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FINAL REPORT
UNIVERSITY OF PUERTO RICO AGRICULTURAL EXPERIMENT STATION,
NRC LICENSE NO. 52-01986-01, DOCKET NO. 030-01182,
DOSE ASSESSMENT OF POTENTIAL DISPOSAL OR BURIAL OF CARBON-14

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1.0 EXECUTIVE SUMMARY

On September 28, 2004, the University of Puerto Rico (UPR) Agricultural Experiment Station (AES) in Rio Piedras, Puerto Rico, submitted a request to terminate its NRC License No. 52-01986-01. The license was issued by the Atomic Energy Commission (AEC) on February 13, 1957, originally authorizing the use of unsealed short-lived radionuclides as tracers for laboratory plant studies. Later amendments added sealed sources for use in gas chromatograph (GC) detectors and moisture/density gauges. The only long-lived radioactive material (RAM) authorized by the license was carbon-14 (^{14}C), which was added in 1966. According to available records and interviews with current and former AES personnel, radioactive material use was limited over much of the site's history. Since 1966, licensed activities only involved the GCs, while the unsealed materials and gauges were maintained in storage. In the termination request, the licensee provided radiological surveys of laboratory facilities and records verifying the disposition of the licensed material.

NRC staff review of the AES license history identified that UPR may have at one time inadvertently discarded plants and soil containing ^{14}C onsite, or buried the material as radioactive waste in accordance with the former regulation 10 CFR 20.304. Because unsealed radioactive material was neither used nor obtained after 1966, any short-lived material that may have been buried would have since decayed. Only ^{14}C could have a potential impact on public health and safety. This report documents the staff's investigation of the licensee's past use and disposition of ^{14}C , and the results of a staff dose analysis to determine the potential impact of the contaminated material being left onsite. Through record review and licensee interviews, the staff has determined that only a small amount of ^{14}C may have potentially been discarded or buried at this site. The estimated concentration is less than one-hundredth of the DandD dose modeling computer code (DandD) screening value for ^{14}C , listed in Appendix B of NUREG-1757, Vol. I, "Consolidated Decommissioning Guidance: Decommissioning Process for Materials Licensees." The staff concludes that the potential dose from this amount is well below the dose provisions of the License Termination Rule, and that the license may be terminated and the site released for unrestricted use.

2.0 FACILITY OPERATING HISTORY

2.1 License Number/Status/Authorized Activities

NRC License No. 52-01986-01 expired on September 30, 2004. Shortly before the expiration date, the licensee requested termination of the license and release of the site for unrestricted use. At the time of the request, the license authorized the storage of five milliCuries (mCi) of

^{14}C , and the use of hydrogen-3 (^3H) and nickel-63 (^{63}Ni) foils in GC detector cells for sample analysis. However, previous amendments of this license authorized the use of sealed moisture/density gauges and unsealed radioactive materials as tracers incorporated in pesticides and applied to plants.

2.2 License History

This license was issued by the AEC on February 13, 1957, and authorized the possession and use of 15 mCi of unsealed iron-59 (^{59}Fe) and 450 mCi of phosphorus-32 (^{32}P) for studies of the transport of these materials in plants. Subsequent license amendments added other unsealed radionuclides for similar purposes, and also added ^3H and ^{63}Ni foils for use in GC detectors and americium and cesium sealed sources in moisture/density gauges. A summary of the license amendments is listed below:

