Oak Ridge National Laboratory Chemical Sciences Division STANDARD ANALYTICAL METHOD	Procedure No.	CSD-AM-RML-RA01
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Title: **DEER HUNT RADIATION MONITORING GUIDELINES**

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1 PURPOSE

This document provides instructions for the monitoring of radioactivity of deer harvested in the annual managed hunts on the Department of Energy's Oak Ridge Reservation (ORR).

2 SCOPE

Deer hunts are held annually on the ORR. The monitoring of radioactivity of deer harvested during the hunts is the responsibility of the Coordinator, Analytical Support (CAS) for the hunts. An animal is not released to a hunter without clearance from the CAS. A random number (approximately 5%) of samples from released deer plus the retained deer samples are taken to the laboratory after each hunt for verification analysis of ^{137}Cs on tissue and ^{90}Sr on bone.

Tasks are performed by personnel from the Chemical Sciences Division (CSD), Environmental Sciences Division (ESD) and the Environmental Protection & Waste Services (EPWS) of Oak Ridge National Laboratory (ORNL), Tennessee Wildlife Resources Agency (TWRA) officers, and support personnel.

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Division Director Date — Group Leader Date

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Quality Manager Date — Group Leader, Research Support Date

3 TERMINOLOGY

3.1 Effective Dose Equivalent: The product of absorbed dose in rad (or gray) in tissue and a quality factor. Effective dose equivalent (EDE) is expressed in units of rem (or sievert).

3.2 Scintillation Probe: A radiation probe in which the radiations cause individual flashes of light in a solid (or liquid) "scintillator" material.

3.3 pCi/g: Any reference to pCi/g in this document is based on wet weight.

4 GENERAL INFORMATION

The radiological monitoring performed during managed deer hunts is conducted to provide assurance that harvested animals do not contain levels of radionuclides which would result in significant internal exposure to humans consuming meat from the animals. The basic principles developed for previous hunts are followed. Soft-tissue radionuclide concentrations (mainly ^{137}Cs) are determined by gamma-ray spectrometry. Beta emitting radionuclides (i.e., ^{90}Sr) in bone are detected by use of a sensitive plastic scintillation phosphor. Following review of the counting data those animals found to be free of internal contamination that meet the criteria of this document are released to the hunter. All critical radiological measurements are performed by personnel from CSD who have experience in performing such measurements under strict Quality Assurance (QA) procedures or by support personnel under the supervision of CSD personnel.

Requirements for radiological assessments include the necessity to have all pertinent data associated with a measurement in a filing system that is amendable to a variety of sorting techniques as well as rapid report generation.

All radioactivity determinations are performed in as "near real-time" as possible in order to allow the hunters to leave the area as soon as possible. The hunter remains at the checking station until the animal has been cleared.

In addition to radiation measurements made in the field at the deer hunt checking station, additional analysis of soft tissue and bone from the deer may be requested by ESD or EPWS and are to be performed in the Radioactive Materials Analysis Laboratory (RMAL) at ORNL. These analyses are performed to verify and validate the results obtained from measurements made at the checking station. The analyses in the laboratory consist of radiochemical analysis of bone and tissue.

The requirement that the dose from all sources of radiation exposure be less than 100 mrem/year to the general public is used as a guideline (reference 15.1). An administrative EDE limit to the whole body from consumption of a harvested deer has been set at less than 25 mrem/year. Administrative

limits of 5 pCi/g for ^{137}Cs and 20 pCi/g for ^{90}Sr for retention of a deer translate to an EDE of 1.6 mrem and 5 mrem, respectively (reference 15.2). If the deer contained both ^{137}Cs and ^{90}Sr at the administrative limit, the total EDE would only be 7 mrem (reference 15.2). Consequently, screening guidelines have been established to detect ^{137}Cs and other gamma emitting nuclides at levels of about 1 pCi/g with counting periods of 5 minutes on samples of 40-50 grams of soft tissue. A sample of muscle is chosen to be representative of soft-tissue. If the muscle sample contains more than 5 pCi/g of ^{137}Cs, the deer will be retained. Screening of bone samples from harvested deer is performed to detect ^{90}Sr. Strontium behaves like calcium in the body, and accumulates in the bone (i.e., it is a bone seeker). The bone samples are measured for ^{90}Sr using a beta scintillation detector. Any bone sample with net counts that consistently read 1.5 (~20 pCi/g) times the background level results in retention of the deer.

