USER TRAINING FOR FIXED NUCLEAR GAUGES

Presented by

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Training Introduction

TAKE ADDITIONAL NOTES!

Highlight important information

Clear detailed notes and highlights are valuable for future reference in the workplace

Listen to the instructor's promptings

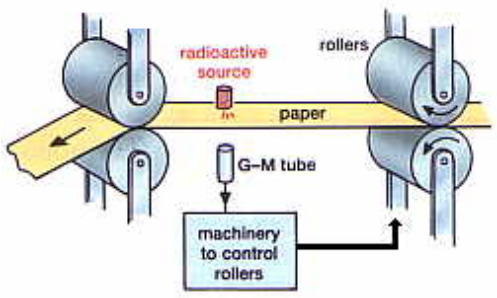
Fixed Gauge Types

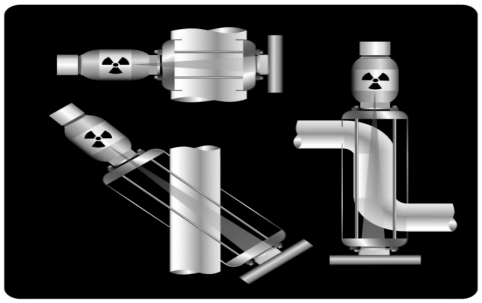
Most Fixed Gauges are used in these industries:

- Petroleum
- Lumber
- Paper Mills
- Mining
- Construction
- Even Archaeology!

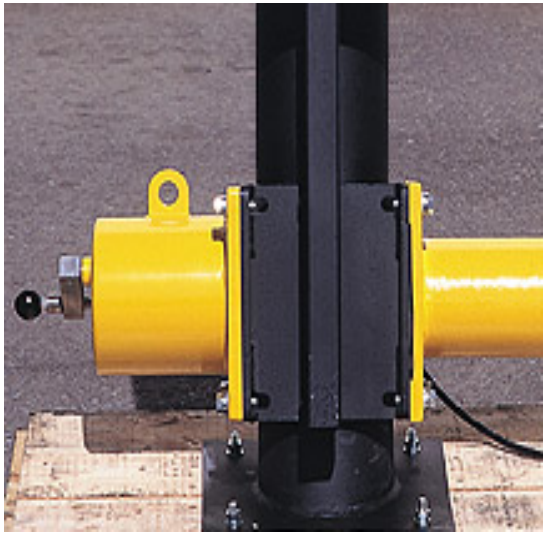
All Types of Fixed Gauges

Fixed gauges are large and heavy, some are mounted hundreds of feet high, others are small and used in precise measurements such as thicknesses, uniformity, levels and others are used for density and moisture content.



