

SAFETY PROTOCOL: ²⁴¹AM (BE) NEUTRON PROBE

Use of ²⁴¹Am (Be) neutron probes (gauges) is contingent upon prior approval by the UNL Radiation Safety Committee (RSC). To obtain RSC approval:

- Submit an Authorization for Radioactive Material Use request for review by the UNL RSC. Contact the UNL Radiation Safety Officer (RSO) for specific instructions.
- Agree to use this safety protocol or submit an alternative and equivalent procedure that you develop to meet your unique needs.

All gauge users must be at least 18 years of age and have completed radiation safety training through EHS prior to handling or operating a gauge. **Use or transport of a gauge off university property requires approval by the UNL Radiation Safety Officer.** Contact the UNL Radiation Safety Officer (402.472.4925) for specific instructions.

Physical Data

- Half-life of Am-241 = 432 years.
- The primary radiation hazard from an AmBe source is neutrons.
- Am-241 and Be produce neutrons of approximately 4.2 MeV at a rate of approximately 2200 neutrons/second per mCi of Am-241.
- Dose rate at 1 meter = 0.017 rem/hr per Ci.

Security

- When a portable gauge is not under the control and constant surveillance of an authorized user, it must be secured from unauthorized removal with tangible barriers created by a minimum of two independent physical controls. To comply with this security requirement, the two independent physical controls must prevent both 1) unauthorized removal of the gauge; **AND** 2) unauthorized removal of case containing the gauge.
- Proper implementation of this security requirement can be confusing. Contact the Radiation Safety Office if you have any questions regarding gauge security. **In addition, it is important to note that the requirement for two independent controls applies when the gauge is transported or at a job site, if the gauge is not under the control and constant surveillance of the user (e.g., stopping during transport for lunch).**

- A gauge accountability use log must be completed each time a gauge is removed from the designated storage location. The use log must minimally contain the following information (see Appendix A for an example use log):
 - Gauge identifying information (e.g. manufacture, model and serial number).
 - Dates removed from and returned to the storage location.
 - Individual removing and returning the gauge.
 - Location of use.

Radiation Protection Procedures

1. Standard Operating Procedures
 - a. Before removing a gauge from its place of storage, ensure that the source is locked in the fully shielded position (e.g., keyed lock, padlock, mechanical control). Place the gauge in the transport case and lock the case. Verify that the transport case is marked/labeled as discussed in the transport section of this SOP and contains the necessary documents (copy of this SOP and current leak test data).
 - b. Complete gauge accountability use log as previously described.
 - c. Block and brace the gauge to prevent movement during transport and secure the gauge in or to the vehicle.
 - d. Do not transport the gauge in the passenger compartment of the vehicle. Block and brace the gauge at a location in the vehicle as far from the occupants as practical.
 - e. If the gauge is transported off university property or via public roads, follow all applicable Department of Transportation (DOT) requirements (discussed later in this safety protocol), including completion of an appropriate bill-of-lading prior to transport.
 - f. Use the gauge according to the manufacturer's instructions and recommendations.
 - g. Do not touch the unshielded source rod with your fingers, hands, or any part of your body.
 - h. Do not place hands, fingers, feet, or other body parts in the radiation field from an unshielded source.
 - i. Unless absolutely necessary, do not look under the gauge when the source rod is being lowered into the ground. If you must look under the gauge to align the source rod with the hole, follow the manufacturer's procedures to minimize radiation exposure.
 - j. Verify the integrity of the connection between the source and cable prior to use to ensure the source does not separate from the cable.



- k. After completing each measurement in which the source is unshielded, immediately return the source to the shielded position.
- l. Always maintain constant surveillance and immediate control of the gauge when it is not in storage. At job sites, do not walk away from the gauge when it is left on the ground. Take actions necessary to protect the gauge and yourself from danger of moving heavy equipment.
- m. Always keep unauthorized persons (e.g., individuals that are not trained radiation workers or members of the public) away from the gauge.
- n. Perform routine cleaning and maintenance according to the manufacturer's instructions and recommendations. **Any maintenance on the gauge involving dismantling or removal of the source holder is prohibited and must only be performed by the manufacturer of the device.**
- o. If gauges are used for measurements with the unshielded source extended more than 3 feet beneath the surface, use piping, tubing, or other casing material to line the hole from the lowest depth to up to 12 inches above the surface. If the piping, tubing, or other casing material needs to be less than 12 inches above the surface (e.g., in order to avoid interference with farm equipment in the field), cover the hole liner or take other steps to ensure that the hole is free of debris and it is unlikely that debris will re-enter the cased hole. In addition, the deepest end of the casing must be closed to ensure the gauge source would be contained in the casing if it became disconnected from the control wire.

