculations used to produce Table 8.

7.0 CALCULATION/RESULTS – SNC TRANSTOR STORAGE CANISTER ACCIDENT

The following sections describe the calculations that were performed for the 30-day canister leakage accident for the SNC TranStor storage canister. Details are provided for each of the eight tables of spreadsheet results, on a column-by-column basis.

Table 1a - SNC TranStor Storage Canister Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (μCi/m^2) at 500 m Downwind

As previously described in the Input Section, the first seven columns are entered from data provided on the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 1a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.00E+1 (Ci/Assembly) x 61 (Assemblies) x (1.0E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 1 = 6.41E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 1a.

The ninth column of Table 1a contains the X/Q at a distance of 500 m downwind. This value is 1.94E-3 s/m^3. The tenth column of Table 1a contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6). The eleventh column of Table 1a contains the committed effective dose equivalent dose conversion factor from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The twelfth column of Table 1a contains the committed effective dose equivalent dose conversion factor for inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 11 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for Co-60 produces:

5.91E-8 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 2.19E2 mrem/μCi

This value compares to the value calculated for Co-60 in the twelfth column of Table 1a.

The exposure duration for this accident is 30 days in accordance with ISG-5, converted to seconds as follows:

30 d x 24 h/d x 3600 s/h = 2.59E6 s

This value compares to the value entered in the thirteenth column of Table 1a.

The inhalation committed effective dose equivalent is found in the fourteenth column of Table 1a as:

CEDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for Co-60:

CEDE (mrem/y) = 2.19E+2 (mrem/μCi) x 6.41E-8 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 23.3 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 1a.

The final two columns of Table 1a contain deposition estimates. This estimate was made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111, as 8.0 E-5 m^{-1} at 500 m downwind. The calculation performed in the next to last column of Table 1a is as follows:

Deposition at 500 m (Ci/m^2) = Relative Deposition (m^{-1}) x Release Rate (Ci/s) x Accident Exposure Duration (s) / (π x 2 x 500 m)/16)

Substituting values for Co-60:

Deposition at 500 m (Ci/m^2) = 8E-5 m^{-1} x 6.41E-8 (Ci/s) x 2.59E+6 (s) /(196) = 6.78E-8 (Ci/m^2)

This value compares to the value calculated for Co-60 in the next to last column of Table 1a.

Finally, the deposition in units of pCi/g is calculated to produce input to the RESRAD computer program. It is assumed that the deposited material is mixed in the top 1 cm of soil, and that the soil density is 1.5E+6 g/m^3. This calculation is in the last column of Table 1a and is as follows:

Deposition at 500 m (pCi/g) = Deposition at 500 m (Ci/m^2) x Unit Conversion (pCi/Ci) / (Effective Soil Depth (m) x soil density (g/m^3))

Substituting values for Co-60:

Deposition at 500 m (pCi/g) = 6.78E-8 (Ci/m^2) x 1E12 pCi/Ci / (0.01 (m) x 1.5E6 (g/m^3))
= 4.52 pCi/g

This value compares to the value calculated for Co-60 in the last column of Table 1a, completing the verification of the spreadsheet calculations used to produce Table 1a.

Table 2a - SNC TranStor Storage Canister Accident Conditions: Effective Dose - External Exposure from Submersion at 500 m Downwind

Again, the first seven columns of Table 2a are entered from data regarding the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 2a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.00E+1 (Ci/Assembly) x 61 (Assemblies) x
(1.0E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 1 = 6.41E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 2a.

The ninth column of Table 2a shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for Co-60 produces:

Release (Ci) = 6.41E-08 (Ci/s) x 2.59E+6 (s) = 1.66E-1 Ci

This value compares to the calculated value for Co-60 in the ninth column of Table 2a.

The tenth column of Table 2a contains the X/Q at a distance of 500 m downwind. This value is 1.94E-3 s/m^3. The eleventh column of Table 2a contains the exposure duration for this accident, 30 days, as expressed in seconds as: 2.59E6 s.

The twelfth column of Table 2a contains the effective dose equivalent dose conversion factor from submersion in the plume, expressed in units of (Sv m^3/Bq s). This information was obtained from Federal Guidance Report No. 12 (Reference 7). The thirteenth column of Table 2a contains the effective dose equivalent dose conversion factor for submersion in the plume, in

units of (mrem m^3/μCi s), and is obtained as the product of the entry in Column 12 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 12 (Reference 7). A check of this calculation for Co-60 produces:

1.26E-13 (Sv m^3/Bq s) x 3.7E9 mrem/μCi per Sv/Bq = 4.66E-4 (mrem m^3/μCi s)

This value compares to the value calculated for Co-60 in the thirteenth column of Table 2a.

The effective dose equivalent from submersion in the plume is found in the fourteenth column of Table 2a as:

EDE (mrem/y) = DCF (mrem m^3/μCi s) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x 1E6 μCi/Ci

Substituting the values for Co-60:

EDE (mrem/y) = 4.66E-4 (mrem m^3/μCi s) x 6.41E-8 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3) x 1E6 μCi/Ci = 1.50E-1 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 2a, completing the verification of the spreadsheet calculations used to produce Table 2a.

Table 3a - SNC TranStor Storage Canister Accident Total Effective Dose Equivalent at 500 m Downwind

Table 3a contains the total effective dose equivalent for the accident involving the SNC TranStor Storage Canister at a distance of 500 m downwind, and is calculated using the following equation:

Total Effective Dose Equivalent (mrem/y) = Effective Dose Equivalent from Submersion in the Plume Totaled over all Radionuclides in the Plume (mrem/y) + Inhalation Committed Effective Dose Equivalent Totaled over all Radionuclides in the Plume (mrem/y)

The dose results are obtained from Tables 1a and 2a and inserted in Columns 1 and 3 of Table 3a. Substituting the values for Inhalation Committed Effective Dose Equivalent and the Effective Dose Equivalent from Submersion for this accident at 500 m in the equation above:

1.53E-1 (mrem/y) + 7.47E+1 (mrem/y) = 7.49E+1 (mrem/y)

This value compares to the value calculated for this accident at 500 m shown in the last column of Table 3a, completing the verification of the spreadsheet calculations used to produce Table 3a.

Table 4a - SNC TranStor Storage Canister Accident Thyroid Dose at 500 m Downwind

Thyroid doses for I-129 are calculated next. As previously described, the first seven columns of Table 4a are entered from data regarding the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 4a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for I-129 produces:

7.64E-3 (Ci/Assembly) x 61 (Assemblies) x (1.00E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 0.3 = 2.45-12 (Ci/s)

This value compares to the value calculated for I-129 shown in the eighth column of Table 4a.

The ninth column of Table 4a shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for I-129 produces:

Release (Ci) = 2.45E-12 (Ci/s) x 2.59E+6 (s) = 6.34E-6 Ci

This value compares to the calculated value for I-129 in the ninth column of Table 4a.
The tenth column of Table 4a contains the X/Q at a distance of 500 m downwind. This value is 1.94E-3 s/m^3. The eleventh column of Table 4a contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

The twelfth column of Table 4a contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The thirteenth column of Table 4a contains the thyroid committed dose equivalent dose conversion factor for I-129 from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The fourteenth column of Table 4a contains the committed dose equivalent dose conversion factor for I-129 from inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 13 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for I-129 produces:

1.56E-6 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 5.77E+3 mrem/μCi

This value compares to the value calculated for I-128 in the fourteenth column of Table 4a.

