Title: **DEER HUNT RADIATION MONITORING GUIDELINES**

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FILENAME:AMRA01.SAM

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). This document replaces CASD-AM-RML-RA01, Revision 0.

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 for the hunts (CAS). 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. If possible, the thyroid glands are removed from retained deer and analyzed for iodine isotopes in the laboratory.

Tasks are performed by personnel from the Chemical and Analytical Sciences Division (CASD) and the Office Of Environmental Compliance and Documentation (OECD) of Oak Ridge National Laboratory (ORNL), Tennessee Wildlife Resources Agency (TWRA) officers, and support personnel.

Approval:_____ Concurrence: _____
Division Director Date Group Leader Date

Reviewed by:_____ Reviewed by: _____
Technical Reviewer Date Technical Reviewer Date

Concurrence:_____ Concurrence:_____
QA Specialist Date Manager ESH&Q 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 Proportional Counter: A radiation detector that measures ionizing radiation (alpha/beta particles) by counting the number of particles emitted into a gas filled container.

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

3.4 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 and meet the criteria of this document are released to the hunter. All critical radiological measurements are performed by personnel from CASD who have experience in performing such measurements under strict Quality Assurance (QA) procedures or by support personnel under the supervision of CASD 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. Such a technique was devised for the deer hunts. It consists of a customized and compiled version of Microsoft® FoxPro® for Windows™.

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 since it is difficult to recall an animal after it has been removed from the area.

A van is provided by CASD for use during the hunting days. The main purpose of this vehicle is to provide an operational base for the equipment and supplies necessary to conduct the surveys. The van is positioned near the "office" area of the checking station.

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 are 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 consists of radiochemical analysis of bone and tissue, as well as iodine isotope analysis of the thyroids from retained deer.

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 liver is chosen to be representative of soft-tissue (if unavailable a muscle sample is taken). If the liver 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 that consistently reads 1.5 (~20 pCi/g) times the background level (net counts) results in retention of the deer. This document meets the requirements for review and compliance with the Cooperative Agreement between the Department of Energy (DOE) and TWRA for the managed deer hunts (reference 15.3).

5 RESPONSIBILITIES

5.1 CASD Radioactive Material Analysis 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 Supervising/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 a report of hunt results at the end of each hunt day and submission of the report to 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 Storing the liver or muscle and bone samples in the freezer at the checking station.

5.1.10 Transfer of retained deer to Waste Management personnel for disposal.

5.2 TWRA personnel are responsible for the following:

5.2.1 Operation of the deer hunt checking station.

5.2.2 Obtaining deer tissue and bone samples.

5.4 Support personnel are responsible for the following:

5.4.1 Assisting with operations at the checking station.

5.4.2 Assisting TWRA personnel in obtaining deer tissue and bone samples.

5.4.3 Performing beta counting of bone samples under supervision of CASD staff.

5.4.4 Updating the hunt map with the grid location of the deer being checked.

5.5 Waste Management personnel are responsible for disposal of retained deer.

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

5.6.1 Setup and calibration of the gamma spectrometry system at the checking station.

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

5.6.3 Providing the ORNL Office of Environmental Compliance and Documentation with field and laboratory radiochemical analysis results.

6 INTERFERENCES

6.1 Interferences associated with laboratory radiochemical analysis of bone samples are as follows:

6.1.1 Color quenching of the light can occur in the measurement of $^{90}Sr/^{90}Y$ by Cerenkov counting if a sample contains any colored materials. Samples should be colorless or as clear as possible to ensure adequate counting efficiency. Any color which can be removed should be removed prior to analysis. Iron (III), for example, can be reduced by the addition of NH_2OH-HCl. Moderate quenching can be compensated for by spiking the sample with a known amount of ^{90}Y after the initial count is performed and recounting the sample to determine the efficiency. Colorless materials will not interfere with the method.

6.1.2 Isotopes other than ^{90}Y that emit beta radiation (beta max >0.6 meV) can interfere with the method if they are present in high concentrations.

6.1.3 Photoluminescence and chemiluminescence can also interfere with Cerenkov

counting. The former occurs when delayed light is emitted from the sample due to excitation by sunlight or fluorescent lights. The latter is caused by chemical reactions in the sample. These interferences are rare in Cerenkov counting, but can usually be mitigated by leaving the sample in the dark for a period of time prior to counting the sample (usually one hour is sufficient to remove the interference).

