



# Transportation of Radioactive Material

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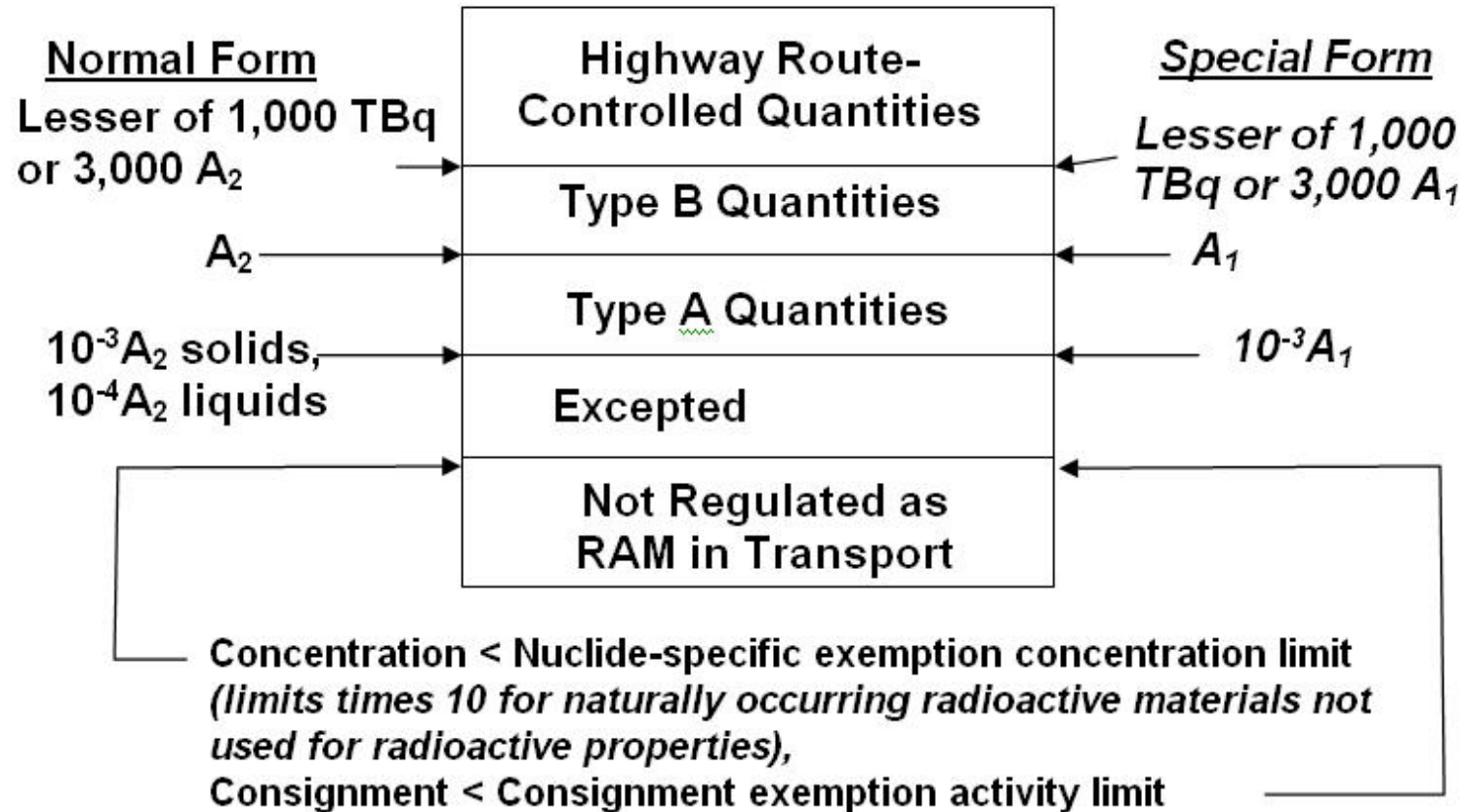
Transportation and Siting for Fission Batteries Workshop  
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# Domestic Transportation Regulations

- U.S. Nuclear Regulatory Commission (NRC) and U.S. Department of Transportation (DOT) co-regulate radioactive material transportation
  - NRC transportation regulations (10 CFR Part 71)
  - DOT transportation regulations (49 CFR Parts 107; 171 – 180)
- NRC only regulates a portion of radioactive material transportation
- NRC and DOT regulations are compatible
- The Memorandum of Understanding (MOU) (44 FR 38690), published July 2, 1979, delineates the respective agency responsibilities