The inhalation thyroid committed dose equivalent from I-129 is found as:

Thyroid CDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for I-129:

Thyroid CDE (mrem/y) = 5.77E+3 (mrem/μCi) x 2.45E-12 (Ci/s) x 2.59E6 (s) x 1.94E-3 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 2.34E-2 mrem/y

This value compares to the value calculated for I-129 in the fifteenth column of Table 4a, completing the verification of the spreadsheet calculations used to produce Table 4a.

Table 5a - SNC TranStor Storage Canister Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (μCi/m^2) at 3,219 m Downwind

As previously described in the Input Section, the first seven columns are entered from data supporting the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 5a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for Co-60 produces:

6.00E+1 (Ci/Assembly) x 61 (Assemblies) x (1.00E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 1 = 6.41E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 5a.

The ninth column of Table 5a contains the X/Q at a distance of 3,219 m downwind. This value is 9.42E-5 s/m^3. The tenth column of Table 5a contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6). The eleventh column of Table 5a contains the committed effective dose equivalent dose conversion factor from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The twelfth column of Table 5a contains the committed effective dose equivalent dose conversion factor for inhalation, in units of mrem/μCi, and is

obtained as the product of the entry in Column 11 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for Co-60 produces:

5.91E-8 Sv/Bq x 3.7E9 mrem/μCi per Sv/Bq = 2.19E2 mrem/μCi

This value compares to the value calculated for Co-60 in the twelfth column of Table 5a.

The exposure duration for this accident is entered into the thirteenth column of Table 5 as 30 days, converted to seconds: 2.59E6 s.

The inhalation committed effective dose equivalent is found as:

CEDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for Co-60:

CEDE (mrem/y) = 2.19E+2 (mrem/μCi) x 6.41E-8 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 1.13 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 5a. The final two columns of Table 5a contain deposition estimates. This estimate was made assuming that the effluent concentration in a given sector is uniform across the sector at a given distance, as described in Regulatory Guide 1.111 (Reference 8). The relative deposition (m^{-1}) was obtained from Figure 6 of Regulatory Guide 1.111 as 2.3E-5 m^{-1} at 3,219 m, downwind. The calculation performed in the next to last column of Table 5a is as follows:

Deposition at 3,219 m (Ci/m^2) = Relative Deposition (m^{-1}) x Release Rate (Ci/s) x Accident Duration (s) / (π x 2 x 3,219 m)/16

Substituting values for Co-60:

Deposition at 3,219 m (Ci/m^2) = 2.3E-5 m^{-1} x 6.41E-8 (Ci/s) x 2.59E+6 (s) / (1264) = 3.02E-9 (Ci/m^2)

This value compares to the value calculated for Co-60 in the next to last column of Table 5a.

Finally, the deposition in units of pCi/g is calculated to produce input to the RESRAD computer program. It is assumed that the deposited radioactive material is mixed in the top 1 cm of soil, and that the soil has a density of 1.5E+6 g/m^3. This calculation is in the last column of Table 5a and is as follows:

Deposition at 3,219 m (pCi/g) = Deposition at 3,219 m (Ci/m^2) x Unit Conversion (pCi/Ci) / (Effective Soil Depth (m) x soil density (g/m^3))

Substituting values for Co-60:

Deposition at 3,219 m (pCi/g) = 3.02E-9 (Ci/m2) x 1E12 pCi/Ci / (0.01 (m) x 1.5E6 (g/m^3))
= 2.01E-1 pCi/g

This value compares to the value calculated for Co-60 in the last column of Table 5a, completing the verification of the spreadsheet calculations used to produce Table 5a.

Table 6a - SNC TranStor Storage Canister Accident Conditions: Effective Dose - External Exposure from Submersion at 3,219 m Downwind

Again, the first seven columns of Table 6a are entered from data provided for the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 6a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction =Release Rate

An independent calculation for Co-60 produces:

6.00E+1 (Ci/Assembly) x 61 (Assemblies) x
(1.00E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 1 = 6.41E-8 (Ci/s)

This value compares to the value calculated for Co-60 shown in the eighth column of Table 6a. The ninth column of Table 6a shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for Co-60 produces:

Release (Ci) = 6.41E-08 (Ci/s) x 2.59E+6 (s) = 1.66E-1 Ci

This value compares to the calculated value for Co-60 in the ninth column of Table 6a.

The tenth column of Table 6a contains the X/Q at a distance of 3,219 m downwind. This value is 9.42E-5 s/m^3. The eleventh column of Table 6a contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The twelfth column of Table 6a contains the effective dose equivalent dose conversion factor from submersion in the plume, expressed in units of (Sv m^3/Bq s). This information was obtained from Federal Guidance Report No. 12 (Reference 7). The thirteenth column of Table 6a contains the effective dose equivalent dose conversion factor for submersion in the plume, in units of (mrem m^3/μCi s), and is obtained as the product of the entry in Column 12 times a conversion factor of 3.7E+9 found in Federal Guidance Report No. 12 (Reference 7). A check of this calculation for Co-60 produces:

1.26E-13 (Sv m^3/Bq s) x 3.7E9 mrem/μCi per Sv/Bq = 4.66E-4 (mrem m^3/μCi s)

This value compares to the value calculated for Co-60 in the thirteenth column of Table 6a.

The effective dose equivalent from submersion in the plume is found as:

EDE (mrem/y) = DCF (mrem m^3/μCi s) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x 1E6 μCi/Ci

Substituting the values for Co-60:

EDE (mrem/y) = 4.66E-4 (mrem m^3/μCi s) x 6.41E-8 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3) x 1E6 μCi/Ci = 7.2E-3 mrem/y

This value compares to the value calculated for Co-60 in the fourteenth column of Table 6a, completing the verification of the spreadsheet calculations used to produce Table 6a.

Table 7a - SNC TranStor Storage Canister Accident Total Effective Dose Equivalent at 3,219 m Downwind

Table 7a contains the total effective dose equivalent for the accident involving the SNC TranStor Storage Canister at a distance of 3,219 m downwind, and is calculated using the following equation:

Total Effective Dose Equivalent (mrem/y) = Effective Dose Equivalent from Submersion in the Plume Totaled over all Radionuclides in the Plume (mrem/y) + Inhalation Committed Effective Dose Equivalent Totaled over all Radionuclides in the Plume (mrem/y)

The dose results are obtained from Tables 5a and 6a and inserted in Columns 1 and 3 of Table 7a. Substituting the values for Inhalation Committed Effective Dose Equivalent and the Effective Dose Equivalent from Submersion for this accident at 500 m in the equation above:

7.43E-3 (mrem/y) + 3.63 (mrem/y) = 3.64 (mrem/y)

This value compares to the value calculated for this accident at 3,219 m shown in the last column of Table 7a, completing the verification of the spreadsheet calculations used to produce Table 7a.

