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January 22, 2004 Docket 50-62

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Attention: Mr. Daniel E. Hughes, Project Manager
Operating Reactor Improvements Program

Subject: University of Virginia --Master Final Status Survey Plan and Addenda 001-008 (TAC NO. MB8233)

References: 1. Amendment No. 26 to Amended Facility Operating License No. R-66 for the University of Virginia Research Reactor, Docket 50-62
2. Transmittal D. E. Hughes to P. E. Benneche , " University of Virginia -- Master Final Status Survey Plan and Addenda 001-008 (TAC NO. MB8233)" dated December 12, 2003

Dear Mr. Hughes,

Please find enclosed the University's response package to the NRC's Request for Additional Information of December 12, 2003. In making our response we were assisted by CH2M HILL and Safety and Ecology Corporation, our contractors who performed the Final Status Survey activities. Please note that this response contains no proprietary data.

The response package was reviewed and approved by the University of Virginia's Reactor Decommissioning Committee on January 14, 2003. In accordance with 10CFR50.30(b) the signed original and attachments are submitted by me under oath.

We are pleased to transmit for your information three copies (enclosed) of the "UVA Response to NRC Request for Additional Information Final Status Survey Plan University of Virginia Reactor Facility License No. R-66 Docket 50-62."

A020

Should you have any questions regarding this document, please call me at (434) 982-5440.

Sincerely and,

I declare under penalty of perjury that the forgoing is true and correct.

Paul E. Benneche

Paul E. Benneche
Reactor Director
University of Virginia

Enclosure:

UVA Response to NRC Request for Additional Information Final Status Survey Plan
University of Virginia Reactor Facility License No. R-66 Docket 50-62

c: Ralph Allen, Chair Reactor Decommissioning Committee
Stephen Holmes, NRC

UVA Response to NRC Request for Additional Information Final Status Survey Plan University of Virginia Reactor Facility License No. R-66 Docket 50-62

The University of Virginia is providing the following in response to a Request for Additional Information (RAI) from the U.S. Nuclear Regulatory Commission (NRC) (Daniel E. Hughes to Paul E Benneche), dated December 12, 2003. Upon receipt of NRC concurrence with these responses, the University of Virginia will revise and resubmit the affected Final Status Survey Plan documents.

1. **Section 5, Page 5-1, 2nd Paragraph (UVA 2003a (*Master Final Status Survey Plan*)) - The text references Table 3-1 as providing the screening values for total surface contamination. This appears to be a typographical error as the current reference is likely Table 5-1.**

   Response

   This is a typographical error and will be changed to Table 5-1. In addition, because this list is limited to a fraction of the radionuclides that are potential contaminants of concern at a reactor facility, values (P_{crit}=0.90) for other potential contaminants from Table 5.19 of NUREG/CR-55-12, Vol. 3, will be added to the table in the Master FSS Plan, and the source of these added values will be identified in the document.

2. **Sections 7.10.1 and 7.10.2 (UVA 2003a (*Master Final Status Survey Plan*)) – Scan coverage is listed as 25% for Class 2 and 10% for Class 3 survey units for both beta and gamma surface scans. However, Section 4.4.3 of the UVA decommissioning plan (UVA 2000) states that beta and gamma surface scans coverage will be 100% for Class 2 and 25% for Class 3. What is the reason for the reduced scan coverage?**

   Response

   Explanation for this reduced coverage was provided in a December 5, 2003 letter from Paul Benneche (University of Virginia) to Daniel E Hughes (NRC). No revisions to FSS Plans should be necessary.

3. **Appendix A, Section A (UVA 2003a (*Master Final Status Survey Plan*)) – This Section describes the method for determining the mix of radionuclide contaminants. In particular, steps 4 through 6 appear to be incorrect. Once steps 1 through 3 are complete, the total activity in each sample should be calculated. Then the fraction for each radionuclide should be calculated by dividing the radionuclide's concentration in the sample by the total activity in the sample, rather than by dividing by the derived concentration guideline level ($DCGL_W$) as stated in step 6. Provide clarification of this issue.**

Response

Step 3 of the approach currently described in Appendix A already includes determining the total activity of the radionuclides of interest in the sample and the fractional activity contribution of each radionuclide. The remainder of the approach follows a different sequence of steps than the "traditional" approach, by deriving and directly applying relative dose contributions of the different hard-to-detect contaminants to the sum-of-fractions, rather than adjusting the DCGL of the radionuclide used for the surrogate measurement to a $DCGL_{surrogate}$ and then dividing the concentration of that radionuclide by the $DCGL_{surrogate}$ to account for the dose contributions of the hard-to-detect contaminants. The bottom line sum-of-fraction value determined is the same for both the "traditional" approach and that currently described in Appendix A.

