Class 7 HAZMAT Employee Training

DOT/NRC – Radioactive Materials Shipment

Compliance with 49 CFR and 10 CFR 71
Training Objectives/Requirements

Training must include
- General awareness (familiarization with regulations)
- Function-specific training
- Safety training
- Security awareness training

Required documentation
- Trainee must take exam
- Copy of test and training must be available
GENERAL AWARENESS
Hazardous Materials Regulations

- For general awareness and familiarization with the regulations we suggest users of this training obtain the latest copy of the Hazardous Materials Regulations (HMR)
  - The current HMR may be found online
Applicable Regulations

The transfer and/or shipment of packages that contain radioactive materials are considered hazardous materials shipments and are governed by the following federal regulations:

- 49 CFR Parts 171-180, - Hazardous Materials Regulations (HMR)- Department of Transportation (DOT)
- 10 CFR Part 30.34(c) and Part 30.41- Nuclear Regulatory Commission (NRC) or equivalent state regulations
- 10 CFR Part 71 - Nuclear Regulatory Commission (NRC) or equivalent state regulations
Training Requirements

- DOT training is required
  - within 90 days of employment (initial), and
  - every 3 years thereafter (recurrent)
  - Training must be function specific

- If an employee will be performing duties before being trained, they may do so under the supervision of a fully trained individual.

49 CFR Part 172, Subpart H

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FUNCTION-SPECIFIC TRAINING
Function-Specific Activities

The following activities require training if the package contains radioactive material:

- Transferring
- Packaging
- Marking and labeling
- Measuring
- Preparing shipping papers
- Storing and loading/unloading
Transferring

- **Verify License**
  - Before radioactive material is transferred from one licensee to another, confirmation must be obtained
  - Confirm radionuclide and activity

- **Methods acceptable for verification:**
  - Possession of actual license
  - Written certification
Packaging

- Determine if package is defined as radioactive
  - Be aware some materials exempt from DOT regulations might still be subject to control under other license conditions or the NRC

- Determine activity in SI (not customary)
  - Becquerel (not Curie)
  - 1 mCi = 37000000Bq or 37MBq
The list on the left contains commonly used nuclear medicine radionuclides and the limits determining if the package will be radioactive by definition.

<table>
<thead>
<tr>
<th>Radio- nuclide</th>
<th>Activity concentration (uCi/g)</th>
<th>Consignment activity limit (uCi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m</td>
<td>$2.7 \times 10^{-3}$</td>
<td>270</td>
</tr>
<tr>
<td>F-18</td>
<td>$2.7 \times 10^{-4}$</td>
<td>27</td>
</tr>
<tr>
<td>I-123</td>
<td>$2.7 \times 10^{-3}$</td>
<td>270</td>
</tr>
<tr>
<td>I-131</td>
<td>$2.7 \times 10^{-3}$</td>
<td>27</td>
</tr>
<tr>
<td>Tl-201</td>
<td>$2.7 \times 10^{-3}$</td>
<td>27</td>
</tr>
<tr>
<td>In-111</td>
<td>$2.7 \times 10^{-3}$</td>
<td>27</td>
</tr>
<tr>
<td>Ga-67</td>
<td>$2.7 \times 10^{-3}$</td>
<td>27</td>
</tr>
</tbody>
</table>
Types of Packages

- Numerous types
  - Excepted
  - Type A
  - Industrial
  - Type B
  - Fissile

- Only concerned with Excepted and Type A
Packaging-Excepted Packages

- Excepted Packages also referred to as Limited Quantity shipments
  - Limited by:
    - Total activity
    - External radiation limits
    - Non-fixed contamination limits
  - What is (almost) always returned to your nuclear pharmacy

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Determination of Limited Quantity

  - \( A_1 \) is the maximum activity of special form material
  - \( A_2 \) is the maximum activity of normal form

- The list on the right contains some common nuclides used in nuclear medicine.

<table>
<thead>
<tr>
<th>Radio-nuclide</th>
<th>( A_1 ) (TBq)</th>
<th>( A_1 ) (Ci)</th>
<th>( A_2 ) (TBq)</th>
<th>( A_2 ) (Ci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m</td>
<td>10</td>
<td>270</td>
<td>4.0</td>
<td>110</td>
</tr>
<tr>
<td>F-18</td>
<td>1.0</td>
<td>27</td>
<td>0.6</td>
<td>16</td>
</tr>
<tr>
<td>I-123</td>
<td>6.0</td>
<td>160</td>
<td>3.0</td>
<td>81</td>
</tr>
<tr>
<td>I-131</td>
<td>3.0</td>
<td>81</td>
<td>0.7</td>
<td>19</td>
</tr>
<tr>
<td>Tl-201</td>
<td>10</td>
<td>270</td>
<td>4.0</td>
<td>110</td>
</tr>
<tr>
<td>In-111</td>
<td>3.0</td>
<td>81</td>
<td>3.0</td>
<td>81</td>
</tr>
<tr>
<td>Ga-67</td>
<td>7.0</td>
<td>190</td>
<td>3.0</td>
<td>81</td>
</tr>
</tbody>
</table>
Limited Quantities- Liquids

