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SOP Training 19 – Radiation Safety

You are required to review **Standard Operating Procedure (SOP) 19 Radiation Safety** because your work may involve the safe storage, transportation, and use of nuclear density gauges for projects.

Corporate safety is your internal resource for conducting hazard assessment to working safely. Please contact your radiation safety officer (Dave Albright) for assistance on identifying potential radiation hazards on your (or your project team's) job site.

After reviewing this SOP, you will be required to mark yourself complete on the LMS.

Feel free to email safety@gfnet.com to confirm you have reviewed this SOP.

Safety is in your hands!

Sincerely,

A handwritten signature in blue ink that reads "Paula Loht".

Paula Loht, CIH, CSP, Corporate Safety Manager
717 763 7211 x2846
717 884 5137
ploht@gfnet.com

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STANDARD OPERATING PROCEDURE NUMBER 19 NUCLEAR DENSITY GAUGE RADIATION SAFETY PROGRAM

19.0 PURPOSE

The purpose of the Nuclear Density Gauge Radiation Safety Program Standard Operating Procedure is to:

- Provide guidance for Nuclear Density Gauge activities conducted by Gannett Fleming, Inc., as well as its subsidiaries and affiliated companies (hereinafter the Company) that are within the scope of the operations encompassed by the Federal Nuclear Regulatory Commission (NRC) License, State Regulatory Licenses, and 29 CFR 1910.1096.
- Identify the Company procedures for the implementation of a Radiation Safety Program relative to the safe storage, transportation, and use of Nuclear Density Gauges on Company projects.

19.1 SCOPE

This program applies to all Company activities where the Company employees are involved with the storage, transport, and use of the Troxler Nuclear Density Gauges Model numbers 3411, 3450, 3430.

19.2 POLICY

- Furnish the Company employees a place of employment as free as possible from recognized hazards;
- Inform each manager, supervisor and employee of Nuclear Density Gauge Safety requirements;
- Provide information to employees on low-level radiation which they may be exposed to within the workplace and provide training on how to minimize potential hazards; and
- Comply with applicable laws, regulations, and licenses regarding nuclear density gauge operations.

19.3 DEFINITIONS

19.3.1 Radiation

Includes alpha rays, beta rays, gamma rays, X-rays, neutrons, high speed electrons, high speed protons, and other atomic particles; but does not include sound or radio waves, or visible light, or infrared or ultraviolet light.

19.3.2 Radioactive Material

Any material which emits, by spontaneous nuclear disintegration, corpuscular or electromagnetic emanations.

The Company nuclear density gauges radioactive sources are special form, encapsulated sealed sources consisting of a gamma source (cesium-137) and a neutron source (americium-241:beryllium mixture) with source activity of 8 mCi and 40 mCi respectively.

19.3.3 Restricted Area

An area where access is controlled by the employer for purposes of protection of individuals from exposure to radiation and radioactive materials.

19.3.4 Unrestricted Area

An area where access is not controlled by the employer for purposes of protection of individuals from exposure to radiation and radioactive materials.

19.3.5 Dose

The quantity of ionizing radiation absorbed, per unit of mass, by the body or by any portion of the body.

19.3.6 Rad

A measure of the dose of ionizing radiation to body tissues in terms of the energy absorbed per unit of mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue [1 millrad (mrad)=0.001 rad].

19.3.7 Rem

A measure of the dose of ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays [1 millirem (mrem)=0.001 rem]. The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions for irradiation. Each of the following is considered to be equivalent to a dose of 1 rem:

- 1 roentgen due to X-, or gamma radiation,
- 1 rad due to X-, gamma, or beta radiation,
- 0.1 rad due to neutrons or high energy protons,
- 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye.