However, to avoid similar confusion of others, the "traditional" approach will be used. Steps 1 through 3 of Section A, Appendix A, remain unchanged. The remainder of this Section will be revised as follows:

4. Repeat steps 1 - 3 for all samples from the area of interest.

5. Calculate the average and standard deviation of the fractional contribution of each radionuclide of concern.

6. Calculate the 95% upper confidence level (UCL) fractional contribution of each radionuclide of concern that is potentially present, using the method described in Section 8.5.5 of NUREG/CR-5849.

7. Calculate the total of the radionuclide UCL fractions, and normalize the individual UCL values, based on a total of 1 (i.e., unity). The resulting values represent the fractional activity contributions (f_1 through f_n) for radionuclides 1 through n in the survey area of interest.

Note: Some FSS areas have few, if any, locations with activity of most hard-to-detect radionuclides above analytical detection levels. Therefore, there may be limited data available for determining the average and variability of relative radionuclide ratios. In such situations, radionuclide mixes for other survey areas with the potential for similar contamination will be used, if available. If multiple data sets are not available, radionuclide mixes will be based on a single sample, and analyses of FSS samples will be used to confirm (or modify) the radionuclide mix, used for survey planning and design and to evaluate the final status, relative to criteria.

4. **Appendix A, Section B (UVA 2003a (*Master Final Status Survey Plan*)) - This Section describes the approach for establishing a gross beta surface activity guideline of a mixture. The methodology, as presented, appears to miscalculate an adjusted gross $DCGL_{adjgross}$ value when non-detectable (hard-to-detect) radionuclides are present. As written, Step B1 uses the fractions calculated from the preceding Section A. First, these fractions appear to be incorrectly calculated (see Comment 3). Second, the equation given in step B.1 does not describe that the f_1 through f_n values need to be**

normalized to only include the contributions of detectable radionuclides.

For example, assume the following mixture of radionuclides and their fractions: Co-60, f=0.3, Cs-137, f=0.5, and H-3, f=0.2. The fractions stated are based on the total activity. The $DCGL_{gross}$ from Step B.1 should be calculated as:

$$DCGL_{gross} = \frac{1}{\frac{f_{Co-60}/F}{DCGL_{Co-60}} + \frac{f_{Cs-137}/F}{DCGL_{Cs-137}}}$$

Where F is the total fraction of detectable radionuclides. In this example, F would equal 0.3 + 0.5 = 0.8.

The equation presented in B.2 to calculate the $DCGL_{adjgross}$ that accounts for non-detectable radionuclides is correct. However, clarify by providing additional text describing how to calculate the value R. To continue the example, RH-3 would equal 0.2/F = 0.25.

Addenda 001 through 008 shows that a conservative approach of applying the lowest $DCGL_W$ of the identified contaminants in most cases was used, rather than deriving a $DCGL_{adjgross}$ as discussed above. Provide clarification to the master final status plan in the event that this DCGL modification process is used in the future.

Response

Since Section A of this Appendix has been modified, Section B will also be revised as follows:

B. <u>Establish the Gross Beta Surface Activity Guideline of a Mixture</u>

1. Using the fractional activity contributions of radionuclides, determined from Section A, calculate the gross activity guideline value ($DCGL_{gross}$) by:

$$DCGL_{gross} = \frac{F}{\frac{f_1}{DCGL_1} + \frac{f_2}{DCGL_2} + \cdots + \frac{f_n}{DCGL_n}}$$

Where f_1 through f_n are the activity fractions of radionuclides 1 through n, with DCGLs, $DCGL_1$ through $DCGL_n$, respectively, and F represents the total fraction of detectable radionuclides in the mixture.

An alternative to deriving a $DCGL_{gross}$ based on the fractional activity contributions is to identify the most conservative DCGL for the identified radionuclides present and use the DCGL value for that radionuclide in the above calculation. Use of this approach will be indicated in Addenda for survey areas with potential surface activity, where applicable.

2. When one or more of the radionuclides present will not be detected by the gross measurement, the gross measurement may serve as a surrogate for the undetected radionuclides by adjusting the $DCGL_{gross}$ to account for the activity fractions of the undetected radionuclides by:

$$DCGL_{adjgross} = \frac{1}{\frac{1}{DCGL_{gross}} + \frac{R_2}{DCGL_2} + \cdots + \frac{R_n}{DCGL_n}}$$

Where R_2 through R_n represent the ratio of the activity fractions, f_2 through f_n, of the non-detectable radionuclides, 2 through n, respectively, to the total fraction of detectable radionuclides in the mixture, i.e., f_n/F.

