DEPARTMENT OF ENERGY	LESSON PLAN
	Course: Radiological Control Technician Unit: Site Academics Lesson: 2.12 Shipment and Receipt of Radioactive Materials

Learning Objectives:

2.12.01 List the applicable agencies which have regulations that govern the transport of radioactive material.

2.12.02 Define the following terms used in DOT regulations.

a. LSA
b. Limited Quantity
c. Transport Index
d. Exclusive Use
e. Closed Transport Vehicle

2.12.03 List methods that may be used to determine the radionuclide contents of a package.

2.12.04 Describe the necessary radiation and contamination surveys to be performed on packages and state the applicable limits.

2.12.05 Describe the necessary radiation and contamination surveys to be performed on exclusive use vehicles and state the applicable limits.

2.12.06 Identify the proper placement of placards on a transport vehicle.

☞ 2.12.07 Identify inspection criteria that should be checked prior to releasing a shipment at your site.

☞ 2.12.08 Describe site procedures for receipt and shipment of radioactive material shipments.

☞ 2.12.09 List the actions required at your site if a shipment is received exceeding radiation or contamination limits.

☞ 2.12.10 Describe the proper step-by-step method for opening a package containing radioactive material at your site.

References:

1. DOE Order 5400.3
2. 49CFR, Parts 100-177, Transportation

Instructional Aides:

Overhead projector/screen, Chalkboard/whiteboard

LESSON PLAN | INSTRUCTOR'S NOTES

I. LESSON INTRODUCTION

A. Self Introduction

1. Name
2. Phone number
3. Background

B. Motivation

C. Lesson Overview

1. Regulations
2. Regulation applicability
3. Definition of terms
4. Application of regulatory requirement
5. Violations of regulations
6. Receipt of radioactive material procedures
7. Shipment of radioactive material procedures
8. Shipment exceeding limits
9. Precautions in opening packages

D. Introduce Objectives — O.H.: Objectives

II. LESSON OUTLINE

A. RADIOACTIVE MATERIAL SHIPMENT REGULATIONS

1. Regulation Basis/Goal — Write the basis of regulations on the board. Leave this on the board for future reference.

   a. Prevent radioactive material affecting environment during transportation

   b. Prevent environment affecting radioactive material integrity

LESSON PLAN	INSTRUCTOR'S NOTES
2. Goal Achievement Method	Ask the students how regulations achieve the basis/goal mentioned above. List the answers on the board. Modify answers for completeness, correctness, and clarity.
a. Regulatory requirements	
1) Package requirements	
a) Effective barrier	
2) Method of shipment	
b. Degree of Regulation	
1) More restrictive for increased:	
a) Quantity	
b) Concentration	
c) Potential hazard	
3. Primary Organizations	Objective 2.12.01
a. DOE	List each organization across the top of the board. As the lesson progresses list pertinent information such as; responsibility, applicable publications, and specific jurisdiction, under each organization heading.
b. NRC	
c. DOT - Hazardous Materials Bureau	
d. Postal Service	
e. F.A.A./Coast Guard	
f. State agencies	
1) Transportation departments	
2) Radiation Health Bureaus	Point out the interface between organizations.
4. Department of Energy	

a. General Responsibility

1) Regulates its own nuclear activities

b. Specific Responsibilities

1) Set standards

2) Authorizes operation contractor activities

3) Inspects operating contractor activities

c. Regulatory Publications

1) DOE Orders/DOE RCM

d. DOE Regulations/Documents

Point out that in this discussion of regulations only those applicable to shipment and receipt of radioactive material are specifically addressed. This does not imply that these regulations do not address other topics.

1) DOE RCM Chapter 4, Part 2, Article 423

2) DOE Order 1540.1

a) Management of all transportation activities

3) DOE Order 1540.2

a) DOE certification of hazardous material packaging

4) DOE Order 5480.3

a) Standards, requirements for packaging

b) Standards, requirements for transportation

5) DOE Order 5480.4

a) Reference list of other standards

b) Mandatory by law

- 49 CFR 170-179
- 10 CFR 71

c) Mandatory by DOE policy

- IAEA Safety Series 6
- International Air Transport Association Restricted Article Regulations

d) Good practice references

- ORNL
- ANSI
- NRC Reg. Guides

5. Department of Transportation

a. General Responsibility

1) Regulate transportation

b. Specific Responsibility

1) Materials Transportation Bureau

2) Governs hazardous material transport

c. Regulatory Publications

Point out that all DOT regulations apply regardless of the transport being interstate. Cite an example of the applicability such as; the Westinghouse Nuclear Fuels Plant near Columbia, South Carolina, transferring rad waste to the burial site at Barnwell, South Carolina. Although no state lines are crossed, DOT regulations still apply.