19.3.8 Exposure Limits (Restricted Areas)

Employees shall not be permitted to receive a dose in any period of one calendar quarter in excess of the limits established below:

Body Part	Rems per Calendar Quarter
Whole body: Head and trunk; active blood-forming organs; lens of eyes; or gonads.	1 $\frac{1}{4}$
Hands and forearms; feet and ankles.	18 $\frac{3}{4}$
Skin of whole body.	7 $\frac{1}{2}$

19.4 RESPONSIBILITIES

19.4.1 Radiation Safety Officer (RSO)

Dave Albright, CSP, CIH has been designated as the company Radiation Safety Officer and will assume duties and responsibilities that include the following:

- To ensure that all *terms* and conditions of the NRC license are being met and that the information contained in the license is up-to-date.
- To ensure that the equipment has been leak tested in the required timely manner and that the leak test is performed as prescribed by the gauge manufacturer.
- To ensure that the use of the equipment is only by individuals that have received the appropriate nuclear density gauge training and have been authorized by the RSO.
- Ensure that all gauge users wear personnel monitoring dosimeter badges when using the gauge.
- To maintain the records required by the licenses and the regulations. These records shall include personnel exposure records, leak test records, training certificates for all users, and an inventory.
- To ensure that the equipment is properly secured against unauthorized removal at all times when it is not in use.
- To serve as a point of contact and give assistance in case of *emergency* and to notify the proper authorities if needed.
- To ensure that all users have read and understand the radiation safety operating and emergency procedures.

19.4.2 Employee

- Attend training and refresher training as required.
- Use, transport, and store nuclear density gauges in accordance with this program and the requirements established in the Company NRC and state licenses.
- Immediately report incidents such as damaged, lost, or stolen nuclear density gauges to Dave Albright, RSO at (717)763-7212 extension 2595 (Cell # 717-877-7104)

19.5 OPERATING PROCEDURES

19.5.1 Transportation of Equipment

- Nuclear gauges shall be transported in the cargo area of vehicles, **secured with 2 independent physical controls to prevent theft, loss or shifting during transport**. The gauge must be secured to the vehicle. It is best to use the cable and lock provided with the gauge.
- Nuclear gauges shall be transported in **LOCKED** shipping cases. **Please Note:** The US DOT requires that a tamper-evident security seal be attached to the case to provide evidence that the case has not been opened during transit. These seals are required every time a gauge is transported on a public highway. This can be accomplished by securing a plastic zip tie through the case lock hasp. Cases must have affixed legible labels that include (Examples in Appendix B):
 1. RADIOACTIVE WHITE-I (49 CFR 172.403) on two opposite sides of the package.
 2. U.S. DOT 7A Type "A".
- The following pertinent documents included in the envelope accompanying each gauge to be transported in passenger area of vehicle, must be immediately accessible to the driver during transport.
 1. Bill of Lading
 2. Certificate of Competent Authority (Special Form Source Certificate)
 3. Type A Package Certification
 4. Troxler Nuclear Gauge Emergency Response Information required for Transportation
 5. Emergency Procedures

19.5.2 Utilization Procedures (See Appendix A)

- When the gauge is in the field, the authorized user must maintain control over the gauge at all times. The gauge must never be left unattended.
- When not taking measurements, the gauge should be placed in the transportation case and returned to its permanent storage area as soon as possible. The gauge is to be used only for its intended purpose. By doing so, any radiation exposure will be as low as reasonably achievable.
- When using the equipment, the authorized or designated user will wear the personnel monitoring device that has been assigned to them. When not using the equipment, the individuals personnel monitoring device is to be stored in a designated radiation free area.

19.5.3 Maintenance and Leak Test Procedures

- Periodic maintenance includes cleaning the gauge. During maintenance, the person performing the maintenance must wear their own personnel monitoring device.
- No maintenance is to be performed that includes removing the source(s) from the gauge. For this type of maintenance, the gauge must be returned to the Troxler Service Department or other approved service agency.
- The leak test is to be performed using the Troxler Model 3880 Leak Test Kit or equivalent, according to instructions accompanying the kit. During any maintenance, the person performing the maintenance must wear his own personnel monitoring device. Gauges must be leak tested at intervals not exceeding six months.

