HAZARDOUS MATERIALS SHIPPING:

DOT TRAINING, PART 1

PRESENTER

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  - Office of Radiation Safety
  - Department of Risk Management
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- Assistant/alternate RSO for medical/academic broadscope radioactive material licensee; Manages institutional RAM transportation and waste programs; manages dosimetry program; provides training in laboratory radioactive material safety, DOT regulations, regulations related to the medical use of radioactive material (10CFR35), etc.
- Loma Linda University Health is a University/Medical Center (Level 1 trauma center)
- Includes 6 hospitals in three cities with 1,045 licensed beds
- University includes schools of medicine, dentistry, pharmacy, nursing, allied health professions, public health, religion, behavioral health with over 1500 faculty members
- Over 16,000 employees
- Campus Transformation Project with new adult and children's hospitals
  - 17 floors; 320 adult beds/128 children's beds
  - Approximately 1 million square feet constructed with ability to withstand earthquakes (126 base isolators) and will be most seismically sophisticated building in North America
  - Tallest building in San Bernardino County
  - Heaviest per square foot building in North America (over 48 lbs of steel/square foot); more steel than Eiffel Tower

LEARNING OBJECTIVES

- Review NRC and DOT regulations applicable to the following:
  - Training and certification of personnel who package/ transport radioactive material
  - Classification of radioactive material
    - Special vs. Normal form
    - Quantities
  - Packaging of radioactive material
  - Labeling and marking of radioactive material packages
  - Transportation of radioactive material
  - Radiation level limits and contamination control
  - Receipt and opening of radioactive material packages

OUTLINE – PART 1

- Regulations and Guidance
- Definitions
- Enforcement: Assessments and Fines
- Training
- General Information
- Quantities
- Packaging
- Markings
- Labeling
- Shipping Papers

OUTLINE – PART 2

- Emergency Response Information
- Contamination Limits/Radiation Level Limits
- Placards
- Security and Safety Plans
- Incident Reporting
- Package Receipt
- Practical Application
- Conclusion
- Sample Questions

REGULATIONS AND GUIDANCE

REGULATIONS/GUIDANCE

- 10 CFR 71: Packaging and Transportation of Radioactive Materials (NRC)
- 49 CFR 100 – 185: Hazardous Materials Regulations (DOT)
- 10 CFR 20: Standards for Protection Against Radiation (NRC)
- For Agreement States, may also be some State regulations (California – refers to 10 CFR 71)

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS (10CFR71)

- Purpose and Scope:
  - Apply to any licensee authorized to receive, possess, use, or transfer licensed material if licensee delivers material to a carrier, transports the material outside the site of usage listed on the license, or transports on public highways
  - Requirements for packaging, preparation for shipment, and transportation
  - Procedures and standards for NRC approval of packaging
  - Shipping procedures for fissile material and material > Type A quantities (Type B)
  - IN ADDITION TO, not in place of, other regulations and requirements

PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS (10CFR71)

- Subpart A – General Provisions – Incorporates applicable DOT Regulations
- Subpart B – Exemptions
  - Licensee exempt from the requirements for this part (10CFR71) if:
    - Exempt quantity or consignment
  - Licensee exempt from the requirements for this part (10CFR71) except for DOT requirements in §71.5 if
    - Package does not contain fissile material (or is exempt from classification of fissile)
    - Package contains no more than Type A quantity
    - Package contains only LSA-I, SCO-I or LSA/SCO material that has an external radiation dose ≤ 10 mSv/h (1 rem/h) @ 3 m
- Subpart C – General License (packages)
- Subpart D – Application for package approval
- Subpart E – Package approval standards
- Subpart F – Package, Special Form, and LSA-III Tests
- Subpart G – Operating Controls and Procedures
- Subpart H – Quality Assurance
- Appendix A – Determination of A_1 and A_2; Exempt Quantities (same as DOT)

HAZARDOUS MATERIALS REGULATIONS (49CFR 100-185)

- Applicability (§172.3):
  - Each person who offers a hazardous material for transportation
  - Each carrier by air, highway, rail, or water who transports hazardous material

HAZARDOUS MATERIALS REGULATIONS (49CFR PARTS 105, 107, 109, 110, 130)

- Subchapter A – Hazardous Materials and Oil Transportation
  - Part 105 – Hazardous Materials Program Definitions and General Procedures
  - Part 106 – Rulemaking Procedures
  - Part 107 – Hazardous Materials Program Procedures
    - **Subpart G – Registration of Persons Who Offer or Transport Hazardous Materials (HRCQ)**
  - Part 109 – Department of Transportation of Hazardous Material Procedural Regulations
  - Part 110 – Hazardous Materials Public Sector Training and Planning Grants
- Subchapter B – Oil Transportation
  - Part 130 – Oil Spill Prevention and Response Plans

HAZARDOUS MATERIALS REGULATIONS (49 CFR PART 171)

- Subchapter C – Hazardous Materials Regulations
  - Part 171 – General Information, Regulations, and Definitions
    - Subpart A – Applicability, General Requirements, and North American Shipments
    - **Subpart B – Incident Reporting, Notification (and registration for carriers of HRCQ or quantities requiring placards) (§171.15, 16)**
    - Subpart C – Authorization and Requirements for the Use of International Transport Standards and Regulations

HAZARDOUS MATERIALS REGULATIONS (49 CFR PART 172)

- Part 172 – Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans
  - Subpart A – General
  - Subpart B – Table of Hazardous Materials and Special Provisions
  - **Subpart C – Shipping Papers**
  - **Subpart D – Marking**
  - **Subpart E – Labeling (§172.400 – 407; 172.436 – 441)**
  - **Subpart F – Placarding (§172.500 – 519; 172.526; Appendices B & C – Trefoil symbol/Dimensional Specifications)**
  - **Subpart G – Emergency Response Information**
  - **Subpart H – Training**
  - **Subpart I – Safety and Security Plans**
- Appendix A to §172.101 – List of Hazardous Substances and Reportable Quantities

HAZARDOUS MATERIALS REGULATIONS (49 CFR PART 173)

- Part 173 – Shippers – General Requirements for Shipments and Packagings
  - **Subpart A – General**
    - *"In general, the Hazardous Materials Regulations (HMR) contained in this subchapter are based on the UN Recommendations and are consistent with international regulations issued by the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMDG Code). However the HMR are not consistent in all respects with the UN Recommendations, the ICAO Technical Instructions or the IMDG Code, and compliance with the HMR will not guarantee acceptance by regulatory bodies outside of the United States"*
  - **Subpart B – Preparation of Hazardous Materials for Transportation**
  - Subpart C – Definitions, Classification and Packaging for Class 1
  - Subpart D – Definitions, Classification, Packing Group Assignments and Exceptions for Hazardous Materials Other than Class 1 and Class 7
  - Subpart E – Non-bulk Packaging for Hazardous Materials
  - Subpart F – Bulk Packaging for Hazardous Materials Other than Class 1 and Class 7
  - Subpart G – Gases; Preparation and Packaging
  - Subpart H – [Reserved]
  - **Subpart I – Class 7 (Radioactive) Materials**

HAZARDOUS MATERIALS REGULATIONS (49 CFR PART 174, 175, 176)