5 RESPONSIBILITIES

5.1 CSD Radioactive Materials Analytical Laboratory (RMAL) personnel are responsible for the following:

5.1.1 Setup of the counting equipment at the TWRA checking station at the beginning of each hunting season.

5.1.2 Calibration of the gamma spectrometry and beta counting systems used for field measurements at the checking station.

5.1.3 Performing gamma spectrometry measurements of tissue samples at the checking station during the managed hunts.

5.1.4 Performing the bone screening operation at the checking station during the managed hunts.

5.1.5 Operation of the deer hunt data base.

5.1.6 Generation of reports of hunt results as needed by the LSS, TWRA and the CAS.

5.1.7 Radiochemical analyses of the bone and tissue samples for selected radionuclides after completion of the managed hunts.

5.1.8 Routine review of both field and laboratory analysis results to be certain that radioactively contaminated deer are not being released to hunters.

5.1.9 Storage of the muscle and bone samples.

5.1.10 Transfer of packaged/retained deer to Laboratory Waste Services (LWS) personnel for disposal.

5.2 ESD and TWRA personnel are responsible for the operation of the deer hunt checking station.

5.3 Support personnel (ESD and EPWS) are responsible for the following:

5.3.1 Assisting with operations at the checking station.

5.3.2 Obtaining deer tissue and bone samples.

5.3.3 Packaging retained deer for disposal.

5.4 LWS personnel are responsible for disposal of retained deer and collected samples.

5.5 The CAS or a designated alternate is responsible for the following:

5.5.1 Setup and calibration of the gamma spectrometry system and beta counting instrument at the checking station.

5.5.2 Make decisions on release of harvested deer to hunters after review of radiological data collected at the hunt checking station.

5.5.3 Providing the ORNL ESD with field and laboratory radiochemical analysis results.

6 INTERFERENCES

6.1 Interferences associated with gamma scans of muscle samples.

6.1.1 Significant interference can occur when samples are counted at the checking station with a NaI(Tl) detector and the tissue sample contains radionuclides that emit gamma photons of nearly identical energies to ^{137}Cs. This can result in more activity being attributed to ^{137}Cs due to the higher counts registered for the ^{137}Cs photopeak. Such interference is greatly reduced by counting the sample with a HPGe detector in the laboratory.

7 APPARATUS

7.1 S-16 Oak Ridge area map (supplied by TWRA).

7.2 DOE Oak Ridge Reservation map (supplied by TWRA).

7.3 Platform type weighing scale (supplied by EPWS).

7.4 Plastic vials (1 1/4" x 3") with plastic caps.

7.5 Adhesive labels for plastic vials.

7.6 Multichannel analyzing system, consisting of a comprehensive software package and plug-in card.

7.7 Sodium iodide (NaI(Tl)) detectors (2) with ~40% efficiency for ^{137}Cs - 6" x 6" with a 2" x 4" well.

7.8 Lead shields - "refrigerator" type.

7.9 Ludlum Model 2200 single-channel scaler system.

7.10 Ludlum Model 44-1 beta scintillation probe.

7.11 Personal computer with compatible printer.

7.12 Plastic bags sufficient to contain bone and tissue samples.

8 REAGENTS AND MATERIALS

8.1 None used at the TWRA checking station.

9 HAZARDS

9.1 The NaI(Tl) detectors used in this document operate under high voltage. The high voltage sources are part of the computer's system unit and cannot be accessed unless the cover to the system unit is removed. The computer must be powered down if the cover is to be removed.

9.2 The beta scintillation probe used in this document operates under high voltage. The high voltage source is part of the single channel scaler system and cannot be accessed unless the cover to the scaler system is removed. Set the high voltage to 0 when connecting or disconnecting the detector probe.

9.3 Due to their weight, doors to the gamma spectrometry shields must be operated with care to avoid injury to the operator's fingers.

