RADIATION SAFETY MANUAL
AND OPERATING INSTRUCTIONS

U. S. GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
CALIFORNIA DISTRICT

SACRAMENTO, CALIFORNIA
1983
REVISED JUNE 1986

I. GENERAL INFORMATION

The California District of the U.S. Geological Survey, Water Resources Division, owns four sealed radioactive sources: (A) one 20 millicurie Actinium 227:Beryllium neutron emitter; (B) three 125 millicurie Americium 241:Beryllium neutron emitters; and (C) one 10 millicurie Americium 241:Beryllium neutron emitter, and uses, periodically, a 10 millicurie Americium 241:Beryllium neutron emitter, owned by Inyo County Water Department, Bishop. Sources A, B, and C are used in the neutron-scattering method for soil-moisture measurements.

The radioactive materials are encapsulated in stainless steel jackets that can withstand pressures and temperatures much greater than would be expected under normal operating conditions. The source capsules are kept inside shields that reduce exposure to radiation except when radioactive sources are actually being used during operations. When not in use or in transit to field sites, radioactive sources A, B, and C (owned by the California District) will be stored in storage facilities at the U.S. Geological Survey, WRD warehouse, 1560E Juliesse, Sacramento, CA. When sources are stored and transported in vehicles, the radiation level at the surface of the shipping container in the vehicle will be 2 mrem/hr or less. This will insure that the radiation level in the passenger-occupied portion of the vehicle never exceeds 2 mrem/hr.

Additional information regarding the radioactive sources, normal operations, emergency procedures, and the radiation safety program for the California District is included in the remainder of the manual. Copies of this manual will be kept in all California District Water Resource Division offices by all personnel designated to use or supervise the use of the radioactive sources; and with shielded sources, either in permanent storage shelters or in vehicles during transport and use. Changes or updates to this manual will be provided to all designated users, with the appropriate changes highlighted or noted.

Note about radiation exposures:

It is not "dangerous" to be near any of the radioactive sources in an unshielded condition for several minutes at a time. In order for a person to evaluate how much exposure he is receiving, the following data is given: The intensity of radiation is inversely proportional to the square of the distance from the source, so that distance is as effective as shielding in reducing exposure.

Nuclear Regulatory Commission regulations limit occupationally-exposed personnel to 1,250 millirem for a 3-month period. A millirem is 1/1,000th of a rem, which is a unit of absorbed radiation dose in living matter. For the 125 millicurie Am 241:Be neutron source, the exposure-rate-distance is 40 mr/hr at 1 foot, 5 mr/hr at 3 feet, and 2 mr/hr at 6 feet. The lowest limit of detectable body damage from short-term high exposure is between 25,000 and 50,000 millirem, at which time significant damage occurs to immature white blood cells.

Unnecessary exposure should be avoided. Keep to a minimum the exposure necessary to perform soil-moisture measurement operations, particularly exposure of the neutron source to the eyes.

II. RADIATION PROGRAM MANAGEMENT AND RESPONSIBILITIES

A. Training and Experience

A prospective user who expects to be an authorized user shall have acceptable training and experience in the use of radioactive materials. Such training can consist of formal college courses or short-term specialized courses as offered by universities, industries, and government agencies. Training should include such subjects as (1) principles and practices of radiation protection, (2) radioactivity measurement and monitoring techniques, (3) calculations basic to the use and measurement of radioactivity, (4) biological effects of radioactivity, and (5) safe operation of the neutron soil-moisture probe.

B. Radiation Protection Officer (RPO)

1. The Radiation Protection Officer for the U.S. Geological Survey, Water Resources Division, California District, is overall manager for the use of radioactive material(s) by the District.

2. The duties of the Radiation Protection Officer include the delegation of authority to persons responsible for carrying out the duties such as that of Radiation Safety Officer, overall responsibility for records and surveys, and, in general, the administrative procedures for the entire radiation program. The Radiation Protection Officer is:

John M. Neil
U.S. Geological Survey
Water Resources Division
2800 Cottage Way, Room W-2235
Sacramento, California 95825
Phone: (916) 978-4648 (FTS 460-4648)

III. RADIATION SAFETY PROGRAM

A. Management Records

1. Source History Log

This log will contain the master file on each type of radioactive material received by the California District and the file maintained at the District Office, 2800 Cottage Way, Room W-2235, Sacramento, California. Some of the records contained in this file are:

a. Copy of the purchase order listing the type and strength (activity) of the materials.

b. Packing slip and receipt of delivery.

c. Radioactive source storage record (see attached form) of the time the materials are removed and returned to the permanent storage as well as the location where the source was used. The source storage record will be forwarded to the District office, for filing, when an entire form is completed.

d. Emergency procedure reports.

e. Records of disposal.

f. Receipt for shipment when the source is disposed.