19.6 EMERGENCY PROCEDURES

Emergency signals for nuclear gauge emergencies will consist of

- GF Fire alarm system in the office
- Air horns during field activities

In the event of physical damage to a gauge, the following steps must be taken:

- Locate the gauge and/or source.
- Do not touch or move the gauge.
- Immediately cordon off an area around the nuclear *gauge* and/or source (Restricted Area). A radius of 15 feet (5 m) will be sufficient. Do not leave the area unattended.
- *Keep* all unauthorized personnel from the nuclear gauge.
- If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.
- The gauge user should perform a visual inspection of the nuclear gauge to determine if the source housing and/or shielding has been damaged.
- Use a survey meter to measure the dose rate at a distance of one meter (3 ft) from the gauge.
- Contact the company RSO (Dave Albright 717-763-7212 extension 2595 , cell #717-877-7104). Provide the RSO with the following:
 1. Date, time, and location of the accident,
 2. Gauge model and serial number,
 3. Nature of the accident,
 4. Location and condition of the gauge and/or source,
 5. Dose rate at one meter (3 ft) from the gauge.
- If you are unable to reach the RSO, then call your regulatory agency.
- Follow the instructions of the RSO. The RSO should report the incident to the appropriate regulatory agency. The RSO may also be required to notify the USDOT of accidents during transport.

- Before shipping a damaged gauge to Troxler or other approved service agency, obtain an RGA (returned goods authorization) number from the Troxler or other approved agency RSO.

In the event that a gauge is lost or stolen, the Radiation Safety Officer listed above is to be notified immediately.

19.7 STORAGE

Nuclear Density Gauges, when not being used in the field, are stored in a designated storage area located in the Company Corporate Office at 207 Senate Ave., Camp Hill, Pa 17011 (Gannett East Bldg. Basement room 110). The storage area conforms to and is monitored by the RSO in accordance with the Company US NRC License #37-20647-02 and Pennsylvania Radioactive Materials License #PA-1137.

Access to this area is restricted to the RSO and those with appropriate training and specifically designated by the RSO. The entrance to this area is posted with the following signage:

- Yellow and Magenta “Radiation Area”
- USNRC Notice to Employees – NRC Form 3
- Gannett Fleming Notice to Employees

19.8 TRAINING AND INFORMATION

Nuclear density gauge users are not permitted to handle, use, or transport nuclear density gauges until they have completed the Nuclear Gauge Safety Training Program and US DOT Hazardous Materials Transportation training in accordance with US NRC and US DOT requirements. Training includes:

- Radiation Theory
- Radiological Safety
- Regulatory Requirements
- Transportation and Shipping
- Sample Transportation Documents
- Sample Transportation Labels
- Radiation Safety Program
- Emergency Response Procedures

Each Gauge user must complete an annual refresher provided by the RSO. Refer to Appendix A for topics covered during the refresher training.

Also, gauge users are notified on a quarterly basis of their radiation dosimetry results and cumulative dosage.

19.9 RECORDKEEPING

The RSO is responsible for maintaining all applicable records relative to the Nuclear Density Gauge Program. These records include:

- Radiation exposure data for each individual in the radiation dosimetry monitoring program. The RSO must also provide each individual with their annual dose.
- Results of measurements, analysis, and calculations for radioactive dosage for individuals and the Company storage area.
- Current Radioactive Materials Licenses.
- Employee training certificates and record of refresher training for radiation Safety and Hazardous Materials Transportation.
- Up to date copies of applicable Federal, State, and local regulations and requirements.
- Leak test reports for each Nuclear density Gauge owned by the Company. Leak tests must be performed on each gauge at intervals not to exceed six months.
- Personnel monitoring reports.
- Inventory, Receipt, and Transfer Records. A utilization log is maintained for each gauge showing the location and the individual who is in possession. The location of each gauge must be known at all times. Physical inventories are conducted by the RSO on a monthly basis.
- Transportation, shipping, and Bills of Lading.
- Daily utilization logs.
- Certificate of Competent Authority (Special Form Source Certificate) for each gauge.
- Results of Type A Package Testing.
- Emergency response sheet.
- Notice to Employees Poster.

APPENDIX A

Summary of Procedures

NUCLEAR DENSITY GAUGE USERS

A. Exposure Limits

1. Permissible Occupational Dose Limits (NRC) whole body 5000 mrem/yr
 - Declared pregnant woman - 500 mrem for entire term
 - ALARA Rule - Follow safe procedures for handling, storage and transport such that occupational exposure is As Low As Reasonably Achievable
2. Personnel Monitoring (Dosimetry Device)
 - Film Badge - monthly
 - Thermoluminescent Dosimeter (TLD) - quarterly
 - Each gauge user must have a dosimetry device - no sharing badges.
 - Dosimetry device must be worn at all times when handling or transporting a gauge.
 - Monitoring device is for measuring occupational exposure
 - DO NOT** - wear during medical x-rays
 - store with gauge
 - expose to microwaves
 - expose to excessive sunlight
 - Control Badge - measures background radiation; store in radiation free area.

