University of Nebraska Lincoln

Safe Operating Procedure

(Revised 2/10)

SAFETY PROTOCOL: ^{241}AM (BE) NEUTRON PROBE

(For assistance, please contact EHS at (402) 472-4925, or visit our web site at http://ehs.unl.edu/)

Use of ^{241}Am (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 of a gauge off of university property requires approval by the UNL Radiation Safety Officer.*** Contact the UNL Radiation Safety Officer (472-2157) for specific instructions.

Physical Data

- Half-life of Am-241 = 458 years.
- The primary radiation hazard from an AmBe source is neutrons.
- Am-241 and Be produce neutrons of approximately 4.5 MeV at a rate of approximately 2200 neutrons/second per mCi of Am-241.
- Dose rate at 1 meter = 0.06 rem/hr per Ci.

A specific type of asphalt gauge will contain a Cs-137 source in addition to the AmBe source. Physical data for the Cs-137 source is provided below.

- Half-life of Cs-137 = 30.2 years.
- Primary Emissions – Beta particles at 0.514 (max) and 1.176 (max) MeV and Gamma ray at 0.662 MeV.
- Dose rate at 1 meter = 0.33 rem/hr per Ci.

Radiation Protection Procedures

Standard Operating Procedures

- 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. ***The lock on the gauge manufacturer's case that prevents the case from being opened is not acceptable as an independent physical barrier. An***

acceptable physical barrier must stop the gauge and/or case from being removed. Examples of acceptable physical barriers include secured chains with locks or secured locked cabinets/cages

- 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).
- Sign out the gauge in a log book (that remains at the storage location) including the date(s) of use, name(s) of the authorized users who will be responsible for the gauge, and the temporary jobsite(s) where the gauge will be used. Log the gauge into the log book when it is returned to storage.
- Block and brace the gauge to prevent movement during transport and lock the gauge in or to the vehicle. Follow all applicable Department of Transportation (DOT) requirements when transporting the gauge (discussed later in this safety protocol), including completion of an appropriate bill-of-lading prior to transport.
- Use the gauge according to the manufacturer's instructions and recommendations.
- Do not touch the unshielded source rod with your fingers, hands, or any part of your body.
- Do not place hands, fingers, feet, or other body parts in the radiation field from an unshielded source.
- 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.
- Verify the integrity of the connection between the source and cable prior to use to ensure the source does not separate from the cable.
- After completing each measurement in which the source is unshielded, immediately return the source to the shielded position.
- 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.
- Always keep unauthorized persons away from the gauge.
- Perform routine cleaning and maintenance according to the manufacturer's instructions and recommendations.
- When the gauge is not in use at a temporary jobsite, place the gauge in a secured storage location implementing two levels of physical barriers. Return the gauge to its proper locked storage location at the end of the work shift.
- 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.

Emergency Procedures

If the source fails to return to the shielded position (e.g., as a result of being damaged, source becomes stuck below the surface) or if any other emergency or unusual situation arises (e.g., the gauge is struck by a moving vehicle, is dropped, is in a vehicle involved in an accident):

- 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	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

- Follow the directions provided by the person contacted above.

Additional Emergency Procedures RSO and Authorized User

- As necessary, 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.
- Arrange to have the source and access tube excavated as necessary to free the source. This should 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.
- If required by Title 180, Chapter 4 sections 004.57, 004.58, or 004.59, make reports to State officials.

Shielding Requirements
The gauge is self-shielded and under normal use, does not require additional shielding.

Surface Contamination Survey Schedule
Semi-annual leak tests of the neutron probe will be coordinated by the UNL Radiation Safety staff. Maintain a copy of the most current leak test data in the gauge case.

Bioassay Requirements
Bioassays are not required for users of neutron gauges.

Dosimetry
Neutron gauge users will be issued neutron dosimetry that must be worn when using the neutron probe. Extremity dosimetry is not required.

Waste Disposal
Surplus neutron probes shall be returned to the UNL Radiation Safety Office for proper disposal.

Survey Meters
A survey meter is not required for routine work with neutron probes.

Major DOT Regulations and 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

Per 180 NAC 13-005.01, the following requirements apply to "each licensee who transports licensed material outside of the site of usage, as specified in the Agency license, or where transport is on public highways."