Amendment 1:	5/16/57 Increased ^{59}Fe possession limit to 22 mCi
Amendment 2:	2/18/59 Increased ^{32}P possession limit to 451 mCi
Amendment 3:	1/31/62 Added 1mCi each: unsealed potassium-42 (^{42}K), calcium-45 (^{45}Ca), sulfur-35 (^{35}S), strontium-89 (^{89}Sr), and sodium-24 (^{24}Na) for tracer studies
Amendment 4:	11/21/63 Added a tritiated titanium foil for use in a GC unit
Amendment 5:	2/26/64 License renewed
Amendment 6:	2/14/66 Added 10 mCi each: unsealed ^{14}C and ^{35}S for studies of pesticides and insecticides, respectively
Amendment 7:	6/14/67 Added GC detector cells containing ^{63}Ni foils
Amendment 8:	2/14/68 Extended expiration date.
Amendment 9:	6/9/70 Modified authorized users and added sealed source leak test requirements
Amendment 10:	10/5/70 Modified mailing address
Amendment 11:	8/2/71 Added a letter as a tie down (note: the letter could not be located in the docket, the Agencywide Document Access and Management System (ADAMS), or the ADAMS Legacy Library, and there was no indication of its content in the amendment)
Amendment 12:	6/7/73 Added a letter as a tie down (note: the letter could not be located in the docket, ADAMS, the ADAMS Legacy library, and there was no indication of its content in the amendment)
Amendment 13:	10/5/73 Increased ^{14}C possession limit to 35 mCi

- Amendment 14: 4/18/74 Specified that ^{14}C is for laboratory use. The documents associated with the amendment could not be located in the docket, ADAMS, the ADAMS Legacy library.
- Amendment 15: 5/16/74 Added another tritium foil for a GC detector.
- Amendment 16: 5/26/78 Removed all unsealed materials, leaving only the GC detectors (^3H and ^{63}Ni foils)
- Amendment 17: 12/4/78 Added 10 mCi of ^{14}C for storage only
- Amendment 18: 4/27/83 License renewed
- Amendment 19: 3/27/84 Added an authorized use for preconditioning tritium foils
- Amendment 20: 10/11/84 Modified leak test requirements
- Amendment 21: 9/15/88 License renewed and amended to add sealed americium-241 (^{241}Am) and cesium-137 (^{137}Cs) in moisture density gauges
- Amendment 22: 5/22/89 Added another moisture density gauge.
- Amendment 23: 9/9/94 Decreased the possession limit on the ^{14}C being maintained in storage from 10 mCi to 5 mCi
- Amendment 24: 3/3/04 Extended the license expiration date to allow UPR to complete license termination surveys

2.3 Radioactive Materials Usage History:

All records and interviews indicate that radioactive materials usage under this license has been very limited. In particular, there has been no documented use of unsealed RAM since 1966. The unsealed radionuclides authorized by the UPR license and their respective radiological half-lives are summarized in the table below:

Unsealed Radionuclide	Half-Life	Possession Limit	Licensing Dates	Notes (*)
carbon-14	5715 years	10 mCi*	1966-current	amended to 5mCi in 1994
sodium-24	14.95 hours	1 mCi	1962-1978	
phosphorus-32	14.28 days	15 mCi	1957-1978	
sulfur-35	87.2 days	1 mCi	1962-1978	
sulfur-35	87.2 days	10 mCi	1966-1978	
potassium-42	12.36 hours	1 mCi	1962-1978	

Unsealed Radionuclide	Half-Life	Possession Limit	Licensing Dates	Notes (*)
calcium-45	162.7 days	1 mCi	1962-1978	
iron-59	44.5 days	450 mCi*	1957-1978	amended to 451mCi in 1959
strontium-89	50.52 days	1 mCi	1962-1978	

Aside from ^{14}C and ^{45}Ca , all other authorized radionuclides were short-lived, with radiological half-lives of less than 120 days. Given the length of time since ^{45}Ca was possessed under the license, and the small quantity that was authorized, the staff determined that any used ^{45}Ca would be decayed to insignificant levels.

Historical review of the AES license was complicated by large gaps in the docket record and by the length of time since unsealed materials have been used. The current Radiation Safety Officer (RSO) has been at the AES since 1986. He stated that there has been no use of unsealed RAM since he has been there, and that he contacted a former RSO, who was an authorized RAM user from 1970-1993, and worked at the AES since 1961. The former RSO knew of only one experiment using ^{14}C , which occurred in 1964. Details of this experiment are provided in Section 2.5 below.

