Smithsonian Institution

Office of Safety, Health and Environmental Management

August 8, 2013

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington DC 20555

Subject: Reply to a Notice of Violation

Re: License Number: 08-05938-13
Expiration Date: January 31, 2015
Docket Number: 030-30945

Dear Sir or Madam:

The Smithsonian Institution is providing the following reply in response to NRC Inspection Report No. 03030945/2013001, dated July 11, 2013.

With regard to Violation A, historical records and specific documents related to the research project involved with this violation are absent. Whether or not all appropriate surveys were conducted during this research project in 1993, or subsequent to it, is difficult to determine conclusively at this time since written records are not available due to loss, misfiling or omission. Samples of soil and vegetation were collected; however, since we have incomplete historical documentation, we must assume that analyses of soil and vegetative samples were not conducted.

As your letter notes, calculations of the carbon-14 soil uptake have been previously forwarded to your office in correspondence related to this inspection. A copy of the calculations used to determine the concentration of radioactive material remaining is enclosed. The calculations indicate that the soil concentrations of Carbon 14 are well below the NRC Derived Concentration Guideline (DCGL) for unrestricted release. As an additional measure in support of the calculations, we will collect additional soil samples for quantative analyses. Results of the soil sample analyses will be forwarded to your attention on or before November 30, 2013.

As an added measure of assurance to avoid future NRC license variances, a copy of this inspection report, the notice of violation and all responses submitted to the NRC will be addressed in future safety training for Smithsonian staff whose work is associated with the possession or use of licensed radioactive material. The emphasis of this topic will also address compliance with the regulatory requirements for documentation, the adequacy of recordkeeping methods and appropriate documentation media.

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With regard to Violation B, it was the intent of the Smithsonian Institution to identify this research project and request authorization to conduct this work through a formal license amendment. Included in the Smithsonian's submission to the NRC, dated February 24, 1993, were the curricula vitae of the researcher, the proposal for this particular research project, details of the research chambers, the plant species under study and various maps detailing the location of the field site. The subsequent license amendment the Smithsonian Institution received included this researcher as an authorized user. In addition, License Condition 10.A. identified outdoor experimental sites on Smithsonian property as authorized locations at the Smithsonian Environmental Research Center where licensed material may be used or stored. Although License Condition 12 required such activity to be a specific condition of the license, the licensing actions of the NRC were not questioned since both the user (and therefore their protocol) as well as the location were identified on the license. This apparent misunderstanding was unfortunate, but entirely unintentional. It was our understanding that sufficient information pertaining to this research project had been submitted to the NRC for review and acknowledged by the NRC in the subsequent license amendment with the inclusion of the researcher and therefore the protocol. Again, outdoor experimental sites on Smithsonian property were already identified as authorized locations. Again, we did not question the license actions of the NRC since it seemed logical that Condition 12 would apply to outdoor research protocols and areas that were not already identified on the license. As an example, License Condition 10.B. specifically authorized the one time use of radioisotopes at the San Antonio Zoological Gardens and Aquarium, at least in part, because this was not an authorized location in Condition 10.A.

Furthermore, the Smithsonian conducted its program in accordance the statements, representations and procedures contained in the documents, including enclosures listed in the license, which would include the letter of February 24, 1993.

In the future, to avoid any possible misunderstanding of license terminology, all amendment requests will be submitted in writing, as required. And in addition, a review of the licensing actions received will be conducted by SI staff and discussed with NRC licensing assistance representatives. This will ensure complete understanding and agreement among all parties, with all aspects of amendment requests.

This inspection was very detailed and informative and has served, in many ways, to help strengthen our radiation safety program. The Smithsonian Institution's overall safety goal is to strengthen our safety culture with regard to all regulated activities. In July 2010, the SI began the process of developing a means to assess our baseline safety culture. The assessment consisted of a detailed questionnaire and the establishment of focus groups to evaluate qualitative perceptions, opinions, beliefs, and attitudes. The safety culture assessment and its report have given the SI a deeper understanding of our strengths and opportunities for improvement in areas where we can to work to enhance compliance activities.

Please contact me or David Peters, at (202) 633-2672, should you have any questions regarding this reply.

Sincerely,

Roger F. Yankoupe, P.E.
Director for the Office of Safety, Health and Environmental Management

Enclosure

Cc:
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Enclosure

Date: 27 Jun 2013

In August of 1993, a researcher performed a $^{14}CO_2$ label experiment in the Global Change Research Wetland of the Smithsonian Environmental Research Center. His goal was to improve our knowledge of carbon cycling in this ecosystem by following a pulse-label of $^{14}CO_2$ from the atmosphere into the plant shoots and roots. The label was applied for a short period of time, perhaps as little as 10 minutes. The proposal called for plant samples to be taken immediately after labeling, one year later and two years later. The samples were taken but they were not analyzed for ^{14}C. Soil samples were taken five years later but were not analyzed for ^{14}C either. As an alternative to analyzing archived samples, this is a calculation of the amount of ^{14}C that is likely to be found in the ecosystem 20 years later (i.e. 2013). The calculations are made in four steps, each with a set of listed assumptions. The end result was about 4 picocuries per gram of dry soil (4 pCi g^{-1}) remaining after 20 years.

