ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

June 7, 2006

Mr. Tom Youngblood
U.S. Nuclear Regulatory Commission
NMSS/DWMEP/DCD
Mail Stop T-7E18
Washington, DC 20555

SUBJECT: NRC RFTA # 06-008
ORISE COMMENTS ON THE TECHNICAL ADEQUACY OF YANKEE ROWE USE OF *IN SITU* GAMMA SPECTROSCOPY

Dear Mr. Youngblood,

The Oak Ridge Institute for Science and Education (ORISE) is providing the enclosed comments in partial response to Request for Technical Assistance (RFTA) # 06-008.

Our comments specifically address RFTA items 1(a) and 1(b) concerning the technical basis for *in situ* gamma spectroscopy.

These comments are provided as a follow-up to the draft requested in your 17 May 2006 e-mail, and provided to you via e-mail on 2 June 2006.

Should you have any questions, please contact me at 865.574.6273 or Mr. Alex Boerner at 865.574.0951

Sincerely,

Matt Buchholz

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Health Physicist

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Enclosure

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ORISE COMMENTS ON THE TECHNICAL ADEQUACY OF YANKEE ROWE USE OF *IN SITU* GAMMA SPECTROSCOPY

Background:

Yankee Atomic Electric Company, Yankee Rowe site (YR), has used *in situ* gamma ray spectroscopy (ISGRS) as an alternative to traditional hand-held survey instruments to complete the 100% surface scan requirement for Class 1 areas at the Yankee Rowe site. The use of ISGRS (with Canberra's ISOCS system) was justified in the technical basis document (TBD) YA-REPT-00-018-05 (Ref 1).

NRC RFTA # 06-008 (Ref 2) requested ORISE assistance to determine if YR has an adequate technical basis for the ISGRS measurements, and to review YR technical procedures and other bases for the capability of ISGRS.

ORISE reviewed applicable sections of the License Termination Plan (Ref 3), Final Status Survey reports (Refs 4,5,6), and ISOCS procedures (Refs 7,8). We would be pleased to review these references in further detail and provide constructive comments to the NRC as needed for this task. However, the vast majority of material pertinent to the RFTA is contained in the *in situ* TBD. The majority of effort was therefore focused on the TBD.

ORISE did:

- Review the scientific principles and methods for technical soundness, based on the information provided in the reports.

ORISE did not:

- Verify equipment performance data provided by YR (e.g. MDCs provided in the report were taken at face value)
- Comprehensively verify calculations
- Verify data quality or integrity

ORISE discussion is divided into two topics:

1. General use of ISGRS for 100% scans of Class 1 areas
2. The impact of discrete particles

To begin the discussion, it is helpful to first restate the context of the MARSSIM (Ref 9) methodology.

- MARSSIM uses a combination of statistical samples and scan surveys to demonstrate compliance with the 25 mrem (or other target value) Total Effective Dose Equivalent (TEDE) criteria.
- MARSSIM is based on the assumption that activity is evenly distributed, and concentrations are spatially independent.
- MARSSIM does not address discrete ("hot") particles.
- The purpose of scans is to detect any areas with activity concentrations above an investigation level, typically set at the $DCGL_{emc}$ in Class 1 areas.

Topic 1) General use of ISGRS for 100% scans of Class 1 areas

Assume for the discussion of this topic that there are no discrete particles. The scope is restricted to a situation where the activity is fairly uniformly distributed over even the smallest area of interest (defined by YR as 1 m^2).

YR's approach to using ISGRS for scans is:

- Using a set height (2 m), and a collimated viewing angle (90 degrees), perform a 100% scan looking at a 12.6 m^2 field of view (FOV) for each measurement. Overlap the FOVs such that 100% coverage is achieved.
- Determine an effective investigation level that accounts for the possibility that, while looking at a 12.6 m^2 FOV, the activity may actually be located (worst case) in a single 1 m^2 at the edge of the FOV.
- The effective investigation level is an observed value that correlates to what 1 m^2 at the edge of the FOV, containing activity at the 1 m^2 $DCGL_{emc}$, would "look like" while in fact measuring a 12.6 m^2 area.
- The effective investigation level is thus calculated as the $DCGL_{emc}$ for a 1 m^2 area, multiplied by the ratio of the 12.6 m^2 MDC to the 1 m^2 MDC.