Table 8a - SNC TranStor Storage Canister Accident Thyroid Dose at 3,219 m Downwind

Thyroid doses for I-129 are calculated next. As previously described, the first seven columns of Table 8a are entered from data provided for the SNC TranStor Storage Canister and the release fractions that are consistent with ISG-5 guidance (Reference 1). The eighth column of Table 8a contains the release rate, by radionuclide in Ci/s, and is found by the following formula:

Inventory (Ci/Assembly) x Number of Assemblies x (Leak rate (cm^3/s) / Volume (cm^3)) x Release Fraction = Release Rate

An independent calculation for I-129 produces:

7.64E-3 (Ci/Assembly) x 61 (Assemblies) x
(1.00E-4 (cm^3/s)/ 5.71E+6 (cm^3)) x 0.3 = 2.45E-12 (Ci/s)

This value compares to the value calculated for I-129 shown in the eighth column of Table 8a.

The ninth column of Table 8a shows the total release in Ci over the 30 day accident duration. This value is found as follows:

Release (Ci) = Release Rate (Ci/s) x Accident Duration (s)

A check of this calculation for I-129 produces:

Release (Ci) = 2.45E-12 (Ci/s) x 2.59E+6 (s) = 6.34E-6 Ci

This value compares to the calculated value for I-129 in the ninth column of Table 8a.

The tenth column of Table 8a contains the X/Q at a distance of 3,219 m downwind. This value is 9.42E-5 s/m^3. The eleventh column of Table 8a contains the breathing rate of 3.30E-4 m^3/s, consistent with guidance provided in Federal Guidance Report No. 11 (Reference 6).

The twelfth column of Table 8a contains the exposure duration for this accident, 30 days, as expressed in seconds: 2.59E6 s.

The thirteenth column of Table 8a contains the thyroid committed dose equivalent dose conversion factor for I-129 from inhalation, in units of Sv/Bq inhaled. This information was obtained from Federal Guidance Report No. 11 (Reference 6). The fourteenth column of Table 8a contains the committed dose equivalent dose conversion factor for I-129 from inhalation, in units of mrem/μCi, and is obtained as the product of the entry in Column 13 times a conversion

factor of 3.7E+9 found in Federal Guidance Report No. 11 (Reference 6). A check of this calculation for I-129 produces:

1.56E-6 (Sv/Bq) x 3.7E9 (mrem/μCi per Sv/Bq) = 5.77E+3 mrem/μCi

This value compares to the value calculated for I-129 in the fourteenth column of Table 8a.

The inhalation thyroid committed dose equivalent from I-129 is found in the fifteenth column of Table 8a as:

Thyroid CDE (mrem/y) = DCF (mrem/μCi) x Release Rate (Ci/s) x Duration (s) x X/Q (s/m^3) x Breathing Rate (m^3/s) x 1E6 μCi/Ci

Substituting the values for I-129:

Thyroid CDE (mrem/y) = 5.77E+3 (mrem/μCi) x 2.45E-12 (Ci/s) x 2.59E6 (s) x 9.42E-5 (s/m^3) x 3.30E-4 (m^3/s) x 1E6 μCi/Ci = 1.14E-3 mrem/y

This value compares to the value calculated for I-129 in the fifteenth column of Table 8a, completing the verification of the spreadsheet calculations used to produce Table 8a.

8.0 CONCLUSION

Estimates of the public doses and the radioactive material deposited from a plume released during a 30-day canister leak accident were developed for the HI-STAR and TranStor canisters using a spreadsheet analysis. The results of this analysis are shown in Tables 1 through 8 (Attachment A) for the HI-STAR canister, and in Tables 1a through 8a for the TranStor canister (Attachment B). The dose results are:

HI-STAR MPC-68 Cask: 13.4 mrem/y Total Effective Dose Equivalent at 500 m downwind
0.653 mrem/y Total Effective Dose Equivalent at 3,219 m downwind

TranStor Cask: 74.9 mrem/y Total Effective Dose Equivalent at 500 m downwind
3.64 mrem/y Total Effective Dose Equivalent at 3,219 m downwind

9.0 REFERENCES

1. 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.

2. Holtec International . Topical Safety Analysis Report for the Holtec International Storage, Transport, and Repository Cask System (HI-STAR 100 Cask System). NRC Docket No. 72-1008, Holtec Report HI-941184, Rev. 8. August 1998.

3. NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel (Draft Report for Comment), U.S. Nuclear Regulatory Commission, Washington, D.C. March, 1998.

4. Stone & Webster Calculation 05996.02-UR-1, Revision 1, "Accident X/Qs for the Private Fuel Storage Facility", dated October 22, 1997.

5. PFSF Environmental Report, Docket No. 72-22, Revision 1.

6. Federal Guidance Report No. 11. *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion.* U.S. Environmental Protection Agency, Washington, D.C. September, 1988.

7. Federal Guidance Report No. 12. *External Exposure to Radionuclides in Air, Water, and Soil.* U.S. Environmental Protection Agency, Washington, D.C. September, 1993.

8. Regulatory Guide 1.111. *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors.* U.S. Nuclear Regulatory Commission, Washington, D.C. July 1977.