- Part 174 – Carriage by Rail
  - **Subpart A – General Requirements**
  - **Subpart B – General Operating Requirements**
  - **Subpart C – General Handling and Loading Requirements**
  - **Subpart D – Handling of Placarded Rail Cars, Transport Vehicles and Freight Containers**
  - **Subpart K – Detailed Requirements for Class 7 (Radioactive) Materials**
- **Part 175 – Carriage by Aircraft**
- Part 176 – Carriage by Vessel
  - **Subpart A - General**
  - **Subpart B – General Operating Requirements**
  - **Subpart C – General Handling and Stowage**
  - **Subpart D – General Segregation Requirements**
  - **Subpart E – Special Requirements for Transport Vehicles Loaded with Hazardous Materials**
  - **Subpart F – Special Requirements for Barges**
  - **Subpart M – Detailed Requirements for Radioactive Materials**

HAZARDOUS MATERIALS REGULATIONS (49 CFR PART 177-180)

- **Part 177 – Carriage by Public Highway (and parts 390-397)**
  - Parts 390 – 397 includes driving and parking rules for radioactive materials (placarded vehicles)
    - Consideration of route, accident rates, transit time, population density, etc.
    - HRCQ must be transported over "preferred routes" which are interstate system highways without designated alternative State routes or State-designated routes, etc.
- Part 178 – Specifications for Packagings
- Part 179 – Specifications for Tank Cars
- Part 180 – Continuing Qualification and Maintenance of Packagings

STANDARDS FOR PROTECTION AGAINST RADIATION (10CFR20)

- Package Opening Procedures
- Incident Notifications

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

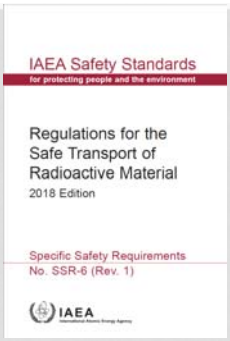
- Worldwide
- Represents most major scheduled airlines
- Airline safety
- Dangerous Goods Regulations manual
- Standard recognized by airlines

- FedEx

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO)

- UN body which focuses on international harmonization of civil aviation regulations
- Codes used for "official" purposes such as air traffic control

INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)



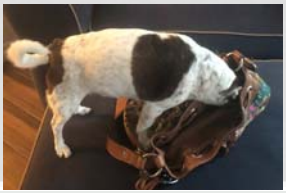
INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

- Regulations for the Safe Transport of Radioactive Material (2018)
- Apply to transport by all modes; including transport incidental to the use of RAM
- Includes design, manufacture, maintenance, repair of packaging; preparation, consigning, loading, carriage, unloading and receipt of RAM and packages
- Same exemptions as DOT/NRC and
  - RAM in or on a person who is transported for medical treatment due to accidental or deliberate intake or to contamination
  - RAM in consumer products that have regulatory approval

AND NOW…

- Review important topics that relate to what we typically do with radioactive materials
- Focus on HMR (Hazardous Materials Regulations)
- Some NRC requirements

- Won't cover fissile, HRCQ, bulk packages



DEFINITIONS

DEFINITIONS (§173.403, 10CFR71)

- **A_1** – Maximum activity of special form material permitted in a type A package (§173.435 Table of A_1 and A_2 values)
- **A_2** – Maximum activity of material other than special form, LSA, and SCO permitted in a type A package (§173.435 Table of A_1 and A_2 values)
- **Acting Knowingly** – Acting or failing to act while having actual knowledge of the facts giving rise to the violation or having the knowledge that a reasonable person acting in the same circumstances and exercising due care would have had.
- **Certificate of Compliance** - Certificate issued by the NRC under Subpart D that approves the design of a package for transport of RAM (Type B/fissile)
- **Closed Transport Vehicle** – Vehicle with a securely attached exterior enclosure that during normal transportation restricts the access of unauthorized persons to the cargo space containing class 7 materials. May be temporary or permanent; or see-through. Must limit access from top, sides, and bottom.

DEFINITIONS (§173.403, 10CFR71)

- **Competent Authority** – National agency that is responsible (under national law) for control or regulation of some aspects of hazardous materials transportation
  - Competent Authority approval required for:
    - Special form radioactive material
    - Low dispersible radioactive material
    - Fissile material
    - Packages containing ≥ 0.1 kg uranium hexafluoride
    - Packages containing fissile material (unless excepted)
    - Type B(U) and B(M) packages (unilateral/multilateral)
    - Type C packages (small amounts of high activity RAM transported by aircraft – can survive more severe transport incidents/accidents – not required by transport regulations)
    - Special arrangements
    - Calculation of A and exempt limits not listed in tables
    - Etc.
- **Consignment** – Each shipment of package or groups of packages or load of RAM offered by shipper for transport in the same shipment

DEFINITIONS (§173.403, 10CFR71)

- **Containment System** – Assembly of components of packaging intended to retain RAM during transport
- **Contamination** – Presence of RAM greater than allowable limits
  - Fixed: Contamination that cannot be removed from the surface during normal conditions of transport
  - Non-fixed: Contamination that can be removed from the surface during normal conditions of transport
- **Conveyance**
  - Public highways/rail: Any transport vehicle or large freight container
  - Water: Any vessel, hold, compartment, defined deck area, including any transport vehicle on board
  - Air: Any aircraft

DEFINITIONS (§173.403, 10CFR71)

- **Excepted** – Excepted from specific DOT requirements – NOT EXEMPT
- **Exclusive Use** – Sole use by a single consignor of a conveyance for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee.
  - Consignor must ensure that any loading or unloading is performed by personnel having radiological training and appropriate resources for safe handling.
  - Consignor must have specific written instructions for maintenance of exclusive use shipment controls and include them with the shipping paper information provided to the carrier
- **Fissile Material** – U-233, U-235, Pu-239, Pu-241 or any combination
- **HMR** – Hazardous Materials Regulations; 49CFR171 – 180

DEFINITIONS (§173.403, 10CFR71)

- **HRCQ** – Highway Route Controlled Quantity
  - 3,000 x A_1 for special form,
  - 3,000 x A_2 for normal form; OR
  - 27,000 Ci whichever is LESS
- **Hazardous Substance –** Listed in Appendix A to §172.101 (RQ); has a quantity in one package ≥ RQ; sum of fractions for mixture of radionuclides exceeds unity
- **Hazardous Waste –** Any material that requires a Hazardous Waste Manifest

DEFINITIONS (§173.403, 10CFR71)

- **Hazmat Employee – A person who is:**
  - Employed full-time, part time, temporary by a hazmat employer and who directly affects hazardous materials safety
  - Loads, unloads, or handles hazmat
  - Designs, manufacturers, fabricates, inspects, marks, maintains, reconditions, repairs, tests a package, container, component
  - Prepares hazmat for transportation
  - Responsible for safety of transporting hazmat
  - Operates a vehicle transporting hazmat
- **Hazmat Employer – A person who:**
  - Is self-employed or employs or uses at least one hazmat employee (includes government departments, agencies, etc.)
  - Transports hazardous materials in commerce
  - Causes hazardous materials to be transported in commerce
  - Designs, manufactures, fabricates, inspects, marks, maintains, reconditions, repairs or tests a package, container or component that is represented, marked, certified, or sold by that person as qualified for use in transporting hazardous materials in commerce