Addenda for survey areas with surface activity (i.e., Addenda 002, 004, 005, 006, and 008) will be modified in accordance with these changes.

5. **Section 3, Page 3-1, 1st Paragraph (UVA 2003b (*Final Status Survey Plan Addendum 001- Underground Waste Tank Excavation*)) – The text in this paragraph notes that contaminated soil was identified at the base of the demineralizer regeneration waste tank blockhouse. Soil samples collected down to a depth of three meters in the area were analyzed by gamma spectrometry and identified Co-60 and Cs-137. A sample of waste tank sludge was also collected and identified Co-60 and Cs-137. The paragraph concludes to say that based on the sample results and history of reactor operations, that the radionuclides of concern are only Co-60 and Cs-137. Provide clarification on what was or is to be done to rule out the presence of hard-to-detect radionuclides (e.g., additional analyses).**

Response

The waste tank sludge was analyzed for hard-to-detect radionuclides. This was the only characterization sample from the area, which contained sufficient activity to enable a meaningful radionuclide mixture to be determined. This sample did not contain significant levels of non-gamma emitters. These results will be described in a revision to Final Status Survey Plan Addendum 001. In addition, a composite of FSS samples was analyzed for hard-to-detects to confirm the absence of significant levels of non-gamma emitters.

6. **Section 4.8, Page 4-3 (UVA 2003b (*Final Status Survey Plan Addendum 001- Underground Waste Tank Excavation*)) – The reviewer interprets the discussion in this section to mean that the results of a single composite sample will be used to calculate modified DCGLs to account for hard-to-detect radionuclides. One composite sample may misrepresent the hard-to-detect radionuclide concentrations by averaging the ratios without providing the spatial variability in the survey unit. In other words, it appears an analysis of the ratios was not done to determine if a consistent relationship exists. Describe what was or is to be done to ensure the spatial**

variability of the hard-to-detect radionuclide concentrations throughout the survey unit are consistent with the survey design input (e.g., analysis of a portion of the final status survey samples for hard-to-detect radionuclides).

Response

As in the case of the Waste Tank Excavation, there were few facility locations at the University of Virginia Reactor facility with sufficient activity of radionuclides other than the dominant gamma emitters (Cs-137 and/or Co-60) to enable a meaningful determination of the radionuclide mixture; in such situations, activity concentrations are typically less than analytical method detection sensitivity limits. In such circumstances the activity fractions are erroneously high and the significance (based on potential dose contribution) of hard-to-detect radionuclides is overestimated. Because of the limited number of samples available, spatial variability of specific radionuclide contributions in many areas could not be determined during the characterization phase.

The alternative chosen is to perform analyses for contaminants of concern on composite FSS samples and to compare the results of these analyses with the specific radionuclide DCGLs. Although a composite analysis result represents the average concentration for the samples constituting the composite, if the concentration, multiplied by the number of samples in the composite, is less than the DCGL, no individual sample in the composite could contain a level in excess of the DCGL. This not only provides a conservative overestimate of the contribution from hard-to-detect radionuclides in an individual sample, but a cost-effective means for demonstrating that significant levels of hard-to-detect radionuclides are not present.

7. **Appendix A, Section C (UVA 2003a (*Master Final Status Survey Plan*)) – Equations are not provided in step 2 for adjusting DCGLs for surrogate measurements. Provide clarification on the specific calculational approach, including reference to guidance documents as appropriate.**

Response

The calculational approach for adjusting DCGLs for surface activity measurements was described in the response to RAI Item 3. Section C.2 of Appendix A will be modified as follows:

C. Establish a Soil Guideline

1. For multiple contaminants in soil, the Unity Rule is applicable. This means that the sum of ratios of concentrations present to their respective $DCGL_W$'s from the NRC Table of default screening values must be ≤ 1.

$$\frac{C_1}{DDCL_1} + \frac{C_2}{DCGL_2} + \cdots + \frac{C_n}{DCGL_n} \leq 1$$

Where

C_n = concentrations of each individual radionuclide (1, 2...n)

$DCGL_n$= guideline value for each individual radionuclide (1, 2.., n)

In other words, there is not a single soil guideline value for the radionuclide mix, but, rather, a group of guidelines applicable to each radionuclide and a Unity Rule applicable to the sum of ratios.