- A "special form certification" must be maintained on file. This certification is provided by the manufacturer and maintained on file by EHS.
- A neutron gauge must be blocked and braced during transport and cannot be transported in the passenger compartment of the vehicle.
- Neutron gauges must be transported in a type "A" package. 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.
- Markings and labels must be durable, legible, in English, and printed on or affixed to the surface (e.g., a label, tag or sign) of the case. Required markings include the following and are referenced by specific gauge model in Table 2:
    - Shipping name (e.g., RQ, Radioactive material, special form, 7, UN3332, TYPE A package).

- Two DOT labels (e.g., RADIOACTIVE YELLOW II) on opposite sides of the package.

- Package contents (isotopes) and activity in SI and customary units.
- If Yellow II, the package's Transportation Index. The TI is the maximum dose rate in mrem/hr at one meter from the surface of the package.

- Inspect the markings and labels prior to transport. If markings or labels are missing or have become illegible, contact the RSO to request replacements.
- 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 this SOP. Operating and emergency procedures requirements are met if a copy of this SOP is maintained with the gauge. Therefore, a copy of this protocol shall be included with the shipping papers.
- If a gauge requires return to the manufacturer for repair or service, contact the RSO for assistance in preparing the gauge for shipment.

Table 2. Gauge labeling marking and labeling requirements.

Gauge Manufacturer	Model Number	Shipping Designation	Shipping Designation and Name	Isotope(s) & Activity SI (mCi)	Transportation Index
Troxler	4301	White I	RQ, Radioactive material, special form, 7, UN3332 TYPE A package	Am-241 0.37 GBq (10 mCi)	NA
Troxler	4302	Excepted	RQ, Radioactive material, excepted package-instrument or articles, 7, UN2911	Am-241 0.37 GBq (10 mCi)	NA

Table 2. Continued.

Gauge Manufacturer	Model Number	Shipping Designation	Shipping Designation and Name	Isotope(s) & Activity SI (mCi)	Transportation Index
Troxler	3440 (Asphalt)	Yellow II	RQ, Radioactive material, special form, 7, UN3332 TYPE A package	Am-241 1.48 GBq (40 mCi) Cs-137 0.296 GBq (8 mCi)	0.6
Troxler	3411B (Asphalt)	Yellow II	RQ, Radioactive material, special form, 7, UN3332 TYPE A package	Am-241 1.48 GBq (40 mCi) Cs-137 0.278 GBq (7.5 mCi)	0.1
Campbell Pacific Nuclear (CPN)	503DR	Yellow II	RQ, Radioactive material, special form, 7, UN3332 TYPE A package	Am-241 1.85 GBq (50 mCi)	0.2

BILL OF LADING
for
CPN Gauge – Model No. 503DR

Shipper: _____

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RQ, Radioactive material, special form, 7, UN3332
TYPE A package, containing:

Am-241: 1.85 GBq (50 mCi)

RADIOACTIVE YELLOW II Label, TI = 0.2

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

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

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

BILL OF LADING
for
Troxler – Model No. 3440

Shipper: _____

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_____

RQ, Radioactive material, special form, 7, UN3332
TYPE A package, containing:

Am-241: 1.48 GBq (40 mCi)

Cs-137: 0.296 GBq (8 mCi)

RADIOACTIVE YELLOW II Label, TI = 0.6

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

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

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

(Created 8/03; Revised 6/06, 7/09)

BILL OF LADING
for
Troxler – Model No. 3411B

Shipper: _____

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RQ, Radioactive material, special form, 7, UN3332
TYPE A package, containing:

Am-241: 1.48 GBq (40 mCi)

Cs-137: 0.278 GBq (7.5 mCi)

RADIOACTIVE YELLOW II Label, TI = 0.1

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

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

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

(Created 8/03; Revised 6/06, 7/09)

BILL OF LADING
for
Troxler – Model No. 4301

Shipper: _____

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RQ, Radioactive material, special form, 7, UN3332
TYPE A package, containing:

Am-241: 0.37 GBq (10 mCi)

RADIOACTIVE WHITE I Label

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

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

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

(Created 8/03; Revised 6/06, 7/09)

BILL OF LADING
for
Troxler – Model No. 4302

Shipper: _____

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RQ, Radioactive material, excepted package-instrument or articles, 7, UN2911 containing:

Am-241: 0.37 GBq (10 mCi)

EMERGENCY CONTACT INFORMATION

Name	Work	Cellular	Home
Joel Webb, RSO	402-472-2157	402-304-5333	402-465-9153
UNL Police	402-472-2222	NA	NA

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

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

(Created 8/03; Revised 6/06, 7/09)