UNIT 7
SHIPPING REQUIREMENTS

U.S. Nuclear Regulatory Commission and Agreement States

"Transportation of Radioactive Materials"
NRC Course H-308

OBJECTIVES

- Identify the marking and labeling requirements for transport of Radioactive Material.
- Apply marking requirements to over-packs.
- Determine the appropriate label to be applied to a given radioactive material package or over-pack and the Transport Index.
- Identify vehicle placarding requirements.

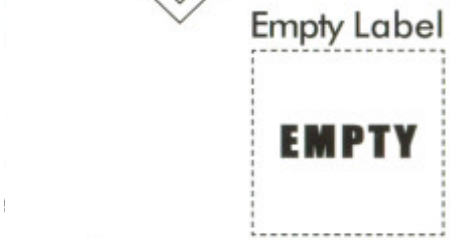
COMMUNICATION OF CONTENTS

- RAM has unique communications.
- The regulations require that the hazards posed by the material(s) and the consignment are clearly communicated to all parties concerned to facilitate:
  - Complete radiation protection at all phases
  - Correct emergency response for accidents

10 CFR 71.5

COMMUNICATION OF CONTENTS

- Hazard communications are accomplished by:
  - Marking material and packages
  - Labels on packages
  - Placards on freight containers, tanks, road and rail vehicles
  - The transport document
  - Emergency response information



Labels

Placard

49 CFR Subpart C, D, E, F and G; 10 CFR 71.5

GENERAL REQUIREMENTS FOR APPLICATION OF PACKAGE MARKINGS

- Durable
- Legible
- Visible
- Contrasting background
- In English – International too
- Size
  - ½ inch for non-bulk packages (recommended)
  - 1” – 4” depending on bulk packaging type

49 CFR 172.304

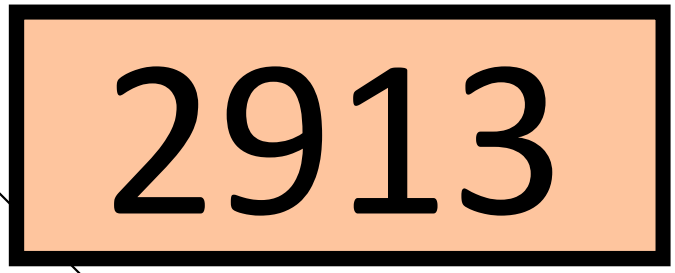
MARKING REQUIREMENTS FOR NON-BULK RADIOACTIVE MATERIAL CONTENTS

- Proper shipping name
- UN Number
- To/From information
- Others specific to content/package
  - Gross weight (if > 50 Kg or 110 lbs) or NRC packaging
  - Package type as appropriate
  - VRI Code: Country code of design (e.g. “USA”)
  - Trefoil symbol (Type B(*) packages
  - USA if for export
- Package certification marking
- Others as applicable
  - RQ, DOT–SP (DOT Special Permit), etc.

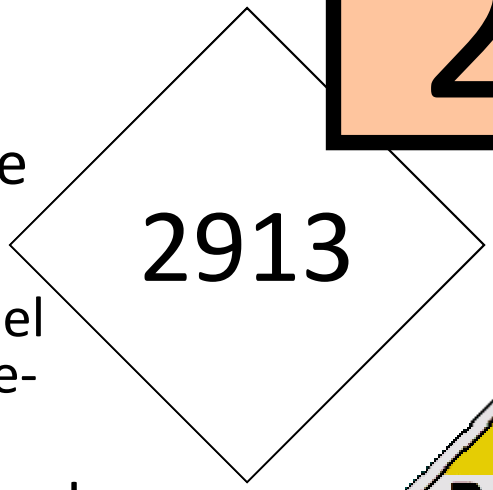
Specific to Class 7 Materials

MARKING REQUIREMENTS FOR BULK RADIOACTIVE MATERIAL PACKAGES

- Is it a bulk package?
  - Only "general" definition
  - PHMSA opinion letter
- Each package type unique
- Identification number
  - ID number in orange panel display or in white square-on-point configuration
- Gross mass if NRC approved package
- ID number not authorized in a Class 7 domestic placard