The staff reviewed the current and archived docket files, ADAMS, and the ADAMS Legacy Library for all documents related to AES and other UPR licenses. No inspection records for this license prior to 1970 or from 1970 to 1990 could be found. The oldest documented inspection report (IR) referring to this license was from 1970. The report documented that the only material used or possessed by the licensee was a sealed ^{63}Ni GC detector. This IR states that no other RAM had been received or transferred since the last inspection, noted as occurring in 1966. A summary of available records with information pertaining to RAM use at the site is provided below:

- 4/8/70: Inspection Report (oldest in docket and ADAMS). The report states that licensed material is only used in the Central Analytical Laboratory (and has been that way since the last inspection on 9/12/66). The only licensed material possessed at the time of the inspection was a ^{63}Ni GC detector source. A ^3H detector source had been returned to the manufacturer (inspector viewed records). No other licensed material had been received or transferred since the 1966 inspection.
- 2/6/78: Application for Renewal. Item 13 states, "At present, only ^3H and ^{63}Ni are being used." Item 10 states that these are the only uses that have taken place in the past two years. Item 15 states, "Disposal of ^{63}Ni and ^3H will be done by returning the items involved to the manufacturers."

- 7/23/91: Inspection Report. The inspector documents that the RAM program is of limited scope. He observed a refrigerator containing vials of ^{14}C tagged pesticides and plant material. The licensee informed the inspector that this material was left over from experiments performed in 1958, and had been in storage since that time. The inspector noted there were two authorized users, one for the GCs and one for the moisture/density gauges.
- 09/94: Letter from UPR to NRC with inventory of RAM in possession. Includes sealed sources and eleven vials of ^{14}C in pesticides and plant matter awaiting disposal. (Note: All eleven vials were transferred to the UPR Mayaguez campus License No 52-10510-04 in 2003 for eventual disposal)
- 04/96: Inspection Report. The notes state that there is no use of unsealed RAM, and that labeled pesticides remain in storage.
- 02/02: Inspection Report. The report states that there has been no use of licensed materials since 1998. The licensee was cited against the Timeliness Rule.
- 06/03: Inspection Report. The report states that all RAM has been disposed and the licensee is completing surveys in support of license termination.
- 12/03: Letter from UPR stating that two of the gauges they had on hand were returned to the manufacturers, and that the third was transferred to the UPR Medical Sciences Campus, and added to their license (52-10510-04).
- 09/04: Letter from UPR requesting license termination. Transmits facility surveys and documentation for disposition of RAM.

2.4 Spills

No reports of spills were identified in the licensing files. The current RSO has no records or knowledge of spills at the facility.

2.5 Prior Onsite Burials

The AES was not previously identified as a site where burials were performed under 10 CFR 20.304, nor did the termination request refer to prior burials. While reviewing the license history for the termination request, the staff identified early licensing documents citing burial as the intended radioactive waste disposal method. A summary of the documents referring to waste disposal under this license follows below:

- 1/29/57: Initial license application. Item 19 states, "Radioactive wastes are buried." The radionuclides listed on the application are: ^{32}P and ^{59}Fe .

- 2/13/57: Letter from AEC to UPR. States that info on the burials would be required if the material did not meet the specifications of 20.304 (i.e. # one thousand times the 10 CFR 20 Appendix C quantities of material at any location, minimum depth of four feet, separated by six feet, and no more than twelve burials in a year).
- 2/4/59: Amendment request. Item 15 states, "The wastes will be disposed by burial following regulations . . . (20.304)."
- 12/19/61: Amendment request. Item 15 states, "The waste material is disposed of by burying in the soil in holes measuring three feet by nine feet by ten feet (3' x 9' x 10'). The distance between holes is twenty feet, and not more than twelve burials are made in the year."
- 1/24/66: Amendment request. Item 15 states, "All wastes are kept until they reach an activity of less than one microCurie (FCi) per milliliter (ml), and then they are buried in the soil at a depth of not less than six feet."
- 1/25/68: Renewal application. Item 15 states, "The waste material is disposed of by burying in the soil in holes 3' x 9' x 10'. The distance between holes is twenty feet, and not more than twelve burials are made in the year."
- 2/6/78: Renewal application. Item 15 states, "Disposal of nickel-63 and hydrogen-3 (sealed sources) will be done by returning the items involved to the manufacturers."

