May 20, 2005

Ms. Barbara Hamrick, Esq., CHP
Radiologic Health Branch
Division of Food, Drug & Radiation Safety
California Department of Health Services
1800 E. Lambert Road, #125
Brea, CA 92821

Dear Ms. Hamrick:

This letter is in response to your March 12, 2005 e-mail to Dr. Terry Brock of my staff. In your e-mail you requested assistance on five issues related to the evaluation and license termination of experimental agricultural sites with residual contamination of carbon-14 from licensed chemical applications (e.g., the ABC Laboratories, Inc. site in Madera, California). We have enclosed responses to each of the five issues you submitted in your e-mail. We hope this information is helpful.

If you have any questions, please contact Dr. Terry Brock at 301-415-2323, or Mr. David Brown of our Office of Nuclear Materials Safety and Safeguards at 301-415-5257 or ddb@nrc.gov.

Sincerely,

/RA By Mark R. Shaffer Acting for/
Paul H. Lohaus, Director
Office of State and Tribal Programs

Enclosure:
As stated

cc: Edgar Bailey, Chief, CHP
Radiologic Health Branch

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NRC response to the 5 issues in 3/12/2005 e-mail from B. Hamrick

Issue 1: The combustion process for analyzing C-14 in soil includes the incorporation of sugars or cellulose powder, which creates a "process background" of approximately 10 pCi/gram of C-14 in the samples, in addition to the natural background of C-14 in soil, resulting in a Minimum Detectable Concentration of about 12 - 15 pCi/gram above "total background," for a typical count time. This exceeds the "screening level" for the resident-farmer scenario of 12 pCi/gram reported in Appendix B, NUREG 1757, Volume 1, Rev. 1, implying that the licensee may need to make a demonstration that the radioactivity is indistinguishable from background, if other site-specific parameters cannot be incorporated into the modeling.

Response: You describe a problem in which a laboratory radioanalytical procedure results in a minimum detectable concentration (MDC) of carbon-14 in soil that is approximately equal to, or even slightly exceeds, the NUREG-1757, Appendix B, screening level value for carbon-14 in soil. The screening level value is 12 pCi/gram carbon-14 for a resident farmer scenario. We asked the manager of the Environmental Radioanalytical Laboratory (ERL) at the Environmental Survey and Site Assessment Program of the Oak Ridge Institute for Science and Education, about the ERL's MDC for carbon-14 in soil. He stated that an MDC of 1.5 pCi/gram in soil is achievable using a biological materials oxidizer for sample preparation, and standard liquid scintillation spectroscopy. He suggested that this MDC is reached with a 1.0 gram soil sample size, and a 1 hour counting time, but that the laboratory may be capable of larger sample sizes. Assuming the laboratory could accommodate both a 2 gram sample and a 2 hour counting time, it is possible to reach a lower MDC of 0.5 pCi/gram. These MDCs should allow a licensee to demonstrate that site levels are below the NUREG-1757 screening level values. Therefore, we believe that laboratory radioanalytical protocols are available which may alleviate the problem of high detection limits that you describe.

Issue 2. The model used to set the screening level noted above includes an assumption that the C-14 "moves like water" (from an email from Rachel Browder on 12/4/2004 to Linda McLean, in Region IV), and should be "gone within a few years (5 - 7 years)." It is not clear that this is the case. There is some limited data from some of our licensees indicating that the C-14 may be binding in the soil due to the compound in which it was incorporated. We have not modified the RESRAD model we use to incorporate a transfer factor other than zero, so have not yet determined how this would impact the projected dose, since we do not have any data regarding realistic transport factors for the various compounds used at these sites.

Response: We agree that the statement that carbon-14 "moves like water" is an oversimplification of carbon behavior. Nonlabile organic carbon will behave differently than its inorganic chemical forms, such as the oxides and carbonates [$CO_2(g)$, CO_3^{2-}, HCO_3^-, H_2CO_3]. In fact, the fate of pesticides applied to soil is a matter of ongoing research. A recent publication by the Florida Cooperative

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Extensive Service (Rao, et al., 1998) suggests that the fate of pesticides in soil depends largely on the persistence and solubility of the originally-applied compound. Some pesticides, such as aldicarb and malathion, persist with half-lives of less than 30 days in the root zone. Others, such as bromacil, persist with half-lives greater than 100 days. With regard to solubility, partition coefficients (ratio of adsorbed concentration to soil-water concentration) range from 10 for aldicarb, to up to 243,000 for DDT. Therefore, should your office, or a licensee, decide to use RESRAD to perform a dose assessment for residual carbon-14 in soil, some knowledge of the originally-applied pesticide(s) may provide useful input to an analyst who would select RESRAD carbon soil-water distribution coefficients and carbon-14 evasion rate factors. Given the potential for these parameters to significantly affect dose results, we recommend that your licensees work closely with you on the development of these assumptions. In addition, a dose assessment should take into consideration the uncertainty in these parameters, by either conservative selection of values in a deterministic assessment, or consideration of parameter value distribution and ranges, and parameter correlation.

Issue 3. The MARSSIM process is generally not appropriate where soil contamination extends beyond the top 15 cm of soil. In most cases, the sites in question here do have contamination extending below 15 cm of soil. In addition, due to the low energy of the C-14 beta, scanning for "small elevated areas" is not practical. Separately, and in combination, these two limitations severely restrict one's ability to provide a statistically sound justification for demonstrating the final radiological status of a site. These problems also affect the scoping and characterization survey phases, and it has been difficult to establish whether the depth and areal extent of contamination has been adequately characterized.