DEFINITIONS (§173.403, 10CFR71)

- **Limited Quantity** – Quantity of RAM not exceeding package limits specified in §173.425 and conforming with requirements in §173.421
- **Low Specific Activity (LSA)** – RAM with limited specific activity which is non-fissile (or is excepted under §173.453 – exceptions to fissile material) and meets descriptions/activities. PROBABLY NOT IMPORTANT UNLESS YOU HAVE YOUR OWN TRANSPORTATION PROGRAM!
  - Classification depends upon specific activity and whether solid/liquid, possibility of leaching, etc.
- **Low Toxicity Alpha Emitters** – Natural uranium, depleted uranium, natural thorium, U-235, U-238, Th-232, Th-228, Th-230 when contained in ores or physical or chemical concentrates or tailings or alpha emitters with $T_{1/2} < 10$ days
- **Normal Form** – RAM not demonstrated to be Special Form
- **PHMSA** – Pipeline and Hazardous Materials Safety Administration

DEFINITIONS (§173.403, 10CFR71)

- **Package** – Packaging together with radioactive contents as presented for transport (Excepted, Industrial, Type A, Type B, etc.)
- **Packaging** – Assembly of components necessary to ensure compliance with packaging requirements.
- **Radiation Level** – Radiation dose-equivalent rate in mSv/hr or mrem/hr. Sum of all dose-equivalent rates from all types of ionizing radiation present

DEFINITIONS (§173.403, 10CFR71)

- **Radioactive instrument or article** – Any manufactured instrument or article such as an instrument, clock, electronic tube or apparatus, or similar item having Class 7 material in gaseous or non-dispersible solid form as a component part (a device performing the sole function of containing radioactive material shall not be considered to be an instrument or article)

- **Radioactive Material** – Any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values in §173.436 (or derived using §173.433) (activity greater than "exemption value")

DEFINITIONS (§173.403, 10CFR71)

- **Special Form Radioactive Material** – Radioactive material that is:
  - A single solid piece or contained in a sealed capsule that can only be opened by destroying the capsule
  - Has at least one dimension not less than 5 mm (0.2 in)
  - Satisfies testing requirements of §173.469 (IAEA, DOT, NRC)
  - Certified as special form - sources have been tested to demonstrate compliance with testing requirements
    - ANSI classification
    - Registry of Radioactive Sealed Sources and Devices (Safety Evaluation)


RADIOACTIVE SOURCE CERTIFICATE
Model: Biogr. Repl. Sources Kit (TrueV)
Order Number: 704357416
ANSI Classification: 97C32312
Radionuclide: Germanium/Gallium-68
Apparent Half Life: 271 days

DEFINITIONS (§173.403, 10CFR71)

- **Specific Activity** – Activity of radionuclide per unit mass of that nuclide
- **Surface Contaminated Object** – a solid object that is not itself RAM but which has RAM distributed on any of its surfaces
  - SCO-I/SCO-II classification depends upon fixed and non-fixed contamination
- **Transport Index** – a dimensionless number placed on the label to designate the degree of control to be exercised during transport.
  - Number determined by multiplying the maximum radiation level in mSv/hr at 1 meter from the external surface of the package by 100 (EQUALS mrem/hr @ 1 m)
- **Type A Quantity** – Quantity of RAM which does not exceed the applicable "A" value
- **Type B Quantity** – Quantity of RAM greater than a Type A quantity

ENFORCEMENT: ASSESSMENTS AND FINES

NRC: DELIBERATE MISCONDUCT

- 10CFR71.8
  - Deliberate misconduct means an intentional act or omission that the person knows
    - Cause a licensee, certificate holder, etc., to be in violation of any rule, regulation, order, etc.
    - Constitutes a violation of a requirement, procedure, instruction, etc.
    - Subject to enforcement action in accordance with procedures in 10CFR2, Subpart B (Procedure for Imposing Requirements by Order, or for Modification, Suspension, or Revocation of a License, or for Imposing Civil Penalties)

DOT: ACTING KNOWINGLY (§107.329, 333)

- For a person who knowingly violates Federal hazmat transportation law (etc.); OR
- For a person who knowingly violates regulations/ orders/special permits, etc., applicable to design, manufacture, fabrication, inspection, marking, maintenance, reconditioning, repair or testing, and sells items as qualified:
  - $78,376 for each violation
  - $182,877 if violation results in death, serious illness, severe injury or substantial destruction of property
  - $471 for violations related to training
- Criminal penalties for a person who knowingly, willfully, or recklessly violates a requirement of
- the Federal hazmat transportation law (etc.):
  - Fined under USC Title 18; OR
  - Imprisoned for ≤ 5 years (≤ 10 years for release of hazmat that results in death or bodily injury)
  - OR BOTH
- May take into consideration other factors such as ability to pay, effect on business, etc.

CIVIL PENALTIES (PHMSA)
(APPENDIX A TO SUBPART D OF PART 107)

Violation	Baseline assessment
Failure to provide initial training	$1,000 - $1,500 for each area of training
Failure to create and maintain training records	$600 - $1,000
Placing a label that understates the proper label category	$6,200
Offering materials as LQ without meeting requirements for LQ	$8,000
Offering a package that exceeds permitted radiation level or TI	$12,500
Offering materials for transport under exceptions for instruments and articles without meeting requirements	$6,200 to $12,500
Offering in excess of Type A quantity in Type A package	$15,000

20th Century Fox via Energy.gov

TRAINING

WHO MUST BE TRAINED? (49CFR172.704)

- Each person who:
  - Offers a hazardous material for transportation
  - Each carrier who transports a hazardous material
  - Performs any function subject to the requirements of Subchapter C (parts 171 – 180)

WHO TRAINS?

- Employer shall ensure that employees are trained in accordance with regulations.
  - The employer is responsible for the compliance with the applicable regulations and to thoroughly instruct each hazmat employee!
- Hazmat employee may not perform any function (subject to these regulations) unless instructed appropriately
- Training may be provided by the employer or other public/private source
  - (Employers will still be responsible for training on company-specific policies/procedures)
- Employer shall ensure that hazmat employees are tested (by appropriate means)

TRAINING PROGRAM (49CFR172.700)

- Systematic program that ensures each hazmat employee:
  - Is familiar with the general provisions of regulations
  - Is able to recognize and identify hazardous materials
  - Has knowledge of specific requirements in the regulations applicable to functions performed
  - Has knowledge of emergency response information
  - Has knowledge of self-protection measures
  - Has knowledge of accident prevention methods and procedures

TRAINING CONTENT (49CFR172.704)

- General awareness/familiarization
  - Familiarity with requirements of regulations
  - Recognize and identify hazardous materials
    - Signage, labels, SDS
  - Include general radiation safety (e.g., ALARA)
- Function-specific training
- Safety training
  - Emergency response information
  - Measures to protect employee from hazards associated with hazardous materials encountered in workplace including specific protection measures that have been implemented
  - Methods and procedures to avoid accidents
- Security awareness
  - Security risks associated with transportation and methods designed to enhance transportation security
  - How to recognize and respond to possible security threats