The current RSO stated that he had no records or knowledge of RAM burials occurring at the facility. With the exception of ^{14}C , all other unsealed radionuclides authorized by the license have half-lives of 163 days or less. Based on the short half-lives, the span of forty years, and the small amounts of radionuclides authorized, the staff determined that any unsealed material other than ^{14}C that may have been buried or otherwise disposed has since decayed.

The staff requested that the RSO investigate any ^{14}C usage, and determine the possibility of any burials of this radionuclide. He contacted the former RSO, who stated that only one such use had occurred in 1964. A herbicide labeled with ^{14}C was applied to soil in boxes (he only provided a size of 4 square feet (ft^2)), to evaluate the response of coffee plants. He said he had taken a two month leave of absence in 1965, during which the soil from the experiment was disposed. He was unaware of the exact details of the disposal, but thought the soil may have been discarded in a "dump site" behind the greenhouse.

The staff independently contacted the former RSO to obtain additional information on this experiment. He stated that in 1964 a researcher had obtained a vial containing one FCi of ^{14}C for use as a tracer in an herbicide study. The staff pointed out that ^{14}C was not approved on the license until 1966. Although he was not the RSO at the time of the experiment, he recalled that the material was provided by New England Nuclear, who told them the amount was sufficiently small as to not require NRC approval for use.

The former RSO stated that one-half (appx. 0.5 FCi) of the ^{14}C was diluted with the herbicide, and applied to coffee plants in twelve boxes with dimensions of approximately 3' X 3' x 2'. He

said that the experiment was deemed unsuccessful because the ^{14}C could not be detected in the plants. He felt that the application may have been too dilute. He then went on a two-month sabbatical, and when he returned, the material (soil and plants) in the boxes was gone. He stated that he did not know what had become of it, but that he suspected it had been “dumped” in a pile of other waste soils in an area behind a potting shed. However, the remaining 0.5 F Ci of ^{14}C was returned to New England Nuclear. The staff concluded that it is possible the ^{14}C contaminated material from this experiment was buried or otherwise dispersed from AES. The staff’s assessment of the potential impact of such a disposal is provided in Section 5 of this report.

2.6 Prior Partial Site Releases

None

3.0 FACILITY DESCRIPTION

3.1 Site Location and Description

The AES is located in Rio Piedras, San Juan, Puerto Rico. Located in the Caribbean Sea, Puerto Rico is the eastern-most island of the Greater Antilles. Rio Piedras is a primarily residential area in the southern part of San Juan, and is home to UPR’s largest campus.

The AES is the center for all scientific research for the University’s School of Agricultural Sciences. There are two research centers and six smaller satellite locations across Puerto Rico. Licensed activities were authorized only at the main research center in Rio Piedras. The facility is situated on just under 200 acres, and consists of a botanical garden, conservatories, office space, and laboratories. However, use of unsealed RAM was confined to the Central Analytical Laboratory (21'x13'), a sample processing room (10'x20'), and a soils laboratory (20'x40'). The sealed source gauges were stored in the Old Phytotron Building (12'x24') and within a storage room inside the soils laboratory (10' x10'). (Sources: UPR website, License Docket files, and RSO)