Non-bulk: requires "UN####"



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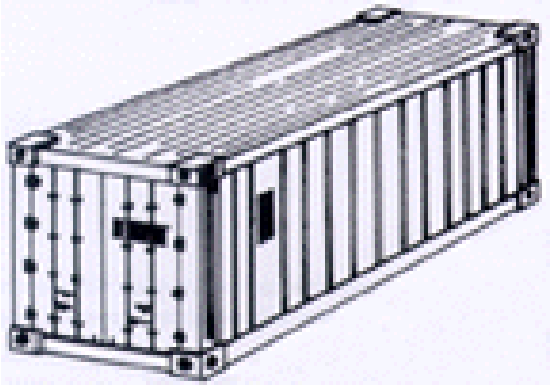
MARKING EXCEPTIONS

FOR LSA/SCO IN EXCLUSIVE USE CONVEYANCE

- LSA/SCO < $_{A2}$ VALUE
  - "RADIOACTIVE – LSA"
  - "RADIOACTIVE – SCO"

    Only 2 required markings

    and
  - "RQ"
- Full shipper paper required



49 CFR 173.427(a)(6)

MARKING REQUIREMENTS EXCEPTED PACKAGES

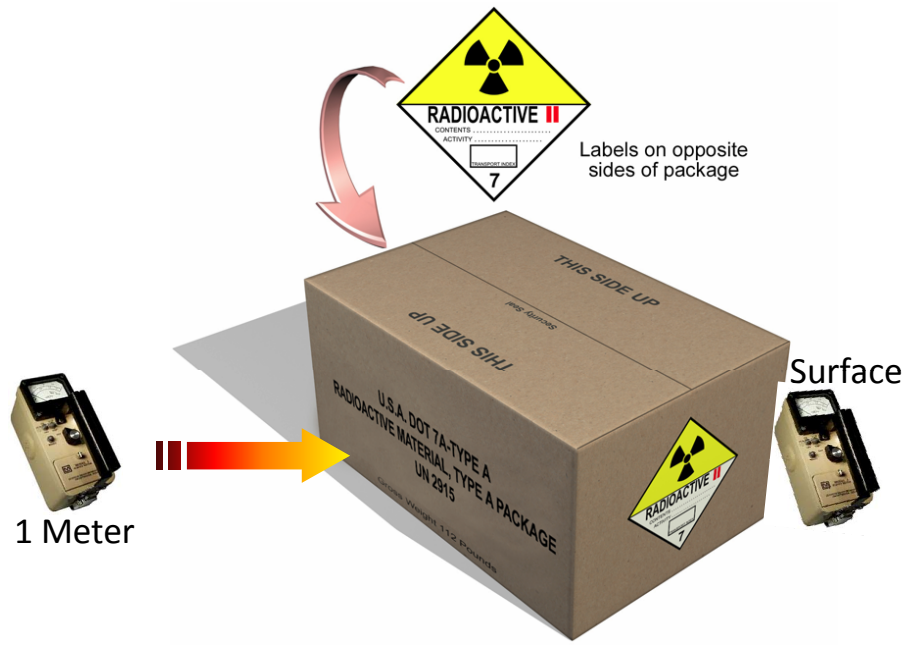
- UN Number on each package and for…
  - Limited Quantity [§173.421(a)(4)]
    - "RADIOACTIVE" on inner container or outer package if inner is not present
  - Instrument or Article
    - Nothing else required (unless by air)
  - Articles from U/Th only (§173.426)
    - "RADIOACTIVE" on inner container or outer package if inner is not present
  - Empty Packages (§173.428)
    - Empty label required

No shipping Paper is required. Even the *Certification Notice* of §173.422(a) required for many Years was removed from the regulations effective 10/1/04!