1) 49 CFR 171-179

d. Regulation Applicability

Point out that in this discussion of regulations only those portions applicable to shipment and receipt of radioactive material are specifically addressed. This does not imply that these regulations do not address other topics.

1) Any person transporting/shipping

a) Hazardous material

2) Interstate commerce only

3) Preempts other jurisdiction regulations

4) 49 CFR - 10 CFR 71 used in conjunction

a) Negates "interstate only" application

B. REGULATION APPLICABILITY

1. Full compliance-all regulations from each agency

2. Variables dictating regulation applicability

Point out that these two variables are the general basis of the regulatory limits presented later in this lesson.

a. Transport mode

b. Quantity radioactive material

C. DEFINITION OF TERMS

Objective 2.12.02

LESSON PLAN	INSTRUCTOR'S NOTES
1. Radioactive Material	Point out that in order to understand the regulations, it is necessary to understand the basic language in the regulations. Explain that these are explanatory (working) definitions and the students should look up the referenced regulation section for the official definition and requirements.
a. Reference 49 CFR 173.403	
b. Definition	
1) Material/combination of materials	
2) Spontaneously emits ionizing radiation	
c. Exception	Emphasize that this exception is only applicable to DOT regulation, not DOE Orders. This exception is only applicable to the transport of the material and is not an exception for DOE controlled or NRC licensed material, or the disposal of radioactive material.
1) Activity <0.002 Ci/gm	
2) DOT exception only	
2. Special Form	
a. Reference 49 CFR 173.403	
b. Definition	
1) Term describing encapsulated radioactive material	
c. "Special Form" Requirements	
1) Pass series of tests	

a) Worst case accidents

2) Obtain "Special Form" certificate

3. Normal Form

Write the term on the board with its reference and the organization applying the definition. State the definition then write it on the board.

a. Reference 49 CFR 173.403

b. Definition

1) Any radioactive material not special form

4. Package

a. Reference 49 CFR 173.403

b. Definition

1) Packaging and radioactive contents

5. Packaging

Write the term on the board with its reference and the organization applying the definition. State the definition then write it on the board.

a. Reference 49 CFR 173.403

b. Definition

1) Container-wrappers-contents

Emphasize the difference between package and packaging, and its importance when reading the actual regulations.

a) Excluding radioactive material

2) Material/equipment preventing radioactive release

6. Low Specific Activity (LSA)

Objective 2.12.02
Write the term on the board with the reference and the organization applying the definition. State the definition then write it on the board.

   a. Reference 49 CFR 173.403

   b. General Definition

      1) Radioactive material classification

         a) Concentration

         b) Surface contamination

      2) Exempt from certain regulations

         a) Packaging

         b) Shipping

   c. Exemption

      1) LSA transported "Exclusive Use"

         a) Exempt - "specification" packaging

         b) Alternate packaging

Emphasize the legal definition of a "strong, tight package."

            - Tight/strong package
            - No leakage under normal transport conditions

      2) LSA Type B quantities

Explain that while present DOT regulations exempt LSA from specification packaging, the NRC does not exempt Type B Quantities of LSA from the requirements in 10 CFR 71.

         a) More restrictive packaging per NRC

         b) Essentially requires Type A package

      3) Bulk shipments radioactive liquids

a) Require specification tank truck/car

b) DOT exception

7. Quantities

a. Reference (DOT)

1) 49 CFR 173

b. Definition

1) Radioactive material classification

a) Package total curie content

b) Limits based on A_1/A_2 values

2) Dictates maximum Ci/type package

c. Limited Quantities Objective 2.12.02

1) Limits

a) Table 2 values

b) Based on solids, liquids, gases

2) Packaging Requirements

a) Exempt from specification packaging

b) Marked "Radioactive"