This log will be retained at least five (5) years after the source is disposed.

2. Survey Files

The Survey file is four separate files that will be maintained by the Sacramento office and will contain the following:

File 1. Instrument and calibration reports and certificates.

File 2. Leak test reports.

File 3. Biannual inspections and surveys of radioactive storage areas, shields, and sealed sources.

File 4. Radioactive source storage and utilization logs.

3. Personnel Monitoring Procedures and File

a. All Personnel directly related to activity involving radioactive materials will wear a film badge to monitor gamma, neutron, and beta exposure. Film badge service will be provided by R.S. Landaur, Jr. and Co., Glenwood Science Park, Glenwood, Illinois 60425, telephone (312) 755-7000: General rules for film badges are as follows:

(1) Film packets in badge holders shall be exchanged and returned to the supplier regardless of whether they are used.

(2) Film badges shall not be subjected to extreme temperatures and humidity or be tampered with.

(3) When not in use, film badges shall be stored with control badges in places where radiation is lowest.

(4) Film badges should be worn at waist or shirt pocket level and outside all clothing.

b. Film badge monitoring will be on a monthly basis. Copies of quarterly reports will be sent to all monitored individuals upon request or when unusual levels of radiation have been reported.

c. All personnel not badged will be kept outside a zone where the exposure level of 2 mr/hr or greater exists.

B. Radiation Monitoring Instruments and Calibration

1. A radiation monitoring instrument will be used each time source A or B is used at a job site. The monitoring instrument will not be required when using source C.

2. The radiation survey instrument, a portable alpha, beta, gamma, neutron counter, will be calibrated at intervals not to exceed six (6) months, by the manufacturer, Ludlum Instruments, Inc., Post Office Box 248, Sweetwater. Texas, or a company authorized by NRC to do so.

3. Records of the instrument calibration will be maintained in the Survey file and a copy of the record will be carried with the instrument.

4. Sealed sources A and B will not be used unless a survey meter with a current calibration is available.

C. Leak Tests

1. All sealed sources will be leak tested at an interval not to exceed six (6) months. A leak test service kit will be used to make the leak tests.

   Leak tests will be performed in the following manner:

   a. The leak test kits supplied by Gulf Nuclear, Inc., include two swabs and a packet of detergent, all in individual plastic containers. Dissolve the detergent in the packet with a small amount of water. Remove swab A (the left swab) and dip it in the detergent and water mixture. Swipe all areas where personnel may handle the sealed sources, shields, or housings. Concentrate on rusty, worn or cracked areas, along seams, around vent parts, or adjacent to components which slide in or out of shields.

      Cautions: If swabbing near the sealed source itself, use a pair of tongs or long tweezers to maximize the distance between hands and source. Wear rubber gloves if you suspect any surface contamination. Do not touch the surface of the swab which came in contact with swabbed areas. Return swab A to its packet.

   b. Remove the dry swab B (right swab) and repeat the swabbing process described above. Do not dip this swab in the water and detergent mixture. Upon completion of swabbing, replace the swab in the packet from which it came, observing all cautions noted in the previous discussion.

   c. Complete the information required on the cover of the leak test service kit, place the kit(s) in an envelope and seal. Do not lick the envelope, seal with tape. Send the envelope directly to Gulf Nuclear, Inc., 202 Medical Centr Blvd., Webster, Texas 77598 (address is on the cover of test kits).

   d. A biannual source inventory may be completed at the same time as a leak test if present inventory is within six months of past inventory. However, the biannual Inventory and Survey forms must be completed in their entirety and submitted to RPO.

2. The swipe pads will be evaluated by Gulf Nuclear, Inc., Webster, Texas, and the results forwarded to the RPO.

3. A source is not to be used without proof that it has been leak tested within the last six (6) months. If a source has not been leak tested within six months, the source shield shall be tagged so as to preclude the use or transport of the source before the results of a current leak test have been evaluated. This condition must be documented and included in the Survey file no. 2.

4. A copy of leak test report will be with the sources at all times.

D. Biannual Inspection of Sources

1. A physical inventory of all sealed sources maintained by the District will be completed every six (6) months. The inventory will be conducted to account for all sources. A survey of radiation levels near the shield and shelters will also be completed at the same time. A record of the inspection and radiation survey, with pertinent information, is to be kept by the RPO.

