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FOR INFORMATION

BVY: 16-021 **DATE:** 6/28/16

☐ YES ☒ NO 10CFR19.11(a)(4) action? If yes, posting required within 2 working days after dispatch.

SUBJECT: Response to Request for Additional Information Related to 10 CFR 20.2002 Alternate Waste Disposal Request (CAC No. L53116)

LICENSING LEAD: Tom Silko **COMMITMENTS: YES (Enter EN-LI-110) NO**

COMMENTS: _____

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Latest update: May 9, 2016 (DME)

Entergy Nuclear Operations, Inc.
Vermont Yankee
320 Governor Hunt Rd.
Vernon, VT 05354
802-257-7711

John W. Boyle
Decommissioning Director

10 CFR 20.2002

BVY 16-021

June 28, 2016

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Response to Request for Additional Information Related to 10 CFR 20.2002 Alternate Waste Disposal Request (CAC No. L53116)
Vermont Yankee Nuclear Power Station
Docket No. 50-271
License No. DPR-28

REFERENCES:

1. Letter, Entergy Nuclear Operations, Inc. to USNRC, "10 CFR 20.2002 Request for Alternate Disposal at US Ecology Idaho, BVY 16-001, dated January 14, 2016 (ML16029A071)

2. Letter, USNRC to Entergy Nuclear Operations, Inc., "Request for Additional Information Related to 10 CFR 20.2002 Alternate Waste Disposal Request for Vermont Yankee Nuclear Power Station (CAC No. L53116) (ML16077A345)

Dear Sir or Madam:

By letter dated January 14, 2016 (Reference 1), Entergy Nuclear Operations, Inc. (ENO) submitted a request for alternate disposal under 10 CFR 20.2002 of liquid low-activity radioactive waste from the Vermont Yankee Nuclear Power Station to the US Ecology, Inc. (USEI) Resource Conservation and Recovery Act (RCRA), Subtitle C hazardous and low-activity radioactive waste treatment and disposal facility located near Grand View, Idaho. In Reference 2, the NRC requested additional information to complete review of the request. The additional information requested is attached.

This letter contains no new regulatory commitments. Should you have any questions concerning this letter, please contact Mr. Coley Chappell at (802) 451-3374.

Sincerely,

JWB/tbs

Attachment: Response to Request for Additional Information

cc: Mr. Daniel H. Dorman
Regional Administrator, Region 1
U.S. Nuclear Regulatory Commission
2100 Renaissance Blvd, Suite 100
King of Prussia, PA 19406-2713

Mr. Jack D. Parrott, Sr. Project Manager
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop T-8F5
Washington, DC 20555

Mr. Christopher Recchia, Commissioner
Vermont Department of Public Service
112 State Street – Drawer 20
Montpelier, Vermont 05602-2601

Attachment

Vermont Yankee Nuclear Power Station

Response to Request for Additional Information

REQUEST FOR ADDITIONAL INFORMATION
RELATED TO 10 CFR 20.2002 ALTERNATE WASTE DISPOSAL REQUEST
FOR VERMONT YANKEE NUCLEAR POWER STATION (CAC NO. L53116)

Additional Information Required:

1. **Comment:** More information is needed on the inputs to the USEI Site-Specific Data Assessment (SSDA) workbook.

   Basis: It is not clear what inputs and changes were made to the SSDA workbook other than those listed in Attachment 2 on the data input worksheet. For example, the number of trips for the long-haul direct truck drivers on the dose summary sheet appears to have been manually input instead of being calculated from the volume of the waste. This edit appears to be reasonable since the volume of water transported is less than the volume of waste ultimately disposed of. The NRC staff would like to understand if other edits were also made to the spreadsheet because the NRC staff would need to review any changes to the spreadsheet from the version the NRC previously reviewed.

   Path forward: Provide a description of all inputs and changes made to the SSDA workbook other than those listed in Attachment 2 on the data input worksheet and the basis for those changes.

   Response: USEI did amend the input for number of trips in the Vermont Yankee (VY) version of the SSDA workbook. This was due to the fact that trips will consist of water in tanker trucks (5,000 gallons each). However, the volume of waste to be disposed also includes the addition of solidification agent (i.e., clay) once the water has reached the USEI facility and has been prepared for land disposal. The number of trips therefore had to be amended manually such that the added waste volume from the solidification agent was not reflected in the required number of tanker truck shipments. No other changes to the internal calculation logic of the SSDA were made.