TRAINING CONTENT (49CFR172.704)

- In-depth security training for each hazmat employee of a person required to have a security plan (e.g., HRCQ)
  - Who handles hazardous materials covered by the plan
  - Who performs a regulated function related to the materials covered by the plan
  - Who is responsible for the implementation of the plan
  - And should include:
    - Company security objectives
    - Organizational security structure
    - Specific security procedures
    - Specific security duties and responsibilities for each employee
    - Specific actions to be taken by each employee in the event of a security breach
- Other training may satisfy some/all of training required such as:
  - OSHA, EPA, etc., conducted to comply with hazard communication programs required by OSHA
  - Training required by other Federal (or international) agencies
    - e.g., Training required by 10CFR37 (Physical protection of category 1 and category 2 quantities of radioactive material)
  - Must still cover all required components

TRAINING FREQUENCY (49CFR172.704)

- Initial:
  - May perform job functions prior to training IF directly supervised by a trained employee
  - Training must be completed within 90 days of hire or change in job duties
- Recurrent:
  - At least every three years
  - For in-depth security training, at least every three years or if the security plan changes (within 90 days of change)
- Relevant training from a previous employer or other source may be used provided a current record of training is obtained from that source
- Each hazmat employer is responsible for compliance with the regulatory requirements WHETHER OR NOT training has been completed

TRAINING RECORDS (49CFR172.704)

- Records must include current training and the preceding three years for length of employment and at least 90 days after
- Training records must be made available upon request to an authorized DOT official or entity granted authority to enforce HMR
- Records to include:
  - Name
  - Most recent training completion date
  - Description, copy, location of training materials
  - Name and address of person providing training
  - Certification that the employee has been trained and tested

This notice certifies that the individual(s) on the attached list attended and successfully completed the "Department of Transportation Regulations for Shipping of Radioactive Materials" training on May 24, 2019. This course, in addition to site-specific requirements and safety training, meets the DOT training requirement as specified on 49CFR172.704.

*This certificate is valid until **May 24, 2022.** Retraining and recertification will be required at that time.*

GENERAL INFORMATION

APPLICABILITY TO RAM (49CFR173.401)

- Does NOT apply to:
  - RAM produced, used, transported, or stored in an establishment EXCEPT during the course of transportation, including storage in transportation
  - RAM that has been implanted or incorporated into, and are still in, a person or live animal for diagnosis or treatment
  - RAM that is an integral part of the means of transportation
  - Natural material and ores containing naturally occurring RAM which are either in their natural state or which have only been processed for purposes other than for extraction of radionuclides and which are not intended to be processed for the use of the radionuclides; provided the activity concentration does not exceed the exempt material activity concentration (§173.436)
  - Non-radioactive solid objects with radioactive substances present on any surfaces in quantities not exceeding the threshold limits for contamination (§173.403)

DOT HAZARDOUS MATERIALS CLASSES

DOT Hazard Class	Description
1	Explosives
2	Gases
3	Flammable liquids
4	Flammable solids, spontaneously combustible materials, materials that are dangerous when wet
5	Oxidizers and organic peroxides
6	Poisons and etiologic (infectious) materials
7	Radioactive Material
8	Corrosives
9	Miscellaneous

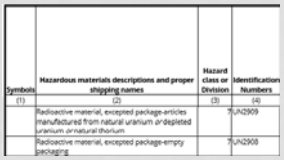
CLASSIFICATION OF MATERIAL HAVING MORE THAN ONE HAZARD (§173.2a)

- In general, materials having more than one hazard are classed according to the highest applicable hazard class in the following order:
  1. Class 7 (other than LQ and UN3507- uranium hexafluoride…)
  2. Division 2.3 (poisonous gases)
  3. Division 2.1 (flammable gases)
  4. Division 2.2 (nonflammable gases)
  5. Division 6.1 (poisonous liquids), poisonous by inhalation only
  6. Division 4.2 (pyrophoric)
  7. Division 4.1 (self-reactive)
  8. Class 3 (flammable liquids)
  9. Etc…

HAZARDOUS MATERIALS TABLE (§172.101)

HAZARDOUS MATERIALS TABLE (§172.101)

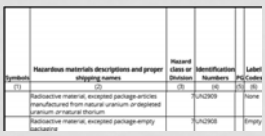
- Column 1 – Symbols
  - +, A, D, G, I, W (risk to humans; regs may only apply to transport by aircraft; domestic shipping names; requires technical name to be added; international shipping names; regs may only apply to transport by vessel)
  - None apply to radioactive materials
- Column 2 – Description and proper shipping name
- Column 3 – Hazard class or division (RAM = 7)
- Column 4 – UN identification number



Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers
(1)	(2)	(3)	(4)
	Radioactive material, excepted package-articles manufactured from natural uranium *or* depleted uranium *or* natural thorium	7	UN2909
	Radioactive material, excepted package-empty packaging	7	UN2908

HAZARDOUS MATERIALS TABLE (§172.101)

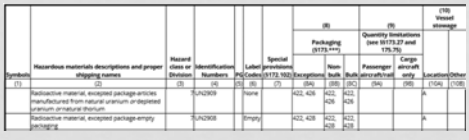
- Column 5 – Packing group
  - Grouping according to the degree of danger presented by the hazardous materials
  - PG 1 - Great danger
  - PG 2 - Medium danger
  - PG 3 - Minor danger
  - Radioactive materials do not have assigned packing groups
- Column 6 – Label codes (None, "Empty", "7"…)



Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	PG	Label Codes
(1)	(2)	(3)	(4)	(5)	(6)
	Radioactive material, excepted package-articles manufactured from natural uranium *or* depleted uranium *or* natural thorium		UN2909		None
	Radioactive material, excepted package-empty packaging		UN2908		Empty

HAZARDOUS MATERIALS TABLE (§172.101)

- Column 7 – Special provisions (§172.102)
  - A = Aircraft
  - T = Tanks
  - TP = Portable tanks
  - W = Water
  - Account for subsidiary hazards; tank requirements; stowage; special arrangement requirements
- Column 8 – Packaging authorizations – references applicable regulation
- Column 9 – Quantity limitations (none for Class 7)
- Column 10 – Vessel stowage requirements
  - 10A – Specifies stowage location on cargo and passenger vessels (if "A" material may be stowed "on deck" or "under deck" on cargo or passenger vessel)
  - 10B – Codes for stowage and handling for specific hazardous materials (§176.84)
    - Typically "separated from foodstuffs" except for special provisions for uranyl nitrate, uranium hexafluoride, etc.



Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	PG	Label Codes	Special provisions (§172.102)	(8) Packaging (§173.***) Exceptions	(8) Non-bulk	(8) Bulk	(9) Quantity limitations (see §§173.27 and 175.75) Passenger aircraft/rail	(9) Cargo aircraft only	(10) Vessel stowage Location	(10) Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)
	Radioactive material, excepted package-articles manufactured from natural uranium *or* depleted uranium *or* natural thorium		UN2909		None		422, 426	422, 426	422, 426			A	
	Radioactive material, excepted package-empty packaging		UN2908		Empty		422, 428	422, 428	422, 428			A	

(Courtesy of Eckert & Ziegler Isotope Products)

QUANTITIES

QUANTITIES

- Exempt
- Limited Quantity
- Type A
- Type B
- HRCQ

Lowest Activity and Hazard

Highest Activity and Hazard

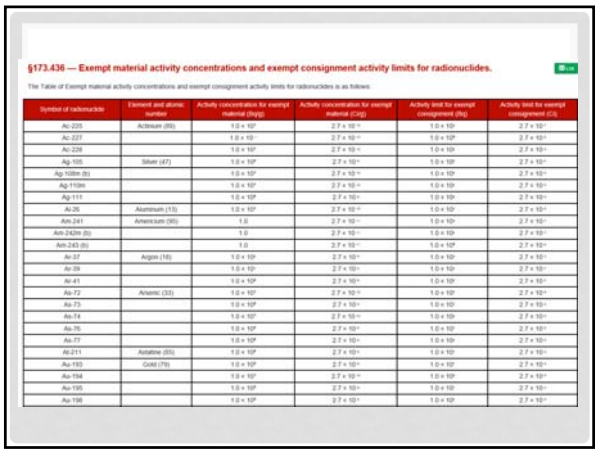
EXEMPT QUANTITIES (GENERAL VALUES - §173.433, TABLE 8)

Activity concentrations/activity limits for radioactive material that is EXEMPT from DOT requirements.

Radioactive contents	Activity concentration for exempt material		Activity limits for exempt consignment	
	(Bq/g)	(Ci/g)	(Bq)	(Ci)
Beta or gamma only	1×10^{1}	2.7×10^{-10}	1×10^{4}	2.7×10^{-7}
Alpha (no neutron emitters)	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}
Neutron emitters or no relevant data	1×10^{-1}	2.7×10^{-12}	1×10^{3}	2.7×10^{-8}

Table with limits for individual radionuclides found in §173.436

The SI quantities are the regulatory limits; conventional units are provided for convenience



§173.436 — Exempt material activity concentrations and exempt consignment activity limits for radionuclides.

The Table of Exempt material activity concentrations and exempt consignment activity limits for radionuclides is as follows:

Symbol of radionuclide	Element and atomic number	Activity concentration for exempt material (Bq/g)	Activity concentration for exempt material (Ci/g)	Activity limit for exempt consignment (Bq)	Activity limit for exempt consignment (Ci)
Ac-225	Actinium (89)	1.0×10^{1}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ac-227		1.0×10^{-1}	2.7×10^{-12}	1.0×10^{3}	2.7×10^{-8}
Ac-228		1.0×10^{1}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ag-105	Silver (47)	1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ag-108m (5)		1.0×10^{1}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ag-110m		1.0×10^{1}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Ag-111		1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
Al-26	Aluminum (13)	1.0×10^{1}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
Am-241	Americium (95)	1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Am-242m (5)		1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Am-243 (5)		1.0	2.7×10^{-11}	1.0×10^{3}	2.7×10^{-8}
Ar-37	Argon (18)	1.0×10^{6}	2.7×10^{-5}	1.0×10^{8}	2.7×10^{-3}
Ar-39		1.0×10^{7}	2.7×10^{-4}	1.0×10^{4}	2.7×10^{-7}
Ar-41		1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
As-72	Arsenic (33)	1.0×10^{1}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
As-73		1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
As-74		1.0×10^{1}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}
As-76		1.0×10^{2}	2.7×10^{-9}	1.0×10^{5}	2.7×10^{-6}
As-77		1.0×10^{3}	2.7×10^{-8}	1.0×10^{6}	2.7×10^{-5}
At-211	Astatine (85)	1.0×10^{3}	2.7×10^{-8}	1.0×10^{7}	2.7×10^{-4}
Au-193	Gold (79)	1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Au-194		1.0×10^{1}	2.7×10^{-10}	1.0×10^{6}	2.7×10^{-5}
Au-195		1.0×10^{2}	2.7×10^{-9}	1.0×10^{7}	2.7×10^{-4}
Au-198		1.0×10^{2}	2.7×10^{-9}	1.0×10^{6}	2.7×10^{-5}

LIMITED QUANTITIES (§173.425, TABLE 4)

	Instruments and Articles		
Nature of contents	**Limits for each instrument or article[1]**	**Package limits[1]**	**Limited quantity package limits[1]**
Solids:			
Special form	10^{-2} A_1	A_1	10^{-3} A_1
Normal form	10^{-2} A_2	A_2	10^{-3} A_2
Liquids:			
Tritiated water:			
<0.0037 TBq/L (0.1 Ci/L)			37 TBq (1,000 Ci)
0.0037 TBq to 0.037 TBq/L (0.1 Ci to 1.0 Ci/L)			3.7 TBq (100 Ci)
>0.037 TBq/L (1.0 Ci/L)			0.037 TBq (1.0 Ci)
Other liquids	10^{-3} A_2	10^{-1} A_2	10^{-4} A_2
Gases:			
Tritium[2]	$2x10^{-2}$ A_2	$2x10^{-1}$ A_2	$2x10^{-2}$ A_2
Special form	10^{-3} A_1	10^{-2} A_1	10^{-3} A_1
Normal form	10^{-3} A_2	10^{-2} A_2	10^{-3} A_2

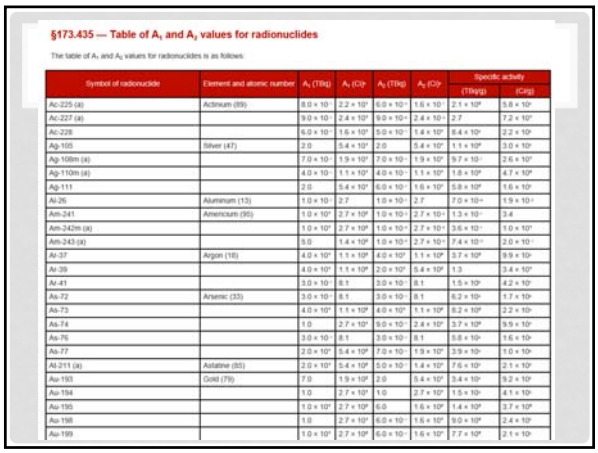
[1] For mixtures of isotopes, see §173.433(d)
[2] These values also apply to tritium in activated luminous paint and tritium adsorbed on solid carriers

TYPE A/TYPE B QUANTITIES: (GENERAL VALUES - §173.433, TABLE 7)

Radioactive contents	A_1		A_2	
	(TBq)	(Ci)	(TBq)	(Ci)
Beta or gamma only	1×10^{-1}	2.7×10^{0}	2×10^{-2}	5.4×10^{-1}
Alpha emitters and no beta, gamma, neutron	2×10^{-1}	5.4×10^{0}	9×10^{-5}	2.4×10^{-3}
Alpha emitters with beta or gamma	1×10^{-1}	2.7×10^{0}		
Neutron emitting or no relevant data available	1×10^{-3}	2.7×10^{-2}	9×10^{-5}	2.4×10^{-3}

Activities ≤ applicable "A" value = TYPE A
Activities > applicable "A" value = TYPE B