3.2 Population Distribution

The most recent census indicates that over 430,000 people live in San Juan, making it the most populated city in Puerto Rico. Although data on the population of the Rio Piedras section could not be found, the UPR Rio Piedras campus has approximately 21,500 students and approximately 1000 faculty and staff. (Source: Wikipedia) Fewer than 50 individuals work in the AES at Rio Piedras. (Source: UPR Website)

3.3 Meteorology and Climatology

The Puerto Rican climate is characterized as Tropical Marine. For Rio Piedras, the average annual rainfall is 68.97 inches (68.97"), the mean temperature is 78.5 degrees Fahrenheit (E F), and the average wind speed is 8.4 miles per hour (mph). Temperatures remain fairly stable throughout the year. (Sources: National Oceanic & Atmospheric Administration, Southeast Regional Climate Center (of the South Carolina Department of Natural Resources).

3.4 Geology and Seismology

San Juan is in Puerto Rico's northern coastal plain, with the AES located at an elevation approximately thirty meters (m) above sea level (Source: UPR). Soils in this area are typically Bayamon clay soils, which are interspersed between limestone hills. According to the US Department of Agriculture's Natural Resource Conservation Service, Bayamon soils form in highly weathered clayey marine sediments, have low to medium fertility, and are highly acidic. The US Geological Survey (USGS) describes the soil as alluvial clay, and a 1996 study by this agency concluded that the region is susceptible to earthquakes.

3.5 Surface Water Hydrology

According to the USGS, the combination of heavy rainfall over the interior mountains and sedimentary rocks along the coast results in an abundant supply of ground and surface water sources. Surface water accounts for approximately 70% of the island's usage, mostly drawn from man-made reservoirs. San Juan primarily draws on the Carraizo reservoir. The city is situated in the San Juan Bay Estuary Watershed, which encompasses 242 square kilometers. (242 km²) (Source: Environmental Protection Agency (EPA))

3.6 Ground Water Hydrology

The Puerto Rican north coast contains a large artesian aquifer system, which underlies several shallow water-table aquifers. (Source: EPA)

3.7 Natural Resources

Due to the area's tropical soil, agricultural cultivation is limited to products such as coffee and sugarcane. Agriculture as an industry has been declining, with only about 5.5% of the island currently used for permanent crops. Primary natural resources consist of copper and nickel, along with some potential off shore and on shore crude oil (Source: CIA World Factbook).

4.0 RADIOLOGICAL STATUS OF FACILITY

4.1 Contaminated Structures

All structures at the AES within which RAM was used have been surveyed by the licensee and found to be acceptable for release for unrestricted use.

All licensee use of radioactive materials ceased in 1998. There has been no use of unsealed radioactive material since at least 1966. The most prolific licensed activity was use of the GCs. Unsealed RAM used at the site were primarily short-lived (less than 163 day half lives). ¹⁴C was the only long-lived unsealed radionuclide at the AES.

Use of unsealed radioactive materials at the site was confined to the following laboratories in the old Agronomy Building: the Central Analytical Laboratory, the Federal Soils Laboratory, and the sample processing room. Sealed sources were most recently stored in the Phytotron Building, and formerly in a storage room within the Federal Soils Laboratory.

The licensee performed radiological surveys of the above areas, consisting of surface scans to assess fixed contamination and wipe tests to identify loose contamination. All survey results fell well below the screening value for ^{14}C ($3.7\text{E}6$ disintegrations per minute per 100 square centimeters ($\text{dpm}/100\text{cm}^2$)), indicating that the facility may be released for unrestricted use. The scans were conducted with a Ludlum Model 14C Geiger-Mueller (G-M) survey meter with a 44-9 G-M pancake detector. The ^{14}C efficiency was calculated to be 9%. The wipe tests were analyzed with a liquid scintillation counter by the RSO at the UPR's Mayaguez campus.