49 FR 173.421 – 173.426; 173.428

PACKAGE LABELING

- Three categories
  - Radioactive White-I
  - Radioactive Yellow-II
  - Radioactive Yellow-III
- Selection of appropriate category
  - Based on Table, §172.403
  - Highest category assumes precedence
  - Package transported as Highway Route Controlled Quantity always a Radioactive Yellow III regardless of above criteria



Primarily based on surface radiation level and TI

49 CFR 172.403; 173.403; 10 CFR 71.4

PACKAGE LABELING

- Categorization of packages is primary factor in selection of radioactive label

DETERMINING THE APPROPRIATE CATEGORY OF LABEL TO APPLY

§172.403(c)

Transport index	Maximum radiation level at any point on the external surface	Label category[1]
0[2]	Less than or equal to 0.005 mSv/h (0.5 mrem/h)	White I
More than 0 but not more than 1	Greater than 0.005 mSv/h (0.5 mrem/h) but less than or equal to 0.5 mSv/h (50 mrem/h)	Yellow II
More than 1 but not more than 10	Greater than 0.5 mSv/h (50 mrem/h) but less than or equal to 2 mSv/h (200 mrem/h)	Yellow III
More than 10	Greater than 2 mSv/h (200 mrem/h) but less than or equal to 10 mSv/h (1,000 mrem/h)	YELLOW-III (Must be shipped under exclusive use provisions; see 173.441(b).

1. Any package containing a “highway route control quantity” (173.403) must be labeled as “RADIOACTIVE YELLOW-III”
2. If the measured TI is not greater than 0.05, the value may be considered to be zero.

DETERMINING THE TRANSPORT INDEX

- Determining the TI
  - Maximum radiation level in mSv/hr @ 1 m (RL_{1m})
  - Multiply value determined by 100
  - Resulting number is the TI

$$(RL_{1m})\ (mSv/hr \times 100) = TI\ (\text{unitless number})$$

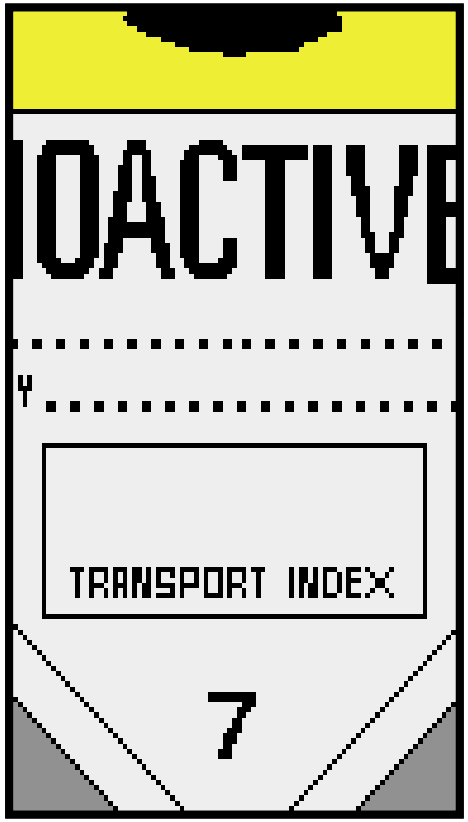
- Round up to the next highest decimal
- TI $\leq$ 0.05 may be considered zero (0) [§172.403(c)(2)]

The Transport Index is the highest dose rate in mrem/hr, at 1 meter from the package…Including top and bottom!

KEY COMPONENT IN LABEL SELECTION

TRANSPORT INDEX

- The transport index is a single number assigned to a package, over-pack, tank, or freight container used to provide control over radiation exposure and establish transport controls.