9. Safety Analysis Report for the TranStor Storage Cask System. Docket 72-1023, Revision B. March 1997.

Table 1 MPC-68 Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (uCi/m2) at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15	Column 16
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	X/Q (s/m3)	Breathing Rate (m3/s)	DCF (Sv/Bq)	DCF (mrem/uCi)	Exposure Duration (s)	Inhalation CEDE (mrem/y)	Deposition at 500 m (Ci/m2)	Deposition at 500 m Depth = 0.01 m (pCi/g)
									Gases						
H-3	8.72E+01	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.69E-09	1.94E-03	3.30E-04	1.73E-11	6.40E-02	2.59E+06	4.98E-04	4.96E-09	3.31E-01
I-129	7.72E-03	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.15E-13	1.94E-03	3.30E-04	4.69E-08	1.74E+02	2.59E+06	1.20E-04	4.39E-13	2.93E-05
Kr-85	1.43E+03	68	5.99E+06	1.58E-05	2.63E-12	0.3	7.69E-08	1.94E-03	3.30E-04	0.00E+00	0.00E+00	2.59E+06	0.00E+00	8.14E-08	5.43E+00
									Crud						
Co-60	6.50E+01	68	5.99E+06	1.58E-05	2.63E-12	1	1.17E-08	1.94E-03	3.30E-04	5.91E-08	2.19E+02	2.59E+06	4.23E+00	1.23E-08	8.22E-01
									Volatiles						
Sr-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	5.45E-10	1.94E-03	3.30E-04	3.51E-07	1.30E+03	2.59E+06	1.18E+00	5.77E-10	3.84E-02
Ru-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	1.49E-10	1.94E-03	3.30E-04	1.29E-07	4.77E+02	2.59E+06	1.18E-01	1.58E-10	1.05E-02
Cs-134	7.20E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	2.58E-10	1.94E-03	3.30E-04	1.25E-08	4.63E+01	2.59E+06	1.98E-02	2.73E-10	1.82E-02
Cs-137	2.29E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	8.21E-10	1.94E-03	3.30E-04	8.63E-09	3.19E+01	2.59E+06	4.35E-02	8.69E-10	5.79E-02
									Fines						
Pu-241	2.10E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.13E-10	1.94E-03	3.30E-04	2.23E-06	8.25E+03	2.59E+06	1.55E+00	1.20E-10	7.97E-03
Y-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.18E-11	1.94E-03	3.30E-04	2.28E-09	8.44E+00	2.59E+06	1.14E-03	8.65E-11	5.77E-03
Pm-147	8.88E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.78E-11	1.94E-03	3.30E-04	1.06E-08	3.92E+01	2.59E+06	3.11E-03	5.05E-11	3.37E-03
Ce-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	1.94E-03	3.30E-04	1.01E-07	3.74E+02	2.59E+06	8.21E-03	1.40E-11	9.33E-04
Pr-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	1.94E-03	3.30E-04	1.17E-11	4.33E-02	2.59E+06	9.51E-07	1.40E-11	9.33E-04
Eu-154	1.07E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.76E-12	1.94E-03	3.30E-04	7.73E-08	2.86E+02	2.59E+06	2.73E-03	6.09E-12	4.06E-04
Cm-244	9.30E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.00E-12	1.94E-03	3.30E-04	6.70E-05	2.48E+05	2.59E+06	2.06E+00	5.29E-12	3.53E-04
Pu-238	7.49E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.03E-12	1.94E-03	3.30E-04	1.06E-04	3.92E+05	2.59E+06	2.62E+00	4.26E-12	2.84E-04
Sb-125	6.40E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.44E-12	1.94E-03	3.30E-04	3.30E-09	1.22E+01	2.59E+06	6.98E-05	3.64E-12	2.43E-04
Eu-155	3.51E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.89E-12	1.94E-03	3.30E-04	1.12E-08	4.14E+01	2.59E+06	1.30E-04	2.00E-12	1.33E-04
Am-241	2.20E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.18E-12	1.94E-03	3.30E-04	1.20E-04	4.44E+05	2.59E+06	8.72E-01	1.25E-12	8.35E-05
Te-125m	1.56E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.39E-13	1.94E-03	3.30E-04	1.97E-09	7.29E+00	2.59E+06	1.02E-05	8.88E-13	5.92E-05
Pu-240	1.26E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	6.78E-13	1.94E-03	3.30E-04	1.16E-04	4.29E+05	2.59E+06	4.83E-01	7.17E-13	4.78E-05
Pu-239	6.16E+01	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.31E-13	1.94E-03	3.30E-04	1.16E-04	4.29E+05	2.59E+06	2.36E-01	3.51E-13	2.34E-05
												Total:	**1.34E+01**		

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G. Smith Date: 2.5.99

Attachment A Holtec MPC-68 Accident Spreadsheets
Calc 05996.02-NR-009
Page A1

Table 2 MPC-68 Accident Conditions: Effective Dose - External Exposure from Submersion at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Exposure Duration (s)	DCF (Sv m3/Bq s)	DCF (mrem m3/uCi s)	Effective Dose (mrem)
H-3	8.72E+01	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.69E-09	1.22E-02	1.94E-03	2.59E+06	3.31E-19	1.22E-09	2.89E-08
I-129	7.72E-03	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.15E-13	1.08E-06	1.94E-03	2.59E+06	3.80E-16	1.41E-06	2.93E-09
Kr-85	1.43E+03	68	5.99E+06	1.58E-05	2.63E-12	0.3	7.69E-08	1.99E-01	1.94E-03	2.59E+06	1.19E-16	4.40E-07	1.70E-04
Co-60	6.50E+01	68	5.99E+06	1.58E-05	2.63E-12	1	1.17E-08	3.02E-02	1.94E-03	2.59E+06	1.26E-13	4.66E-04	2.73E-02
Sr-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	5.45E-10	1.41E-03	1.94E-03	2.59E+06	7.53E-18	2.79E-08	7.63E-08
Ru-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	1.49E-10	3.87E-04	1.94E-03	2.59E+06	0.00E+00	0.00E+00	0.00E+00
Cs-134	7.20E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	2.58E-10	6.69E-04	1.94E-03	2.59E+06	7.57E-14	2.80E-04	3.63E-04
Cs-137	2.29E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	8.21E-10	2.13E-03	1.94E-03	2.59E+06	7.74E-18	2.86E-08	1.18E-07
Ba-137m	2.16E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.16E-10	3.00E-04	1.94E-03	2.59E+06	2.88E-14	1.07E-04	6.21E-05
Pu-241	2.10E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.13E-10	2.93E-04	1.94E-03	2.59E+06	7.25E-20	2.68E-10	1.52E-10
Y-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.18E-11	2.12E-04	1.94E-03	2.59E+06	1.90E-16	7.03E-07	2.89E-07
Pm-147	8.88E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.78E-11	1.24E-04	1.94E-03	2.59E+06	6.93E-19	2.56E-09	6.16E-10
Rh-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	2.23E-11	5.78E-05	1.94E-03	2.59E+06	1.04E-14	3.85E-05	4.31E-06
Ce-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	3.43E-05	1.94E-03	2.59E+06	8.53E-16	3.16E-06	2.10E-07
Pr-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	3.43E-05	1.94E-03	2.59E+06	1.95E-15	7.22E-06	4.80E-07
Eu-154	1.07E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.76E-12	1.49E-05	1.94E-03	2.59E+06	6.14E-14	2.27E-04	6.57E-06
Cm-244	9.30E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.00E-12	1.30E-05	1.94E-03	2.59E+06	4.91E-18	1.82E-08	4.57E-10
Pu-238	7.49E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.03E-12	1.04E-05	1.94E-03	2.59E+06	4.88E-18	1.81E-08	3.66E-10
Sb-125	6.40E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.44E-12	8.92E-06	1.94E-03	2.59E+06	2.02E-14	7.47E-05	1.29E-06
Eu-155	3.51E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.89E-12	4.89E-06	1.94E-03	2.59E+06	2.49E-15	9.21E-06	8.74E-08
Am-241	2.20E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.18E-12	3.07E-06	1.94E-03	2.59E+06	8.18E-16	3.03E-06	1.80E-08
Te-125m	1.56E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.39E-13	2.17E-06	1.94E-03	2.59E+06	4.53E-16	1.68E-06	7.09E-09
Pu-240	1.26E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	6.78E-13	1.76E-06	1.94E-03	2.59E+06	4.75E-18	1.76E-08	6.00E-11
Pu-239	6.16E+01	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.31E-13	8.59E-07	1.94E-03	2.59E+06	4.24E-18	1.57E-08	2.61E-11
												Total:	**2.79E-02**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Y. Smith Date: 2.5.99

Table 3 MPC-68 Accident Total Effective Dose Equivalent at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5
External Dose (mrem/y)	**Plus**	**Inhalation CEDE (mrem/y)**	**Equals**	**TEDE (mrem/y)**
2.79E-02	Plus	1.34E+01	Equals	**1.34E+01**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G Smith Date: 2.5.99

Table 4 MPC-68 Accident Thyroid Dose at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Breathing Rate (m3/s)	Exposure Duration (s)	Thyroid DCF (Sv/Bq)	Thyroid DCF (mrem/uCi)	Thyroid Dose (mrem/y)
I-129	7.72E-03	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.14E-13	1.07E-06	1.94E-03	3.30E-04	2.59E+06	1.56E-06	5.77E+03	**3.96E-03**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G Smith Date: 2.5.99