2. **Comment:** The potential doses to the excavator operator and the back-end truck drivers were not provided.

   Basis: The description of the USEI Worker Dose Assessment in Section 4.2 states that the excavator operator removes the treated waste from the stabilization tank and places it into an on-site haul truck for transport to the disposal cell for burial. However, doses to the excavator operator and back-end truck drivers were not calculated by the SSDA workbook.

   Path forward: Provide an evaluation of the doses to the excavator operator and the back-end truck drivers.

   Response: Dose to the excavator operator in USEI's Treatment Building was captured in the SSDA workbook under the Function Name "Treatment Workers." However, the truck drivers that deliver the solidified waste from USEI's treatment building to the landfill were not accounted for in the calculations. A dose evaluation for these workers can be found on the dose calculation worksheet provided below, using the following information and assumptions:

Water that has been solidified is transferred from the treatment pans into an awaiting dump truck for transit to the landfill for disposal. This task uses the same Microshield model as the "Back-End Dray Truck Drivers" since the geometries are virtually identical. Each dump truck can carry 25 tons of solidified waste to the landfill per trip. Average transit time from the Treatment Plant to the landfill is 10 minutes. Two drivers perform this task at USEI with each assumed to receive equal portions of the total project dose. The VY project will require 100 trips between the Treatment Plant and the Landfill to dispose of the 2,500 tons of solidified water (and clay). The expected total effective dose equivalent (TEDE) to each truck driver is 7.76E-03 mrem.

ENO notes that the "Treatment Plant Truck Driver" function was not included in US Ecology's original SSDA workbook that was previously approved by NRC for use. Via communication between ENO and USEI, it has been identified that USEI plans to submit a revised SSDA Workbook and Technical Basis Document to NRC to correct this oversight.

USEI T&D Dose Calculation Worksheet

(for US NRC 20.2002 Alternate Disposals

Date: 6/16/2016

Customer: Entergy
Project: Vermont Yankee Torus Water

I. Radionuclides of Concern - Provided by Customer

Isotope	Assumed in Waste Stream pCi/ml	pCi/cm³ for Microshield[1]	uCi/cm³ for Microshield[1]
Co-58	0.09	9.00E-02	9.00E-08
Co-60	6.9	6.90E+00	6.90E-06
Cs-137	3.00	3.00E+00	3.00E-06
Fe-55	0.10	9.50E-02	9.50E-08
H-3	1870	1.87E+03	1.87E-03
Mn-54	0.47	4.70E-01	4.70E-07
Ni-63	0.79	7.90E-01	7.90E-07
Tc-99	3.89	3.89E+00	3.89E-06
U-238	0.38	3.80E-01	3.80E-07
Zn-65	1.95	1.95E+00	1.95E-06

Volume of waste (ft³):	80,000	(after solidification)
Waste Density (lb/ft³):	62.5	
Waste Density (g/cc):	1.00	
Mass of Waste (lbs):	5,000,000	
Mass of Waste (tons):	2,500	
Mass per Truck Trip (tons):	25	(post-solification)

II. Summary of Potentially Exposed Workers

a) Total Project Dose

Function	No. Employees	Waste Contact Time (hr)	External Exposure Rate (mR/hr)[1]	Internal Dose Rate (mrem/hr)	Distance (m)	No. Required Trips or Reps.[2]	Total External Dose per Worker (mrem)	Total Internal Dose per Worker (mrem)	Total Project TEDE per Worker (mrem)	% of Max Annual Dose
Treatment Plant Truck Driver	2	0.2	7.63E-04	1.30E-05	0.6	100	7.63E-03	1.30E-04	7.76E-03	0.16%
Tanker Truck Driver	8	78.4	3.29E-03	1.30E-05	3.3	40	1.29E+00	5.09E-03	1.29E+00	25.86%

b) Total Dose per Year # of proj. years: 1

Function	No. Employees	Waste Contact Time (hr)	External Exposure Rate (mR/hr)[1]	Internal Dose Rate (mrem/hr)	Distance (m)	No. Required Trips or Reps.[2]	Annual External Dose per Worker (mrem)	Annual Internal Dose per Worker (mrem)	Total Annual TEDE per Worker (mrem)	% of Max Annual Dose
Treatment Plant Truck Driver	2	0.2	7.63E-04	1.30E-05	0.6	100	7.63E-03	1.30E-04	7.76E-03	0.16%
Tanker Truck Driver	8	78.36	3.29E-03	1.30E-05	3.3	40	1.29E+00	5.09E-03	1.29E+00	25.86%

