

UNIT 5

PACKAGING SELECTION and PROPER SHIPPING NAME



U.S. Nuclear Regulatory Commission and Agreement States

“Transportation of Radioactive Materials”

NRC Course H-308



OBJECTIVES

- Identify Class 7 (radioactive) material proper shipping name options.
- Determine the most appropriate proper shipping name based on activity, packaging, or type of material.
- Determine acceptable packaging options based on the most appropriate proper shipping name.



CLASS 7 PROPER SHIPPING NAMES

§172.101

- Required selections:
 - Radioactive material, uranium hexafluoride
 - Radioactive material, uranium hexafluoride, fissile

NOTE: There are 6 Proper Shipping Names containing “fissile”



CLASS 7 PROPER SHIPPING NAMES

- Selections based on limited activity:
 - Radioactive material, excepted package – limited quantity of material
 - Radioactive material, excepted package – instruments
 - Radioactive material, excepted package – articles



CLASS 7 PROPER SHIPPING NAMES

- Selections based on limited activity:
 - Radioactive material, excepted package – empty packaging
 - Radioactive material, excepted package – articles manufactured from natural uranium.
 - Radioactive material, excepted package – articles manufactured from depleted uranium.
 - Radioactive material, excepted package – articles manufactured from natural thorium.



CLASS 7 PROPER SHIPPING NAMES

- Required selections (cont'd):
 - Radioactive material, Type A package, fissile
 - Radioactive material, Type A package, special form
 - Radioactive material, Type A package, special form, fissile



CLASS 7 PROPER SHIPPING NAMES

- Required selections (cont'd):
 - Radioactive material, Type B(M) package, fissile
 - Radioactive material, Type B(U) package, fissile



CLASS 7 PROPER SHIPPING NAMES

- Selections based on activity and packaging type:
 - Radioactive material, Type A package
 - Radioactive material, Type B(M) package
 - Radioactive material, Type B(U) package



CLASS 7 PROPER SHIPPING NAMES

- Selections based primarily on material disposal:
 - Radioactive material, surface contaminated object (SCO-I) or SCO-II)
 - Radioactive material, low specific activity (LSA-I) or (LSA-II) or (LSA-III)



DEFINITION and ACTIVITY LIMITS

(LOW SPECIFIC ACTIVITY)

- *Low Specific Activity (LSA)* - material with limited specific activity (e.g. rocks, ores, etc).
- LSA material is in one of three groups:
 - *LSA-I*:
 - Specifically listed materials; or
 - Unlimited A_1 / A_2 nuclides; or
 - Other materials with activity *distributed throughout* and ≤ 30 x activity concentrations in §173.436 (or Table 8 if unlisted)



DEFINITION and ACTIVITY LIMITS

(LOW SPECIFIC ACTIVITY)

- *Low Specific Activity-II (LSA-II)*
 - Tritium water (≤ 0.8 TBq/L); or
 - Activity *distributed throughout* matrix
 - $\leq 10^{-4}$ A₂ /g solids or gases
 - $\leq 10^{-5}$ A₂ /g liquids
- *Low Specific Activity-III (LSA-III)*
 - Solids, excluding powders
 - Activity *distributed throughout* solid or collection of solid objects
 - Activity *essentially uniformly distributed* in a solid compact binding agent
 - Material is relatively insoluble
 - Estimated average specific activity $\leq 2 \times 10^{-3}$ A₂ /g



CALCULATING FOR LSA MATERIAL MIXTURE

$$\frac{\text{Total Activity} \cdot (\text{pkg})}{\text{Netweight (grams)}} \\ \text{(LSA-I Limit)(Mixture)}$$

ISOTOPE	ACTIVITY	MATRIX	ACTIVITY CONC.
Cf-252	0.75 MBq	15,000 g	1×10^1 Bq/g
Cd-115	0.74 MBq	15,000 g	1×10^2 Bq/g
Ga-67	0.41 MBq	15,000 g	1×10^2 Bq/g