6.2 Interferences associated with gamma scans of liver and/or muscle samples.

6.2.1 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.

6.3 Interferences associated with strontium analysis of liver and/or muscle samples.

6.3.1 Radioactive barium will be carried down with radioactive strontium as carbonate. The methods include steps to separate strontium from barium.

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 TWRA).

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

7.5 Adhesive labels for plastic vials.

7.6 Target TMCA2 multichannel analyzing system, consisting of a comprehensive software package and plug-in card.

7.7 Sodium iodine (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 Northgate 80386 personal computer (or equivalent).

7.12 Hewlett Packard LaserJet graphics printer.

7.13 Tennelec LB4000 proportional counter (low-background beta counter).

7.14 Packard Liquid Scintillation Analyzer Model TR2750.

7.15 Canberra Nuclear Genie-ESP data acquisition and processing system with HPGe detectors.

7.16 Thermolyne Type 6000 medium muffle furnace with a 16 segment controller and 860 cubic inch heating chamber.

8 REAGENTS AND MATERIALS

8.1 Nitric acid, concentrated.

8.2 Nitric acid, 8 *M*, Add 500 mL of concentrated HNO_3 to 500 mL of water and dilute to 1 liter.

8.3 Hydrochloric acid, 4 *M*: Add 250 mL of concentrated HCl to 500 mL of water and dilute to 1 liter.

8.4 Hydrogen peroxide, 30% H_2O_2 solution.

8.5 Kitchen variety plastic wrap.

9 HAZARDS

9.1 Strong acids and bases must be handled with care in the laboratory. A Material Safety Data Sheet (MSDS) database is available in the laboratory for chemicals used at ORNL.

9.2 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.

9.3 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.

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

9.5 Lopping shears used to remove bone samples and the knives used to obtain liver/muscle samples must be used with care.

9.6 All rules for general laboratory safety as presented in reference 15.4 shall be observed for radiochemical analyses performed in the laboratory.

10 SAMPLING, TEST SPECIMENS, AND TEST UNITS

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

10.2 If possible, thyroids glands from each retained deer shall be collected.

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

10.4 Deer liver and/or 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.

10.5 Retained deer are turned over to Waste Management personnel for disposal.

11 PREPARATION OF APPARATUS

11.1 Prior to the first scheduled hunt for each year, all necessary equipment is moved to the checking station location from ORNL. The NaI(Tl) well detectors have to be installed in the shields and detector cabling connected under the direct supervision of the CAS or a designated alternate.

11.2 Equipment used for validation of field results and chemical separations is maintained at ORNL and used on a daily basis. No special preparation is needed.

12 CALIBRATION AND STANDARDIZATION

12.1 The checking station gamma spectrometry system is energy calibrated using a ^{60}Co source at the beginning of each hunting day. ^{137}Cs efficiency, ^{137}Cs/^{40}K ratio, and background checks are performed for each detector using NIST traceable standards (see steps 14.2.2 to 14.2.6) under the supervision of the CAS. The acceptable range for ^{137}Cs efficiency is 37% to 42%, and the ^{137}Cs/^{40}K ratio should fall between 0.25 and 0.32. The CAS is contacted if an efficiency, or ratio is outside the acceptable range.

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.

12.3 The Packard TR2750 is calibrated for beta counting efficiency by a senior staff member in the RMAL. The counting efficiency for Cerenkov radiation is determined with each batch of samples and should not be below 49%. Any deviations from normal levels (55-65%) are immediately brought to the attention of the CAS.

12.4 The gamma spectrometry systems in the RMAL counting laboratory are calibrated as specified in reference 15.5. The detection limit for ^{137}Cs should be 0.1 pCi/g or lower.

12.5 Counting efficiencies for Total-Rad-Sr shall be determined according to the method specified in reference 15.6. The required detection limit for ^{90}Sr should be 0.1 pCi/g or lower.

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 TWRA and placed close to the checking table for convenience.

14.1.4 TWRA or support personnel shall retrieve the liver sample. Prepare the soft tissue for counting by cutting sufficient tissue to fill a 1 1/4" x 3" 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. Type of soft tissue
h. Weight of soft tissue

14.1.6 A label containing the deer number, the hunter's permit number, hunter's name, type of soft tissue (liver or muscle) and weight of soft tissue shall be attached to the sample vial.