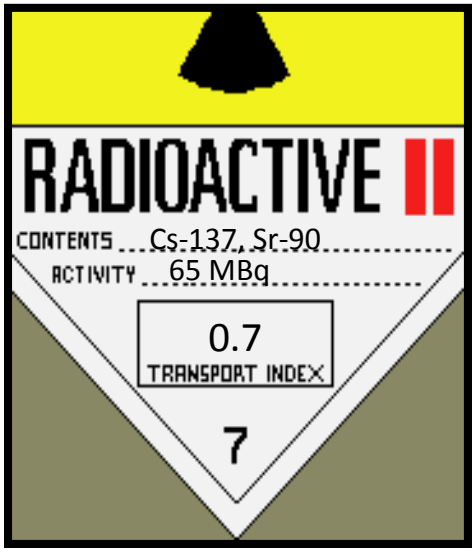
49 CFR 173.403; 10 CFR71.4

TI APPLIES TO MORE THAN JUST LABEL DETERMINATION

- TI is also used to establish:
  - Content limits on packages, overpacks, tanks or freight containers
  - Need for exclusive use shipment conveyance
    - Exclusive use has no TI limit
  - Spacing requirements during storage or transit
  - Mixing restrictions during transport or storage under special arrangements
  - Number of packages in freight container or conveyance

LABEL DATA

- Contents §172.403(g)(1)
  - Names or symbols of radionuclide(s)
  - "LSA-I" [in place of radionuclide(s)]
  - List most restrictive nuclides as room permits (based on 173.433)
- Activity [§172.403(g)(2)]
  - Maximum activity during transport (units of Bq with appropriate SI Prefix)
  - If fissile material, mass of fissile material in grams (or multiples thereof) may be inserted
- Transport Index §172.403(g)(3)
  - Applicable to Radioactive Yellow II and Radioactive Yellow-III label categories
  - Rounded UP to nearest first decimal



EMPTY LABEL

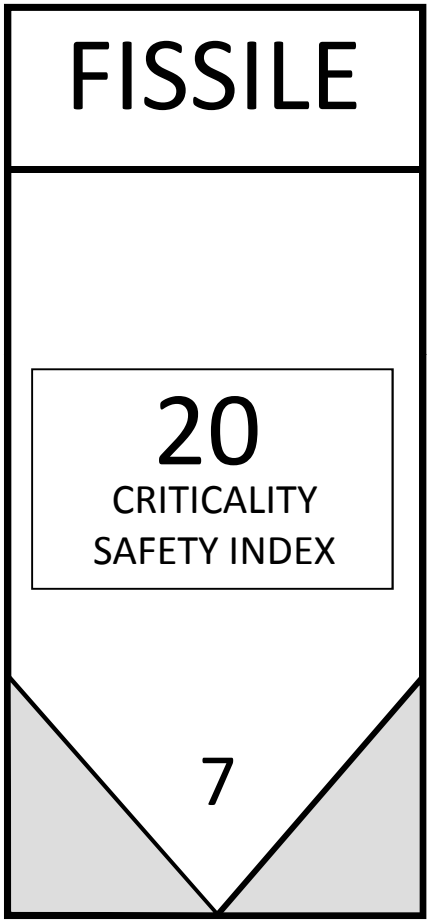
EMPTY: §173.428(d) & 172.403(d)

- EMPTY label – if package is:
  - Unimpaired condition
  - Outer surface covered with inactive sheath
  - Internal contamination < 100 times 173.443(a)
  - Remove, obliterate, or cover previously applied labels

  Meets requirements of 173.421(a)(2), (3) & (5)
  - Radiation level < 0.005 mSv/hr
  - Surface contamination ≤ Table 9 limits
  - Does not contain fissile material (unless excepted)

CRITICALITY SAFE INDEX

- A number assigned to a package, overpack or freight container containing fissile material used to provide control over the accumulation of fissile material [10 CFR 71.22(e); § 71.23(e); § 71.59(b)]
- Component of the fissile material package CoC based on 10 CFR 71.59