- Inner package if double container
- Outer package if single container

c) Strong-tight package

- No leakage

d. Type A Quantities

1) Limits

a) Based on A_1/A_2 values

2) Packaging Requirements

a) Type A quantity/LSA shipped mixed lading

- Type A specification package

b) Type A package requirements

- DOT specifications
- Complete supporting safety analysis
- Certificate not required for each package

Explain that Specification 7A in 49 CFR 178.415 does not describe a package type (such as a drum or a box). Basically the user must prove that each specification package meets the standards for Type A packaging listed in 49 CFR 173.465. The MLM-3245 report documents the normally used specification containers that meet Specification 7A.

e. Type B Quantities

1) Limits

a) Quantities above Type A quantity

2) Packaging Requirements

Explain that these packagings are specifically designed and tested to meet the stringent test criteria in 10 CFR 71. These tests represent a severe, hypothetical transportation accident. Vendors will supply these packages which are usually shielded casks with overpacks designed to absorb the impact of a severe accident.

a) Type B

- Require Type B packaging

b) Type B packaging requirements

- Meets requirements in 10 CFR 71

- Issued NRC "Certificate of Compliance"
- Specifies maximum Ci/package
- QA program required

8. Fissile Material

Write the term on the board with the reference and the organization applying the definition. State the definition then write it on the board.

a. Reference 49 CFR 173.403

b. Definition

1) Radioactive material classification

a) Classified by necessary controls

2) Fissile radionuclides

Point out that DOE also defines Np-237 and Cm-244 as fissile.

a) U-233

b) U-235

c) Pu-238

d) Pu-239

e) Pu-241

c. Classifications

1) Fissile-Class I

a) No controls necessary

2) Fissile-Class II

a) Package contents limited

b) Number packages limited

3) Fissile-Class III

a) Special shipper-carrier arrangements

b) Complex packaging requirements

- Many provisions/ exemptions

9. Exclusive Use/Sole Use

Objective 2.12.02
Write the term on the board with the reference and the organization applying the definition. State the definition then write it on the board.

   a. Reference (49 CFR 173.403)

   b. Definition

      1) Describes shipment made

         a) Only used by single shipper

         b) Initial, intermediate, and final loading/unloading controlled

         c) Written instructions given to carrier

      2) Loaded at plant - unloaded at destination

         a) No intermediate storage

         b) Prevents putting other material on vehicle

10. Closed Transport Vehicle (49 CFR 173.403)

Objective 2.12.02
Write the term on the board with the reference and the organization applying the definition. State the definition then write it on the board.

   a. Securely attached enclosure to restrict access

   b. Enclosure permanent or temporary

   c. Must limit access from all directions

11. Mixed Lading

Write the term on the board. State the definition and then write it on the board.

   a. Definition

      1) Radioactive material which can be stored or shipped with other commodities

b. More restrictive packaging requirements

12. Transport Index

Objective 2.12.02
Write the term on the board with the reference and the organization applying the definition. State the definition then write it on the board.

a. Reference (49 CFR 173.403)

b. Definition

1) Package classification

a) Radiation level

- Highest level at 1 meter
- In mrem/hr

b) Mixed lading shipments

2) Limits are per package and per shipment

D. APPLICATION OF REGULATORY REQUIREMENTS

Refer students to appropriate text section.

1. Must consider other hazards if present

Mixed waste

a. Acid/base

b. Toxicity

c. Flammable

2. Text discusses following steps

a. Determine type and quantity

b. Packaging

c. Package marking, labeling and vehicle placarding

Emphasize that regulations require "all" radionuclides to be identified by quantity.

d. Package radiation and contamination surveys

e. Transport vehicle surveys

f. Shipping papers

3. Determining activity and radionuclide content

Objective 2.12.03

a. Regulatory requirement

b. Methods

1) Materials accountability

a) Measure nuclides in/out

b) May be useful for HEPA filters

2) Classification by source

a) Maintain inventory of material received

b) Could be used on containers if waste is exhumed

3) Measurement of gross activity

a) Initial measurement correlates activity by nuclide to gross measurements

4) Direct measurement

a) Similar to gross activity measurement

b) Direct measurement of gamma emitters by spectroscopy

c) Other nuclides correlated to gamma emitters

4. Package Radiation Surveys Objective 2.12.04

a. Radiation Surveys

1) Large package

a) Contact readings

b) All points on surface

2) Small package (less than 55 gallon drum size)

a) Contact reading not adequate

b) Must translate to surface dose rates

3) Mixed Lading

a) Determine Transport Index (T.I.)