4.2 Contaminated Systems and Equipment

No systems were contaminated from the licensed activities at AES. Surveys of most equipment and of fume hoods met the screening criteria. A drawer of glassware exhibiting elevated readings was transferred to the UPR Mayaguez campus, for eventual disposal under NRC License No. 52-10510-04 (Note that radioactive waste disposal from Puerto Rico is currently not available). The remaining ^{14}C vials, the GC detectors, and one moisture/density gauge were also transferred to this license in Amendments 17 - 19. The other gauges were returned to their manufacturers.

4.3 Surface and Subsurface Soil Contamination

The licensee performed only one experiment with ^{14}C that may have resulted in burial or release of the contaminated soil and plant material. The impact of this potential soil contamination is evaluated in Section 5. Based on the licensee's primary use of sealed sources, and the short half lives of most of the unsealed materials authorized by the license, there is no additional potential for soil contamination.

4.4 Surface Water

N/A

4.6 Ground Water

N/A

5.0 RADIONUCLIDE CONCENTRATION SCREENING AND DOSE MODELING

5.1 Objective

The staff compared the concentration of ^{14}C in the potentially discarded or buried soil to a screening value developed using DandD screening methodology, as described in NUREG/CR-5512, Volume 3, "Residual Radioactive Contamination from Decommissioning: Parameter Analysis." The screening values are based on the criteria contained in 10 CFR 20 Subpart E (The License Termination Rule (LTR)) for release of a site for unrestricted use. This criteria states that a site, "will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of the critical group that does not exceed 25 millirem per year (mrem/yr)." The staff also determined the potential dose consequence of the material, by performing a site-specific dose assessment.

5.2 Analysis Methodology

In January 1959, burial of limited quantities of radioactive waste without specific NRC approval was authorized by the former regulation 10 CFR 20.304. Such burials were restricted by the following requirements:

1. The total quantity of licensed and other radioactive material buried at any one location and time does not exceed, at the time of burial, 1000 times the amount specified in Appendix C to Part 20.
2. The burial is at a minimum depth of four feet, and
3. Successive burials are separated by distances of at least six feet and not more than twelve burials are made in any year.

In 1981, NRC rescinded 10 CFR 20.304, and required licensees to obtain commission approval to perform on-site burials. In the 1988 rule, "General Requirements for Decommissioning Nuclear Facilities," the NRC stated that it will review such burials and determine the need for additional characterization and/or remediation prior to license termination. In 1996, NRC issued a Draft Branch Technical Position (BTP) containing a quantitative screening method for assessing prior burial sites. Publication of the LTR in 1997, necessitated a change to the screening, which had been based on a dose limit of 100 mrem/yr. In 1998, NRC rescinded use of the Draft BTP and required evaluation of such disposals in a manner consistent with the LTR.

Appendix J of NUREG-1757, Vol 2, "Consolidated Decommissioning Guidance: Characterization, Survey, and Determination of Radiological Criteria," provides assessment methods for evaluating burials using either the DandD or RESRAD dose modeling codes. The staff followed this guidance, and assessed the potential soil disposal both by using the probabilistic DandD screening values and by performing a deterministic dose assessment using the RESRAD Version 6.22 (RESRAD) dose modeling code. The dose assessment used site-specific parameters to determine the potential dose from all pathways to a resident farmer, assuming no cover was placed over the material.

5.3 Data Analysis and Exposure Scenario

The staff determined the ^{14}C concentration of the potentially discarded soil and evaluated the physical conditions at the site including climate, geology, and hydrology. The concentration value was compared against the DandD screening value for ^{14}C (12 pCi/g). The specific inputs that were used in the RESRAD dose assessment are described in the next section. In accordance with NUREG-1757, the staff evaluated the potential dose using a resident farmer scenario. This scenario considers the pathways of direct radiation exposure; inhalation; ingestion of contaminated produce, animal products, and fish; as well as ingestion of contaminated drinking water and soil.