B. Limiting Exposure

1. Time - Limit time you are exposed to gauge.
Limit time source rod is exposed (only for testing).
2. Distance - Maintain safe distance from gauge during testing.
Store gauge at safe distance from occupied areas.
Inverse Square Law
 - 2 x dist. = 1/4 exposure
 - 4 x dist. = 1/16 exposure
3. Shielding - Design feature of gauge

Keep source locked in safe position except as needed for testing.

C. Handling Procedures

1. Only authorized persons to use instrument. GF employees certified to use gauge.
2. Keep source in safe or stored position when not in use.
3. Wear dosimeter when using or transporting gauge.
4. Never expose yourself to bare source without justification.
5. Keep unauthorized persons 15 feet from operating area.
6. Maintain security of instrument. Keep source and case locked when not in use.
Keep storage area locked. Keep vehicle locked when transporting.
7. Follow Gannett Fleming standard operating procedure and operating manual.
8. Insure gauge has current Leak Test.
9. If you have any questions about instrument - ask.

D. Accidents and Incidents

1. Gannett Fleming Emergency Procedures

In the event of physical damage to a gauge, the following will be performed:

- a. Immediately cordon off an area around the gauge. An area radius of 15 feet will be sufficient.
- b. If a vehicle is involved, it must be stopped until the extent of contamination, if any, can be established.
- c. A visual inspection of the gauge is to be made to determine if the source housing and/or shielding has been damaged.
- d. At the earliest possible time, when the situation is under control, you must contact Dave Albright at 717-763-7212, Ext. 2595, cell # 717-877-7104. Describe the present conditions and follow the instructions of the Radiation Safety Officer.

In the event the gauge is lost or stolen, immediately notify the Radiation Safety Officer as listed above.

2. Troxler Nuclear Gauge Emergency Response Information Required for Transportation (Reference DOT P 5800.5 ERG90 and 49 CFR).

- a. Proper shipping name and hazard class:
 - Radioactive material, special form, n.o.s., UN 3332, Class 7
- b. Potential Hazards
 - Immediate Hazards to Health
 - External radiation hazard from unshielded radioactive material.
 - Low level radioactive material; little personal radiation hazard.
 - Materials in Special Form are not expected to cause contamination in accidents.
 - Some radioactive materials cannot be detected by commonly available instruments.
 - Potential internal radiation hazard from inhalation, ingestion, or breaks in skin, only if special form source capsule is breached.
 - Fire or Explosion
 - No risk of fire or explosion.
 - Radioactivity does not change flammability or other properties of the material.
- c. Emergency Action
 - Immediate Precautions
 - Isolate hazard area and deny entry.
 - Emergency response actions may be performed prior to any measurement of radiation; limit entry to shortest time possible.
 - Notify Radiation Authority of accident conditions (Dave Albright at 717-763-7212, Ext.2595, cell # 717-877-7104.
 - Detain uninjured persons, isolate equipment with suspected contamination, and delay cleanup until instruction of Radiation Authority.

-CALL TROXLER ELECTRONIC LABORATORIES AT (919) 549 9539 FOR EMERGENCY ASSISTANCE.

-Positive pressure SCBA and structural firefighters' protective clothing will provide limited protection.

- Fire
 - Do not move damaged containers; move undamaged containers out of fire zone.
 - Small fires: Dry Chemical, CO₂, water spray, or regular foam.
 - Large fires: Water spray, fog (flooding amounts).
- Spill or Leak
 - Do not touch damaged containers or exposed contents.
 - Damage to outer container may not affect primary inner container.
- First Aid
 - Use first aid treatment according to the nature of the injury.
 - Advise medical personnel that victim may be contaminated with low level radioactive material.