Table 5 MPC-68 Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (uCi/m2) at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15	Column 16
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	X/Q (s/m3)	Breathing Rate (m3/s)	DCF (Sv/Bq)	DCF (mrem/uCi)	Exposure Duration (s)	Inhalation CEDE (mrem/y)	Deposition at 3,219 m (Ci/m2)	Deposition at 3,219 m Depth = 0.01 m (pCi/g)
									Gases						
H-3	8.72E+01	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.69E-09	9.42E-05	3.30E-04	1.73E-11	6.40E-02	2.59E+06	2.42E-05	2.21E-10	1.48E-02
I-129	7.72E-03	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.15E-13	9.42E-05	3.30E-04	4.69E-08	1.74E+02	2.59E+06	5.81E-06	1.96E-14	1.31E-06
Kr-85	1.43E+03	68	5.99E+06	1.58E-05	2.63E-12	0.3	7.69E-08	9.42E-05	3.30E-04	0.00E+00	0.00E+00	2.59E+06	0.00E+00	3.63E-09	2.42E-01
									Crud						
Co-60	6.50E+01	68	5.99E+06	1.58E-05	2.63E-12	1	1.17E-08	9.42E-05	3.30E-04	5.91E-08	2.19E+02	2.59E+06	2.05E-01	5.50E-10	3.67E-02
									Volatiles						
Sr-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	5.45E-10	9.42E-05	3.30E-04	3.51E-07	1.30E+03	2.59E+06	5.71E-02	2.57E-11	1.71E-03
Ru-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	1.49E-10	9.42E-05	3.30E-04	1.29E-07	4.77E+02	2.59E+06	5.74E-03	7.04E-12	4.69E-04
Cs-134	7.20E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	2.58E-10	9.42E-05	3.30E-04	1.25E-08	4.63E+01	2.59E+06	9.63E-04	1.22E-11	8.12E-04
Cs-137	2.29E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	8.21E-10	9.42E-05	3.30E-04	8.63E-09	3.19E+01	2.59E+06	2.11E-03	3.87E-11	2.58E-03
									Fines						
Pu-241	2.10E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.13E-10	9.42E-05	3.30E-04	2.23E-06	8.25E+03	2.59E+06	7.51E-02	5.33E-12	3.55E-04
Y-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.18E-11	9.42E-05	3.30E-04	2.28E-09	8.44E+00	2.59E+06	5.56E-05	3.86E-12	2.57E-04
Pm-147	8.88E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.78E-11	9.42E-05	3.30E-04	1.06E-08	3.92E+01	2.59E+06	1.51E-04	2.25E-12	1.50E-04
Ce-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	9.42E-05	3.30E-04	1.01E-07	3.74E+02	2.59E+06	3.99E-04	6.24E-13	4.16E-05
Pr-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	9.42E-05	3.30E-04	1.17E-11	4.33E-02	2.59E+06	4.62E-08	6.24E-13	4.16E-05
Eu-154	1.07E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.76E-12	9.42E-05	3.30E-04	7.73E-08	2.86E+02	2.59E+06	1.33E-04	2.72E-13	1.81E-05
Cm-244	9.30E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.00E-12	9.42E-05	3.30E-04	6.70E-05	2.48E+05	2.59E+06	1.00E-01	2.36E-13	1.57E-05
Pu-238	7.49E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.03E-12	9.42E-05	3.30E-04	1.06E-04	3.92E+05	2.59E+06	1.27E-01	1.90E-13	1.27E-05
Sb-125	6.40E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.44E-12	9.42E-05	3.30E-04	3.30E-09	1.22E+01	2.59E+06	3.39E-06	1.62E-13	1.08E-05
Eu-155	3.51E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.89E-12	9.42E-05	3.30E-04	1.12E-08	4.14E+01	2.59E+06	6.31E-06	8.91E-14	5.94E-06
Am-241	2.20E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.18E-12	9.42E-05	3.30E-04	1.20E-04	4.44E+05	2.59E+06	4.24E-02	5.58E-14	3.72E-06
Te-125m	1.56E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.39E-13	9.42E-05	3.30E-04	1.97E-09	7.29E+00	2.59E+06	4.93E-07	3.96E-14	2.64E-06
Pu-240	1.26E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	6.78E-13	9.42E-05	3.30E-04	1.16E-04	4.29E+05	2.59E+06	2.34E-02	3.20E-14	2.13E-06
Pu-239	6.16E+01	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.31E-13	9.42E-05	3.30E-04	1.16E-04	4.29E+05	2.59E+06	1.15E-02	1.56E-14	1.04E-06
												Total:	**6.52E-01**		

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G. Smith Date: 2.5.99

Table 6 MPC-68 Accident Conditions: Effective Dose - External Exposure from Submersion at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Exposure Duration (s)	DCF (Sv m3/Bq s)	DCF (mrem m3/uCi s)	Effective Dose (mrem)
H-3	8.72E+01	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.69E-09	1.22E-02	9.42E-05	2.59E+06	3.31E-19	1.22E-09	1.40E-09
I-129	7.72E-03	68	5.99E+06	1.58E-05	2.63E-12	0.3	4.15E-13	1.08E-06	9.42E-05	2.59E+06	3.80E-16	1.41E-06	1.42E-10
Kr-85	1.43E+03	68	5.99E+06	1.58E-05	2.63E-12	0.3	7.69E-08	1.99E-01	9.42E-05	2.59E+06	1.19E-16	4.40E-07	8.27E-06
Co-60	6.50E+01	68	5.99E+06	1.58E-05	2.63E-12	1	1.17E-08	3.02E-02	9.42E-05	2.59E+06	1.26E-13	4.66E-04	1.33E-03
Sr-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	5.45E-10	1.41E-03	9.42E-05	2.59E+06	7.53E-18	2.79E-08	3.71E-09
Ru-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	1.49E-10	3.87E-04	9.42E-05	2.59E+06	0.00E+00	0.00E+00	0.00E+00
Cs-134	7.20E+03	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	2.58E-10	6.69E-04	9.42E-05	2.59E+06	7.57E-14	2.80E-04	1.77E-05
Cs-137	2.29E+04	68	5.99E+06	1.58E-05	2.63E-12	2.00E-04	8.21E-10	2.13E-03	9.42E-05	2.59E+06	7.74E-18	2.86E-08	5.74E-09
Ba-137m	2.16E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.16E-10	3.00E-04	9.42E-05	2.59E+06	2.88E-14	1.07E-04	3.02E-06
Pu-241	2.10E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.13E-10	2.93E-04	9.42E-05	2.59E+06	7.25E-20	2.68E-10	7.40E-12
Y-90	1.52E+04	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.18E-11	2.12E-04	9.42E-05	2.59E+06	1.90E-16	7.03E-07	1.40E-08
Pm-147	8.88E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.78E-11	1.24E-04	9.42E-05	2.59E+06	6.93E-19	2.56E-09	2.99E-11
Rh-106	4.16E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	2.23E-11	5.78E-05	9.42E-05	2.59E+06	1.04E-14	3.85E-05	2.09E-07
Ce-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	3.43E-05	9.42E-05	2.59E+06	8.53E-16	3.16E-06	1.02E-08
Pr-144	2.46E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.32E-11	3.43E-05	9.42E-05	2.59E+06	1.95E-15	7.22E-06	2.33E-08
Eu-154	1.07E+03	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.76E-12	1.49E-05	9.42E-05	2.59E+06	6.14E-14	2.27E-04	3.19E-07
Cm-244	9.30E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	5.00E-12	1.30E-05	9.42E-05	2.59E+06	4.91E-18	1.82E-08	2.22E-11
Pu-238	7.49E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	4.03E-12	1.04E-05	9.42E-05	2.59E+06	4.88E-18	1.81E-08	1.78E-11
Sb-125	6.40E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.44E-12	8.92E-06	9.42E-05	2.59E+06	2.02E-14	7.47E-05	6.28E-08
Eu-155	3.51E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.89E-12	4.89E-06	9.42E-05	2.59E+06	2.49E-15	9.21E-06	4.25E-09
Am-241	2.20E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	1.18E-12	3.07E-06	9.42E-05	2.59E+06	8.18E-16	3.03E-06	8.75E-10
Te-125m	1.56E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	8.39E-13	2.17E-06	9.42E-05	2.59E+06	4.53E-16	1.68E-06	3.44E-10
Pu-240	1.26E+02	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	6.78E-13	1.76E-06	9.42E-05	2.59E+06	4.75E-18	1.76E-08	2.91E-12
Pu-239	6.16E+01	68	5.99E+06	1.58E-05	2.63E-12	3.00E-05	3.31E-13	8.59E-07	9.42E-05	2.59E+06	4.24E-18	1.57E-08	1.27E-12
												Total:	**1.36E-03**