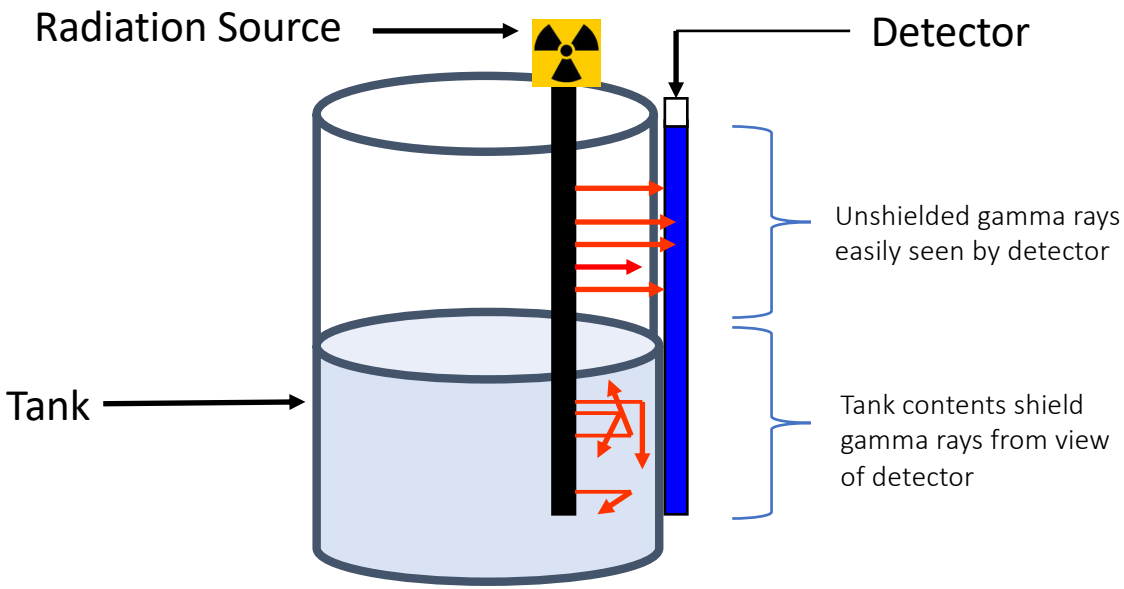


Flow Measurement

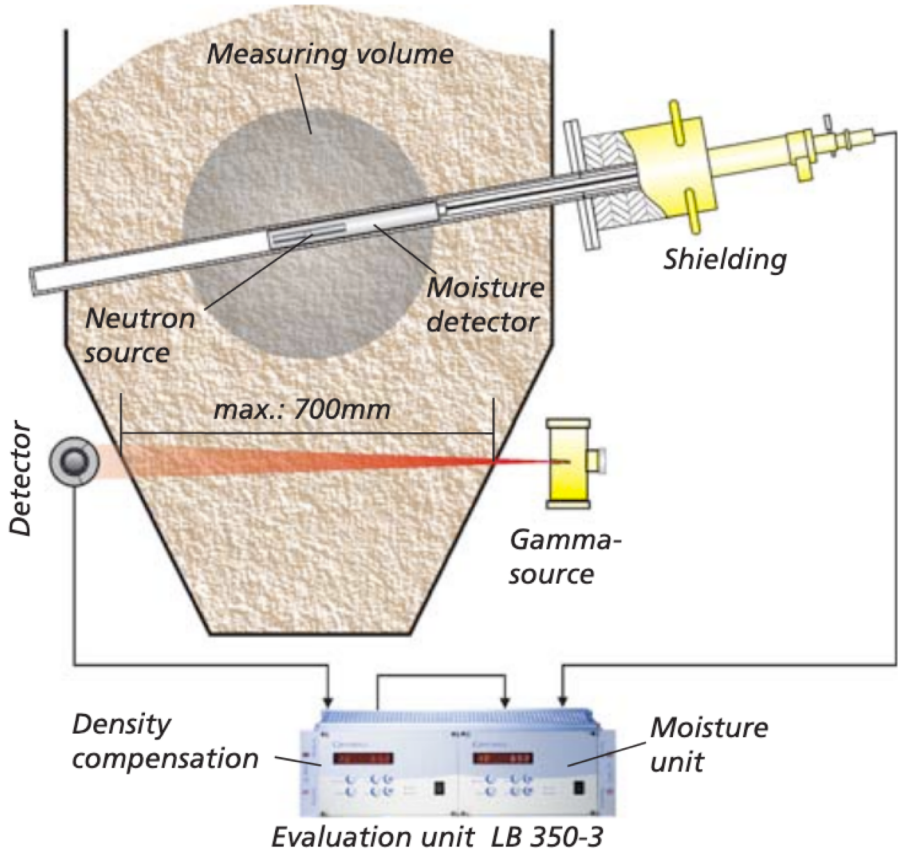


Level Indicator

When gamma rays from the radiation source are surrounded by the tank contents (i.e. liquids or solids) the detector is shielded from them. The point at which the detector stops seeing gamma rays is the fill level of the tank.



Hopper Feeder Measurement

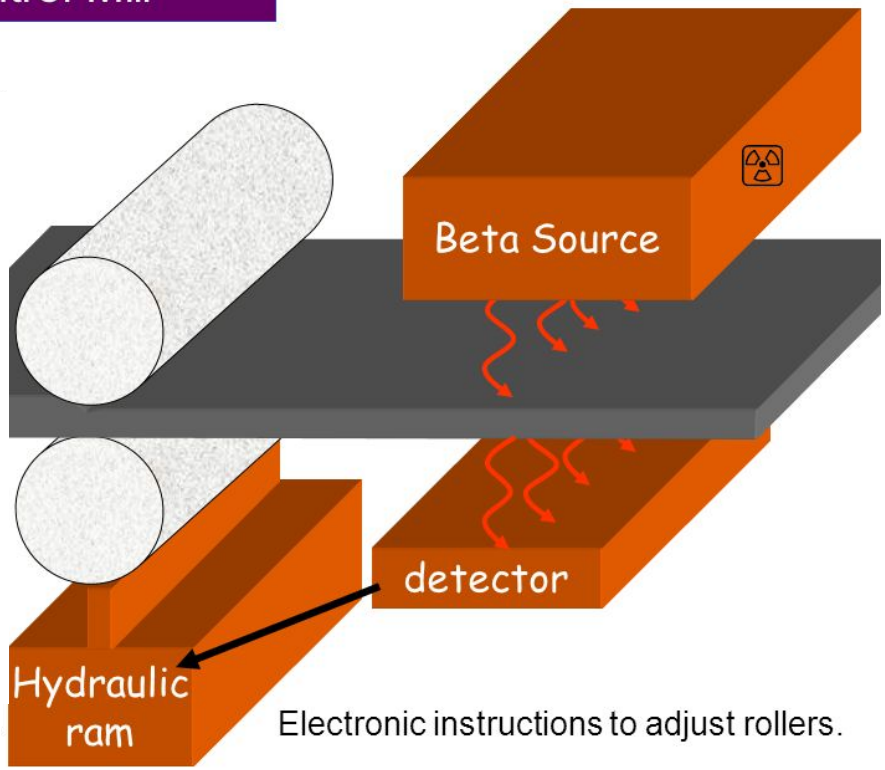


Thickness & Uniformity Measurement

Thickness Control Mill

If not enough radioactivity is detected then the rollers compress to make the material thinner.