- Survey at 1 meter
- Highest radiation level

4) Limits — Objective 2.12.05

a) Exclusive Use, closed transport vehicle

- 1,000 mrem/hr on accessible surfaces of package

b) Mixed Lading — Point out that 10 mrem/hr at 1 meter corresponds to a T.I. of 10.

- 200 mrem/hr - surface
- 10 mrem/hr at 1 meter

c) Limited Quantity

- 0.5 mrem/hr - any point on surface

b. Contamination Survey - Non-DOE conveyance of off-site shipments — Emphasize the need for determining that little or no contamination is present, since the packages are going out into the general environment. The next shipment could be your food.

1) Method — See DOE RCM Art. 423

a) Disc smear

2) Limits (dpm/100 cm^2)

a) Exclusive Use, Closed Transport Vehicle, Radioactive Material Only

- 22,000 beta-gamma
- 2,200 alpha

b) Exclusive Use

- During transport:
  - 22,000 beta-gamma
  - 2,200 alpha
- Beginning of transport:
  - 2,200 beta-gamma
  - 220 alpha

c) All other shipment modes/packages

- 2,200 beta-gamma
- 220 alpha

d) Inner surfaces of Empty Package

- 220,000 beta-gamma
- 22,000 alpha

c. Contamination surveys - On-site or off-site shipments by DOE conveyance — See DOE RCM Art. 423

1) Use DOE RCM Table 2-2 contamination values in place of DOT limits

5. Package Marking - Sealing - Labeling — Emphasize the need for properly warning personnel of the exact extent of the hazard through the use of the proper labels recognized and understood by members of the shipping industry.

Illustrate labels or markings by using actual examples and/or sketching at the blackboard.

a. LSA Package Sent Exclusive Use

1) Marking

a) "Radioactive----LSA"

b. Limited Quantity Package

1) Inner Container Marking

a) "Radioactive"

2) Sent by Mail

a) Inner container marking

b) "Radioactive Material - No Label Required"

c. Type A Package

Emphasize that for a limited quantity package sent by mail, no marking should be present on outer packaging.

1) Smallest Dimension 10 cm
2) Package Seal
   a) Not easily breakable
   b) Reveal opening/tampering
3) Meet Design Requirements
4) Package Marking
   a) Contrasting color
   b) Identify shipping name and UN number
   c) Shipper name - street address
5) Labeling
   a) "White I"
      - ≤0.5 mrem/hr on surface
   b) "Yellow II"
      - >0.5 but <50 mrem/hr on surface
      - ≤1 mrem/hr at 3 ft
   c) "Yellow III"
      - >50 mrem/hr on surface
      - >1 mrem/hr at 3 ft

d. LSA packages Sent Mixed Lading
   1) Type A Packaging
   2) Exemptions
      a) 10 cm smallest dimension
      b) Tamper indicating seal

e. Type B Package Labeling
   1) Same as Type A

2) Any additional requirements in NRC certificate

6. Survey of Transport Vehicle

Illustrate by sketching a vehicle on the blackboard. Indicate the appropriate locations where surveys should be taken.

a. Survey on Arrival

b. If exceed limits

1) Do not load

Point out the need for the survey before loading to ensure that you do not have to decon a mess caused by some past shipment. Immediately report levels to the RC supervisor.

2) Notify vehicle owner

c. Survey while loading

1) Survey frequently

2) Avoids load rearrangement

d. Outgoing Vehicle Radiation Surveys

Emphasize that a thorough survey must be made to ensure that the levels are within limits at all locations. The limits are not an average but are the absolute maximum. It is generally not possible to ship packages over 200 mrem/hr contact (and not more than 10 at this level) on an "unshielded van shipment".