<http://www.nrc.gov/what-we-do/regulatory/enforcement/moudot.pdf>

# Activity and Packaging Types



# Transportation Packages

- Type A fissile package (Type AF)
  - Less than a Type B quantity (less than  $A_2$  value in 10 CFR Part 71, Table A-1)
  - $A_2$  value for uranium (U) with enrichment  $\leq 20$  weight percent U-235 is unlimited (see Table A-1)
- Type B package (Type B or Type BF)
  - Greater than  $A_2$  value from 10 CFR Part 71, Table A-1
  - Enrichments  $> 20$  weight percent U-235, mass dependent

# Packaging and Transportation

## Philosophy

- Three safety functions
  - Shielding – limit external radiation dose rates
  - Containment – limit release of radioactive material
  - Subcriticality – prevent criticality in transport
- NRC reviews/approves the package design that was evaluated


# Transportation Tests

- Normal conditions of transport (10 CFR 71.71)
  - Hot and cold temperatures
  - Reduced and increased external pressure
  - Vibration
  - Water spray
  - Free drop (1 to 4 feet)
  - Corner drop
  - Compression test
  - Penetration test
- Hypothetical accident conditions (10 CFR 71.73)
  - 30-foot drop test
  - 40-inch puncture test
  - 30-minute fire at 1,475 degrees Fahrenheit
  - Immersion test

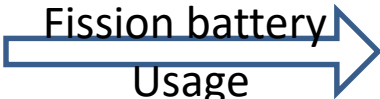
# Transportation Tests cont'd

- Tests for fissile packages transported by air (10 CFR 71.55(f))
- Tests for plutonium package transported by air (10 CFR 71.88, 10 CFR 71.64 and 10 CFR 71.74)

# Package Approval Criteria

- Type AF  Type BF package
- Criticality safety
  - Single package
  - Array of packages
- Containment—Type B packages only
  - Leakage rate testing for Type B packages (10 CFR 71.51, “Additional Requirements for Type B Packages”)
- Shielding
  - Dose rates in 10 CFR 71.47, “External Radiation Standards for All Packages” after tests for normal conditions of transport
  - Dose rate less 1 rem/h at 1 m from the package surface after tests for hypothetical accident conditions (10 CFR 71.51)

Unlimited  $A_2$  Type AF  
Unshielded package

 Fission battery  
Usage

$$A_2 \text{ for mixture} = \frac{1}{\sum_i \frac{f(i)}{A_2(i)}}$$

Heavily shielded Type BF package



# Radiation level limits (10 CFR 71.47 and 49 CFR 173.441)

Package and Vehicle Radiation Level Limits (§ 173.441) <sup>1</sup>				
		Nonexclusive Use Shipment	Exclusive Use Shipment	
		Open or Closed Transport Vehicle	Open (flat-bed)	Closed Transport Vehicle
Package Limits:	External Surface	2 mSv/h (200 mrem/h)	2 mSv/h (200 mrem/h)	10 mSv/h (1000 mrem/h)
	Transport Index (TI) <sup>2</sup>	10	No limit	
	Criticality Safety Index (CSI) <sup>5</sup>	50	No limit	
Transport Vehicle Limits (highway and rail):	Any point on the outer surface	N/A	N/A	2 mSv/h (200 mrem/h)
	Vertical planes projected from outer edges		2 mSv/h (200 mrem/h)	N/A
	Top of		Load: 2 mSv/h (200 mrem/h)	Vehicle: 2 mSv/h (200 mrem/h)
	2 meters from		Vertical Planes: 0.1 mSv/h (10 mrem/h)	Outer Lateral Surfaces: 0.1 mSv/h (10 mrem/h)
	Underside		2 mSv/h (200 mrem/h)	
	Occupied position	N/A <sup>3</sup>	0.02 mSv/h (2 mrem/h) <sup>4</sup>	
	Sum of package TIs	50	No limit	
	Sum of package CSIs <sup>5,6</sup>	50	100	

<sup>1</sup> The limits in this table do not apply to excepted packages. [§§ 173.421, 173.424, 173.426, and 173.428]

<sup>2</sup> The dimensionless number equivalent to maximum radiation level at 1 meter (3.3 feet) from the exterior package surface is in mrem/h rounded up to the next tenth. [§ 173.403]

<sup>3</sup> No dose limit is specified, but separation distances apply to packages with RADIOACTIVE YELLOW-II, RADIOACTIVE YELLOW-III, or CSI labels. (§ 177.842)

<sup>4</sup> Does not apply to carriers if operating under a state or federally-regulated radiation protection program and if personnel wear radiation dosimetry devices. [§ 173.441(b)(4)]

<sup>5</sup> These provisions do not apply to shipment by vessel. See § 176.700–720 for the vessel requirements.

<sup>6</sup> The number of packages containing fissile material stored in transit in any one storage area must be limited so that the total sum of the CSIs is ≤50 and such groups of packages must be spaced at least 6 meters (20 feet) from other such groups. [§§ 173.457 and 173.459]

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