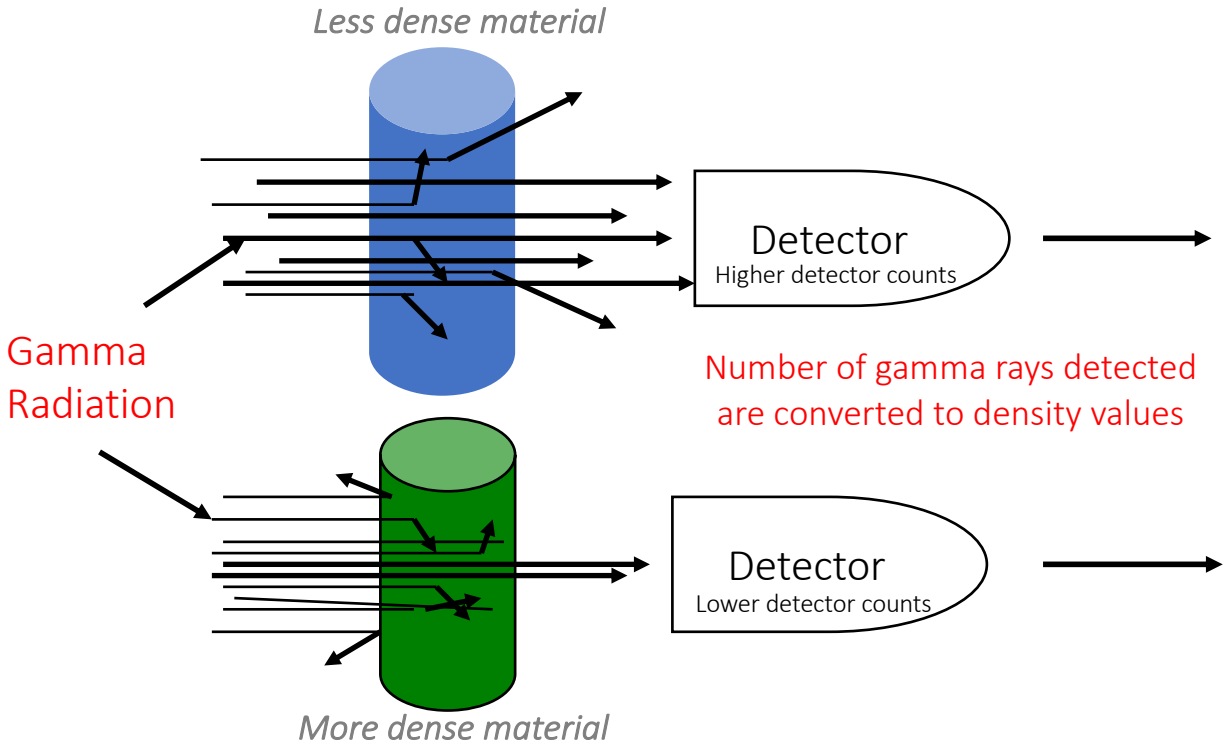
This method is used in the manufacture of lots of sheet materials: plastics, paper, sheet steel.



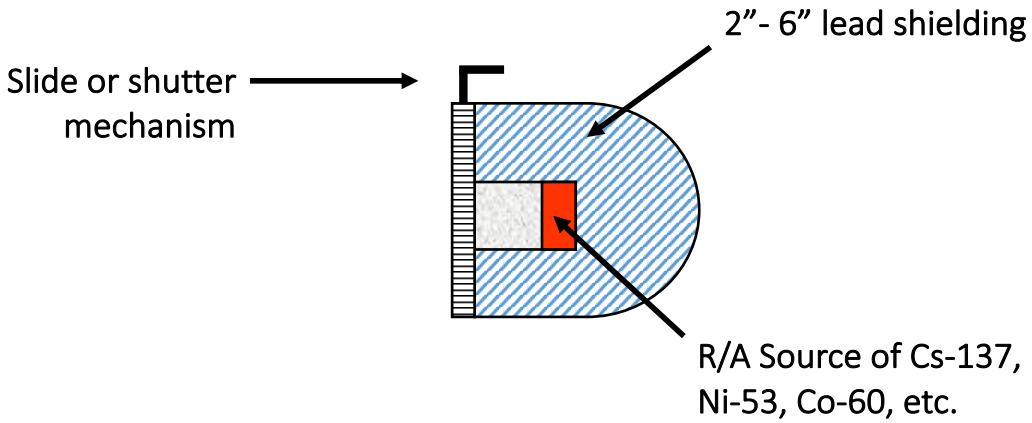
Electronic instructions to adjust rollers.

Nuclear Gauge Detection Principles

The more dense the material that radiation passes through, the fewer number of gamma rays that are able to penetrate it and be counted by the detector



Basic Source Holder Design for Process Nuclear Gauges



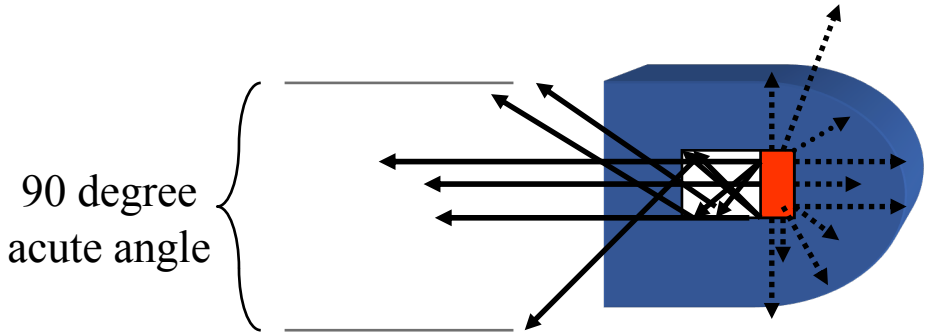
- Slide / shutter mechanism must close freely under all circumstances
- Shielding must be uniform and of suitable thickness to meet NRC limits of <5 mrem/hr @ 30 cm (1 ft)

Beam Geometry

- When the source is closed the beam goes in all directions (360 degree beam of emission)

  (< 5 mrem/hr @ 30 cm or about 1 foot)

- When source shutter is open - it is designed for 45 degrees of opposing angles or less with exposure high and direct. (amount dependent on isotope and curie content, like flash light beam)



Density & Content Measurement

Sources Used in a Fixed Gauge For Density & Content Measurements

- Cs-137 (Cesium), Co-60 (Cobalt), or Fe-55 (Iron)
- Sources usually contain 2 mCi – 1 Ci
- Configuration:
  - Salts mixed in a ceramic ball
  - Double encapsulated in (2) Stainless Steel capsules
  - Fusion welded shut
  - Melting point of 2500 degrees F
  - Crushing point of 4,500 psi
- These radioactive isotopes emit ***gamma rays*** (photons) to allow measurement of density
- Alpha and Beta particles are shielded by the capsule, not a hazard to Fixed Gauges