10 SAMPLING, TEST SPECIMENS, AND TEST UNITS

10.1 The amount of muscle tissue samples collected from each deer shall be sufficient to fill a 1 1/4" x 3" plastic vial (at least 50g).

10.2 A leg bone sample of approximately 3 to 4 inches long shall be collected from each animal.

10.3 Deer muscle and bone samples are kept in the freezer at the checking station until the CAS or a designated alternate gives permission for their release.

10.4 Retained deer and released samples are turned over to LWS personnel for disposal.

11 PREPARATION OF APPARATUS

11.1 Prior to the first scheduled hunt for each year, verify that all necessary equipment is located at or has been moved to the checking station location from ORNL.

12 CALIBRATION AND STANDARDIZATION

12.1 The checking station gamma spectrometry system is energy calibrated using a ^{60}Co and a ^{137}Cs source as necessary depending on the performance of the ^{137}Cs QC standard. The CAS is contacted if a QC result is outside +/- 25% of standardized value.

12.2 The checking station beta counting system is calibrated using a NIST (National Institute of Standards and Technology) traceable ^{90}Sr source positioned in contact with the detector. The acceptable range for ^{90}Sr efficiency is 35% to 45%. The CAS is contacted if the efficiency is outside the acceptable range.

13 ENVIRONMENTAL CONDITIONS

The gamma counting equipment used at the checking station is sensitive to drastic temperature changes and must be housed in the "office" area at the deer hunt checking station.

14 PROCEDURE

14.1 Checking Table Operations (at the deer hunt checking station)

14.1.1 Set up a table at the checking station where hunter and animal information is to be acquired.

14.1.2 Place on the checking table S-16 and TWRA maps.

14.1.3 A platform weighing scale for weighing the deer is provided by the EPWS and placed close to the checking table for convenience.

14.1.4 EPWS or support personnel shall retrieve the tissue sample. Prepare the soft tissue for counting by cutting sufficient tissue to fill the plastic vial. Weigh the sample on a balance that has been zeroed using an empty vial to obtain the net weight of soft tissue to be counted.

14.1.5 A TWRA officer shall interview the hunter to determine the kill location. The hunter's permit card shall be retrieved by support personnel and completed with the following information:

a. Animal's sex
b. Animal's age
c. Animal's weight
d. TWRA compartment number
e. S-16 grid
f. Number of antler points (0 for a doe)
g. Weight of muscle sample

This information is also entered into a successful hunters database at the time of sample collection before the samples are given to the CAS for counting.

14.1.6 A label containing the deer number, the hunter's permit number, hunter's name and weight of muscle sample shall be attached to the sample vial.

14.1.7 EPWS or support personnel shall remove a leg bone sample from the animal.

14.1.8 Create a label containing the deer number, hunter's permit number and hunter's name. Place the bone sample along with the label in a plastic bag.

14.2 Gamma Spectrometry Performed at the Deer Hunt Checking Station

NOTE: Words in **Bold** print are software inputs or menu commands.

14.2.1 Power Up

14.2.1.1 Plug in power supply located on wall above Shield 1

14.2.1.2 Turn on the gamma spec computer and the database computer

14.2.1.3 Log in to windows (UCAMS UID and PWD).

14.2.1.4 Verify the gamma spec computer and database computer are communicating across the network

14.2.1.5 On the gamma spec computer, open Gamma Acquisition and Analysis Program and execute the following menu Commands: **File / Open DataSource / Detector / Select Detector**(Det01/Det02)

14.2.1.6 Next execute the following menu commands: **MCA / Adjust / HVPS / On / Exit**

14.2.2 Energy Calibration - Det01/Det02

14.2.2.1 Place the Co-60 point source on the shoulder of Det01/Det02 and the energy calibration QC in the well.

14.2.2.2 Start count, counting for ~30-60 seconds then execute the following menu commands: **Calibrate / Energy Full / By Certificate File** (using current certificate file) / **Auto** (Verify all energies are located) / **OK**

14.2.2.3 Stop the Count and execute the following menu commands: **File / Save**

14.2.3 Efficiency Check – Det01/Det02

14.2.3.1 Place the Efficiency Check QC in the well of Det01/Det02 and execute the following menu commands: **Analyze / Execute Sequence / 5-Minute Count**