14.1.7 TWRA or support personnel shall remove a foreleg 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. Ensure that the bone does not touch the label.

14.2 **Gamma Spectrometry Performed at the Deer Hunt Checking Station**

NOTE: The counting equipment is supplied by CASD and installed at the checking station prior to the first hunt. Steps 14.2.1 to 14.2.6 shall be performed at the beginning of each counting day prior to performing any gamma spectrometry measurements.

14.2.1 Switch on the computer used with the NaI(Tl) well-counters. Enter "TWRA" to access the Target Multi Channel Analyzer (see reference 15.8) program dedicated for the deer hunt. The program will automatically set up regions of interest (ROI) for the ^{137}Cs, ^{40}K and total spectrum areas.

14.2.2 Perform a ^{60}Co energy calibration as instructed by the computer program after pressing CALIB for each detector.

14.2.3 Place a ^{137}Cs calibration standard in one of the detector wells. Perform a 5 minute count (preset by software) and determine the number of counts in the ^{137}Cs ROI. Repeat this for the other detector.

14.2.4 Place a ^{40}K calibration standard in one of the detector wells. Perform a 5 minute count (preset by software) and determine the number of counts in both the ^{137}Cs and ^{40}K ROI. Repeat this for the other detector.

14.2.5 Perform a 5 minute background count and determine the number of background counts for each of the ROI's.

14.2.6 Use the program DEEREFF.EXE on the database computer to calculate the acceptable count range for the ^{90}Sr standard used for the bone check, the ^{137}Cs efficiency, ^{137}Cs/^{40}K ratio, and background counts/second for ^{137}Cs, ^{40}K, and the total spectrum. The acceptable range for ^{137}Cs efficiency is 37% to 42%, while the ^{137}Cs/^{40}K ratio must fall between 0.26 and 0.35. Contact the CAS if either of the acceptable ranges are not met.

14.2.7 Count the weighed liver/muscle sample for a 300-sec. preset live time (two samples may be counted simultaneously) by placing a sample in each of the counting chambers. The file extension must be set to the deer number by pressing the F5 key then entering the number of the deer to be counted (prior to starting the first deer count of the day). This number automatically increments after each count and may be checked by observing the file identification displayed at the bottom of each spectrum.

NOTE: The gamma spectrum files are automatically archived using the filename format **?DDMMYY.XXX**, where:

? is A or B for detector A or B,
DDMMYY is the date, i.e., 05/02/93, and
XXX is the deer number, i.e., 001, 002, ... XXX.

The ROI data is automatically archived using the filename format **?DDMMYYR .XXX**, where:

? is A or B for detector A or B,
DDMMYY is the date, and
XXX is the deer number.

14.2.8 Record the three ROI determinations on the hunter's permit card.

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 bound notebook located at the bone checking location. The acceptable count range for the ^{90}Sr standard is stored in the DEER folder for the year after it is calculated using the DEEREFF program on the database computer.

14.3.2 Adjust the threshold setting on the discriminator to a position just above the noise level of the phototube (HV ~ 2.1 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 counts of the ^{90}Sr standard in the notebook. Likewise, record 3-5 counts of the background in the notebook.

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 sheet (kitchen variety plastic wrap).

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 count rate 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 current hunt.

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 Take the hunter's permit to the database operator in the checking station for entry into the dBase program.

14.3.8 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 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 spectrometer. The entries for start-up of the program at the beginning of each hunt day are menu-driven, meaning that the operator need only to fill in outlined fields during the addition of each hunter's information.

14.4.1 Start the deer hunt database by entering "HPDEER". This command sets up the program to write to a Hewlett Packard LaserJet printer.

14.4.2 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.

14.4.3 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), type of soft tissue (liver or muscle), weight of the tissue sample, and

net beta count (provided by support personnel working the bone screening counter) into the database.

14.4.4 Record the ROI information from the gamma scan on the hunter's permit and enter into the database. The ROI data are total count in spectrum and counts from the ^{137}Cs, and ^{40}K regions of interest.

NOTE: The final ROI entry is a signal for the program to calculate the ^{137}Cs concentration in units of pCi/g. In the event that measured ^{137}Cs exceeds 5 pCi/g, the final result window will flash, alerting the operator.

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

NOTE: **If a deer is retained for any reason, two # signs must be placed in the last two positions of the hunter's name field.**

14.4.6 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.