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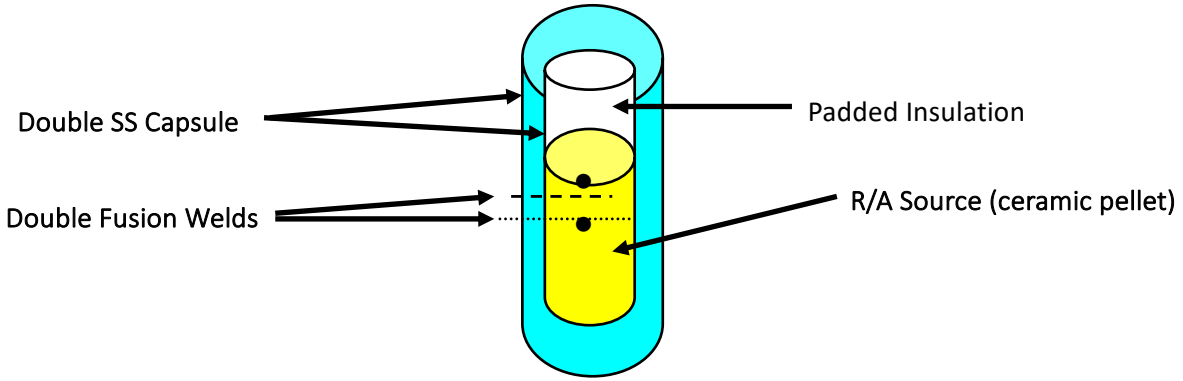
Element: Carbon 14

C-14

- 5730 year half life
- Beta emitter
- 49 kev energy
- Decays to nitrogen 14

Capsule Design

Nuclear Density Gauge (NDG) Source Capsule Design
2500 ºF melting point, 4500 psi crushing point



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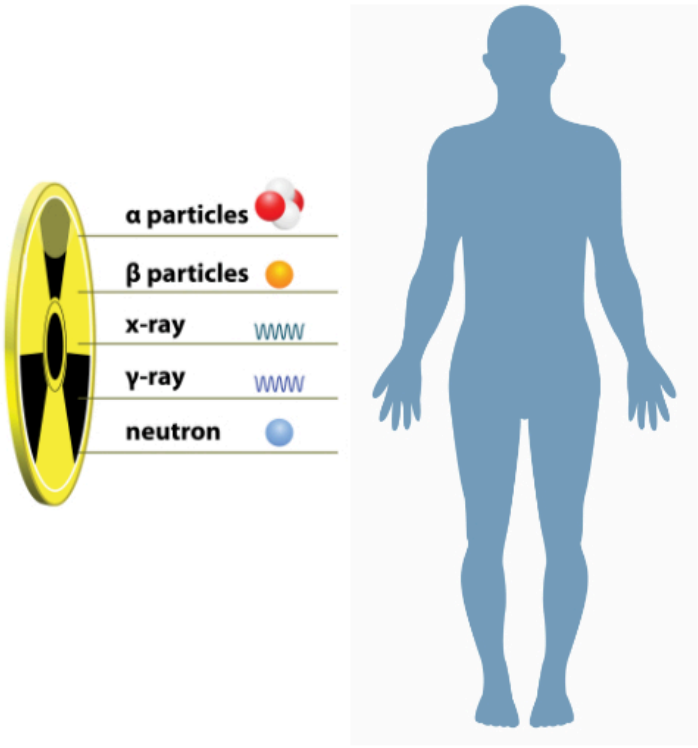
Potential Hazards

- Unnecessary or excessive radiation exposure from handling, working with or around and testing gauges.
- Radiation exposure to unmonitored, under age 18, and/or pregnant individuals
- Spread of radioactive contamination if sealed source is damaged



Program Requirements by Law

- Radiation and contamination detectors (survey meters) are required to be available
- In good working condition and in “Current Calibration”
- Survey meters need to be readily available.
- Survey meters need to be of the correct detector type to recognize the radioactive hazard and produce immediate readings
- Workers and others who could be exposed to doses in the 100 mrem/year range must be provided with personnel dosimeters

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Gauge Operating Procedures

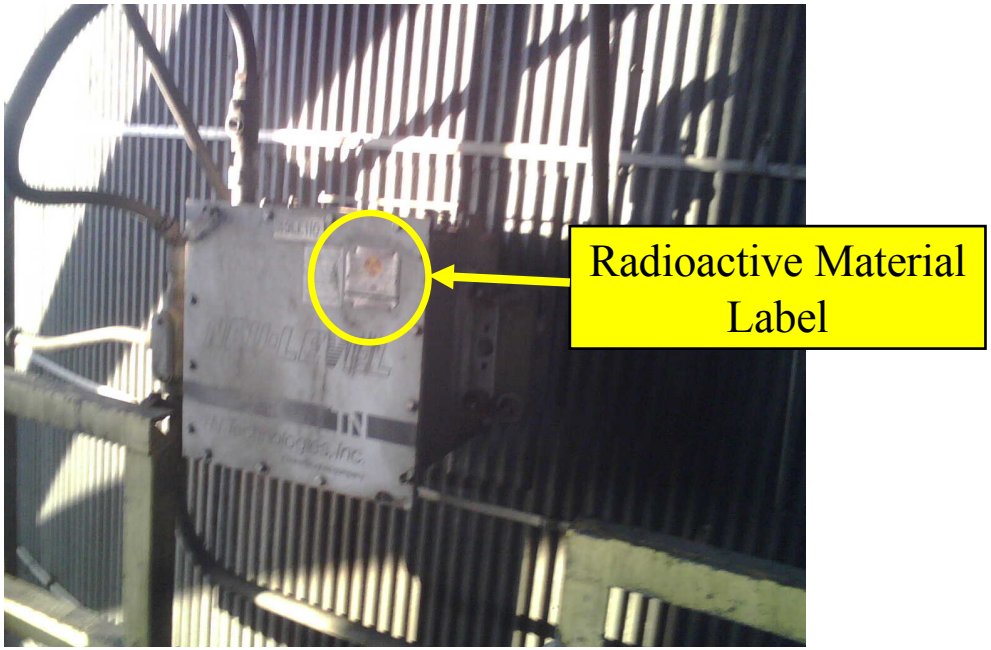
- Leak tests at interval specified by NRC or Agreement State, usually every 6 months or determined by what the SSD requires, 36 months for most sealed sources
- Areas > 5 mrem/hr at 1 ft. posted “Caution Radiation Area”
- Storage Areas Posted “Caution Radioactive Material”
- Labels and signs shall be maintained intact and in a legible condition for each gauge
- Records: Logs, Dose, Surveys, Leak Tests, Events, Annual Program Audits and timely reports.