III. Internal Dose Assessment

Radionuclide	Co-58	Co-60	Cs-137	Fe-55	H-3	Mn-54	Ni-63	Tc-99	U-238	Zn-65
Assumed Transport Class:	Y	Y	D	W	vapor	W	W	W	Y	Y
Concentration in waste (pCi/g):	0.09	6.9	3.00	0.10	1870	0.47	0.79	3.89	0.38	1.95
Dose Conversion Factor (mrem/pCi)[4]	1.09E-05	2.19E-04	3.19E-05	2.96E-06	6.40E-08	6.70E-06	2.30E-06	8.33E-06	1.19E-01	2.04E-05
Respirable dust loading (g/m³):	2.30E-04									
Breathing rate (m³/hr):	1.20E+00									
Dose per Hour per nuclide (mrem):	2.70E-10	4.17E-07	2.64E-08	7.76E-11	3.30E-08	8.69E-10	5.01E-10	8.94E-09	1.25E-05	1.10E-08
Total dose per hour (mrem):	**1.30E-05**	*(<--- For Use in 'Total Dose' calculations above)*								

V. Notes & Assumptions

1. All external dose rates calculated using Microshield ver 10.
2. It is assumed that the Treatment Plant dump trucks deliver 25 tons of solidified waste to the landfill per trip at an average transit time of 10 minutes.
   The number of tanker trips is based on transport of water from VY to USEI (=200,000 gal / 5,000 gal per tanker = 40 trips)
3. Tanker Truck Driver modeled using same model as in HBPP Alternate Disposal Authorization (ML12244A100)
4. Dose Conversion Factors taken from FGR-11 (1988) and converted to units of mrem/pCi.

3. **Comment:** Clarification is needed on the internal dose to the landfill cell operators.

   Basis: The description of the USEI Worker Dose Assessment in Section 4.2 states that the internal dose to personnel working in the disposal cells is estimated to be the bounding dose calculated for a stabilization operator. However, the internal dose to the landfill cell operators in Table 2 is not the same as the stabilization operator dose.

   Path forward: Clarify the method used to calculate the internal dose to the landfill cell operators.

   Response: The method used to calculate the internal dose to the landfill cell operators is as described in Section 4.2. The referenced statement was in error and does not affect the calculated dose results.

4. **Comment:** Additional information is needed on the time the truck drivers spend in the truck.

   Basis: It is not clear if the truck drivers spend any other time in truck other than while driving, such as sleeping or taking breaks in the truck. It is unlikely that the driver would complete the 46.4 hour trip without stopping.

   Path forward: Clarify whether the truck drivers spend any time in the truck other than while driving. If the total time spent in the truck exceeds the 46.4 hours included in the dose calculation, provide an estimate of the potential dose to the truck driver from the total time spent in the truck.

   Response: For the purpose of the SSDA calculations the truck drivers were assumed to spend nights in hotels away from the tanker trucks while not driving. However, ENO recognizes that this assumption may not be conservative, and that the Long-Haul Truck Drivers will not complete the trip from VY to USEI in a continuous run. To correct for the potential non-driving time in transit, an additional 32 hours has been added to the "Long-Haul Direct Truck Drivers" function in the SSDA for a revised total postulated exposure time of 78.36 hours (46.36 hours plus 32 hours). This accounts for 3 nights of sleep (at 8 hours per night) plus 8 hours for breaks and other activities with the assumption that the truck driver remains in the truck. Utilizing this additional time, plus the .6 meter distance assumed in the SSDA, and the revised isotopic make-up of the torus water described in the response to Question 6, the resulting TEDE to each truck driver is 3.13 mrem. This is considered to be a 'worse case' and is captured in the revised Summary of Project Alternative Disposal Dose Results table provided in the response to Question 6.