1) Exclusive Use - Closed Transport

a) Contact with sides, top and bottom - 200 mrem/hr

b) 2 m from vertical plane - 10 mrem/hr

c) Occupied areas - 2 mrem/hr

2) Exclusive Use - Open Transport

Explain that the limits are the same for open and closed transport vehicles, however, the locations of the survey differ.

a) Contact with package sides, top and bottom - 200 mrem/hr

b) 2 m from vertical plane - 10 mrem/hr

c) Occupied areas - 2 mrem/hr

3) Empty Exclusive Use Returned to Service

Each accessible surface - 0.5 mrem/hr

4) Empty "Radioactive Material Use Only" Vehicles

a) Contact with interior surfaces - 10 mrem/hr

b) 1 m from interior surface - 2 mrem/hr

5) Mixed Lading Shipment

a) Each package T.I. 10

b) Cumulative T.I. 50

c) Distance restrictions

- 7 ft to occupied areas
- 36 ft to undeveloped film

e. Outgoing Vehicle contamination surveys

Emphasize the concept that unless a survey is performed and documented, there is no way to prove the vehicle wasn't contaminated at the site.

1) All Vehicles

a) No limits for loaded vehicles

b) Keep packages within limits

c) Surveying vehicle is good practice

d) Survey locations

- Truck bed
- Floor of cab
- Controls in cab
- Tires

2) Returning Exclusive Use to Service

a) Survey required for vehicles carrying packages with >2,200 or 220 dpm/100 cm^2 beta-gamma or alpha, respectively

b) Return to service if < limits

7. Proper Placarding of Transport Vehicle — Objective 2.12.06

a. Placard Requirement — Emphasize that personnel should not "over" label. It is a violation just the same as an improper or missing label.

1) LSA Exclusive Use shipment

2) "Radioactive Yellow III" shipment

b. Placard Description/Location — Illustrate a placard description by drawing an example on the board or providing the students with a picture.

1) Description

a) Must be on white square if "Highway Route Controlled"

2) Location

a) All four vehicle sides

b) Can place on front of tractor and/or trailer — If tractor is removed from trailer, a placard must still be on all four sides of trailer.

10. Inspection Prior to Release — Objective 2.12.07

(Insert site specific information here)

11. Receiving Facility Verification

a. Requirement

1) Verify facility authorized to receive

a) Type

b) Form

c) Quantity

b. Accomplished by either:

1) Receiving facility confirmation

a) Possess license copy

b) Authorization certificate

2) NRC confirmation

3) Agreement state confirmation

E. VIOLATIONS OF REGULATIONS

1. Common Violations

a. Free standing liquid present

b. Leaking packages

c. Contaminated package/vehicle

d. Radiation levels exceeding limits

e. Load not securely fastened

f. Vehicle mechanical deficiencies

g. Vehicle "Exclusive Use" instructions not provide to carrier

h. Improper package closures

i. Improper packaging

1) Type/quantity radioactive material

j. Markings-labels-placarding improper or missing

k. Shipping papers incomplete/ incorrect information

F. RECEIPT OF RADIOACTIVE MATERIAL PROCEDURES

Objective 2.12.08

(Insert site specific information here)

G. SHIPMENT OF RADIOACTIVE MATERIAL PROCEDURES Objective 2.12.08

(Insert site specific information here)

H. SHIPMENT EXCEEDING LIMITS Objective 2.12.09

(Insert site specific information here)

I. PRECAUTIONS IN OPENING PACKAGE Objective 2.12.10

(Insert site specific information here)

III. SUMMARY

Conduct summary by asking questions which will demonstrate that student objectives have been met. Use the student objectives to formulate your questions. Base your selection of questions on the areas that the students have demonstrated some weakness or misconception. Modify answers for completeness, correctness, and clarity.

A. Review major points

1. Regulations
2. Regulation applicability
3. Definition of terms
4. Application of regulatory requirement 10
5. Violations of regulations
6. Receipt of radioactive material procedures
7. Shipment of radioactive material procedures
8. Shipment exceeding limits
9. Precautions in opening packages

B. Review learning objectives

IV. EVALUATION

Evaluation shall consist of a written examination comprised of multiple choice, fill-in the blank, matching and/or short answer questions. 80% shall be the minimum passing criteria for examinations.