14.4.7 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 on the graphics printer.

14.4.8 Provide the summary report to the CAS and TWRA personnel.

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

14.5.1 Before exiting from the TWRA program (at any time during, before, or after the hunt), shutdown the high voltage to the detectors. Use the function keys to select the options for detector, setup, and high voltage. Enter 0 for the high voltage for each detector. After this is done, end the program by selecting "Quit".

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

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

14.6 **Laboratory Analysis for Gross Alpha and Cerenkov Beta in Bone from Deer**

14.6.1 For each retained deer, remove the thyroids and obtain a muscle sample and place all samples in a bag labeled with the deer number. Also, randomly select 10 to 20 bone and tissue samples from deer that were not retained and combine with retained deer samples for analyses as described in this and the following two sections (14.7 and 14.8).

14.6.2 Perform steps 14.6.3 to 14.6.12 for each bone sample selected in step 14.6.1.

14.6.3 Place ~1g (weighed) of the bone sample in a properly sized beaker.

14.6.4 Place the beaker containing the sample in the programmable muffle furnace and ignite the sample. The furnace is programmed to ramp in 100°C increments to 525°C and maintain that temperature for a 16 hour period.

14.6.5 Transfer the ashed sample to a 500 mL tall-form beaker. Add enough 4 *M* HCl to just moisten the sample and take to dryness on a hot plate.

14.6.6 Add enough concentrated HNO_3 to thoroughly wet the sample and take to dryness.

14.6.7 Repeat step 14.6.6 until the sample has the consistency of a heavy syrup.

14.6.8 Dissolve the residue in a minimum of 4 *M* HCl with heat.

14.6.9 Remove any undissolved material by filtering through #541 filter paper into a liquid scintillation counter (LSC) vial and dilute to 15 mL with water. No scintillation fluid is needed.

14.6.10 Perform a Cerenkov count in the TR2500 scintillation system for 30 minutes (see reference 15.9).

14.6.11 After the Cerenkov count, take a 1 mL aliquot and count for gross alpha activity using the Tennelec LB4000 proportional counter (see reference 15.10).

14.6.12 Compare the Cerenkov results with the field results. Report the results for the Cerenkov and gross alpha counts to the CAS.

NOTE: The gross alpha count is performed as a check for alpha emitting radionuclides. The gross alpha results are kept by the CAS.

14.7 **Laboratory Determination of Gamma Emitting Radionuclides in Liver and/or Muscle Samples from Deer**

14.7.1 Perform steps 14.7.2 to 14.7.4 for each tissue sample selected in step 14.6.1.

14.7.2 Cut a piece of liver and/or muscle of approximately 50g each. Place the liver or muscle in a petri dish and obtain the wet weight.

14.7.3 Perform a gamma scan of the tissue samples according to the method described in reference 15.5.

14.7.4 Compare the gamma scan results with the results obtained in the field. Report the results to the CAS.

14.8 **Laboratory Determination of Total Strontium in Liver and/or Muscle Samples from Deer**

14.8.1 Perform steps 14.8.2 to 14.8.15 for each tissue sample selected in step 14.6.1.

14.8.2 Obtain a ~10g (weighed) sample of the liver and/or muscle (from retained deer) and place in an properly-sized beaker.

14.8.3 Place the beaker and sample in a muffle furnace. Dry the sample at 100°C.

14.8.4 Carbonize the sample by allowing it to remain at 210°C for 8 hours.

14.8.5 Initiate the preset program to step the muffle furnace through 100°C increments until the temperature reaches 525°C.

14.8.6 Transfer the ashed sample to a 250 mL glass beaker.

14.8.7 Add 25 mL of concentrated HNO_3. Then add H_2O_2 dropwise until heavy reaction ceases.

14.8.8 Place the sample on a hot plate and take to dryness.

14.8.9 Take up the residue in 15 mL of 8 *M* HNO_3, then add H_20_2 dropwise until reaction ceases.

14.8.10 Take to near dryness and transfer to a 50 mL tube using 8 *M* HNO_3.

NOTE: There are two procedures for total Sr analysis that may be performed. either may be used.

14.8.11 Add 1.00 mL of the standardized strontium carrier if using the reference 15.6 procedure or 0.5 mL of the standardized strontium carrier for the reference 15.12 procedure. See reference 15.6 for standardization of strontium carrier.