Table with limits for individual radionuclides found in §173.435



§173.435 — Table of A_1 and A_2 values for radionuclides

The table of A_1 and A_2 values for radionuclides is as follows:

Symbol of radionuclide	Element and atomic number	A_1 (TBq)	A_1 (Ci)[a]	A_2 (TBq)	A_2 (Ci)[a]	Specific activity	
						(TBq/g)	(Ci/g)
Ac-225 (a)	Actinium (89)	8.0×10^{-1}	2.2×10^{1}	6.0×10^{-3}	1.6×10^{-1}	2.1×10^{3}	5.8×10^{4}
Ac-227 (a)		9.0×10^{-3}	2.4×10^{-1}	9.0×10^{-5}	2.4×10^{-3}	2.7	7.2×10^{1}
Ac-228		6.0×10^{-1}	1.6×10^{1}	5.0×10^{-1}	1.4×10^{1}	8.4×10^{4}	2.2×10^{6}
Ag-105	Silver (47)	2.0	5.4×10^{1}	2.0	5.4×10^{1}	1.1×10^{4}	3.0×10^{5}
Ag-108m (a)		7.0×10^{-1}	1.9×10^{1}	7.0×10^{-1}	1.9×10^{1}	9.7×10^{1}	2.6×10^{3}
Ag-110m (a)		4.0×10^{-1}	1.1×10^{1}	4.0×10^{-1}	1.1×10^{1}	1.8×10^{3}	4.7×10^{4}
Ag-111		2.0	5.4×10^{1}	6.0×10^{-1}	1.6×10^{1}	5.8×10^{3}	1.6×10^{5}
Al-26	Aluminum (13)	1.0×10^{-1}	2.7	1.0×10^{-1}	2.7	7.0×10^{-4}	1.9×10^{-2}
Am-241	Americium (95)	1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	1.3×10^{-1}	3.4
Am-242m (a)		1.0×10^{1}	2.7×10^{2}	1.0×10^{-3}	2.7×10^{-2}	3.6×10^{-1}	1.0×10^{1}
Am-243 (a)		5.0	1.4×10^{2}	1.0×10^{-3}	2.7×10^{-2}	7.4×10^{-3}	2.0×10^{-1}
Ar-37	Argon (18)	4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}	3.7×10^{3}	9.9×10^{4}
Ar-39		4.0×10^{1}	1.1×10^{3}	2.0×10^{1}	5.4×10^{2}	1.3	3.4×10^{1}
Ar-41		3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	1.5×10^{5}	4.2×10^{6}
As-72	Arsenic (33)	3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	6.2×10^{4}	1.7×10^{6}
As-73		4.0×10^{1}	1.1×10^{3}	4.0×10^{1}	1.1×10^{3}	8.2×10^{2}	2.2×10^{4}
As-74		1.0	2.7×10^{1}	9.0×10^{-1}	2.4×10^{1}	3.7×10^{3}	9.9×10^{4}
As-76		3.0×10^{-1}	8.1	3.0×10^{-1}	8.1	5.8×10^{4}	1.6×10^{6}
As-77		2.0×10^{1}	5.4×10^{2}	7.0×10^{-1}	1.9×10^{1}	3.9×10^{4}	1.0×10^{6}
At-211 (a)	Astatine (85)	2.0×10^{1}	5.4×10^{2}	5.0×10^{-1}	1.4×10^{1}	7.6×10^{3}	2.1×10^{5}
Au-193	Gold (79)	7.0	1.9×10^{2}	2.0	5.4×10^{1}	3.4×10^{3}	9.2×10^{4}
Au-194		1.0	2.7×10^{1}	1.0	2.7×10^{1}	1.5×10^{3}	4.1×10^{4}
Au-195		1.0×10^{1}	2.7×10^{2}	6.0	1.6×10^{2}	1.4×10^{2}	3.7×10^{3}
Au-198		1.0	2.7×10^{1}	6.0×10^{-1}	1.6×10^{1}	9.0×10^{2}	2.4×10^{4}
Au-199		1.0×10^{1}	2.7×10^{2}	6.0×10^{-1}	1.6×10^{1}	7.7×10^{2}	2.1×10^{4}

OVERVIEW OF QUANTITIES

Type	Quantity
Exempt	≤ Exemption values for concentration/consignment
Limited	Fraction of applicable "A" value (10^{-2}, 10^{-3}, etc.)
Type A	≤ applicable "A" value for isotope/form
Type B	> applicable "A" value for isotope/form
HRCQ	3000 x applicable "A" value or 27,000 Ci whichever is less

MIXTURES OF RADIONUCLIDES (§173.433)

- Sum of ratios (activity/applicable limit):
  - Special form:
    - $\sum_i \frac{B(i)}{A_1(i)} \leq 1$
  - Normal form:
    - $\sum_j \frac{C(j)}{A_2(j)} \leq 1$
  - Both special form and normal form:
    - $\sum_i \frac{B(i)}{A_1(i)} + \sum_j \frac{C(j)}{A_2(j)} \leq 1$

REPORTABLE QUANTITIES (§172.101, TABLE 2 TO APPENDIX A)

- Listed as hazardous substances under CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) and must be regulated as hazardous materials
  - Seven RQ levels for radionuclides: 0.001, 0.01, 0.1, 1, 10, 100, 1,000 Ci
  - If RQ or more is released, the release must be immediately reported to the National Response Center (NRC is staffed by the US Coast Guard and should not be confused with the Nuclear Regulatory Commission!)

(1) — Radionuclide	(2) — Atomic Number	(3) — Reportable Quantity (RQ) Ci (TBq)
Curium-244	96	0.01 (.00037)
Curium-245	96	0.01 (.00037)
Curium-246	96	0.01 (.00037)

- RQ must be entered on shipping papers either before or after the basic description
- Example:
  - UN3332, Radioactive material, Type A package, special form non fissile or fissile-excepted, 7, RQ
- For multiple isotopes, use sum of ratios. If sum > 1, package contains Reportable Quantity

PACKAGING

QUANTITY → PACKAGING

In general, the quantity of radioactive material will determine your packaging!

Quantity	Package
Exempt	Exempt
Limited Quantity	Excepted Package (General package design)
≤ A_1/A_2 (Type A)	Type A
> A_1/A_2 (Type B)	Type B

Can use a "higher" level package for lower quantities, but must meet the design requirements for that package.
e.g., you can use a Type B package for a Type A quantity, but if package is marked as Type B, it must meet Type B package requirements.

