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
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

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####”
MARKING EXCEPTIONS
FOR LSA/SCO IN EXCLUSIVE USE CONVEYANCE

• LSA/SCO \(< A_2 \) VALUE
  – “RADIOACTIVE – LSA”
  – “RADIOACTIVE – SCO”

  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!
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

49 CFR 172.403; 173.403; 10 CFR 71.4
• Categorization of packages is primary factor in selection of radioactive label
**DETERMINING THE APPROPRIATE CATEGORY OF LABEL TO APPLY**

§172.403(c)

<table>
<thead>
<tr>
<th>Transport index</th>
<th>Maximum radiation level at any point on the external surface</th>
<th>Label category¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>0²</td>
<td>Less than or equal to 0.005 mSv/h (0.5 mrem/h)</td>
<td>White I</td>
</tr>
<tr>
<td>More than 0 but not more than 1</td>
<td>Greater than 0.005 mSv/h (0.5 mrem/h) but less than or equal to 0.5 mSv/h (50 mrem/h)</td>
<td>Yellow II</td>
</tr>
<tr>
<td>More than 1 but not more than 10</td>
<td>Greater than 0.5 mSv/h (50 mrem/h) but less than or equal to 2 mSv/h (200 mrem/h)</td>
<td>Yellow III</td>
</tr>
<tr>
<td>More than 10</td>
<td>Greater than 2 mSv/h (200 mrem/h) but less than or equal to 10 mSv/h (1,000 mrem/h)</td>
<td>YELLOW-III (Must be shipped under exclusive use provisions; see 173.441(b)).</td>
</tr>
</tbody>
</table>

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 (RL₁m)
  – Multiply value determined by 100
  – Resulting number is the TI

\[(RL_{1m}) \text{ (mSv/hr x 100) = TI (unitless number)}\]

• Round up to the next highest decimal

• TI ≤ 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!
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 CFR 71.4
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

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**Example Image:**
- **Contents:** Cs-137, Sr-90
- **Activity:** 65 MBq
- **Transport Index:** 7
EMPTY LABEL

- 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
  - 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
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

To: RRI
Radioactive Material, Type A Package, Fissile UN3327
155 kg

To: RRI
USA/9734/B(U)-85

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)
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
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)

$\text{UF}_6$ 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 ft³
    • 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)
## CONTAMINATION CONTROL

### Table 9, 173.443

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Maximum permissible limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bq/cm²</td>
</tr>
<tr>
<td>1. Beta and gamma emitters and low toxicity alpha emitters</td>
<td>4</td>
</tr>
<tr>
<td>2. All other alpha emitting radionuclides</td>
<td>0.4</td>
</tr>
</tbody>
</table>

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