Calculations Next Slide



CALCULATING FOR LSA MATERIAL MIXTURE

$$\frac{\text{Total Activity} \cdot (\text{pkg})}{\text{Netweight (grams)}} \\ \text{(LSA-I Limit)(Mixture)}$$

$$\frac{7.5 \times 10^5 \text{ Bq}}{15,000 \text{ g}} = 5.0 \times 10^1 \text{ Bq/g}$$

$$= \frac{5.0 \times 10^1 \text{ Bq/g}}{1.0 \times 10^1 \text{ Bq/g}} = 5.0$$

$$\frac{7.4 \times 10^5 \text{ Bq}}{15,000 \text{ g}} = 4.93 \times 10^1 \text{ Bq/g}$$

$$= \frac{4.93 \times 10^1 \text{ Bq/g}}{1.0 \times 10^2 \text{ Bq/g}} = .49$$

$$\frac{4.1 \times 10^5 \text{ Bq}}{15,000 \text{ g}} = 2.73 \times 10^1 \text{ Bq/g}$$

$$= \frac{2.73 \times 10^1 \text{ Bq/g}}{1.0 \times 10^2 \text{ Bq/g}} = .273$$

Total: 5.766



SURFACE CONTAMINATED OBJECT

§173.403

- *Surface Contaminated Object* – a solid object which is not itself radioactive but which has radioactive material distributed on its surface (beta/gamma & low toxicity alpha)
 - SCO-I: (accessible area averaged over 300 cm²)
 - non-fixed contamination < 4 Bq/cm² (β, γ , low toxicity α) or .4 Bq/cm² (all other α)
 - fixed contamination < 4×10^4 Bq/cm² (β, γ , low toxicity α) or < 4×10^3 /cm² (all other α)
 - non-fixed plus fixed contamination < 4×10^4 Bq/cm² (β, γ , low toxicity α) or < 4×10^3 /cm² (all other α)
 - SCO-II: > SCO-I limits, and:
 - non-fixed contamination < 400 Bq/cm² (β, γ , low toxicity α) or 40 Bq/cm² (all other α)
 - fixed contamination < 8×10^5 Bq/cm² (β, γ , low toxicity α) or < 8×10^4 Bq/cm² (all other α) **and**
 - Non fixed plus fixed contamination plus fixed contamination < 8×10^5 Bq/cm² (β, γ , low toxicity α) **or** 8×10^4 Bq/cm² (all other α)



CONVEYANCE ACTIVITY LIMITS

(LSA and SCO)

Table 5, §173.427(e)

Nature of material	Activity limit for conveyances
1. LSA –I	No limit
2. LSA-II and LSA-III, Non-combustible solid	No limit
3. LSA-II and LSA-III, Combustible solids and all liquids and gases	100 A ₂
4. SCO	100 A ₂

Noncombustible solids are all materials with $\leq 1\%$ combustible material by content



IP REQUIREMENTS

(LSA and SCO)

Table 6, §173.427(e)

Contents	Industrial packaging type	
	Exclusive use shipment	Non exclusive use shipment
1. LSA-I		
Solid	IP-1	IP-1
Liquid	IP-1	IP-2
2. LSA-II		
Solid	IP-2	IP-2
Liquid and gas	IP-2	IP-3
3. LSA-III	IP-2	IP-3
4. SCO-I	IP-1	IP-1
5. SCO-II	IP-2	IP-2



DEFINITION and ACTIVITY LIMITS

SURFACE CONTAMINATED OBJECTS

- Surface Contaminated Object – a solid object which is not itself radioactive but which has radioactive material distributed on its surface.

§173.403		SCO-I	SCO-II
Accessible Non-fixed	beta/, gamma and low toxicity alpha	4 Bq/cm ²	400 Bq/cm ²
	Other alpha	0.4 Bq/cm ²	40 Bq/cm ²
Accessible Fixed	beta/, gamma and low toxicity alpha	40,000 Bq/cm ²	800,000 Bq/cm ²
	Other alpha	4,000 Bq/cm ²	80,000 Bq/cm ²
Inaccessible Surfaces	beta/, gamma and low toxicity alpha	40,000 Bq/cm ²	800,000 Bq/cm ²
	Other alpha	4,000 Bq/cm ²	80,000 Bq/cm ²



MIXED LSA MATERIAL & SCO PACKAGE

- Each must meet category requirements prior to consolidation
- Identity of package for shipment
 - If $< A_2$ total in package, identity is LSA Material
 - If $> A_2$ total in package, identity is based on category contributing greatest A_2 fraction