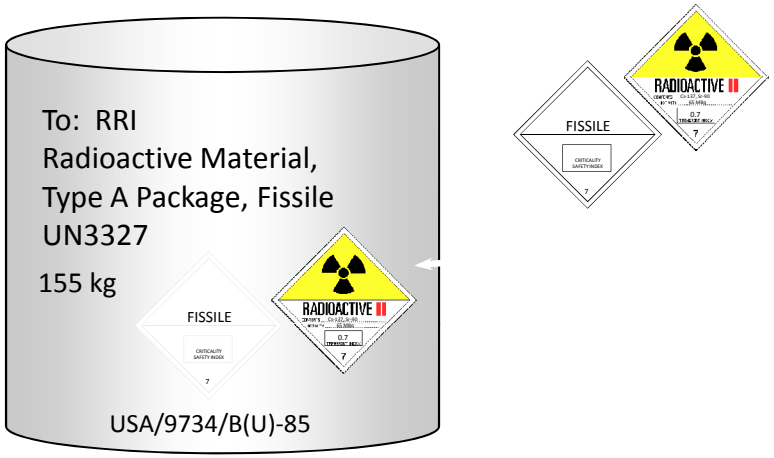


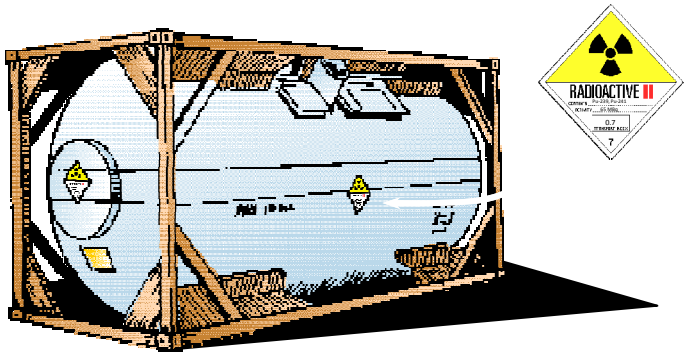
173.453 – fissile exceptions
173.457 – fissile requirements

49 CFR 173.403

APPLYING THE LABELS

- Label configuration on the package shall be:
  - Affixed on two opposite sides of the outside of a-
    - Package
    - Over-pack
    - Freight container
- Freight containers must have one label affixed near the opening
- Labels shall not cover the markings





49 CFR 172.403; 172.406

OTHER LABEL REQUIREMENTS

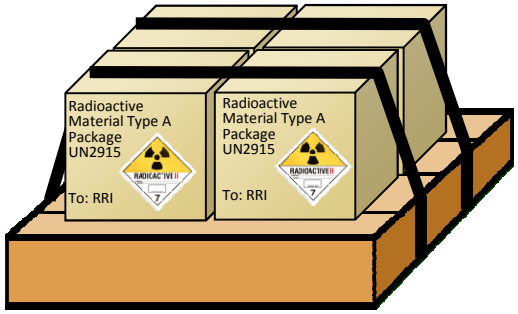
- Other hazardous materials
  - Additional labels as required for other hazardous materials
- Non-applicable labels
  - All labels not relating to the package content must be removed

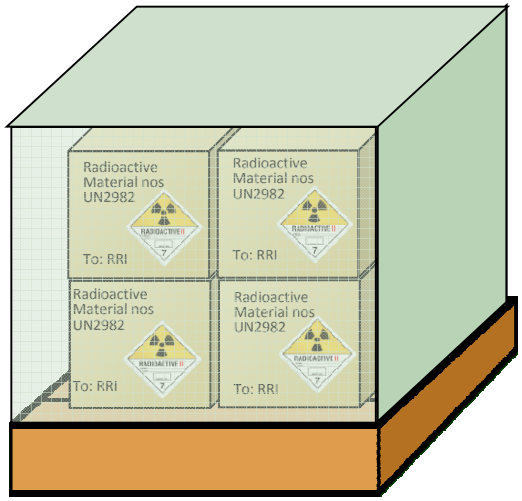
Subsidiary labels – within 6” of RAM label

49 CFR 172.401; 172.402; 172.406

RADIOACTIVE MATERIAL OVERPACKS

- Individual package(s) must meet prerequisite requirements
- Over-pack is a crate, box or pallet used for protection or convenience
- Over-pack fully marked per 49 CFR 172 Subpart D (Marking)
- In full compliance with §173.25(a)





49 CFR 171.8; 173.448(g)

RADIOACTIVE MATERIAL OVERPACKS

§173.25

- Requirements, Class 7 over-packs:
  - Marked in compliance: 49 CFR 172 Subpart D and 49 CFR 173.25(a)
  - Meet general requirements for packagings
  - No forbidden materials; and
  - Additional requirements for non-bulk packgings (173.24a)
- Problems for non-rigid pallet over-packs
  - Gross mass?
  - Transfer of marking to outer surface when some packages unseen?