I. Important Characteristics of the Marsh Ecosystem for the Calculations

According to the proposal, the researchers applied 150 μCi of $^{14}CO_2$ to each of six enclosed chambers, separated from each other by perhaps 10 meters. Calculations here are for the plot of marsh encompassed by one chamber, each which encircles a 0.5 m^2 area of marsh plants and soil.

Known: Chamber diameter = 0.8 m = **0.5 m^2 soil area**

Calculations are directed at the amount of ^{14}C label that was deposited belowground in roots and later in soils. The amount of label that ended up in shoots does not matter because the shoots of the plant species in this experiment die each fall and decompose quickly (within 1 year) back to CO_2. By contrast, the ^{14}C label in the roots is deposited in the soil when the roots die, and some of this material stays stored in the soil for decades. In order to determine how much label remains in the soil, we need to know the mass of soil that was subjected to the ^{14}C label. The numbers in **bold** below were used in later calculations.

Known: Soils at the site weigh 0.12 g dry weight per cm^3

Known: 90% of the roots occur in the top 50 cm of soil (Saunders et al. 2006).

Assumed: the ^{14}C label allocated to roots was confined to the top 50 cm of soil.

Thus, the mass of soil into which ^{14}C was deposited as soil organic matter:

$$0.5\ m^2 \text{ soil area} \times \frac{10{,}000\ cm^2}{m^2} \times 50\ cm \times \frac{0.12\ g\ soil}{cm^3} = \mathbf{30{,}000\ g\ soil}$$

II. Mass of ^{14}C in the Marsh Ecosystem Immediate After Labeling

The following assumptions are made to calculate the amount of ^{14}C that remained in the marsh ecosystem *immediately* after the label had been applied:

- The researchers applied 150 μCi of $^{14}CO_2$ to each of the six enclosed chambers as described in their proposal.
- 50% of the $^{14}CO_2$ was fixed in photosynthesis during the 10 minute exposure, the rest being lost to the atmosphere when the exposure ended (based on Cornell et al. 2007).
- All ^{14}C in the ecosystem immediately after the labeling event was located in plant biomass because soil particles and soil microorganisms do not consume CO_2 from the atmosphere.

$$150\ \mu Ci \times 0.50 = \mathbf{75\ \mu Ci}$$

Thus, the plants inside a single enclosed chamber would have started with a total of 75 μCi of ^{14}C fixed in their biomass.

III. Mass of ^{14}C in Marsh Plant Roots One Week Post Labeling

The following assumptions were made to calculate the amount of ^{14}C that remained in marsh ecosystem *one week* after the label had been applied:

- All ^{14}C remaining in the ecosystem one week after the labeling event was located in living plant biomass because this is too short a period of time for the plants to die.
- **50%** of the CO_2 fixed is used to produce plant tissue (i.e. plant biomass), while the other 50% is lost within one week as CO_2 in plant respiration. Plant respiration supports cell growth, active nutrient transport, and other metabolic activities required for daily physiological functions.
- Based on our published data (Erickson et al. 2007) one-third (**33%**) of the carbon invested in biomass is allocated to root growth, with the remaining two-thirds goes to shoot growth. The shoot growth does not transform into soil organic matter in this ecosystem, but instead decomposes back to CO_2 within about one year.

Concentration of ^{14}C per unit of *dry* soil mass:

$$\frac{75\ \mu Ci}{30{,}000\ g\ soil} \times 0.50 \times 0.33 = \frac{0.00041\ \mu Ci}{g\ soil} = \mathbf{\frac{410\ pCi}{g\ soil}}$$

IV. Mass of ^{14}C in Marsh Plant Roots 20 Years Post Labeling

Assumptions about how much of the original label is likely to remain in the marsh soil 20 years later, are as follows:

- All the roots containing the original ^{14}C label in the form of root biomass died within one year.
- As the dead roots decomposed, this label was converted to $^{14}CO_2$ and lost to the atmosphere.
- 99% of the label in dead roots decomposed to CO_2 in a period of 10 years or less, such that 1% of the original label remained 20 years later.

Thus, 20 years later, all the original roots with label have died and decomposed, and only 1% of the label remains in the soil.

$$410 \text{ pCi} \times 0.01 = \frac{\mathbf{4.1\ pCi}}{\mathbf{g\ soil}}$$

Publications Cited

Cornell, JA, CC Craft and JP Megonigal (2007). Ecosystem gas exchange across a created salt marsh chronosequence. Wetlands. 27(2):240-250.

Erickson, JE, JP Megonigal, G Peresta, BG Drake (2007). Salinity and sea level mediate elevated CO_2 effects on C_3-C_4 plant interactions and tissue nitrogen in a Chesapeake Bay tidal wetland. Global Change Biology 13:202-215. DOI 10.1111/j.1365-2486.2006.01285.x

Saunders, CJ, JP Megonigal and JF Reynolds (2006). Comparison of belowground biomass in C3- and C4-dominated mixed communities in a Chesapeake Bay brackish marsh. Plant and Soil 280:305-322.