2. Using the fractional activity contributions of radionuclide in a mixture, determined from Section A, levels of certain contaminants (e.g., hard-to-detect radionuclides) can be inferred, based on analyses of contaminants that are easier to measure. The measured radionuclide is referred to as the surrogate. The DCGL for the surrogate radionuclide is adjusted for the contributions of inferred contaminants, following the approach described in MARSSIM Appendix I, Section I.11.2. If C_1 and $DCGL_1$ are the concentration and guideline value, respectively, for the surrogate radionuclide, and C_2 through C_n, $DCGL_2$ through $DCGL_n$, and R_2 through R_n are the concentrations, guideline values, and fractional contributions (ratios of C_1/C_{2-n}), respectively, the adjusted DCGL for the surrogate radionuclide is calculated by:

$$DCGL_{surrogate} = 1/[1/DCGL_1 + R_2/DCGL_2 + \ldots + R_n/DCGL_n]$$

The ratio of the concentration of the surrogate radionuclide to its $DCGL_{surrogate}$ thus accounts for all radionuclides for which contributions are inferred by the surrogate measurement.

8. **Section 4.5 (UVA 2003c (*Final Status Survey Plan Addendum 002- Reactor Facility Piping*)) – This section discusses the sample size calculation for the reactor facility piping. The value for σ is noted as 2300, "based on the MDA for the least sensitive measurement technique." The MDA is not used to determine the variability in the survey unit. In addition, the master final status survey plan (UVA 2003a), Section 7.8 provides guidance to assume a σ of 25% of the DCGL when empirical data is not available. Provide clarification of this approach. This approach is also taken and should be clarified in the other addenda where surface activity measurements are described.**

Response

While it is agreed that the MDA is not the correct value to use for estimating the variability in the survey unit, empirical FSS data were not available to support the survey design. However, characterization of the piping and surface activity measurements in support of remediation indicate that, with few exceptions, the anticipated surface contamination levels at FSS will be less than the detection sensitivities of the measurement methods and the variability will consequently be less than the MDA. For such circumstances, use of the MDA for the value of σ provides a

conservatively low initial estimate for the relative shift, thereby assuring an adequate number of data points for survey unit evaluation. Because certain measurement methods have detection sensitivities that are small in comparison with the value of the shift, use of the MDA in such cases for design purposes yields a relative shift that is large and may underestimate data needs. Using a LBGR (Lower Bound of the Gray Region) value of 0.5 DCGL and a σ of 25% of the DCGL for design purposes provides a relative shift of 2; this is in the range of 1 to 3 in accordance with recommendations of MARSSIM. The values from the FSS for the average survey unit concentration (LBGR) and the variability (σ) will be used to reassess the calculation of relative shift and data needs as indicated in Section 8.3 of the Master FSS Plan.

Section 7.8, step 1, of the Master FSS Plan will be revised to indicate that for planning purposes, lacking empirical survey unit data the value of σ will be set at 25% of the DCGL or the MDA of the measurement method, whichever is greater. It will also be indicated in this section that the values from survey unit data will be used to recalculate the relative shift and confirm adequate data were collected for evaluation. This approach will also be referenced and clarified in Addenda 002, 004, 005, 006, and 008 for surface activity measurements.

9. **Attachment A, Page A-3 (UVA 2003c (*Final Status Survey Plan Addendum 002- Reactor Facility Piping*)) – The calculation of the MDA_{scan} appears to be incorrect. The observation interval of 2.1 sec was not included under the radical. The correct calculation is shown below.**

$$MDA_{scan} = \frac{1.38\sqrt{36.1\cdot\frac{2.1}{60}}\cdot\frac{60}{2.1}}{\sqrt{0.5}\cdot 0.0135} = 4{,}643 dpm/100 cm^2$$

Response

The scan MDA calculation was in error, because of failure to include the sampling interval of 2.1 sec in the term under the square root sign. The correct value, as indicated in the RAI, is 4643 dpm/100 cm²; Attachment A to Addendum 002 will be revised accordingly. Also, the static measurement MDA for this measurement method is approximately 33% of the DCGL, as compared to the design objective value of 25% indicated in Sections 7.1 and 7.6 of the Master FSS Plan. It will be clarified in the Master FSS that the 25% level is a design target (or objective), and may not be achievable in all situations. Deviation from this target will be specifically indicated in Addendum 002 and any other Addenda where it cannot be reasonably achieved.