Shipping Labeling

- Most common error of regulations for Licensee is improper labeling
- Gauges must be clearly labeled with the appropriate labels to identify the radiation hazard they present based on curie content

Radioactive Label Visibility

Radioactive Labels Must Be In View at a Safe Distance and Intact



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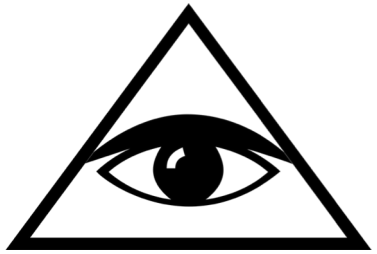
Radiation Signs Legible and Clean

NPG Storage & Accountability

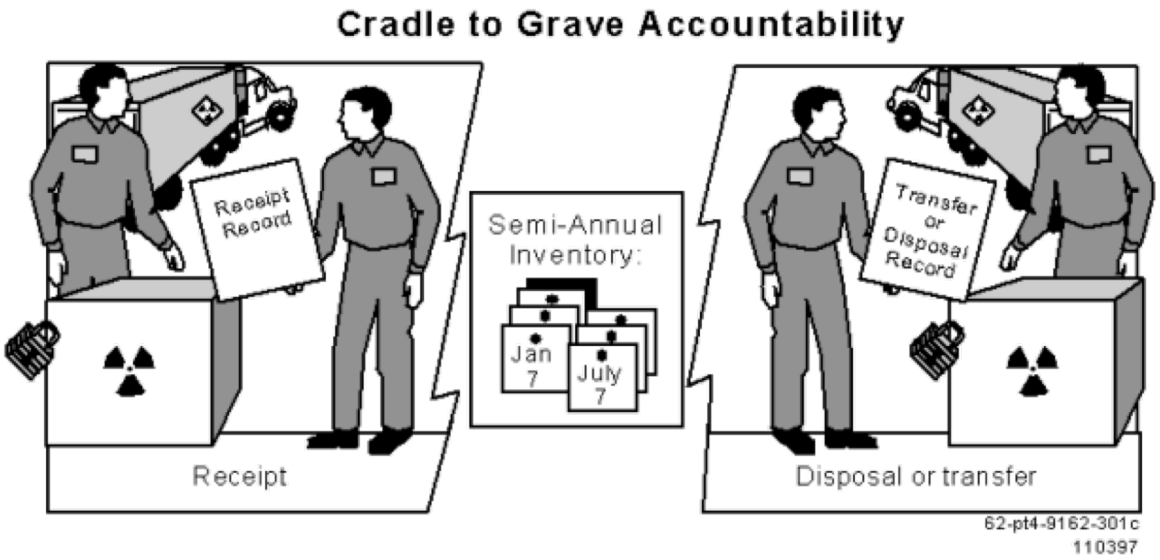
- 20.1801 "The licensee shall secure from *unauthorized removal or access* licensed materials that are stored in controlled or unrestricted areas." *Only Authorized Users.*

- 20.1802 "The licensee shall control and maintain *constant surveillance* of licensed material that is in a controlled or unrestricted area and that is not in storage." Meaning any gauge that is not secured or in use.



NPG Storage & Accountability

Licensee must maintain all records of receipt, transfer, and disposal. They must also conduct semiannual (every 6 months) physical inventories that are documented with serial numbers, makes & model, location, date of the inventory and the authorized user who performed it.



NPG Storage & Accountability

- Secured to avoid theft or damage during operation, transport, relocation, and/or storage

