
PACKAGING/TRANSPORTATION – RADIOACTIVE MATERIALS

1.0 SCOPE

This standard outlines the proper packaging, labeling and marking of radioactive materials or devices in conformance with Department of Transportation (DOT) Regulations.

2.0 REFERENCES

- 2.1 Code of Federal Regulations, Title 49, Parts 100 – 177. Hazardous Materials. U. S. Department of Transportation (DOT) regulations.
- 2.2 Nuclear Regulatory Commission (NRC), (10CFR Part 71)
- 2.3 International Civil Aviation Organization (ICAO) Regulations, Hazardous Material. Transportation by air.
- 2.4 International Air Transport Association, (IATA) Regulations, Hazardous Material. Transportation by air.
- 2.5 U.S. Postal Service (39CFR Part 123)
- 2.6 International Maritime Regulations, (IMCO) Regulations, Hazardous Material. Transportation by water carrier.
- 2.7 California Radiation Control Regulations (California Administrative Code, Title 17).

3.0 DEFINITIONS/REQUIREMENTS

- 3.1 NRC and State of California License Requirements – a license is required for possession, use and transport of radioactive by-product source and special nuclear materials.

NOTE: Certain specific products and limited quantities are exempt from NRC regulations (consult 10 CFR Part 71 and California Administrative Code, Title 17).

- 3.1.1 “A1” – means the maximum activity of special form radioactive material permitted in a TYPE A package.
- 3.1.2 “A2” – means the maximum activity of radioactive material other than special form or low specific activity radioactive material, permitted in a TYPE A package. These values are either listed in 49CFR 173.435 or may be derived in accordance with the procedure prescribed in 49CFR 173.433.
- 3.1.3 “Fissile Material” – means any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233 and uranium-235. Neither natural nor depleted uranium are fissile material. Fissile materials are classified according to the controls needed to provide nuclear criticality safety during transportation, as provided in 49CFR 173.455. Certain exclusions are provided in 49CFR 173.453.
- 3.1.4 “Limited Quantity of Radioactive Material” – means a quantity of radioactive material not exceeding the materials package limits specified in 49CFR 173.423 and which conform with requirements specified in 49CFR 173.421.
- 3.1.5 “Non-Fixed Radioactive Contamination” – means radioactive contamination that can be readily removed from a surface by wiping with an absorbent material. Non-fixed (removable) radioactive contamination is not significant if it does not exceed the limits specified in 49CFR 173.443.
- 3.1.6 “Normal Form Radioactive Material” – means radioactive material which has not been demonstrated to qualify as “special form radioactive material.”
- 3.1.7 “Package” – means, for radioactive materials, the packaging together with its radioactive contents as presented for transport.
- 3.1.8 “Packaging” – means, for radioactive materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The conveyance, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging.

- 3.1.9 “Product Container” – The inner most container (bottle, capsule, vial, etc.) generally in direct contact with the radioactive product.
- 3.1.10 “Radioactive Article” – means any manufactured instruments and articles such as an instrument, clock, electronic tube or apparatus, or similar instruments and articles having radioactive material as a component part.
- 3.1.11 “Radioactive Contents” – means the radioactive material, together with any contaminated liquids or gases, within the package.
- 3.1.12 “Radioactive Material” – means any material having a specific activity greater than .002 microcuries per gram.
- 3.1.13 “Radioactive Label” – Unless specifically exempt by 49CFR, a radioactive label must be applied on two (2) opposite sides of each package. (49CFR 173.403(f) see Figure 1, Figure 2 and Figure 3.)
- 3.1.14 “Special Form Radioactive Material” – means radioactive material which satisfies the following conditions:
 - 3.1.14.1 It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;
 - 3.1.14.2 The piece of capsule has at least one dimension not less than 5 millimeters (.197 inch); and
 - 3.1.14.3 It satisfies the test requirements of 49CFR 173.469. Special form encapsulations designed in accordance with the requirements of 49CFR 173.389 (g) in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used.
- 3.1.15 “Transport Index” – means the dimensionless number (rounded up to the first decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:
 - 3.1.15.1 The number expressing the maximum radiation level in millirem per hour at one meter (3.3 feet) from the external surface of the package; or
 - 3.1.15.2 For Fissile Class II packages or packages in a Fissile Class III shipment, the number expressing the maximum radiation level at one meter (3.3 feet) from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever is larger.
- 3.1.16 “Type A Package” – means a Type A packaging together with its limited radioactive contents. A Type A package does not require competent authority approval, since its contents are limited to A1 or A2.
- 3.1.17 “Type B Package” – means a Type B packaging together with its radioactive contents.
- 3.1.18 “Type A Packaging” – means a packaging designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in 49CFR 173.465 or 49CFR 173.466, as appropriate.
- 3.1.19 “Type B Packaging” – means a packaging designed to retain the integrity of containment and shielding required by this part when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10CFR Part 71.
- 3.1.20 Radioactive Placarding (Figure 4) – Each motor vehicle, rail car, and freight container must be placarded in accordance with 49CFR 173.504. If the carrier does not have the necessary placards they must be supplied by the shipper.
- 3.1.21 Security Seal – The outside of each package must incorporate a seal, which is not readily breakable, and which, while intact, will be evidence that the package has not been illicitly opened.
- 3.1.22 Package Minimum Size – The smallest outside dimension of any radioactive package must be 4 inches or greater. 49CFR 173.412(a).
- 3.1.23 Shipping Paper(s) – Each person who offers a hazardous material for transportation shall describe the hazardous material on the shipping paper in accordance with 49CFR 172.203d.