Input Prepared By: W. E. Kennedy Jr. Date: 2/5/99

Input Reviewed By: Chris G. Smith Date: 2.5.99

Table 7 MPC-68 Accident Total Effective Dose Equivalent at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5
External Dose (mrem/y)	**Plus**	**Inhalation CEDE (mrem/y)**	**Equals**	**TEDE (mrem/y)**
1.36E-03	Plus	6.52E-01	Equals	**6.53E-01**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Chris C. Smith Date: 2.5.99

Table 8 MPC-68 Accident Thyroid Dose at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Breathing Rate (m3/s)	Exposure Duration (s)	Thyroid DCF (Sv/Bq)	Thyroid DCF (mrem/uCi)	Thyroid Dose (mrem)
I-129	7.72E-03	6.80E+01	5.99E+06	1.58E-05	2.63E-12	3.00E-01	4.14E-13	1.07E-06	9.42E-05	3.30E-04	2.59E+06	1.56E-06	5.77E+03	**1.92E-04**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Chris C. Smith Date: 2.5.99

Table 1a SNC TranStor Cask with BWR Fuel Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (uCi/m2) at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15	Column 16
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	X/Q (s/m3)	Breathing Rate (m3/s)	DCF (Sv/Bq)	DCF (mrem/uCi)	Exposure Duration (s)	Inhalation CEDE (mrem/y)	Deposition at 500 m (Ci/m2)	Deposition at 500 m Depth = 0.01 m (pCi/g)
									Gases						
H-3	7.96E+01	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.55E-08	1.94E-03	3.30E-04	1.73E-11	6.40E-02	2.59E+06	2.71E-03	2.70E-08	1.80E+00
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	1.94E-03	3.30E-04	4.69E-08	1.74E+02	2.59E+06	7.05E-04	2.59E-12	1.73E-04
Kr-85	1.30E+03	61	5.71E+06	1.00E-04	1.75E-11	0.3	4.17E-07	1.94E-03	3.30E-04	0.00E+00	0.00E+00	2.59E+06	0.00E+00	4.41E-07	2.94E+01
									Crud						
Co-60	6.00E+01	61	5.71E+06	1.00E-04	1.75E-11	1	6.41E-08	1.94E-03	3.30E-04	5.91E-08	2.19E+02	2.59E+06	2.33E+01	6.78E-08	4.52E+00
									Volatiles						
Sr-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.12E-09	1.94E-03	3.30E-04	3.51E-07	1.30E+03	2.59E+06	6.72E+00	3.30E-09	2.20E-01
Ru-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.95E-10	1.94E-03	3.30E-04	1.29E-07	4.77E+02	2.59E+06	3.13E-01	4.18E-10	2.79E-02
Cs-134	4.77E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	1.02E-09	1.94E-03	3.30E-04	1.25E-08	4.63E+01	2.59E+06	7.82E-02	1.08E-09	7.19E-02
Cs-137	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	4.70E-09	1.94E-03	3.30E-04	8.63E-09	3.19E+01	2.59E+06	2.49E-01	4.97E-09	3.31E-01
									Fines						
Pu-241	1.85E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-10	1.94E-03	3.30E-04	2.23E-06	8.25E+03	2.59E+06	8.12E+00	6.27E-10	4.18E-02
Y-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	4.68E-10	1.94E-03	3.30E-04	2.28E-09	8.44E+00	2.59E+06	6.55E-03	4.95E-10	3.30E-02
Pm-147	6.37E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.04E-10	1.94E-03	3.30E-04	1.06E-08	3.92E+01	2.59E+06	1.33E-02	2.16E-10	1.44E-02
Ce-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	1.94E-03	3.30E-04	1.01E-07	3.74E+02	2.59E+06	1.67E-02	2.84E-11	1.90E-03
Pr-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	1.94E-03	3.30E-04	1.17E-11	4.33E-02	2.59E+06	1.93E-06	2.84E-11	1.90E-03
Eu-154	8.98E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.88E-11	1.94E-03	3.30E-04	7.73E-08	2.86E+02	2.59E+06	1.37E-02	3.04E-11	2.03E-03
Cm-244	8.66E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.78E-11	1.94E-03	3.30E-04	6.70E-05	2.48E+05	2.59E+06	1.14E+01	2.94E-11	1.96E-03
Pu-238	7.12E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.28E-11	1.94E-03	3.30E-04	1.06E-04	3.92E+05	2.59E+06	1.49E+01	2.41E-11	1.61E-03
Sb-125	5.04E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.62E-11	1.94E-03	3.30E-04	3.30E-09	1.22E+01	2.59E+06	3.27E-04	1.71E-11	1.14E-03
Eu-155	2.93E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	9.39E-12	1.94E-03	3.30E-04	1.12E-08	4.14E+01	2.59E+06	6.46E-04	9.93E-12	6.62E-04
Am-241	2.37E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.60E-12	1.94E-03	3.30E-04	1.20E-04	4.44E+05	2.59E+06	5.60E+00	8.03E-12	5.36E-04
Pu-240	1.21E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	3.88E-12	1.94E-03	3.30E-04	1.16E-04	4.29E+05	2.59E+06	2.76E+00	4.10E-12	2.73E-04
Pu-239	5.53E+01	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.77E-12	1.94E-03	3.30E-04	1.16E-04	4.29E+05	2.59E+06	1.26E+00	1.87E-12	1.25E-04
												Total:	**7.47E+01**		