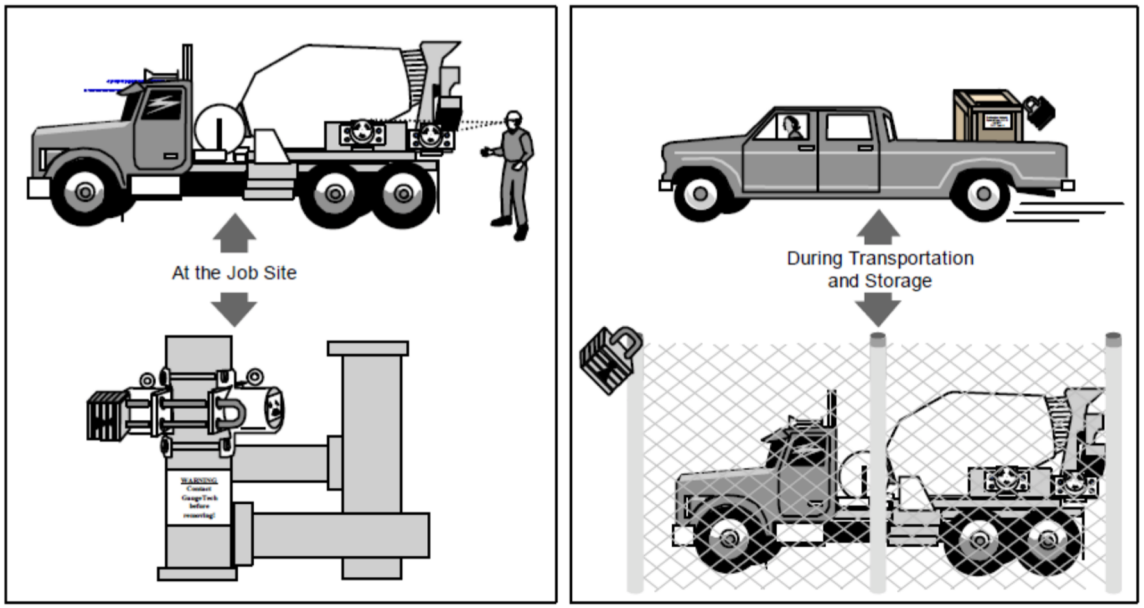
- Maintain dose ALARA to workers by judicious placement and use of the gauges to reduce radiation exposure

Note: Storage areas controlled to < 100 mrem/yr and < 2 mrem/hr

ALARA
As Low As Reasonably Achievable

Double Locking

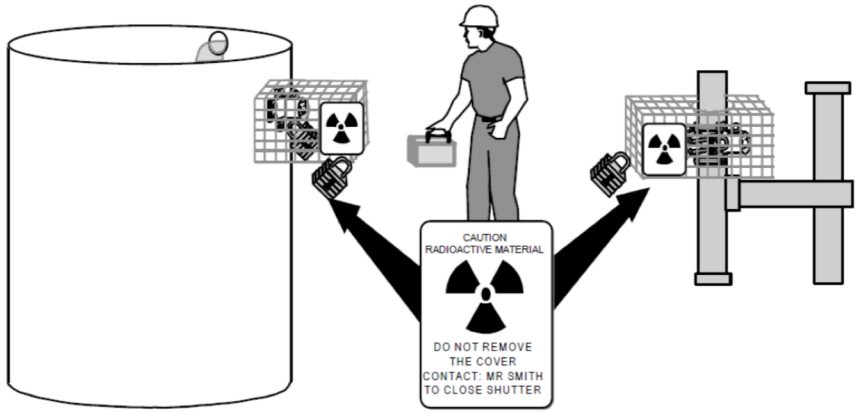
While in transport or vehicle service there must be a 2 lock system to secure the gauge from theft or loss and must be in constant surveillance



Double Barriers

Secured by 2 barriers and locks for those areas of service in the field

- Fenced and locked area, with gauge secured (bolted) to process and locked.
- Gauge bolted and secured with locked guard or cage
- Area is posted properly to protect the public



Surveys & Maps

- Provide a documented survey map of storage areas and surrounding spaces
- Surveys are required with any change to the storage areas or surrounding areas

Gauge Operating Procedures

- Always used in accordance with the manufacturers instructions
- Routine maintenance specifically permitted in license; cleaning, lubrication, electronic repairs
- Non-routine maintenance normally done by outside contractor or manufacturer; activities that effect radiological safety (source, source holder, source drive mechanism, shutter, shutter control, or shielding)

Gauge Operating Procedures

- Never touch unshielded source with hands or body at any time
- Do not place hands or body in the radiation beam of an unshielded source
- **"CAUTION RADIOACTIVE MATERIAL"** signs posted at all entry points useful radiation beam - other engineered controls may be used to prohibit access to these areas if necessary

Gauge Operating Procedures

- Lockout/Tagout procedures to prevent inadvertent exposure to the useful beam during maintenance or repair work (hopers, bins, vessels, etc.)
- Unauthorized access, operation, or removal of any gauge is prohibited
- A radiation survey after any changes that may affect the radiation beam or source integrity

Gauge Operating Procedures

- Follow **ALARA** principles at all times: Time, Distance, and Shielding

- Authorized users are responsible to ensure that no unmonitored personnel (visitors, other workers, etc.) enter the radiation area around the NPG

Time

Distance

Shielding

Lock-Out and Tag Procedures

There must be a lock-out/tag-out procedure in place before repairs and maintenance on equipment near a NPG, the NPG must be locked and tagged out

Gauge Installation

A licensee may initially *mount* a gauge, without specific NRC or Agreement State authorization, if:

1. The gauge's SSD Certificate explicitly permits mounting of gauges by users

Gauge Installation

2. Mounted in accordance with manufacturer's guidelines

3. In location compatible with the "Conditions of Normal Use" and "Limitations and/or Other Considerations of Use" in the certificate of registration issued by NRC or an Agreement State

4. Shutter locked in "off" position, if applicable, or source otherwise fully shielded

Gauge Installation

5. Gauge must be received in good condition (package was not damaged) and not require any modification to fit in the proposed location

6. Mounting does not include electrical connection, activation, or operation of the gauge

7. Source must remain fully shielded and gauge may not be used until it is installed and made operational by a person specifically licensed by the Commission or an Agreement State

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Non-Routine Operations & Maintenance

Non-Routine Maintenance includes:

- Gauge “installation”
- Initial radiation survey
- Repair or maintenance involving the radiological safety of the gauge (e.g., the source, source holder, source drive mechanism, shutter, shutter control, or shielding)
- Gauge relocation, replacement, alignment, removal from service
- Disposal of sealed sources
- Any other activities during which personnel could receive radiation doses exceeding NRC limits