49 CFR 171.8; 172 Subpart D; 173 25(a); 173.448(g)

RADIOACTIVE MATERIAL OVERPACKS

LABELING

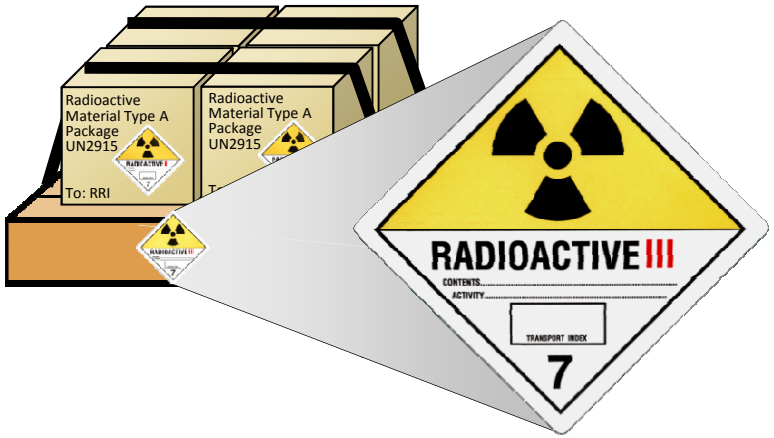
- Label determined in accordance with 172.403(h)
  - Non-rigid Over-pack: TI determined by aggregate total of TI's in the over-pack
  - Rigid Over-pack: TI determined by either:
    - Aggregate total of TI's in the over-pak, OR
    - Obtaining a new TI dose rate measurement
- Other information on label
  - Content: May state "MIXED" unless all packages contain same isotope(s)
  - Activity: Aggregate total activity of all packages in the over-pack
- Over-pack may require new label different from the packages contained

49 CFR 172.403 (h)

RADIOACTIVE MATERIAL OVERPACKS

SHIPPING PAPERS and PLACARDS

- Shipping Paper
  - Complete a description for each package in the over-pack, including labels applied
  - Summarize the description of the over-pack, including new over-pack label required
- Placard
  - Based on the label applied to the over-pack



4 boxes: UN2915; Radioactive Material, Type A Package;7; Am-241; solid; oxide; 0.4 MBq; Radioactive Yellow-II
label; TI = 0.3;…