Input Prepared By: W. E. Kennedy, Jr. Date: 2/5/99

Input Reviewed By: Cheryl G. Smith Date: 2.5.99

Attachment B SNC TranStor Accident Spreadsheets
Calc. 05996.02-HR-009 Page B1

Table 2a SNC TranStor Cask with BWR Fuel Accident Conditions: Effective Dose - External Exposure from Submersion at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Exposure Duration (s)	DCF (Sv m3/Bq s)	DCF (mrem m3/uCi s)	Effective Dose (mrem)
H-3	7.96E+01	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.55E-08	6.61E-02	1.94E-03	2.59E+06	3.31E-19	1.22E-09	1.57E-07
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	6.34E-06	1.94E-03	2.59E+06	3.80E-16	1.41E-06	1.73E-08
Kr-85	1.30E+03	61	5.71E+06	1.00E-04	1.75E-11	0.3	4.17E-07	1.08E+00	1.94E-03	2.59E+06	1.19E-16	4.40E-07	9.22E-04
Co-60	6.00E+01	61	5.71E+06	1.00E-04	1.75E-11	1	6.41E-08	1.66E-01	1.94E-03	2.59E+06	1.26E-13	4.66E-04	1.50E-01
Sr-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.12E-09	8.08E-03	1.94E-03	2.59E+06	7.53E-18	2.79E-08	4.37E-07
Ru-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.95E-10	1.02E-03	1.94E-03	2.59E+06	0.00E+00	0.00E+00	0.00E+00
Cs-134	4.77E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	1.02E-09	2.64E-03	1.94E-03	2.59E+06	7.57E-14	2.80E-04	1.43E-03
Cs-137	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	4.70E-09	1.22E-02	1.94E-03	2.59E+06	7.74E-18	2.86E-08	6.76E-07
Ba-137m	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.05E-10	1.83E-03	1.94E-03	2.59E+06	2.88E-14	1.07E-04	3.78E-04
Pu-241	1.85E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-10	1.54E-03	1.94E-03	2.59E+06	7.25E-20	2.68E-10	7.99E-10
Y-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	4.68E-10	1.21E-03	1.94E-03	2.59E+06	1.90E-16	7.03E-07	1.65E-06
Pm-147	6.37E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.04E-10	5.29E-04	1.94E-03	2.59E+06	6.93E-19	2.56E-09	2.63E-09
Rh-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-11	1.54E-04	1.94E-03	2.59E+06	1.04E-14	3.85E-05	1.15E-05
Ce-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	6.96E-05	1.94E-03	2.59E+06	8.53E-16	3.16E-06	4.26E-07
Pr-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	6.96E-05	1.94E-03	2.59E+06	1.95E-15	7.22E-06	9.75E-07
Eu-154	8.98E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.88E-11	7.45E-05	1.94E-03	2.59E+06	6.14E-14	2.27E-04	3.29E-05
Cm-244	8.66E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.78E-11	7.19E-05	1.94E-03	2.59E+06	4.91E-18	1.82E-08	2.53E-09
Pu-238	7.12E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.28E-11	5.91E-05	1.94E-03	2.59E+06	4.88E-18	1.81E-08	2.07E-09
Sb-125	5.04E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.62E-11	4.18E-05	1.94E-03	2.59E+06	2.02E-14	7.47E-05	6.07E-06
Eu-155	2.93E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	9.39E-12	2.43E-05	1.94E-03	2.59E+06	2.49E-15	9.21E-06	4.35E-07
Am-241	2.37E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.60E-12	1.97E-05	1.94E-03	2.59E+06	8.18E-16	3.03E-06	1.16E-07
Pu-240	1.21E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	3.88E-12	1.00E-05	1.94E-03	2.59E+06	4.75E-18	1.76E-08	3.43E-10
Pu-239	5.53E+01	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.77E-12	4.59E-06	1.94E-03	2.59E+06	4.24E-18	1.57E-08	1.40E-10
												Total:	**1.53E-01**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Gyenter Date: 2.5.99

Table 3a SNC TranStor Cask with BWR Fuel Accident
Total Effective Dose Equivalent at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5
External Dose (mrem/y)	**Plus**	**Inhalation CEDE (mrem/y)**	**Equals**	**TEDE (mrem/y)**
1.53E-01	Plus	7.47E+01	Equals	**7.49E+01**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Gylnutt Date: 2.5.99

Table 4a SNC TranStor Cask with BWR Fuel Accident Thyroid Dose at 500 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Breathing Rate (m3/s)	Exposure Duration (s)	Thyroid DCF (Sv/Bq)	Thyroid DCF (mrem/uCi)	Thyroid Dose (mrem)
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	6.34E-06	1.94E-03	3.30E-04	2.59E+06	1.56E-06	5.77E+03	**2.34E-02**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Gylnutt Date: 2.5.99

Table 5a SNC TranStor Cask with BWR Fuel Accident Conditions: Committed Effective Dose Equivalent From Inhalation Plus Deposition Estimates (uCi/m2) at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15	Column 16
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	X/Q (s/m3)	Breathing Rate (m3/s)	DCF (Sv/Bq)	DCF (mrem/uCi)	Exposure Duration (s)	Inhalation CEDE (mrem/y)	Deposition at 3,219 m (Ci/m2)	Deposition at 3,219 m Depth = 0.01 m (pCi/g)
									Gases						
H-3	7.96E+01	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.55E-08	9.42E-05	3.30E-04	1.73E-11	6.40E-02	2.59E+06	1.32E-04	1.20E-09	8.02E-02
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	9.42E-05	3.30E-04	4.69E-08	1.74E+02	2.59E+06	3.42E-05	1.15E-13	7.70E-06
Kr-85	1.30E+03	61	5.71E+06	1.00E-04	1.75E-11	0.3	4.17E-07	9.42E-05	3.30E-04	0.00E+00	0.00E+00	2.59E+06	0.00E+00	1.96E-08	1.31E+00
									Crud						
Co-60	6.00E+01	61	5.71E+06	1.00E-04	1.75E-11	1	6.41E-08	9.42E-05	3.30E-04	5.91E-08	2.19E+02	2.59E+06	1.13E+00	3.02E-09	2.02E-01
									Volatiles						
Sr-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.12E-09	9.42E-05	3.30E-04	3.51E-07	1.30E+03	2.59E+06	3.26E-01	1.47E-10	9.81E-03
Ru-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.95E-10	9.42E-05	3.30E-04	1.29E-07	4.77E+02	2.59E+06	1.52E-02	1.86E-11	1.24E-03
Cs-134	4.77E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	1.02E-09	9.42E-05	3.30E-04	1.25E-08	4.63E+01	2.59E+06	3.80E-03	4.81E-11	3.20E-03
Cs-137	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	4.70E-09	9.42E-05	3.30E-04	8.63E-09	3.19E+01	2.59E+06	1.21E-02	2.22E-10	1.48E-02
									Fines						
Pu-241	1.85E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-10	9.42E-05	3.30E-04	2.23E-06	8.25E+03	2.59E+06	3.94E-01	2.80E-11	1.86E-03
Y-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	4.68E-10	9.42E-05	3.30E-04	2.28E-09	8.44E+00	2.59E+06	3.18E-04	2.21E-11	1.47E-03
Pm-147	6.37E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.04E-10	9.42E-05	3.30E-04	1.06E-08	3.92E+01	2.59E+06	6.45E-04	9.63E-12	6.42E-04
Ce-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	9.42E-05	3.30E-04	1.01E-07	3.74E+02	2.59E+06	8.10E-04	1.27E-12	8.45E-05
Pr-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	9.42E-05	3.30E-04	1.17E-11	4.33E-02	2.59E+06	9.38E-08	1.27E-12	8.45E-05
Eu-154	8.98E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.88E-11	9.42E-05	3.30E-04	7.73E-08	2.86E+02	2.59E+06	6.63E-04	1.36E-12	9.05E-05
Cm-244	8.66E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.78E-11	9.42E-05	3.30E-04	6.70E-05	2.48E+05	2.59E+06	5.54E-01	1.31E-12	8.73E-05
Pu-238	7.12E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.28E-11	9.42E-05	3.30E-04	1.06E-04	3.92E+05	2.59E+06	7.21E-01	1.08E-12	7.17E-05
Sb-125	5.04E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.62E-11	9.42E-05	3.30E-04	3.30E-09	1.22E+01	2.59E+06	1.59E-05	7.62E-13	5.08E-05
Eu-155	2.93E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	9.39E-12	9.42E-05	3.30E-04	1.12E-08	4.14E+01	2.59E+06	3.14E-05	4.43E-13	2.95E-05
Am-241	2.37E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.60E-12	9.42E-05	3.30E-04	1.20E-04	4.44E+05	2.59E+06	2.72E-01	3.58E-13	2.39E-05
Pu-240	1.21E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	3.88E-12	9.42E-05	3.30E-04	1.16E-04	4.29E+05	2.59E+06	1.34E-01	1.83E-13	1.22E-05
Pu-239	5.53E+01	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.77E-12	9.42E-05	3.30E-04	1.16E-04	4.29E+05	2.59E+06	6.13E-02	8.36E-14	5.57E-06
												Total:	**3.63E+00**		