Response: We agree that the MARSSIM process is not necessarily appropriate where soil contamination extends beyond the top 15 cm of soil. However, NUREG-1757, vol. 2, Appendix G, provides some guidance on decommissioning of sites with subsurface residual radioactivity. In instances where radiolabeled pesticides have been applied to agricultural test plots, a historical site assessment would probably indicate that carbon-14 was applied uniformly over a well-defined area. Therefore, one could justify a relatively large triangular grid spacing for characterization borehole sampling. Statistical methods exist for evaluating the results of characterization sampling to determine whether an adequate number of samples were obtained, and whether the site is adequately characterized. Specifically, NRC has funded development of a free software known as Spatial Analysis and Decision Assistance (SADA), which is available from the University of Tennessee. In fact, some features of SADA may assist decision-makers during early sample design and help minimize the need for secondary sampling.

Issue 4. There is a serious discrepancy between the NRC and EPA models for an agricultural site, where C-14 is the contaminant. The NRC/EPA Memorandum of Understanding (MOU) uses a consultation trigger of 46 pCi/gram and 123,000 pCi/gram for "residential" and "industrial/commercial" soil concentrations, respectively. These numbers correspond precisely to the EPA's Preliminary Remediation Goals (PRGs) at a risk level of 1E-4. The number the

NRC published for screening, as noted above, for a "resident-farmer" scenario is 12 pCi/gram; however, the EPA's PRG for C-14 in an agricultural setting at a risk level of 1E-4 is 5.63E-3 pCi/gram, or over 2000 times lower than the NRC's. Given that NRC and EPA appear to have agreed to a model for the residential and industrial/commercial sites, it is unclear what the basis is for such a colossal difference in the agricultural models. In that the NRC/EPA MOU does not provide consultation triggers for agricultural scenarios, RHB would like information as to what NRC has done or intends to do with respect consulting with EPA on the release of lands for agricultural use, particularly in light of the massive difference in the models for C-14 used to project dose at agricultural sites. I.e., in a totally generic scenario, it appears the NRC screening level would correspond to a risk, as calculated by EPA, of approximately 2E-1.

Response: With regard to NRC plans for consulting with EPA on sites with residual carbon-14 contamination, a criterion which triggers consultation is when NRC expects that ground-water contamination will be in excess of EPA's MCLs. The MCL for carbon-14, a pure beta-emitter, is 4 mrem per year. The EPA Derived Concentration of carbon-14 that corresponds to the MCL is 2,000 pCi/L. In addition, NRC will consult with EPA if either the planned level, or the actual residual level, of soil carbon-14 concentration exceeds the concentrations in Table 1 of the NRC-EPA MOU. These values are, as you stated, 46 pCi/g for the future resident critical group, and 123,000 pCi/g for the industrial/commercial critical group. With regard to NRC consultation with EPA on the release of lands that may have future agricultural use, and which contain residual carbon-14 contamination, the residential value (46 pCi/g) would apply.

In response to your statement regarding agreement between EPA and NRC on a model, we should clarify that NRC and EPA have not, in fact, agreed to a single model. Specifically, the values in Table 1 should not be interpreted as agreement between NRC and EPA on a single acceptable dose modeling method for demonstrating compliance with both 10 CFR 20.1402 requirements and EPA CERCLA-derived remediation goals. The values in Table 1 merely establish a level above which NRC agrees to consult with EPA.

Issue 5. In researching this issue, RHB identified two relatively recent authorizations by the NRC to perform research using C-14, which would result in soil contamination. One is from April 11, 2001, Federal Register pages 18817-18820, "Environmental Assessment...Dow AgroSciences LLC," and the other is from May 22, 2002, Federal Register pages 36046-36048, "E.I. Du Pont de Nemours & Co., Inc., Environmental Assessment." In both cases, in the sections involving impacts to the food chain, it indicates that all contaminated soil will be removed as radioactive waste, and in the case of E.I. Du Pont, it specifically states, "Soil will be removed...to a level where the soil radioactivity is at background." RHB would specifically like to know if this was required due to the problems and concerns noted in the preceding paragraphs, and if not, why this requirement was imposed.

Response: Your question pertains to two license amendment requests, namely Dow AgroSciences, license number 13-26398-01, and E.I. Du Pont de Nemours & Co., Inc., license number 07-13441-02. These licensees are required to remove carbon-14 contaminated soil following the NRC-authorized activities, in accordance with conditions in their licenses. These requirements were not imposed by NRC as a result of the types of concerns noted in your e-mail dated March 12, but rather are simply commitments identified by the licensees in their applications, to which they are held by license condition. Therefore, these specific conditions should not be construed as a constraint for other licensees who may wish to demonstrate by dose modeling that residual carbon-14 contamination meets the intent of 10 CFR 20.1402.

Reference:

(Rao, 1998) P.S.C. Rao, R.S. Mansell, L.B. Baldwin, and M.F. Laurent, "Pesticides and Their Behavior in Soil and Water," Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, <http://pmep.cce.cornell.edu/facts-slides-self/facts/gen-pubre-soil-water.html> Retrieved April 6, 2005. Last modified May 8, 1999.