   Additionally, the .6 meter distance between the "Long-Haul Truck Drivers" and the tank assumes a worse case day cab with no sleeper cabin. A truck that has a sleeper cabin adds shielding and increases the distance between the driver and the tank to at least 3.3 meters. For comparison, if the driver is assumed to be at 3.3 meters for 78.36 hours, the more realistic TEDE would be 1.29 mrem. It is noted that this realistic model is identical to the one approved by the NRC as part of the Humboldt Bay Power Plant Alternative Disposal Authorization (ML 12244A100). The results of this evaluation are provided under the function name "Tanker Truck Driver" in the second part of the Dose Calculation worksheet provided in response to Question 2 above.

5. **Comment:** The basis for the assumed tritium concentration is unclear.

   Basis: The analytical results for tritium have a qualifier that the value was estimated. The data exception report also notes that the sample container was preserved with nitric acid, which could cause the sample results to bias low.

   Path forward: Provide a description of the method used to estimate the tritium concentration.

   Response: In ENO's original submittal (Reference 1), the analytical results utilized a tritium concentration of 1.87E+03 pCi/cm^3 (or 1.87E-03 uCi/ml). The Part 61 analytical results for tritium included as part of the original submittal did include a "Qualifier" which states "Result may be biased low due to the sample container being preserved with nitric prior to analysis." While this qualifier exists, the results remain valid for several reasons. This input was based upon samples taken in November 2015 and was deemed to be representative based on additional sample results that were not included in the original submittal. The data below presents the results of routine samples of the Torus collected by qualified chemistry technicians and analyzed by task-qualified technicians at Vermont Yankee. In addition, a subsequent Part 61 analysis performed by the same lab identified a tritium concentration of 1.70E+03 pCi/cm^3 (or 1.70E-03 uCi/ml), and this sample was not preserved with nitric acid prior to analysis.

   Tritium levels in the torus water have been on a gradual decline since radwaste was added to the torus due to two factors: the station no longer produces tritium, so losses through evaporation are not replaced; and a significant volume of groundwater with low or less than minimum detectable activity (<MDA) tritium concentration was processed to the torus, thereby diluting the torus water. This is shown in the following sample results:

Torus Sample Data

Sample Date	Sample Time	SA-UF {uCi/ml}	Tritium {uCi/ml}
12/02/15	07:45	< 4.30E-06	1.75E-03
12/09/15	12:50	< 4.30E-06	1.80E-03
12/16/15	07:30	< 4.30E-06	1.71E-03
12/22/15	13:20	< 4.30E-06	1.70E-03
01/06/16	07:55	< 4.40E-06	1.69E-03
01/13/16	08:15	< 4.30E-06	1.72E-03
01/20/16	08:30	< 4.40E-06	1.69E-03
01/27/16	07:45	< 4.40E-06	1.67E-03
02/03/16	07:55	< 4.30E-06	1.67E-03
03/02/16	08:10	< 4.30E-06	1.71E-03
03/17/16	07:10	1.21E-05	1.71E-03
04/11/16	09:10	2.55E-05	1.64E-03
04/28/16	08:20	1.84E-05	1.67E-03
05/12/16	14:00	1.09E-05	1.67E-03
06/07/16	13:50	3.83E-05	1.61E-03

Based upon the above information, the assumed tritium concentration of 1.87E+03 pCi/cm^3 remains conservative (from a dose calculation perspective) as well as representative.