General Comments:

1. It is ORISE's opinion that the underlying principles and methodology of the TBD are technically sound. When applied as described in the TBD, ISGRS satisfies MARSSIM scan requirements for detecting areas of elevated activity at or below the $DCGL_{emc}$. However, ORISE suggests that the limited documentation and discussion of the current TBD be significantly expanded. Even to a technical audience, some of the assumptions are not immediately obviously correct, and the discussions are difficult to follow.

2. Several suggested requirements for successful application of the ISGRS in this manner are:
    a. The use of accurate and representative values in the determination of an "effective" investigation level.
    b. Ensuring that the system is applied in a manner consistent with the TBD values and assumptions, such as:
        i. MDC values under actual operating conditions are at or below the effective investigation level for each radionuclide of concern.
        ii. Adequate correction factors are used, such as for moisture self-attenuation.

    These requirements should be addressed in greater detail, either in the TBD, in quality control documents, or operating procedures.

3. Regarding requirement (2.b.i) above, the three FSS reports reviewed by ORISE state that the ISOCS scan MDC was set at the 1 m^2 $DCGL_{emc}$ (Ref 4 page 8, Ref 5 page 26, Ref 6 page 13). It is unclear why the MDC was not set at the effective investigation level. If the investigation level is the value that will trigger further action, then it would intuitively require the equipment to be sensitive enough to detect that value. This discrepancy between suggested requirement (2.b.i) and the FSS statements needs to be addressed.

4. In general, the TBD method of determining investigation levels results in effective investigation levels below the $DCGL_w$. If contamination is routinely present in the survey unit below the $DCGL_w$, such that the survey unit should pass, but above the effective investigation level, many unnecessary investigations may result. As a result, use of ISGRS will likely be limited operationally to situations where the average concentration is well below both the $DCGL_w$ and the effective investigation level.

<u>Specific Comments:</u>

ORISE suggests the following points in particular need more discussion in the TBD:

1. Sections 1.2.3 and 1.2.4: Discuss why 1 m^2 is selected as the "smallest area of concern." Why not larger? Why not smaller? Setting the area as small as 1 m^2 provides a comparatively large $DCGL_{emc}$ compared to traditional $DCGL_{emc}$ values based on the area between sampling points. A justification for the area of concern should be provided.

2. Section 1.2.4: Clarify that the investigation level being derived is an "effective" investigation level. It is an <u>observed</u> value that correlates to the expected reading for a 1 m^2 offset area at the $DCGL_{emc}$.

3. Section 1.2.4: When deriving the effective investigation level, why is the area correction factor (CF) determined by the ratio of the MDCs instead of the ratio of the 1 m^2 offset efficiency to the 12.6 m^2 direct-view efficiency?

   In general, the MDC is a situation-dependent statistical value determined in part by the background count rate, the count time, and the efficiency.

   It is true the MDC must be below the value you are trying to detect. However, when using an effective reading X to infer an activity Y in a different geometry (and therefore different efficiency), the correction factor intuitive to use would be the ratio of the efficiencies.

   ORISE believes the Yankee Rowe method for the effective investigation level is acceptable since it mathematically arrives at the same value (because the background parameter of the MDC formula would be the same regardless of the contamination geometry). However, there should be some discussion to explain the rationale for this approach.

4. Section 1.2.5: Regarding the statement "Count times will be adjusted as necessary [...]", clarify what the driving factor is. Count until the MDC is lower than...?

5. Section 1.2.7: The correction for soil moisture appears well chosen. However, this should be expanded to include correction factors for other conditions that were encountered at the Yankee Rowe site, such as ice and/or snow cover, varying soil types, etc.