2. Biannual inspections of sources will be conducted every six (6) months whether the sources are in active use or not.

E. Storage Facilities and Procedures

1. Permanent storage of radioactive sources will be at the following locations:

a. Sources A, B, and C (for the Troxler Model 3330) used in soil-moisture meters, will be stored at the U.S. Geological Survey, WRD warehouse, 1560E Juliesse, Sacramento, California. The sources will be kept in a locked metal shelter stored within the fenced area adjacent to the WRD warehouse. The survey meter is not required when using or transporting source C beyond the initial survey after the source is loaded into the vehicle.

b. Source C (for the Troxler Model 3220) is stored and maintained by the Inyo County Water Department, Bishop, California. Whenever the source is used by an authorized USGS person, a utilization log will be completed. The survey meter is not required when using or transporting Source C.

c. Storage shelter at the Sacramento warehouse will be posted on the entrance door at the extent of the restricted area with a sign bearing the words "CAUTION - RADIOACTIVE MATERIAL". A restricted area is any area surrounding a controlled radioactive source, shielded or unshielded, in which the penetrating radiation rates exceed two milliroentgens per hour (2mr/hr). Any personnel entering a restricted area will wear a film badge. A calibrated and operating radiation survey meter will also be utilized whenever personnel are operating within a restricted area.

2. Shields

a. Sealed sources A and B--fast neutron sources-- are stored in a Nuclear-Chicago lead and paraffin shield designed for that purpose (figure 2). The P-19 probe, containing the sealed source, will remain within the shield at all times except when lowered into either a storage tube or an access tube for measuring soil moisture.

b. Each shield will bear a tag with the identification and quantity of the radioactive material and the date the material was that particular quantity. The tag will also state "CAUTION-RADIOACTIVE MATERIAL".

F. Training of Personnel

1. Persons who will directly supervise the use of materials or who have radiological safety responsibilities will be required to attend a formal school for the use and safe handling of the materials. The training will be supplied by Gulf Nuclear, Inc., of Webster, Texas, or other NRC approved programs. In addition to the classroom training, training in the safe handling and use of sealed souces will be completed under the supervision of the RPO. Training will include the actual use of sealed sources. The trainee will be instructed in the approved procedures for transferring sealed sources from shields to access tubes, or other potential problems. Complete instruction in maintenance and operation of equipment is also included as well as procedures for handling specific emergencies, i.e.--source lost down hole, automobile accidents while transporting sources, etc. Additional instruction in the use of safety and monitoring equipment, safety inspections, leak tests, site surveys, necessary form completion and NRC and DOT rule compliance will also be given. Upon completion of training to the satisfaction of the RPO, the trainee will be designated in writing by the RPO as an authorized user of licensed byproduct material. A current copy of a letter designating all authorized users and supervisors of radioactive sources in the California District will be maintained with all copies of the license.

2. Persons who will handle radioactive materials and who have no formal trining will be directly supervised by qualified personnel.

3. Records of qualifications and prior exposure to radioactive materials will be maintained in the personnel records.

IV. PROCEDURES FOR THE USE OF RADIOACTIVE SOURCES

A. Normal Operations

1. General

a. Personnel directly in charge of soil-moisture measuring operations utilizing radioactive sources are responsible for the health protection of all personnel associated with the source and the general public who may be associated at times. The above personnel must personally supervise all source handling operations, transportation, storage, and shipping according to the following regulations.

b. Personnel who have been trained in handling sealed sources shall be the only ones who perform or directly supervise operations involving the source. All other individuals shall be required to wear a radiation badge or be outside of the 2 mr zone.

2. Handling of Sources

a. Sealed sources A, B, and C--fast neutron sources (either Americium 241:Beryllium or Actinium 227:Beryllium)--are always kept inside the probe and the probe is locked in the shield when not in use. Release of the locking mechanism allows the probe to be lowered into the soil-moisture profile access tube.

b. When operations are completed, the moisture-density tool will be brought to the land surface and the sources returned to their shields, following the handling procedures described above.

3. Procedure for Measuring and Recording Radiation Level Data

a. Before removing source from storage area, note removal, time, date, and use on source storage record.

b. Before leaving storage area at the start of each job -- with the sources inside their sheilds and stored in the shipping container within the vehicle--use the survey instrument to measure the radiation level at the surface of the container. Radiation levels above 2 mrem/hr are not acceptable, and the source will have to be returned to the storage area until the packaging/shielding can be improved sufficiently so that this requirement is met.

c. Maintain a log of source use on the utilization log during all field activities.

d. Upon return to source storage area, log source in on the source storage record and note that all sources recorded to be there are in fact there.

B. Emergency Situatitions and Procedures

1. Vehicle Accident

If an accident involving a vehicle (while it is transporting sources) occurs:

a. Do not leave the area unattended.

b. Notify investigating officer that the vehicle carries radioactive material; the kind, activity (Curies), and type of shielding.

c. Notify Radiation Protection Officer.

2. Source Lost Down Hole

a. Do not leave area unattended.

b. Attempt to retrieve the probe by "fishing". If unsuccessful at fishing, dig the moisture-access tube out of the ground with hand tools, since access tubes are usually less than twenty feet below land surface.

c. Contact RPO.

70405