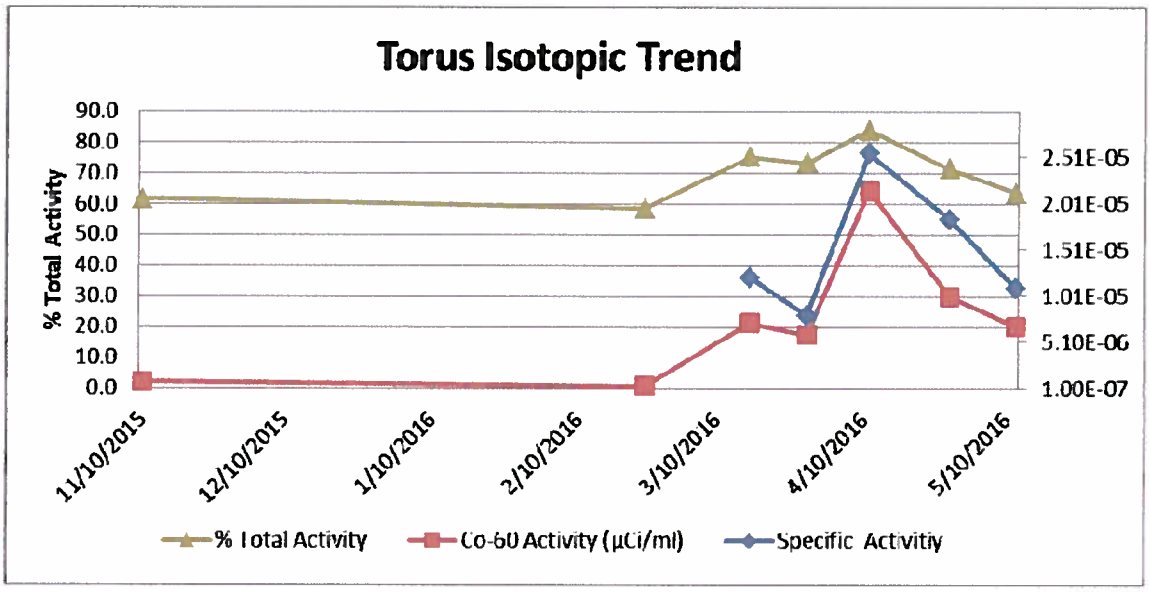
6. **Comment:** More information is needed on the characterization of the water and the uncertainty in the concentration of the radionuclides in the water.

   Basis: The concentrations of the radionuclides in the water were based on data from a single sample. It is not clear if any other samples have been taken and, if so, what the range of concentrations observed was. Because the potential dose was estimated based only on one sample, the uncertainty in the concentrations, and therefore dose, may not have been adequately captured. Additionally, as noted in the previous comment, the reported concentration of tritium in the sample might not be representative of the actual tritium concentration.

   Path forward: Provide information on any other samples taken of the water, including the range of concentrations observed for each of the radionuclides. Also, provide an assessment of the potential uncertainty in the concentrations, and therefore dose, as a result of basing the concentration on a single sample.

   Response: The pumps associated with the torus water treatment system are typically run continuously, circulating 250 gpm through the system (50 gpm through the demineralizers). System suction is from the original torus High Pressure Coolant Injection (HPCI) suction line and discharges via the original HPCI return line back into the torus. Maximum system flow rates create minimal (insignificant) disturbance of sediments that would increase the likelihood of causing changes in the radionuclide concentrations or percent abundance of various radionuclides in the samples, as evidenced by the results shown below.

   The torus water treatment system recirculates the torus volume (capacity 1.1 million gallons) approximately every 3 days, thus promoting a homogenous torus water volume. Chemistry samples showed a steady decline in anion concentration after the demineralizers were placed in service. The steady trend in anion concentrations, vice erratic results, indicates the torus water volume is homogenous. While gamma isotopic analyses have not been performed regularly and may not be useful in determining homogeneity, gross gamma measurements have consistently been < MDA for the samples analyzed (<4.3 E-06 μCi/ml). If the torus water volume was not being uniformly mixed, occasional spikes in activity would be expected.



The trend above shows Co-60 activity and the percent of total activity contributed by Co-60 before and after the contents of the reactor pressure vessel were drained to the torus (during the period from early March to the middle of April). The trend data shows the total activity in the torus increased as expected when the reactor coolant was drained into the torus, and decreased as the torus demineralizers removed corrosion products from the torus water. Co-60 is the predominant isotope present before and after vessel drain.

The data below represents results from routine torus water samples taken at the Fuel Pool Make-Up Demineralizer Influent sample point. In addition to the routine torus sample results shown in the response to Question 5, gamma isotopic analyses were performed on several samples. A summary of the isotopic analysis for each sample is shown in Table 1 below. The samples were collected by qualified chemistry technicians, and the analyses were performed by task-qualified technicians.