GENERAL PACKAGE DESIGN (§173.410)

STRONG, TIGHT PACKAGE

- Package must be easily handled and properly secured
- Lifting attachments that are structural part must be designed with a minimum safety factor of 3; designed so that a failure of any lifting attachment would not impair ability of package to meet other requirements
- External surface free from protruding features and easily decontaminated
- Outer layer does not have pockets or crevices where water can collect
- Each feature added must not reduce safety of package
- Capable of withstanding effects of acceleration, vibration, vibration resonance from normal conditions of transport
- Material and construction is physically and chemically compatible with each other and package contents (take into account irradiation)

GENERAL PACKAGE DESIGN, CONTINUED… (§173.410)

- For transport by air:
  - Temperature of accessible surfaces will not exceed 50ºC (122ºF) at an ambient temperature of 38ºC (100 ºF) with no account taken for insulation
  - Integrity of containment will not be impaired if package exposed to ambient temps ranging from -40 ºC (-40ºF) to +55ºC (131ºF)
  - Packages with liquid contents must be capable of withstanding an internal pressure that produces a pressure differential of not less than the maximum operating pressure plus 95 kPa (13.8 psi)

USE OF PACKAGES MEETING GENERAL DESIGN REQUIREMENTS

- Packages meeting general design requirements may be used for:
  - Limited Quantity (§173.422)
    - Excepted packages
    - Excepted packages for instruments and articles
    - Multiple hazard limited quantity (if the other hazardous substance/waste is a "small quantity" to be transported by highway or rail)
  - LSA - I
  - LSA - II if:
    - Exclusive Use
    - Closed Vehicle

EXCEPTED PACKAGES FOR LIMITED QUANTITIES (§173.422, 424)

- EXCEPTED (NOT EXEMPT) from:
  - Specification packaging (e.g., Type A); Marking (except UN); Labeling; Shipping papers (unless hazardous substance or hazardous waste)
- IF:
  - Package meets general design requirements
  - Radiation level at any point on surface ≤ 0.05 mSv/h (0.5 mrem/h)
    - unpackaged instrument/article: radiation level at 10 cm (4") ≤ 0.1 mSv/h (10 mrem/h)
  - Non-fixed contamination meets limits in §173.443(a)
  - Outside of inner package or outside of packaging marked with "Radioactive" (Instruments/articles do not require this)
  - No fissile material except as allowed by §173.453
  - Prepared for shipment in accordance with §173.422
    - Outside of package marked with appropriate UN ID number; & RQ if required
  - Reporting requirements in §171.15, §171.16; including reporting of decontamination in §174.750, §175.705, §176.710
  - Training requirements must be met
- NOTE: YOU MAY HAVE AN LIMITED QUANTITY THAT DOES NOT MEET RADIATION LEVEL LIMITS FOR THE USE OF EXCEPTED PACKAGING!!

MULTIPLE HAZARD LIMITED QUANTITY CLASS 7 (§173.423)

- If LQ Class 7 meets definition of another hazard class or division:
  - Classed for additional hazard
  - Packaged to conform to requirements of Excepted packages (special form/normal form/instruments and articles)
  - Not required to have UN number for RAM on outside of package or a description of RAM on shipping form, if LQ RAM is on shipping paper with basic description
  - Offered for transport in accordance with requirements applicable to hazard for which it is classed

TYPE A PACKAGES (§173.412)

- Solids:
  - Meets general design requirements
  - Seal (or similar) that provides evidence package has not been opened (closed transport/exclusive use; cargo compartment may be sealed)
  - Smallest external dimension is ≥ 10 cm (4")
  - Containment and shielding maintained during transport and storage in temperature range of -40ºC (-40ºF) to 70ºC (159ºF)
  - Package includes containment system securely closed by positive fastening device that cannot be opened unintentionally (special form material may be considered a component of containment system)
  - Must take into account radiolytic decomposition of materials and generation of gas
  - Containment system must retain radioactive contents with ambient pressure reduction to 50 kPa (8.7 psi)
  - Each valve (except for pressure relief device) is provided with an enclosure to retain any leakage
  - Radiation shield specified as part of containment system will prevent unintentional escape of that component from shield
  - Failure of any tie-down attachment that is structural part of package must not impair ability of package to meet other requirements
  - Must prevent loss or dispersal of contents or significant increase in radiation levels when evaluated against performance requirements

TYPE A PACKAGES, CONTINUED (§173.412)

- Liquids:
  - Meet testing requirements AND
  - Have sufficient suitable absorbent material to absorb twice the volume of the liquid OR
  - Have a containment system with primary inner and secondary outer containment
- Gases (other than H-3):
  - Meet testing requirements

TYPE A PACKAGING TESTS (§173.465)

- Water spray
  - Simulate exposure to rainfall of approx. 5 cm (2") per hour for at least one hour
  - Water must soak in to maximum extent without appreciable drying of exterior before next test (2 hours if water spray from four different directions; immediately if water spray from four directions is consecutive)
- Free drop
  - Depends upon weight of package. For < 5000 kg (11,000 lb), distance of 1.2 m (4')
  - Package must drop onto target so as to suffer maximum damage onto flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact would not significantly increase the damage
  - For fiberboard or wood rectangular packages with mass 50 kg (110 lb) or less, a separate specimen must be subjected to a free drop test onto each corner from a height of 0.3 m (1'). If cylindrical, same drop onto each quarter of each rim.

TYPE A PACKAGING TESTS, CONTINUED… (§173.465)

- Stacking test
  - Compressive load for at least 24 hrs of a total weight = 5 x max weight of package
  - Must be applied uniformly to two opposite sides, one of which must be the base upon which the package normally rests
- Penetration test
  - Package placed on rigid, flat horizontal surface
  - A bar of 3.2 cm (1.25") in diameter with a hemispherical end and mass of 6 kg (13.2 lb) must be dropped onto center of weakest part of package so that if it penetrates, it will hit containment system
  - Height must be at least 1 m (3.3')
- For successful completion:
  - No loss or dispersal of radioactive contents
  - No significant increase in the radiation levels recorded or calculated at the external surfaces

DOT SPECIFICATION 7A (§178.350)

- Must meet all applicable requirements of 173 Subpart B (Preparation of hazardous materials for transportation)
- Do not require Competent Authority certification, but must be designed and constructed to meet requirements for Type A packaging and successfully pass packaging tests
  - The marking is the "certification" that the package meets the appropriate DOT or UN standard
- Marked on outside with "USA DOT 7A Type A"
- Manufacturer must maintain documentation and provide any person who the packaging is transferred to of any specific procedures that must be followed (assemble and close package) to meet testing requirements
- **Must be used for pyrophoric and oxidizing radioactive materials**
- May be used for other Type A quantities, LSA, SCO

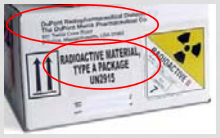
INDUSTRIAL PACKAGES (§173.411)

- Typically won't be using for RAM shipments (used for LSA, SCO)
- IP-1
  - Must meet general design requirements
- IP-2
  - Must meet general design requirements AND
  - must prevent loss/dispersal of contents or significant increase in radiation levels when subjected to free drop test and stacking test
- IP-3
  - Must meet requirements for IP-1 and IP-2 AND
  - Requirements for Type A packaging
- Additional regulations address portable tanks, cargo tanks, tank cars, freight containers, metal intermediate bulk containers
- Documentation of tests and engineering evaluation or comparative data showing that construction methods, package design, and construction materials comply with package specification must be maintained on file for at least two years and provided upon request

MARKINGS

MARKINGS (§§172.301, 304, 310)

- UN number and proper shipping name
- Consignee's or consignor's name/address (some exceptions)
- Mass if > 110 lb
- Package Specification - Industrial, Type A, Type B, etc.
- Markings must be:
  - Durable, in English, printed on or affixed to the surface or on a label, tag, or sign
  - Displayed on a background of sharply contrasting color
  - Unobscured by labels or attachments
  - Located away from any other marking that could substantially reduce its effectiveness