2. Shielding Requirements

- a. The gauge is self-shielded, and under normal use does not require additional shielding.
- b. Gauges should always be stored with the source in the shielded position (i.e., source retracted). Storage locations should be selected to minimize radiation exposure to members of the public and employees.

3. Leak Testing and Physical Inventories

- a. Semi-annual leak tests and physical inventories of gauges are coordinated by the UNL Radiation Safety staff.
- b. Maintain a copy of the most current leak test data in the gauge case.

4. Bioassay Requirements

- a. There are no bioassay requirements for gauge users.

5. Dosimetry

- a. Gauge users will be issued neutron dosimetry that must be worn when using the neutron probe, including during transport. Extremity dosimetry is not required.



- b. Do not store dosimetry near the gauge.

6. Emergency Procedures

- a. If the source fails to return to the shielded position (e.g., as a result of being damaged, source becomes stuck below the surface, etc.) or if any other emergency or unusual situation arises (e.g., the gauge is struck by a moving vehicle, is in a vehicle involved in an accident, etc.):
- In the case of motor vehicle accident or injury accident, immediately notify local authorities.
 - Immediately secure the area and keep people at least 15 feet away from the gauge until the situation is assessed and radiation levels are known. However, perform first aid for injured individuals and remove them from the area only when medically safe to do so.
 - If any heavy equipment is involved, detain the equipment and operator until it is determined there is no contamination present.
 - Gauge users and other potentially contaminated individuals should not leave the scene until emergency assistance arrives.
 - Notify the persons in the order listed below of the situation:

Table 1. Emergency contact information

Name	Work	Cellular
Larry Harisis, Radiation Safety Officer	402.472.8676	531.333.1910
Syed Naeem, Assistant Radiation Safety Officer	402.472.9903	470.278.3532
UNL Police Department	402.472.2222	N/A

- Follow the directions provided by the person contacted above.
- b. As necessary, the RSO will arrange for a radiation survey to be conducted as soon as possible by a knowledgeable person using appropriate radiation detection instrumentation. To accurately assess the radiation danger, it is essential that the person performing the survey be competent in the use of the survey meter.
- c. If the situation arises, the RSO will arrange for excavation to free a source that has become lodged below the ground surface. This must be done in such a way that the source integrity is not compromised. Source excavation may be done by directly withdrawing the access tube if possible, or by excavating the area near



- the tube and removing it. Dosimetry and radiation survey equipment shall be used in order to minimize the dose to the operators.
- d. If required by Title 180, the RSO shall report the occurrence to State officials.

Waste Disposal

Surplus gauges shall be returned to the UNL Radiation Safety Office for proper disposal.

Survey Meters

A survey meter is not required for routine work with gauges.

Transportation Procedures

The quantity of radioactive material in a typical portable gauge is not sufficient to trigger DOT vehicle placard requirements. Nor is a commercial driver's license required to transport a typical neutron gauge. However, radiation safety and DOT training are required for individuals involved in the use and transport of gauges. DOT training is required every three years.

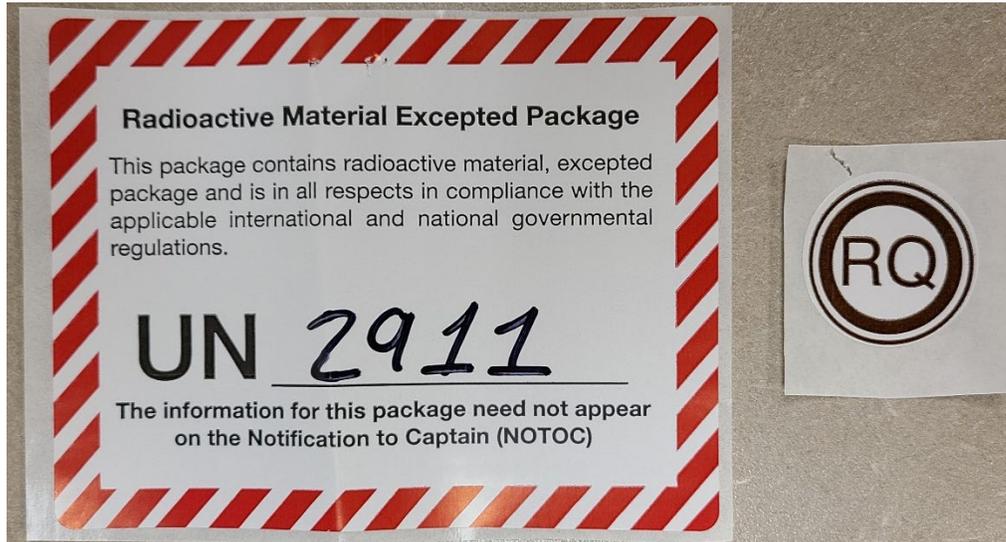
The following requirements apply to "each licensee who transports licensed material outside of the site of usage, as specified in the Department license, or where transport is on public highways." per Title 180.