Table 1: Torus Sample Isotopic Analysis Data

Sample	Sample Date	Spectrum #	Isotope	Activity (µCi/ml)	Nuclide Percent Abundance
Torus	11/10/2015	SP-8553	K-40	2.868E-07	NORM not calculated
			Mn-54	5.817E-08	4.4
			Co-60	**8.110E-07**	**61.6**
			Zn-65	1.743E-07	13.2
			Cs-137	2.727E-07	20.7
Torus	2/24/2016	SP-9140	K-40	2.61E-07	NORM not calculated
			Ra-226	2.90E-07	NORM not calculated
			Th-234	2.770E-07	NORM not calculated
			Co-60	2.198E-07	33.5
			Zn-65	5.258E-08	8.0
			Cs-137	**3.847E-07**	**58.5**

Torus	3/17/2016	SP-9275	Mn-54	4.143E-07	4.4
			Co-60	**7.174E-06**	**75.4**
			Zn-65	9.957E-07	10.5
			Cs-137	9.328E-07	9.8
Torus	3/29/2016	SP-9340	Mn-54	2.111E-07	2.6
			Co-60	**5.870E-06**	**73.4**
			Zn-65	7.028E-07	8.8
			Cs-137	1.212E-06	15.2
Torus	4/11/2016	SP-9415	Mn-54	3.663E-07	1.4
			Co-60	**2.145E-05**	**84.1**
			Zn-65	2.152E-06	8.4
			Cs-137	1.552E-06	6.1
Torus	4/28/2016	SP-9539	Mn-54	2.247E-07	1.6
			Co-60	**1.008E-05**	**71.4**
			Zn-65	1.643E-06	11.6
			Cs-137	2.167E-06	15.4
Torus	5/12/2016	SP-9619	Mn-54	1.75E-07	1.6
			Co-60	**6.81E-06**	**63.6**
			Zn-65	1.10E-06	10.3
			Cs-137	2.62E-06	24.5

NORM = Naturally Occurring Radioactive Material

Since the submittal of Reference 1, the contents of several systems in the process of abandonment, including the majority of the liquid radioactive waste system, and the contents of the reactor pressure vessel have been drained to the torus. As a result of this water addition to the torus, the isotopic make-up of the torus water has slightly changed compared to information provided in Reference 1.

Based upon a recent Part 61 analysis of the torus water as well as samples analyzed by qualified site personnel, the Data Input Worksheet has been revised. Using the revised input data, updated exposure assessments have been completed using US Ecology's NRC-Approved Site Specific Dose Assessment methodology.

The revised Data Input Worksheet and the revised Summary of Project Alternative Disposal Dose Results showing a summary of the total doses for transporters and USEI personnel are provided on the following pages.

USEI Site-Specific Dose Assessment Workbook
Data Input Worksheet

Rev. 2 Date: 6/13/2016

Customer: Entergy
Project: Vermont Yankee Torus Water

Section I - Waste Stream Information		
Maximum annual dose assumed for assessment (mrem/yr):	5	
Volume of waste (cubic feet (ft^3)):	80,000	
Volume of waste (cubic yards (yd^3)):	2,963	
Volume of waste (cubic meters (m^3)):	2,265	
Does waste primarily consist of Soil, Debris, or a Mix of both?	Soil	
Will shipments be made by rail, truck, or a combination of both?	Truck	
If Both, how many miles of front-end dray are required? (N/A if direct shipped)	0	0
Is waste containerized or will it be shipped as bulk?	Bulk	
If shipped direct via truck, how many miles from project site to USEI? (N/A otherwise)	2550	2,550
Number of years required to complete project?	1	
Will waste require RCRA treatment?	Yes	
Percentage of waste volume requiring treatment?	100%	
Waste Density (lb/ft^3):	62.5	
Waste Density (g/cm^3):	1.00	
Waste Mass (lbs):	5.00E+06	
Waste Mass (tons):	2.50E+03	
Waste Mass (g):	2.27E+09	
Does the waste contain Source Material (Uranium or Thorium)? (Yes/No)	No	
Does the waste contain Special Nuclear Material? (Yes/No)	No	

Worksheet User Instructions and Notes:

1. **Enter** data into Yellow shaded cells **ONLY**. All other cells in the workbook are automated and/or protected.
2. Answer all questions in Section I - Waste Stream Information first. Enter values in yellow cells or select answer from drop-down lists provided. Notes are also provided in key cells to assist the user.
3. Enter concentrations (in pCi/g) for all nuclides in your characterized waste stream into Section II - Waste Profile Nuclide Evaluation.
4. The Maximum Acceptable Concentration for each nuclide is determined by either the USEI waste Acceptance Criteria (WAC) or a dose-based limit, whichever is lower. The dose-based limit is tied to the Total Volume of Waste entered by the user. Logic in the SSPA workbook will automatically choose the most appropriate value for each nuclide.
5. USEI is limited to a total of 3,000 pCi/g of source material summed over all parent & progeny nuclides (Th + U).
6. USEI is limited to a total of 3,000 pCi/g of SNM summed over all fissile nuclides and their isotopic mixture nuclides, i.e., U-234, U-235, and U-238 for enriched uranium.
7. Cross-checks against all USEI WAC limits are automatically calculated in the indicators below.