Non-Routine Maintenance and Operations

- Any **non-manufacturer/non-distributor** supplied replacement components or parts, or the use of materials (e.g., lubricants) other than those specified or recommended by the manufacturer or distributor need to be evaluated to ensure that they do not degrade the engineering safety analysis performed and accepted as part of the device registration

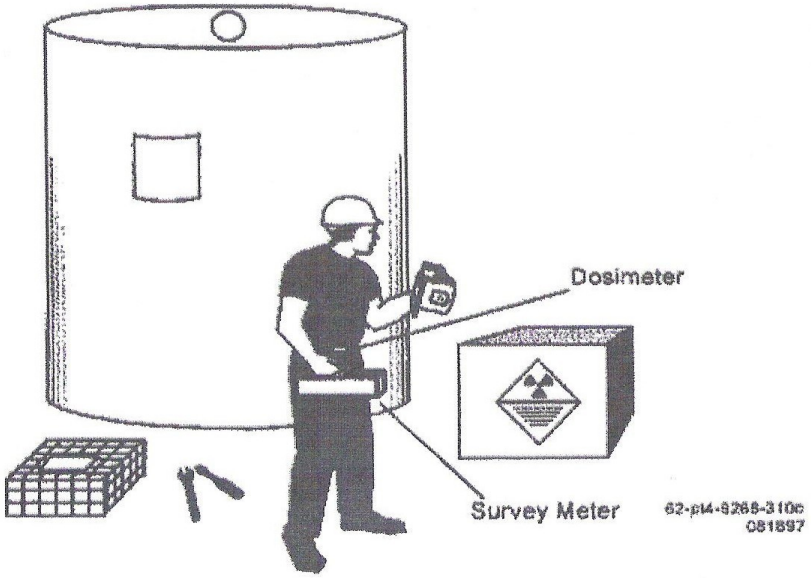
Non-Routine Maintenance and Operations

- After maintenance or repair, the gauge must be tested before the unit is returned to service

- Licensees performing non-routine operations must use personnel with special training and follow appropriate procedures consistent with the manufacturer's or distributors instructions and recommendations

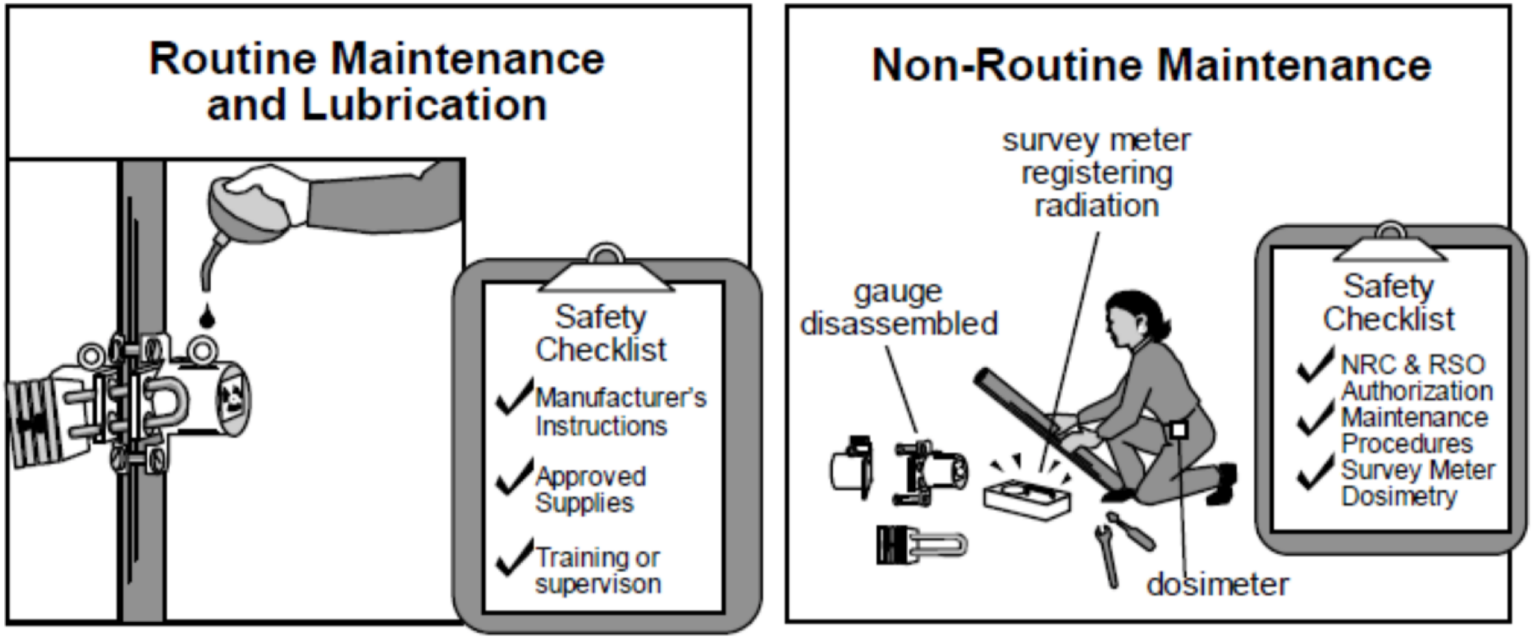
Non-Routine Maintenance and Operations

When performing non-routine maintenance area surveys and contamination checks are required and documented prior to and after service