14.2.3.2 Enter appropriate Sample Information then click **OK**

14.2.3.3 Enter a File Name to save the Spectrum by. Example: **D**YYMMDD-**GEOM**QC where **D** represents Detector Number and **GEOM** represents the geometry of the QC (WELL/WBODY) / **OK**

14.2.3.4 When the count has completed execute the following menu commands: **Analyze / Execute Sequence / Det01/Det02 - Analyze Sample in Well / Choose the FILE option / Enter a Filename**(Replace the * in the filename field with the QC filename used in step 4.3.4) / **OK**

14.2.3.5 To view/print the results using the database computer, use Wordpad and open (all documents) the report file for the QC from the gamma spec computer in C:\GENIE2K\REPFILES.

14.2.3.6 If the QC result is acceptable save and close the QC spectrum.

14.2.4 Sample counting Det01/Det02

14.2.4.1 Place the sample vial in the well of Det01/Det02.

14.2.4.2 At the gamma spec computer execute the following menu commands: **Analyze / Execute Sequence / 5-Minute Count**

14.2.4.3 Enter appropriate sample information then click **OK**

14.2.4.4 Enter the Deer number for the filename then click **OK**

14.2.4.5 Once the 5 minute count is complete execute the following menu commands: **Analyze / Execute Sequence / Det01/Det02 – Analyze Sample In Well / Choose the FILE option / Enter the Filename** (Replace the * in the filename field with the same deer number used in step 14.2.4.4) / **OK.**

14.2.4.6 Once the analysis is complete save and close the sample spectrum file.

14.2.5 Shut down Det01/Det02

14.2.5.1 Execute the following menu commands: **MCA / Adjust / HVPS / Off / Exit / Save / Close** (Repeat this step for both detectors)

14.2.5.2 It is now safe to close the Gamma Acquisition and Analysis program.

14.2.5.3 Unplug power supply on the wall above shield 1.

14.2.5.4 Shut down the computers if needed.

14.3 Bone Screening Performed at the Deer Hunt Checking Station

NOTE: The equipment for the bone screen consists of a Ludlum Model 2200 single-channel scaler system with a beta scintillation probe, Model 44-1.

14.3.1 All beta detector set-up parameters are recorded in the hunt database workbook maintained in Excel by the RMAL. The acceptable count range for the ^{90}Sr standard is stored on the worksheet for each day of the hunt.

14.3.2 Adjust the threshold setting on the discriminator to a position just above the noise

level of the phototube (HV ~ 2.5 on potentiometer, window set to OFF, time set to 2.0 minutes). The detector efficiency is set to 30-40% using the high voltage to adjust the count rate. This adjustment is made using a ^{90}Sr source (NIST traceable) to produce several hundred counts per minute. By proper adjustment, the system will operate with the necessary sensitivity while yielding an ambient background count rate of 25-45 counts for the preset 2 minute time period. Record 3 – 5 background counts in the "Instrument Cal" worksheet, record 4 counts of the ^{90}Sr standard in the worksheet and record 3-5 counts of the ^{90}Sr check source in the worksheet.

NOTE: The bone is kept in the plastic bag during the measurement and the sample positioned with the largest surface possible at the surface of the thin-window probe. To prevent contamination, the probe is covered with a thin plastic bag.

14.3.3 Count the sample for two minutes. Compare the count rate of the bone sample with the most recent background determination (background measurements are performed continuously during the day).

14.3.4 If the net observed counts of the bone sample is equal to or greater than 1.5 times the background count, contact the CAS for further instructions. If the deer proves to be contaminated, the CAS will notify the TWRA officer at the checking table to retain the deer and the officer will inform the hunter of the situation.

14.3.5 A deer that does not meet the release criteria shall be retained and placed in a container for disposal after the deer hunt season.

14.3.6 Record the beta count on the hunter's permit card, circling the recorded count if the deer is to be retained.

14.3.7 Once all counts are completed for a deer and the data has been recorded in the database, the deer is released if it has met the release criteria specified above.

14.3.9 Bone screening personnel or support personnel are responsible for updating a hunt map using the grid location of the deer being checked.