USEI Annual Dose Limit Check	MEI Dose (mrem/yr)
OK	3.13

SOR Check for All USEI Nuclides*
0.631

USEI Total Activity WAC Check*
OK

USEI Source Material WAC Check*
OK

USEI SNM WAC Check*
OK

NOTE:
**These cross-checks only apply to individual shipments for USEI WAC compliance purposes. They are not intended for annualized safety assessment calculations that are dose-based.*

Section II - Waste Profile Nuclide Evaluation

Nuclide	Customer Waste Profile Concentration (pCi/g)	Maximum Acceptable Concentration (pCi/g)[4]	Ratio to USEI Max Concentration
Ac-227		3000	
Ag-108m		3000	
Ag-110m		3000	
Am-241		3000	
Am-243		3000	
Au-195		3000	
Ba-133		3000	
Be-7		3000	
C-14		3000	
Ca-41		3000	
Cd-109		3000	
Ce-139		3000	
Ce-141		3000	
Ce-144		3000	
Cf-252		3000	
Cl-36		3000	
Cm-242		3000	
Cm-243		3000	
Cm-244		3000	
Cm-245		3000	
Cm-246		3000	
Cm-247		3000	
Co-57		3000	
Co-58	0.09	3000	0.000
Co-60	6.90	3000	0.002
Cr-51		3000	
Cs-134		3000	
Cs-135		3000	
Cs-137	3.00	3000	0.001
Eu-152		3000	
Eu-154		3000	
Eu-155		3000	
Fe-55	0.10	3000	0.000
Fe-59		3000	
Gd-152		3000	
Gd-153		3000	
Ge-68		3000	
H-3	1870	3000	0.623
I-125		3000	
I-129		3000	
I-131		3000	
Ir-192		3000	
K-40		3000	
Mn-54	0.47	3000	0.000
Na-22		3000	
Nb-93m		3000	

Nb-94		3000	
Nb-95		3000	
Ni-59		3000	
Ni-63	0.79	3000	0.000
Np-237		3000	
Pa-231		3000	
Pb-210		3000	
Pm-147		3000	
Pu-238		3000	
Pu-239[6]		3000	
Pu-240		3000	
Pu-241		3000	
Pu-242		3000	
Pu-244		3000	
Ra-226		500	
Ra-228		500	
Ru-103		3000	
Ru-106		3000	
S-35		3000	
Sb-122		3000	
Sb-124		3000	
Sb-125		3000	
Sc-46		3000	
Sm-147		3000	
Sm-151		3000	
Sn-113		3000	
Sr-89		3000	
Sr-90		3000	
Tc-99	3.89	3000	0.001
Te-123		3000	
Th-228[5]		3000	
Th-229[5]		3000	
Th-230[5]		3000	
Th-232[5]		55	
Tl-204		3000	
U-233[6]		3000	
U-234[5]		3000	
U-235[6]		3000	
U-236[5]		3000	
U-238[5]	0.38	167	0.002
Natural Uranium[5]		167	
Refined Uranium[5]		167	
Depleted Uranium		169	
Zn-65	1.95	3000	0.001
Zr-95		3000	
Total Concentration (pCi/g)	*1887.6*		
Total Src Matl (pCi/g)	*5.32*		
Total SNM (pCi/g)	*0*		
Total Activity (µCi)	*4.28E+06*		
		SOR:	0.631