Topic 2) Impact of discrete particles

Discrete particles present (at least) two problems for Final Status Surveys. First, MARSSIM is based on the assumption that activity is evenly distributed within the area of interest, and is not equipped to deal with discrete particles. Second, ISGRS investigation levels and calibrations are based on far-field averaged measurements.

The TBD discusses discrete particles on page 10, Section 1.2.8. The approach taken at Yankee Rowe is to treat the activity as though it were evenly distributed over a 1 m^2 area. The evaluation is then no different than if the contamination did not include discrete particles.

Detectability is discussed by considering a theoretical Co-60 particle. If the activity from an entire 12.6 m^2 FOV at the investigation level were compressed into a single point, it would equate to 3.2 microcuries (3.2 μCi). Note the highest particle found by ORISE during prior verification surveys at Yankee Rowe was 1.4 μCi (Ref 10).

General Comments:

1. Discrete particles present unique problems that are not addressed by the MARSSIM process. The approach to evaluating discrete particles with ISGRS needs to be determined between the licensee and regulator. If a decision is made to allow averaging over a 1 m^2 area, then the standard MARSSIM scanning requirements would seem an appropriate approach.

2. Based on the information provided, it is ORISE's opinion that ISGRS is capable of detection at levels low enough to meet the effective investigation level, and thus at the $DCGL_{emc}$ for activity in a 1 m^2 offset area. The YR *in situ* TBD provides a viable, defensible method for accomplishing this objective.

   However, there is insufficient data to support the TBD statement in Section 1.2.8 that the activity will be readily detectable. ORISE believes there needs to be further evaluation of discrete particle detectability when unfavorable conditions are introduced (geometry, isotope, environmental factors, etc.).

3. The modeling used to derive DCGLs does not directly apply to hot particles treated as distributed over an area. The exposure pathways are based on mobility and resuspension factors for an evenly distributed contaminant. In addition, when the area of concern becomes increasingly small, such as 1 m^2, the typical scenario of a resident farmer is no longer realistic.

4. Given the limitations of the current method of determining DCGL values, it may be beneficial to consider alternate risk scenarios when determining acceptable residual levels of discrete particles. Alternate scenarios may provide a better approach than averaging the activity over 1 m^2, and the *in situ* technical basis would then need to be updated to reflect any changes in detection criteria.

Specific Comments for Section 1.2.8, "Discrete Particles in the Soil Matrix"

1. The TBD makes a statement at the beginning of the second paragraph that this level (3.2 μCi) would be readily detected. This statement needs more discussion and supporting data.

2. Is this same statement based on the particle being in the center or edge of the FOV?

3. What about under 15 cm of moist, dense soil at the edge of the FOV?

4. What about radionuclides other than Co-60? Use of this radionuclide represents a very optimistic case, since it has two photons per decay, with each emitted at a high energy.

References:

1. YA-REPT-00-018-05; Use of *In situ* Gamma Spectrum Analysis to Perform Elevated Measurement Comparisons in Support of Final Status Surveys
2. NRC Request for Technical Assistance (RFTA) 06-008; from Mr. Thomas Youngblood. (April 25, 2006)
3. Yankee Nuclear Plant Station License Termination Plan, Yankee Atomic Electric Company, Rev. 1. (November 2004)
4. YNPS-FSS-WST-01-00; Yankee Nuclear Power Station Final Status Survey Report. (April 13, 2006)
5. YNPS-FSS-NOL01-00; Yankee Nuclear Power Station Final Status Survey Report. (March 29, 2006)
6. YNPS-FSS-TBN01-00; Yankee Nuclear Power Station Final Status Survey Report. (February 21, 2005)
7. *In situ* (ISOCS) Gamma Spectrum Assay System Calibration Procedure; YNPS Procedure # DP-8869, Rev. 1. (July 2005)
8. Operation of the Canberra Portable ISOCS Assay System; YNPS Procedure # DP-8871, Rev. 2. (October 2005)
9. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575 Rev. 1. (August 2000)
10. Draft *In situ* Gamma Spectroscopy Proposal To Evaluate Detection Of Discrete Particles (regarding RFTA No. 03-011); ORISE (March 6, 2006)