1. A "special form certification" must be maintained on file. This certification is provided by the manufacturer and maintained on file by EHS.
2. Shipping papers are required whenever the gauge is transported off university property via public roads. Required shipping papers consist of a completed bill of lading, operating procedures, and emergency procedures. Bill-of-lading templates are provided in Appendices B and C of this SOP. Operating and emergency procedure requirements are met if a copy of this SOP is maintained with the gauge. Therefore, a copy of this SOP shall be included with the shipping papers.
 - a. When the driver is at the vehicle's controls, the shipping papers shall be within the immediate reach, even while restrained by the lap belt. Additionally, the shipping papers must be readily visible to a person entering the driver's compartment, or in a holder mounted to the inside of the driver's door.
 - b. When the driver is not at the vehicle's controls, the shipping papers shall either be placed in the holder mounted to the inside of the driver's door or placed on the driver's seat.
3. Gauges must be transported in the manufacturer provided case.

4. The transportation case for the **Campbell Pacific Nuclear (Models 503DR and 503 Elite)** gauges must meet the specifications for a type “A” package due to the quantity of radioactive material contained in the gauge. Transport cases provided by manufacturers meet this requirement. In addition, Type “A” testing results for the transport package must be maintained on file. This certification is provided by the manufacturer and maintained on file by EHS.
5. Inspect the markings and labels prior to transport. If markings or labels are missing or have become illegible, contact the RSO to request replacements.
6. Markings and labels on the transportation case must be durable, legible, in English, and printed on or affixed to the surface (e.g., a label, tag or sign) of the case.
7. Required markings and labels on the transportation case for the **Campbell Pacific Nuclear (Models 503DR and 503 Elite)** gauges are:
 - a. The words “USA DOT 7A Type A” and “Radioactive Material.”
 - b. The words “UN3332, Radioactive Material, Type A Package, Special Form, 7, RQ.” This is the proper shipping name.
 - c. Two DOT RADIOACTIVE YELLOW II labels (see below) affixed on opposite sides of the package. The CONTENTS is marked as “Am-241;” the ACTIVITY is marked as “1.85 GBq” and the TRANSPORT INDEX is marked as “0.2”. The transportation index is the dose rate (mrem/hr) at one meter from the gauge as typically determined by the manufacturer.



8. Required markings on the transportation cases for the **Troxler (Models 4301 and 4302)** gauges are:
- The words “UN 2911, Radioactive material, excepted package, instruments, RQ.” This is the proper shipping name.



9. If a gauge requires return to the manufacturer for repair or service, contact the RSO for assistance in preparing the gauge for shipment.



Appendix B
BILL OF LADING

for
CPN Gauge – Models No. 503DR and 503 Elite

Shipper: _____

UN3332, Radioactive Material, Type A Package, Special Form, 7, RQ, containing:

Am-241: 1.85 GBq (50 mCi)
RADIOACTIVE YELLOW II Label, TI = 0.2

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular
Larry Harisis, Radiation Safety Officer	402.472.8676	531.333.1910
Syed Naeem, Assistant Radiation Safety Officer	402.472.9903	470.278.3532
UNL Police Department	402.472.2222	N/A

This is to certify that the above-named materials are properly classified, described, packaged, marked, labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper: _____ **Date:** _____
(Signature)



Appendix C
BILL OF LADING

for
Troxler Gauge – Models No. 4301 and 4302

Shipper: _____

UN2911, Radioactive Material, excepted package, instruments, RQ, containing:

Am-241: 0.37 GBq (10 mCi)

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular
Larry Harisis, Radiation Safety Officer	402.472.8676	531.333.1910
Syed Naeem, Assistant Radiation Safety Officer	402.472.9903	470.278.3532
UNL Police Department	402.472.2222	N/A

This is to certify that the above-named materials are properly classified, described, packaged, marked, labeled and are in proper condition for transportation according to the applicable regulations of the Department of Transportation.

Shipper: _____ **Date:** _____
(Signature)