USEI Site-Specific Dose Assessment Workbook Rev. 2 Date: 6/13/2016

Summary of Project Alternate Disposal Dose Results

Customer:	Entergy
Project:	Vermont Yankee Torus Water
Number of Project Years:	1
Max Dose Allowed (mrem/yr):	5

a) USEI Worker Total Project Dose

Function	Minimum Number of Workers	Waste Contact Time (hr)	External Exposure Rate (mR/hr)	Internal Dose Rate (mrem/hr)	Distance (m)	Total No. of Repetitions	Total External Dose per Worker (mrem)	Total Internal Dose per Worker (mrem)	Total Project Dose per Worker (mrem)	% of Max Annual Dose
Front-End Dray Truck Drivers	4	0.00	8.00E-03	0.00E+00	0.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Long-Haul Direct Truck Drivers	8	78.36	8.00E-03	0.00E+00	0.6	40	3.13E+00	0.00E+00	3.13E+00	62.67%
Gondola Railcar Surveyors	4	0.33	7.46E-03	0.00E+00	1.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Truck Surveyors	8	0.08	6.25E-03	0.00E+00	1.0	40	2.50E-03	0.00E+00	2.50E-03	0.05%
Intermodal Container Surveyors	8	0.08	6.25E-03	0.00E+00	1.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
RTF Excavator Operator	2	0.75	4.33E-03	1.29E-05	2.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Gondola Railcar Cleanout	4	0.16	2.09E-03	1.29E-05	0.3	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Rail Transfer Equipment Operator	4	0.25	7.16E-04	0.00E+00	4.9	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Back-End Dray Truck Drivers	10	0.75	0.00E+00	0.00E+00	0.6	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Treatment Workers	6	0.75	2.52E-03	1.29E-05	2.0	50	1.57E-02	8.08E-05	1.58E-02	0.32%
Landfill Cell Operators	4	0.25	2.68E-03	1.29E-05	1.0	50	8.37E-03	4.04E-05	8.41E-03	0.17%

b) USEI Worker Total Dose per Project Year (if applicable)

Function	Minimum Number of Workers	Waste Contact Time (hr)	External Exposure Rate (mR/hr)	Internal Dose Rate (mrem/hr)	Distance (m)	Total No. of Repetitions	Annual External Dose per Worker (mrem)	Annual Internal Dose per Worker (mrem)	Total Annual Dose per Worker (mrem)	% of Max Annual Dose
Front-End Dray Truck Drivers	4	0.00	8.00E-03	0.00E+00	0.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Long-Haul Direct Truck Drivers	8	78.36	8.00E-03	0.00E+00	0.6	40	3.13E+00	0.00E+00	3.13E+00	62.67%
Gondola Railcar Surveyors	4	0.33	7.46E-03	0.00E+00	1.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Truck Surveyors	8	0.08	6.25E-03	0.00E+00	1.0	40	2.50E-03	0.00E+00	2.50E-03	0.05%
Intermodal Container Surveyors	8	0.08	6.25E-03	0.00E+00	1.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
RTF Excavator Operator	2	0.75	4.33E-03	1.29E-05	2.0	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Gondola Railcar Cleanout	4	0.16	2.09E-03	1.29E-05	0.3	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Rail Transfer Equipment Operator	4	0.25	7.16E-04	0.00E+00	4.9	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Back-End Dray Truck Drivers	10	0.75	0.00E+00	0.00E+00	0.6	0	0.00E+00	0.00E+00	0.00E+00	0.00%
Treatment Workers	6	0.75	2.52E-03	1.29E-05	2.0	50	1.57E-02	8.08E-05	1.58E-02	0.32%
Landfill Cell Operators	4	0.25	2.68E-03	1.29E-05	1.0	50	8.37E-03	4.04E-05	8.41E-03	0.17%

c) USEI RESRAD Post-Closure Screening Dose 8.42E-02 mrem/yr

d) Inadvertant Intruder Doses

(d) 1. Construction Scenario	2.01E-01	mrem/yr
(d) 2. Well Driller Scenario	1.07E-01	mrem/yr
(d) 3. Driller Occupancy Scenario	1.30E-02	mrem/yr

Notes:

1. Total No. of Repetitions (Tanker Trips) = 200,000 gal / 5,000 gal per tanker = 40
2. Waste Contact Time for the Long-Haul Truck Drivers has been adjusted to 78.36 hrs to account for potential rest time in truck.
3. Dose to Treatment Plant and Landfill Workers represents labor associted with post-solidification soils to landfill.
4. Transportation plan calls for 8 tanker trucks assigned to project, with each truck making 5 trips.
5. The Treatment pathway is turned on due to the need to solidify the water prior to disposal.