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Gyde Smith Date: 2.5.99

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Table 6a SNC TranStor Cask with BWR Fuel Accident Conditions: Effective Dose - External Exposure from Submersion at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Exposure Duration (s)	DCF (Sv m3/Bq s)	DCF (mrem m3/uCi s)	Effective Dose (mrem)
H-3	7.96E+01	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.55E-08	6.61E-02	9.42E-05	2.59E+06	3.31E-19	1.22E-09	7.62E-09
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	6.34E-06	9.42E-05	2.59E+06	3.80E-16	1.41E-06	8.40E-10
Kr-85	1.30E+03	61	5.71E+06	1.00E-04	1.75E-11	0.3	4.17E-07	1.08E+00	9.42E-05	2.59E+06	1.19E-16	4.40E-07	4.48E-05
Co-60	6.00E+01	61	5.71E+06	1.00E-04	1.75E-11	1	6.41E-08	1.66E-01	9.42E-05	2.59E+06	1.26E-13	4.66E-04	7.29E-03
Sr-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.12E-09	8.08E-03	9.42E-05	2.59E+06	7.53E-18	2.79E-08	2.12E-08
Ru-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	3.95E-10	1.02E-03	9.42E-05	2.59E+06	0.00E+00	0.00E+00	0.00E+00
Cs-134	4.77E+03	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	1.02E-09	2.64E-03	9.42E-05	2.59E+06	7.57E-14	2.80E-04	6.96E-05
Cs-137	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	2.00E-04	4.70E-09	1.22E-02	9.42E-05	2.59E+06	7.74E-18	2.86E-08	3.28E-08
Ba-137m	2.20E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.05E-10	1.83E-03	9.42E-05	2.59E+06	2.88E-14	1.07E-04	1.83E-05
Pu-241	1.85E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-10	1.54E-03	9.42E-05	2.59E+06	7.25E-20	2.68E-10	3.88E-11
Y-90	1.46E+04	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	4.68E-10	1.21E-03	9.42E-05	2.59E+06	1.90E-16	7.03E-07	8.03E-08
Pm-147	6.37E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.04E-10	5.29E-04	9.42E-05	2.59E+06	6.93E-19	2.56E-09	1.28E-10
Rh-106	1.85E+03	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	5.93E-11	1.54E-04	9.42E-05	2.59E+06	1.04E-14	3.85E-05	5.57E-07
Ce-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	6.96E-05	9.42E-05	2.59E+06	8.53E-16	3.16E-06	2.07E-08
Pr-144	8.39E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.69E-11	6.96E-05	9.42E-05	2.59E+06	1.95E-15	7.22E-06	4.73E-08
Eu-154	8.98E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.88E-11	7.45E-05	9.42E-05	2.59E+06	6.14E-14	2.27E-04	1.60E-06
Cm-244	8.66E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.78E-11	7.19E-05	9.42E-05	2.59E+06	4.91E-18	1.82E-08	1.23E-10
Pu-238	7.12E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	2.28E-11	5.91E-05	9.42E-05	2.59E+06	4.88E-18	1.81E-08	1.01E-10
Sb-125	5.04E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.62E-11	4.18E-05	9.42E-05	2.59E+06	2.02E-14	7.47E-05	2.95E-07
Eu-155	2.93E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	9.39E-12	2.43E-05	9.42E-05	2.59E+06	2.49E-15	9.21E-06	2.11E-08
Am-241	2.37E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	7.60E-12	1.97E-05	9.42E-05	2.59E+06	8.18E-16	3.03E-06	5.61E-09
Pu-240	1.21E+02	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	3.88E-12	1.00E-05	9.42E-05	2.59E+06	4.75E-18	1.76E-08	1.66E-11
Pu-239	5.53E+01	61	5.71E+06	1.00E-04	1.75E-11	3.00E-05	1.77E-12	4.59E-06	9.42E-05	2.59E+06	4.24E-18	1.57E-08	6.78E-12
												Total:	**7.43E-03**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl Y. Smith Date: 2.5.99

Table 7a SNC TranStor Cask with BWR Fuel Accident

Total Effective Dose Equivalent at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5
External Dose (mrem/y)	**Plus**	**Inhalation CEDE (mrem/y)**	**Equals**	**TEDE (mrem/y)**
7.43E-03	Plus	3.63E+00	Equals	**3.64E+00**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G. Smith Date: 2.5.99

Table 8a SNC TranStor Cask with BWR Fuel Accident Thyroid Dose at 3,219 m Downwind

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15
Nuclide	Inventory (Ci/Assembly)	Number of Assemblies	Canister Volume (cm3)	Leak Rate (cm3/s)	Fraction Released per second	Release Fraction	Release Rate (Ci/s)	Release (Ci)	X/Q (s/m3)	Breathing Rate (m3/s)	Exposure Duration (s)	Thyroid DCF (Sv/Bq)	Thyroid DCF (mrem/uCi)	Thyroid Dose (mrem)
I-129	7.64E-03	61	5.71E+06	1.00E-04	1.75E-11	0.3	2.45E-12	6.34E-06	9.42E-05	3.30E-04	2.59E+06	1.56E-06	5.77E+03	**1.14E-03**

Input Prepared By: W. E. Kennedy, J. Date: 2/5/99

Input Reviewed By: Cheryl G. Smith Date: 2.5.99