E. **Transportation/Shipping (In accordance with DOT regulations)**

1. Nuclear gauge to be transported in cargo area of vehicle, **secured with 2 independent physical controls to prevent theft, loss or shifting during transport**. The gauge must be secured to the vehicle. It is best to use the cable and lock provided with the gauge.
2. Nuclear gauge to be transported in **LOCKED** shipping case. **Please Note:** The US DOT now requires that a tamper-evident security seal be attached to the case to provide evidence that the case has not been opened during transit. These seals are required every time a gauge is transported on a public highway. This can be accomplished by securing a plastic zip tie through the case lock hasp.
3. Pertinent documents included in envelope accompanying gauge to be transported in passenger area of vehicle, immediately accessible to driver during transport.
4. Review of pertinent documents
 - a. Bill of Lading
 - b. Certificate of Competent Authority (Special Form Source Certificate)
 - c. Type A Package Certification
 - d. Troxler Nuclear Gauge Emergency Response Information Required for Transportation
 - e. Emergency Procedures

F. **Leak Test Procedure**

1. Required frequency - 6 month intervals
2. Test per manufacturer's procedure

G. **Gauge Operation**

Operating Procedure for Nuclear Density Gauge for Soil-Aggregate, Troxler Model 3411B

1. Turn power switch to ON/SLOW and allow unit to warm up at least 10 minutes.
2. With handle in standard or safe position and depth knob in BS position, take standard counts as follows:

- a. Place gauge on reference block
 - b. Depress and hold SHIFT
 - c. Depress STANDARD and release
 - d. Release SHIFT
 - e. When ERR disappears, depress MS and DS. Record standard counts in log book. MS and DS should be within 2% and 1%, respectively, of the average of the previous four standard counts.
3. Input Proctor Density
- a. Proctor automatically set at 124.8 pcf
 - b. Depress and hold SHIFT
 - c. Depress and release SET
 - d. Release SHIFT
 - e. While density is displayed depress and hold SET, turn moisture correction switch to + or - to increase or decrease density. When correct density is shown return moisture correction to +.
4. Measurements
- a. Turn PWR/TIME to NORM
 - b. Prepare surface with scraper plate, drive rod 2" deeper than intended test, fill voids, remove loose or dry soil.
 - c. Place gauge over hole and insert scaler to desired depth, gently pull gauge to contact hole.
 - d. Turn depth knob to test depth.
 - e. Depress MEASURE.
 - f. When ERR disappears, depress and record MC, DC, WD, DD, M, %M, depress SHIFT and %PR and record.

H. Gauge Operation

Operating Procedure for Nuclear Density Gauge for Soil-Aggregate, Troxler Model 3430

1. Turn power switch to ON/SLOW and allow unit to warm up at least 10 minutes.
2. Place gauge on reference block, noting the following:
 - a. at least 100pcf material under standard block
 - b. no large vertical objects within 10 feet
 - c. no other nuclear gauges within 30 feet
 - d. source rod away from metal butt plate
 - e. handle in safe position
3. Take standard count
 - a. press TIME, set to 4 min. using ↑ ↓ key
 - b. press DEPTH, set to backscatter using ↑ ↓ key
 - c. press STD key
 - d. press YES key
 - e. press START key
4. Check and record standard count
 - a. Enter standard count (MS and DS) in gauges standard count log book
 - b. DS should be within $\pm 1\%$ of the average of the previous 4 counts
 - c. MS should be within $\pm 2\%$ of the average of the previous 4 counts
 - d. If gauge repeatedly fails standard count, call Ray Deering.
5. Site Preparation
 - a. Prepare surface with scraper plate, drive drill rod to appropriate depth
 - b. Remove drill rod and scraper plate
 - c. Scribe outline of scraper plate with drill rod
 - d. Position gauge over test area and insert source rod to appropriate depth
 - e. Pull gauge toward key pad
6. Measurement
 - a. Press TIME, set to 1 minute by using ↑ ↓ key
 - b. Press DEPTH, set to appropriate depth by using ↑ ↓ key
 - c. Press MA/PR, set to proctor value by using ↑ ↓ key and ENTER
 - d. Press ENTER to start test
 - e. At end of count time, use ↑ ↓ key to display test values
 - f. Record test values on test report data sheet

APPENDIX B

SAMPLE SIGNS/LABELS

Type A Package

USA DOT TA
TYPE - .
RQ RADIOACTIVE MATERIAL
SPECIAL FORM
NOS,7,UN2974

TROXLER ELECTRONIC L-TORIES, INC., Research Triangle Park, N.C. 27709 U.S.A.

Cargo Aircraft Only



Sample Transportation Labels

White/



Yellow//