5.4 Assumptions and Input Parameters

5.4.1 Soil Concentrations

- A. The contamination originated from the dilution of 0.5 F Ci of ¹⁴C into an unknown quantity of herbicide.
- B. The herbicide was homogeneously applied to twelve boxes of soil. Each box measured 3' x 3' x 2', resulting in a total soil volume of 6.12 cubic meters (m³). [Note: To address the possibility that the boxes were not completely filled with the soil, a second dose run was performed using one-half this volume (3.06m³)]
- C. A typical soil density for the alluvial soils in Northern Puerto Rico is 1.25 grams per cubic meter (g/cm³) (Source: US Dept of Agriculture, "Soil Survey of Arecibo Area of Northern Puerto Rico").
- D. The calculated ¹⁴C concentration in the soil, using the above data, was 0.065 picocuries per gram (pCi/g).
- E. The transport factor was based on the derived plant/soil ratio for ¹⁴C.

5.4.2 Contaminated Zone (CZ) Parameters

- A. The size of the potential disposal area was not known by licensee personnel. A conservative CZ Area of 1 square meter (m²) was used [Note: this was deemed conservative based on the burial hole size provided in licensee documents of 3' X 9', resulting in a CZ Area of 2.5m²]
- B. Based on the volume of soil and the selected 1m² CZ area, the calculated CZ thickness is 6.2m

5.4.3 Soil and Environmental Parameters

- A. There is no surface soil cover layer (i.e. cover depth set to 0)
- B. The soil was assumed to be a loamy clay, and physical parameters were selected to correspond with the assumed soil type.
- C. Wind speed = 3.76 meters per second (m/s) (based on 8.4 miles per hour (mph))
- D. Average precipitation = 1.75 meters per year (m/yr) (based on 68.97 inches per year ("/yr))
- E. Watershed area = 2.42E8 m²

5.4.4 Ingestion and Occupancy Parameters

The assessment was based on a Resident Farmer scenario, and input parameters for occupancy and ingestion were modified accordingly

5.4.5 Table of Site-Specific Input Parameters

Parameter	Unit	Value	Parameter	Unit	Value
¹⁴ C Concentration	pCi/g	0.065	Watershed Area	m ²	2.42 E8
CZ Area	m ²	1	CZ, SZ, UZ Total Porosity	N/A	0.42
CZ Thickness	m	6.12	SZ, UZ Effective Porosity	N/A	0.1
Cover Depth	m	0	# of UZs	N/A	1

CZ, SZ, UZ Density	gm/cm ³	1.25	Plant Food Contaminated Fraction	N/A	0.5
CZ, SZ, UZ Hydraulic Conductivity	m/y	77.3	Meat Contaminated Fraction	N/A	1
CZ, SZ, UZ b Parameter	N/A	8.52	Milk Contaminated Fraction	N/A	1
Wind Speed	m/s	3.76	Precipitation	m/yr	1.75

5.5 Results and Conclusion

NUREG-1757, Vol.1, Appendix B, Table B.2 lists the screening values for various radionuclides for soil surface contamination levels. These values “represent superficial soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y unrestricted release dose limit in 10 CFR 20.1402.” They were determined using DandD screening methodology, as described in NUREG/CR-5512, Volume 3, “Residual Radioactive Contamination from Decommissioning - Parameter Analysis”. The screening value for ¹⁴C is 12 pCi/g. Section 5.4.1.D of this report listed the ¹⁴C concentration in the potentially discarded soil as 0.065 picocuries per gram (pCi/g). This concentration is less than one-hundredth of the screening value.

The potential Total Effective Dose Equivalent to a resident farmer from the disposal of 0.05 microCuries of ¹⁴C as described above is calculated to be 0.0042 mrem/yr [Note: the dose run performed with one-half the soil volume predictably doubled the potential dose (0.0085 mrem/yr)]. The potential dose is well below the 25 mrem/yr value in the License Termination Rule. Based on this dose evaluation, no additional investigation into the potential burial is required, the license may be terminated and the site released for unrestricted use.

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