14.8.12 Follow the instructions in reference 15.6 to precipitate Sr as insoluble carbonate. If reference 15.12 is used, after Sr is stripped from the columns, precipitate as a carbonate, wash the precipitate and transfer to tared planchets.

14.8.13 Cool, weigh, and count the sample (within 2 hours) in the Tennelec LB4000 proportional counter (see reference 15.10).

14.8.14 Calculate the activity of ^{90}Sr (use equation in section 16.1) and report the results to the CAS.

14.9 Laboratory Determination of Iodine Isotopes (^{131}I & ^{129}I) in Thyroids from Retained Deer

14.9.1 Remove both thyroids from the retained deer.

14.9.2 Place one of the thyroids in a petri dish, weigh, and perform a gamma ray spectrometric analysis according to the method described in reference 15.5. A detector sensitive to the low energy gamma energies should be used for this analysis. Report the results in pCi/g of any detected gamma emitters to the CAS (principally ^{131}I and/or ^{129}I).

15 APPLICABLE STANDARDS AND REFERENCES

15.1 DOE Order 5400.5, "Radiation Protection of the Public and the Environment", US DOE, June 5, 1990.

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 (see attachment).

15.3 "Wildlife Management Program", Martin Marietta Energy Systems Standard ESS-EP-124, current revision.

15.4 "Chemical Hygiene Plan", Chemical and Analytical Sciences Division, Oak Ridge National Laboratory, current revision.

15.5 EPA Method 901.1, "Gamma Emitting Radionuclides in Drinking Water", U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA 600-4-80-032, August 1980.

15.6 EPA Method 905.0, "Radioactive Strontium in Drinking Water", U.S. Environmental Protection Agency, Cincinnati, Ohio, EPA 600-4-80-032, August 1980.

15.7 "Radiation Contamination Control", RP-2.5, ORNL Health Physics Manual, current revision.

15.8 Target TMCA2 Reference Manual, Target Systemelectronic, Frankfurt, Germany, 1992

15.9 Operation Manual for Packard Liquid Scintillation Analyzer Models 2500TR, 2550TR, 2550TRLL, 2560TR/XL, Canberra Industries, Inc., 800 Research Parkway, Meriden, Connecticut 06450, 1992.

15.10 "Operation and Calibration of the Tennelec LB4000 Proportional Counter", CASD-AM-RML-RA02, current revision.

15.11 Operation Manuals for the Canberra Nuclear Alpha AXP Genie, Canberra Industries, Inc., 800 Research Parkway, Meriden, Connecticut 06450.

15.12 "Total Radioactive Strontium in Aqueous Solutions: Extraction Chromatography Method", AC-MM-2 21807, current revision.

16 CALCULATIONS/INTERPRETATION OF RESULTS

16.1 Calculate the activity of ^{90}Sr by using the following formula:

$$^{90}\text{Sr (pCi/g)} = A \cdot B \cdot C / D \cdot V$$

where:

A = net counts per minute of purified ^{90}Sr,

B = efficiency factor for ^{90}Sr, including self-absorption correction,

C = conversion factor from dpm to pCi (0.451 pCi/dpm)

D = fraction of strontium carrier recovered, and

V = weight of sample, grams.

16.2 All other reportable results are calculated by the software programs using accepted methods. 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 and TWRA personnel.

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

17.3 The CAS provides both the field and laboratory radiochemical analysis data for the deer hunt to the Office of Environmental Compliance and Documentation 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 ±5%, 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 ±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).

18.3 The overall precision of Cerenkov counts performed in the TR2750 liquid scintillation system is $\pm$5%, based on values obtained by running control samples under ideal conditions.

18.4 The precision and bias for the gamma scan of liver and/or muscle and thyroid samples is specified in reference 15.5.

18.5 The precision and bias for Total-Rad-Sr analysis is specified in reference 15.6.

19 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

19.1 Quality Control for the Tennelec LB4000 system is specified in reference 15.10.

19.2 Quality Control for the gamma spectrometry system is specified in reference 15.5.

19.3 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.

19.4 Quality Control for the Packard TR2750 liquid scintillation counting system is performed using NIST traceable ^{90}Sr standards. The liquid scintillation counting system performs its own QC automatically and internally.

20 ADMINISTRATION

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

21 ATTACHMENTS

21.1 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.