- If activity is less than $10^{-4}$ the A2 Value then considered Limited Quantity
- Limits for commonly used nuclear medicine liquid radionuclides listed to the right

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>MBq</th>
<th>mCi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m</td>
<td>400</td>
<td>11</td>
</tr>
<tr>
<td>F-18</td>
<td>60</td>
<td>1.6</td>
</tr>
<tr>
<td>I-123</td>
<td>300</td>
<td>8.1</td>
</tr>
<tr>
<td>I-131</td>
<td>70</td>
<td>1.9</td>
</tr>
<tr>
<td>Tl-201</td>
<td>400</td>
<td>11</td>
</tr>
<tr>
<td>In-111</td>
<td>300</td>
<td>8.1</td>
</tr>
<tr>
<td>Ga-67</td>
<td>300</td>
<td>8.1</td>
</tr>
</tbody>
</table>

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The list on the right contains other select nuclides used in nuclear medicine. Solids and gases have different limits based on the table in 49 CFR 173.425.

<table>
<thead>
<tr>
<th>Radioradionuclide</th>
<th>MBq</th>
<th>mCi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y-90</td>
<td>30</td>
<td>0.8</td>
</tr>
<tr>
<td>Ra-223</td>
<td>0.7</td>
<td>0.019</td>
</tr>
<tr>
<td>Xe-133 gas</td>
<td>10000</td>
<td>270</td>
</tr>
<tr>
<td>Lu-177</td>
<td>70</td>
<td>1.9</td>
</tr>
</tbody>
</table>
The list on the right contains limited quantity activities for solid radionuclides used in radiation oncology and nuclear medicine.

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>MBq</th>
<th>mCi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ir-192 solid</td>
<td>600</td>
<td>16</td>
</tr>
<tr>
<td>Ir-192 special form</td>
<td>1000</td>
<td>27</td>
</tr>
<tr>
<td>Mo-99 Generator</td>
<td>74</td>
<td>2</td>
</tr>
<tr>
<td>I-125 seeds</td>
<td>3000</td>
<td>81</td>
</tr>
<tr>
<td>Co-57 source</td>
<td>10000</td>
<td>270</td>
</tr>
<tr>
<td>Cs-137 source</td>
<td>600</td>
<td>16</td>
</tr>
</tbody>
</table>
Mixtures of Radionuclides

- Multiple radionuclides shipped together
  - Total activity limited to lowest activity (simplified)
- Example: Both Tc-99m and In-111 are being returned to a nuclear pharmacy in the same package. What is the maximum activity that can be in the package?
  - The Tc-99m limit is 11 mCi
  - The In-111 limit is 8.1 mCi
  - So the maximum total activity allowed is 8.1 mCi using the simplified method.
Package Design Requirements for Limited Quantity

- General Standards for all packages
- These packages can be called “strong, tight” packages.
- Examples include:
  - Ammo Boxes
  - Cardboard Boxes
Package Design Requirements for Type A

- Must pass rigorous series of tests
- Outside of package must feature a seal
- Must be made of inert material
- Integrity design
300 cm² on the surface of the package must be wiped.

Limit is 7200 dpm/300 cm² for most medical packages.

- Wipe all sides of all package.

Limits are the same regardless of package type.

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Maximum permissible wipe limits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bq/cm²</td>
</tr>
<tr>
<td>Beta and gamma emitters and low toxicity alpha emitters</td>
<td>0.4</td>
</tr>
<tr>
<td>All other alpha emitting radionuclides</td>
<td>0.04</td>
</tr>
</tbody>
</table>
MARKINGS

Radioactive Material Excepted Package
This package contains radioactive material, excepted package and is in all respects in compliance with the applicable international and national governmental regulations.

UN 2910
The information for this package need not appear on the Notification to Captain (NOTOC)
Package Markings

Marking means...
- a descriptive name,
- identification number,
- instructions,
- cautions,
- weight,
- specification,
- UN marks, or
- combinations of the above on outer packaging of hazardous materials
Marking Size Requirements

- The identification number marking preceded by “UN”, “NA”, or “ID” as appropriate must be marked in characters at least 12 mm (0.47 inches) high.