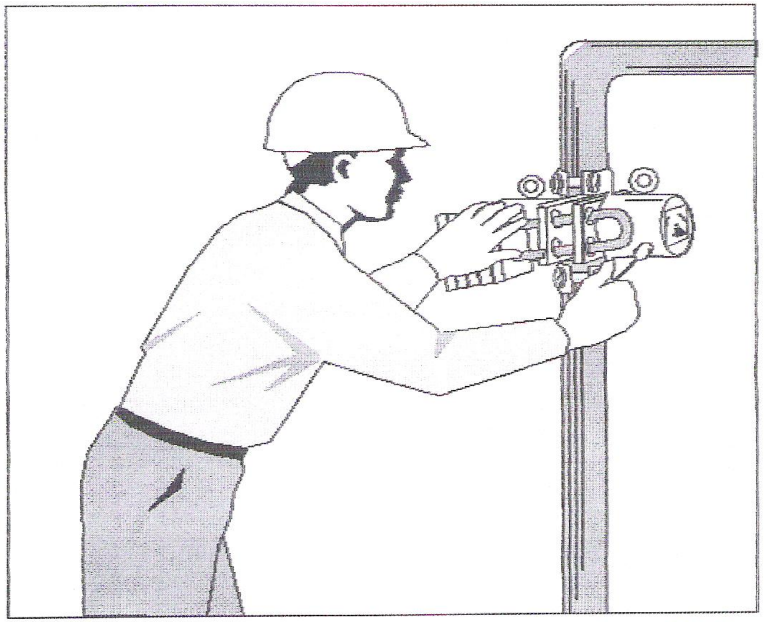
RADIATION SOLUTIONS

Routine v.s. Non-Routine



Periodic Leak Test Required

Leak test requirements found in license conditions and/or SSDC



RADIATION SOLUTIONS

Emergency Actions

Emergency Response - Theft or Loss

- Immediate notification of the cognizant Radiation Safety Officer (RSO)
  - RSO's responsibility is to then notify the NRC and local Government Enforcement offices
  - Immediate recovery efforts are necessary and dependent upon the specific circumstances

Emergency Response - Damaged Gauge

- ✓ Barricade and/or restrict access to the damaged gauge until the integrity of the sources can be established
- ✓ Notify the cognizant RSO who will notify competent authorities and/or emergency response personnel as needed
- ✓ DO NOT attempt to make repairs or authorize anyone to attempt repairs unless authorized by RSO and License issued by the NRC or Agreement State.
- ✓ An authorized service organization will remove, securely package, repair or, if necessary, dispose of the NPG

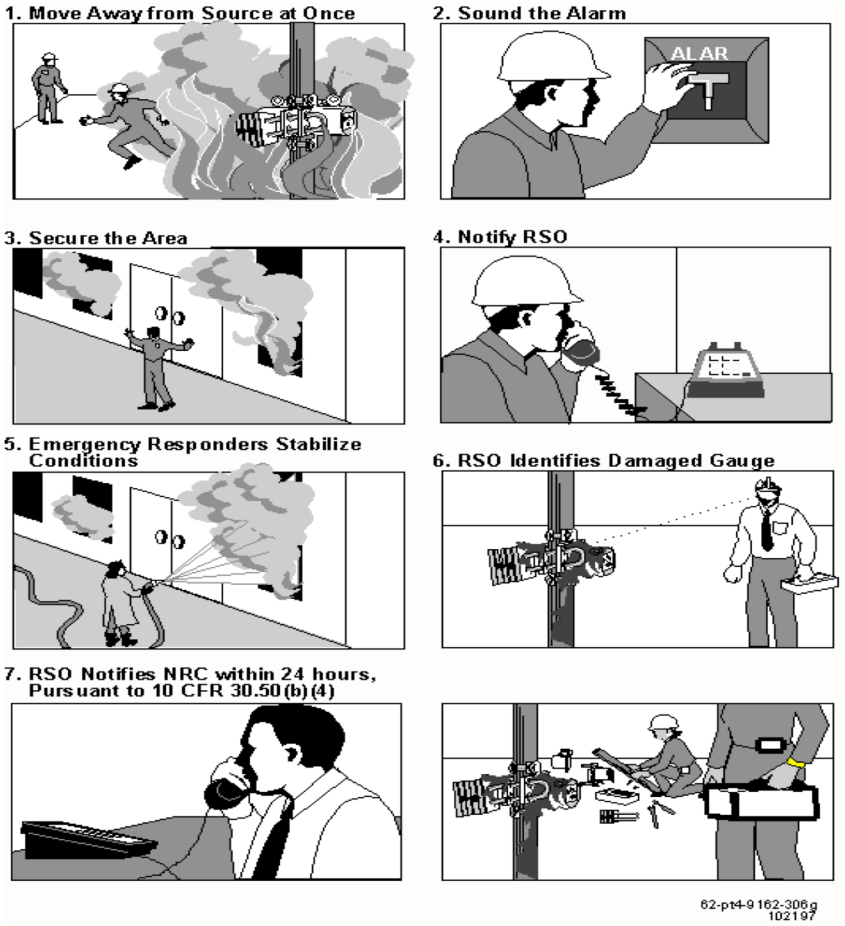
Emergency Response - Fire

- ✓ Follow company fire response plan (if time permits, you can secure shutter in “closed” position)
- ✓ Notify RSO of gauge status and assist him or her as needed
- ✓ If unable to reach RSO, inform emergency responders of radiological hazards (number, location, source type, and operational status of NDGs)

✓ Sealed sources should not be damaged

RADIATION SOLUTIONS

Quick Summary of a Response to Fire



Emergency Response – Shutter Stuck Open

- ✓ Exit the area effected by useful beam to at least 15 feet from source
- ✓ Barrier off area as needed to ensure exposure limits are not exceeded (radiation workers, visitors, general public)
- ✓ Notify Radiation Safety Officer (RSO) as soon as possible
- ✓ Licensed and authorized organization will repair or replace gauge

The End

You must now take the exam and pass with an 80% or better score