1 Pallet; 4 boxes; Radioactive Yellow-III Overpack Label; TI = 1.2

49 CFR 172 Subpart C; 173.448(g)

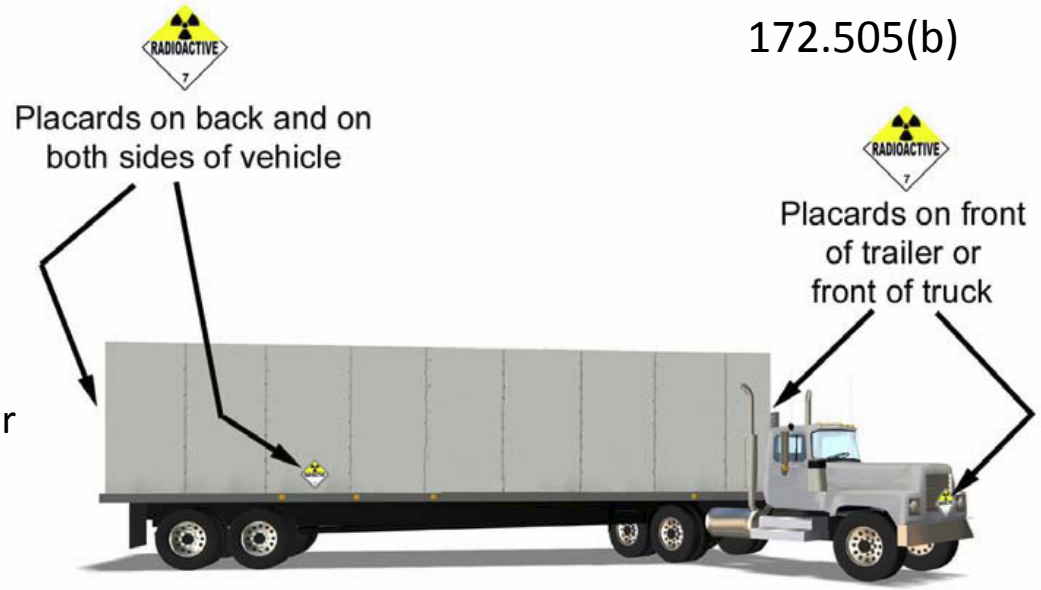
PLACARD DETERMINATION FOR RADIOACTIVE MATERIAL

Radioactive Yellow-III Labeled packages

LSA Material and SCO Utilizing the 173.427 (a)(6) exception

Highway Route Controlled Quantity package (On white square bkg – Highway only)

UF_6 subsidiary hazard (8) If $\geq$ 454 kg gross wt 172.505(b)



Display of placards Consistent with other Hazard placards (172.516)

PLACEMENT OF PLACARDS

ROAD and RAIL

- Rail vehicle: Both sides and both ends
- Road Vehicle: Both sides and both ends
  - Front of tractor in lieu of transport vehicle
- In the case of transport vehicles without sides:
  - Affix directly on cargo carrying unit if placards will remain readily visible
- In the case of transport vehicles carrying bulk package or freight containers
  - Placard on bulk package or freight container sufficient if placards will remain readily visible
- Placement for Other than vehicles
  - Either side and each end
    - Freight containers > 640 ft^3
    - Portable tank > 1,000 gallons
    - Cargo tank, rail tank car

49 CFR 172.504; 172.512; 172.514; 172.516

LOCATION OF PLACARDS

ROAD and RAIL

- Attached securely
- Located away from:
  - Appurtenances and devices
  - Tire/wheel splatterings
  - Advertisements or markings that reduce effectiveness (> 3”)
- Display diamond square-on-point (horizontal with words reading left-to-right)
- Visible on contrasting background
- Available to carrier by shipper for material being offered
- Affixed by carrier (exceptions for bulk packages)

49 CFR 172.516

CONTAMINATION CONTROL

Table 9, 173.443

Contaminant	Maximum permissible limits		
	Bq/cm^2	uCi/cm^2	dpm/cm^2
1. Beta and gamma emitters and low toxicity alpha emitters	4	10^{-4}	220
2. All other alpha emitting radionuclides	0.4	10^{-5}	22

Exclusive use: [(173.443(b)]

contamination < 10 times Table 9

Conveyance survey requirement

- < 0.005 mSv/hr
- no significant surface contamination

Closed transport vehicle (sole use) and contamination levels < 10 times Table 9 [(173.443(b)]

Conveyance survey requirement

- interior vehicle surfaces < 0.1 mSv/hr
- vehicle stenciled with “For Radioactive Materials Only”
- kept closed except for loading and unloading

INSPECTION POINTS

- Markings
  - Bulk, non-bulk, or undefined package
  - General requirements
  - Additional markings for excepted packages and LSA/SCO
  - Exceptions
  - Overpacks and palletized packages
- Labeling
  - Surface and 1 meter dose rates
  - Data entry
  - Placement and locations
  - Exceptions for excepted packages and LSA/SCO
  - Overpacks and palletized loads

SUMMARY

- Requirements applicable before a shipment
- Marking
- Labeling
- Placarding
- Overpack requirements