MARKINGS: REPORTABLE QUANTITIES

- RQ must be added to UN number/proper shipping name (either before or after basic description)

USA DOT 7A TYPE A RADIOACTIVE MATERIAL TYPE A PACKAGE SPECIAL FORM UN 3332 RQ

Humboldt Scientific, Inc. 2525 Atlantic Ave., Raleigh, NC 27604 USA 919.833.3190

LABELING

Early shipping labels for radioactive material courtesy of Oak Ridge Associated Universities Museum
Label on left dates from the 1940s, label on the right from the 1950s

LABELING
(§172.400, 400a, 402, 403, 406, 407, 436, 438, 440)

- Radioactive White-I
- Radioactive Yellow-II
- Radioactive Yellow-III
- Cargo Aircraft Only
- (Fissile, Empty)
- If required to be labeled:
  - Two labels; affixed to opposite sides of package (not the bottom)
  - Labels must be located on the same surface and near the proper shipping name
  - Must be clearly visible and not obscured by markings or attachments
  - Must have contents entered (radionuclide)
  - Must have activity entered (SI units)
  - Must list the Transport Index if required

LABELS

LABELING CATEGORIES

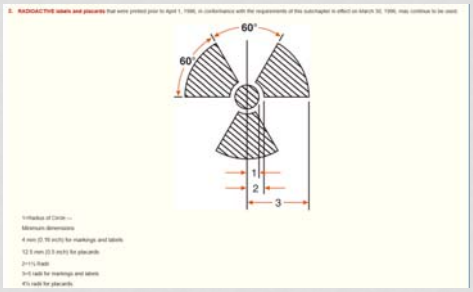
In general, RADIATION LEVELS → LABEL

Transport Index	Maximum radiation level at any point on external surface	Label category
0 (if measured TI is < 0.05 mrem/hr, it is considered to be 0)	≤ 0.5 mrem/hr	WHITE-I
> 0 and < 1	> 0.5 mrem/hr and ≤ 50 mrem/hr	YELLOW-II
> 1 and < 10	> 50 mrem and ≤ 200 mrem/hr	YELLOW-III
>10 (and includes HRCQ)	> 200 mrem/hr and ≤ 1,000 mrem/hr	YELLOW-III Exclusive Use

LABEL DESIGN/SIZE
(§172.400, 400a, 402, 403, 406, 407, 436, 438, 440)

- Diamonds must be at least 100 mm (3.9" on each side)
- Each side must have a solid line inner border 5 mm inside and parallel to edge
- Width of solid line forming inner border must be at least 2 mm
- Hazard class number must be at least 6.3 mm (0.25") and not greater than 12.7 mm (0.5")
- Symbol on label must be proportionate in size as per examples in regs
- Color charts specify required color standards
- Trefoil symbol has very specific size requirements

TREFOIL SYMBOL
(APPENDIX B TO PART 172)



CARGO AIRCRAFT ONLY

- If transported by air, must label as Cargo Aircraft Only if:
  - NOT intended for use in, or incident to research, medical diagnosis or treatment
  - Single package has TI > 3

Must be black on orange background (§172.448)

EMPTY

- Package which has previously contained Class 7 materials and has been emptied as far as practical
- Excepted from shipping paper and marking, but must still have UN number
- Must meet requirements for Excepted package
  - No fissile material
- Unimpaired package/securely closed (no leakage)
- Outer surface of any uranium or thorium in structure is covered by inactive sheath
- Internal contamination ≤ 100 x non-fixed external radioactive contamination limits
- Any labels are removed/obliterated/covered and "Empty" label affixed
- Incident reporting, decontamination reporting, and training requirements apply

SHIPPING PAPERS
DANGEROUS GOODS DECLARATIONS

SHIPPING PAPERS
(§172.200)

- Applicability:
  - Does not apply to any material, other than a hazardous substance, hazardous waste or marine pollutant, that is:
    - Identified with an "A" in column 1 of the Hazardous Materials Table unless offered or intended for transportation by air
    - Identified with an "W" in column 1 of the Hazardous Materials Table unless offered or intended for transportation by water
    - A limited quantity package unless offered for transportation by aircraft or vessel
- However, §§173.421 and 422 specifically state that shipping papers are NOT required for Excepted Packages (including RQ) that meet all requirements UNLESS there is a secondary hazard (hazardous substance or hazardous waste)
- No specific shipping document specified by HMR (except for Hazardous Waste Manifest) so shippers can use whatever form/document UNLESS format is prescribed; e.g., IATA Shipper's Declaration

SHIPPING PAPERS (§§172.200, 203(d))

In summary, shipping papers are:

- Required for all LABELED packages
- Not required for EXCEPTED packages UNLESS there is a secondary hazard

SHIPPING PAPERS (§§172.202(a)(5), 172.202(a)(6), 172.204(c)(4))

- Shipper's name
- Consignee
- Air Waybill No.
- Delete either "Passenger and Cargo Aircraft" or "Cargo Aircraft Only"
  - Remember that to be transported on passenger aircraft, must be used in (or incident to use in) research, diagnosis, treatment
  - TI on single packages must be ≤ 3; combined TIs of all packages ≤ 50
  - Check IATA/ICAO if questions
- Delete "Non-Radioactive"

HAZARDOUS MATERIALS DESCRIPTION (§172.202, 203)

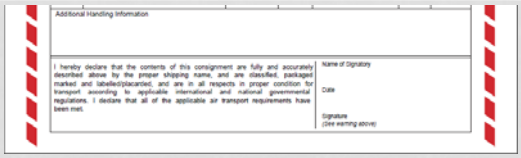
1. ID Number (column 4)
2. Proper Shipping Name (column 2)
3. RQ if required
4. Hazard class or division number (column 3) (subsidiary hazard class not required unless subsidiary hazard label is required)
5. Packing Group (column 5)
6. *Radionuclide*
7. *Physical and chemical form*
8. *Number of packages*
9. *Package type/package identification marking*
10. *Activity in SI units*
11. Label category
12. Transport Index
13. Package Dimensions
14. Exclusive Use Shipment if applicable
15. HRCQ if applicable

NATURE AND QUANTITY OF DANGEROUS GOODS

UN Number or identification Number, proper shipping name, Class or Division (subsidiary risk), packing group (if required), and all other required information.

UN 2915, Radioactive material, Type A package,7//CS-137, CERAMIC MATRIX solid, 1 Type A package X 5.55000 GBq // II Yellow, TI 0.5, dims (L) 31 x (W) 31 x (H) 31 cm

SHIPPING PAPERS (§§172.202(a)(5), 172.202(a)(6), 172.204(c)(4))



- Additional Handling Information:
  - Certification for transport on passenger aircraft *"This shipment is within the limitations prescribed for passenger aircraft. The shipment contains radioactive material intended for use incident to research, medical diagnosis or treatment…"*
  - Emergency Response Telephone Number – must contact someone directly who can answer questions about the package during the entire time of transport
- Shippers Certification:
  - Name of Signatory
    - Must be someone who has appropriate documented/certified training
  - Date (location)
  - Signature