14.4 **Database Operations Performed at the Deer Hunt Checking Station**

NOTE: Database data entry may be initiated while counting each of two samples on the gamma ray spectrometers. The entries for start-up of the program at the beginning of each hunt day are menu-driven, meaning that the operator needs only to fill in outlined fields during the addition of each hunter's information.

14.4.1 Using the hunter's permit provided by support personnel working the checking

station table, enter the information relevant to the hunter; i.e., name, address, city, state, and zip code.

14.4.2 Enter the following information for each animal: sex, age, weight (field dressed), TWRA compartment number, S-16 map coordinates, number of antler points (0 for a doe), weight of the tissue sample, and net beta counts into the database.

14.4.3 If the measured ^{137}Cs exceeds 5 pCi/g, notify the CAS that a count has exceeded the release limits.

14.4.4 For all values less than 5 pCi/g, the animal is released to the hunter after verification that the screening for beta radiation in the bone is within guidelines.

14.4.5 At the conclusion of each hunt day, generate a summary report file in which the current database is merged with all the previous days' information. From this file, an alphabetical listing of all data necessary for dose assessment is generated.

14.4.6 Provide the summary report to the CAS, LSS and TWRA personnel.

14.5 **Systems Shutdown at Close of Deer Hunt Checking Station**

14.5.1 Follow instruction for shutdown of the gamma detectors as outlined in section 14.2.5.

14.5.2 Store the soft tissue and bone samples in the freezers at the checking station.

14.5.3 Store the maps, checking table, and weighing scale in the storage areas at the checking station.

15 APPLICABLE STANDARDS AND REFERENCES

15.1 DOE O 458.1 (4.b.1.a), "Radiation Protection of the Public and the Environment" Chg 2, US DOE, June 6, 2011.

15.2 Dose Assessment Calculations Memo from Pat Scofield, Health and Safety Research Division, Oak Ridge National Laboratory, Martin Marietta Energy Systems, to N. A. Teasley, Jr, December 15, 1994.

15.3 "Oak Ridge Reservation Wildlife Management", Research Safety Summary Report 2440, current revision.

15.4 "Chemical Hygiene Plan", Oak Ridge National Laboratory, current revision.

15.5 "Radiation Protection Management System, Oak Ridge National Laboratory.

15.6 "Radiochemical Analysis Group Quality Assurance Plan", QAP-X-96-CSD/RML-001, current revision.

16 CALCULATIONS/INTERPRETATION OF RESULTS

16.1 Beta results are interpreted as counts above background and are checked against a set limit of 1.5 times the current background.

16.2 Gamma results are calculated by the software program using an accepted method. These calculations are verified to be correct.

17 REPORTS AND REQUIRED RECORDS

17.1 At the conclusion of each hunt day, a summary report file is generated in which the current database is merged with all the previous days' information. From this file, an alphabetical listing of all data necessary for dose assessment is generated. The summary report is provided to the CAS, LSS and TWRA personnel.

17.2 The results of the laboratory radiochemical analysis of bone samples, gamma scan of muscle samples, strontium analysis of muscle samples, and iodine analysis of deer thyroids are reported to the CAS and ESD.

17.3 The CAS provides both the field and laboratory radiochemical analysis data for the deer hunt to the ESD for inclusion in the ORNL Annual Environmental Report.

18 PRECISION AND BIAS

18.1 The overall precision of the gamma spectrometry method used at the checking station is approximately $\pm$10%, based on values obtained by measuring radiological standard samples. No significant bias is shown from calculations of efficiency during standard counting.

18.2 The overall precision of the bone screening method used at the checking station is approximately $\pm$20%. There is a low bias based on bone thickness and location of ^{90}Sr in the bone (since location of ^{90}Sr in the bone is based on the age of the deer and the elapsed time since ingestion of the radionuclide by the deer).

19 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

19.1 Quality Control for the NaI(Tl) well detectors are performed using NIST traceable ^{137}Cs sources (refer to step 12.1 for acceptance range). The QC data is kept in the deer hunt folder.

20 ADMINISTRATION

Interpretation and administration of this procedure is the responsibility of the CAS. The effective date is the date of issue.