- Example:

  UN2910
Limited Quantity/ Excepted Package Markings

- Only UN number required
- Proper shipping name not required
- No other labels required on outside
  - Inner packaging must be marked “Radioactive”
Other Possible Markings

- Gross Mass
- Reportable Quantities
Markings for Type A

- Proper shipping name
- UN identification number
- Consignee name and address
- Markings must be
  - Durable
  - In English
  - Displayed on sharply contrasting color
  - Cannot be obscured by other labels

49 CFR 172.301(d)
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RADIOACTIVE PACKAGE LABELS
DOT Labels

- Diamond shaped “sticker”
- White I, Yellow II and Yellow III
- Activity indicated
- Hazard class
- Transport Index (TI)
Surface reading less than $<0.5 \text{ mR/hr} (<0.005 \text{ mSv/hr})$

1 meter reading background and background must be $<0.05 \text{ mR/hr} (<0.5 \text{uSv/hr})$
Yellow II Label

- Surface reading between 0.5–50 mR/hr (0.005-0.5 mSv/hr)
- 1 meter reading <1 mR/hr (<0.01 mSv/hr)
Yellow III Label

- Surface reading between 50–200 mR/hr (0.05-2.0 mSv/hr)
- 1 meter reading between 1–10 mR/hr (0.01-0.1 mSv/hr)
Transport Index (TI)

- Reading at 1 meter
  - Rounded up to one decimal
  - No units
- If < 0.05 then considered to be zero and marked as such
- Only on Yellow II and Yellow III packages
Determining Proper Label

- A used Co-57 flood source is to be returned to the manufacturer.
  - The current activity is 2.5 mCi
  - The one meter dose rate is 0.08 mR/hr
  - The surface dose rate is 0.6 mR/hr

- Is the package required to be labelled?
  - Yes

- Which label?
  - Yellow-II
“Empty” Package

- Empty is NOT expected
- External exposure and internal contamination limits
  - MUST wipe inside before returning
- Often this label used to return PET packages
SHIPPING PAPERS & CERTIFICATION
Shipping Papers

- Required on all packages that are not limited quantity

- Includes
  - Identification (UN) number
  - Proper shipping name
  - Hazard class
  - Shippers certification
  - Emergency contact
Proper Shipping Names and Identification Numbers

<table>
<thead>
<tr>
<th>Proper Shipping Name</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radioactive material, excepted package-empty packaging.</td>
<td>UN2908</td>
</tr>
<tr>
<td>Radioactive material, excepted package-instruments or articles.</td>
<td>UN2911</td>
</tr>
<tr>
<td>*Radioactive material, Type A package,</td>
<td>UN 2915</td>
</tr>
<tr>
<td>*Radioactive material, excepted package-limited quantity of material.</td>
<td>UN2910</td>
</tr>
</tbody>
</table>

* Most commonly shipped by nuclear medicine technologists.
Shipping Certification

- Declared on shipping paper
  - Certifies properly classed, marked and in good condition
  - Additional requirement for air shipments
- Must be legibly signed
Emergency Contact

- Required on shipping papers
- Must be live voice who answers
- Must be knowledgeable of material shipped
  - Should have copy of shipping paper
  - Note: be certain telephone number used is authorized
Emergency Contact

Necessary Emergency Response Information

- Description and technical name of the hazardous material
- Immediate health hazards
- Risk of fire and explosion
- Immediate precautions
- Immediate methods for handling fires
- Initial methods for handling spills or leaks in absence of fire
- First Aid
Shipping Paper Recordkeeping Requirements

- Record retention for outgoing shipments
  - 2 years after accepted by carrier
  - 3 years for radioactive waste disposal
- NO retention requirements for shipping receipt documentation
Example Emergency Response Information
SAFETY TRAINING
Hazmat employees to receive safety training

- Emergency response information
- Protection measures associated with hazardous materials
  - Personal Protective Equipment (PPE)
  - Time, distance and shielding
- Methods to avoid accidents
SECURITY AWARENESS
Security Awareness

- Security required during
  - Transport
  - Receipt
  - Storage
SHIPPING SEALED SOURCES
Shipment of Sealed Sources

- Utilize source return kit provided by manufacturer
- Usually limited quantity amount
  - Activity limited
  - Exposure rate limited
- Additional requirements for Type A packages
Sealed Source Shipment Checklist

- You need the following to properly ship any package
  - Authorization of receipt
  - Recent leak test
  - Radiation level survey of container at surface and 1 meter
  - External contamination
  - Proper marking (and possibly label)
  - Strong tight or Type A container
Please contact your MPC physicist if you have any questions regarding this training or shipping of packages containing radioactive materials.