NOTE: Unless otherwise excepted, a “Shippers Certification” statement is required on each shipping document. 49CFR 173.204(a)

3.1.24 When specified in the procurement document, manufacturer/supplier shall submit a Material Safety Data Sheet (Form OSHA-20 or equivalent) delineating the specific hazardous characteristics of the substance. If a supplier has previously submitted the required data for the substance ordered, do not resubmit. Material Safety Data sheets shall be forwarded (in advance of shipment) to the cognizant LMSC buyer unless otherwise directed.

Table 1		
MAXIMUM RADIATION LEVELS		
Label (Figure 1, 2, 3,)	Dose Rate Any Point on Accessible Surface of Package	At 1 Meter from Exterior Surface of Package (Transport Index)
Radioactive – White I	0.5 mR/hr	Not Applicable
Radioactive – Yellow II	50.0 mR/hr	1.0 mR/hr
Radioactive – Yellow III*	200.0 mR/hr	10.0 mR/h

*Requires vehicle placarding (see 49CFR 172.504).3.1.24

NOTE: Labels must be exact as specified (they cannot be hand drawn or altered)

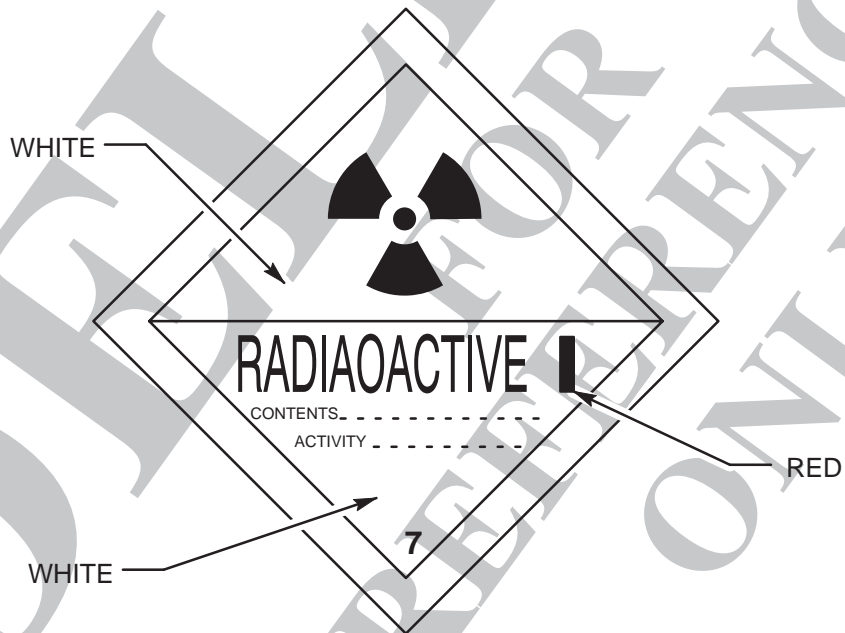


Figure 1. Radioactive Label Category I (White) 49CFR 172.436(a)

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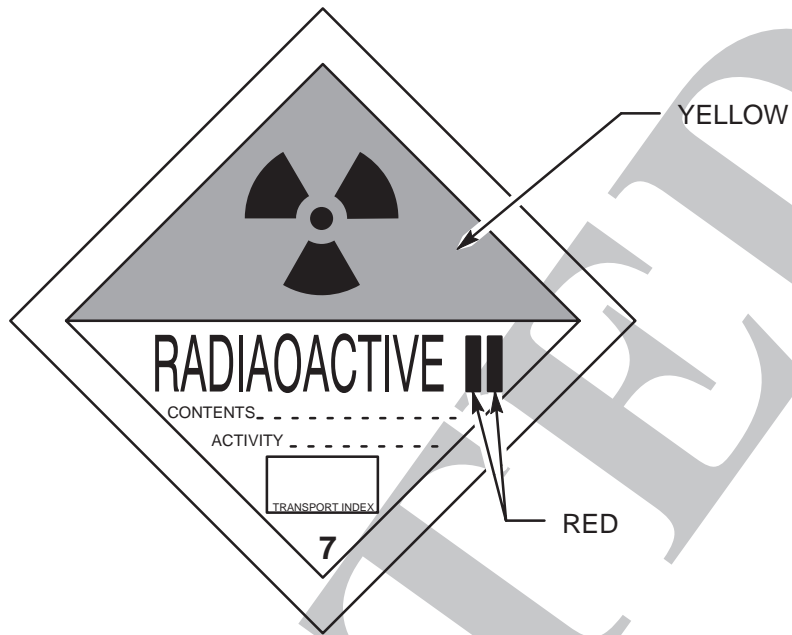


Figure 2. Radioactive Label Category II (Yellow) 49CFR 172.438(a)

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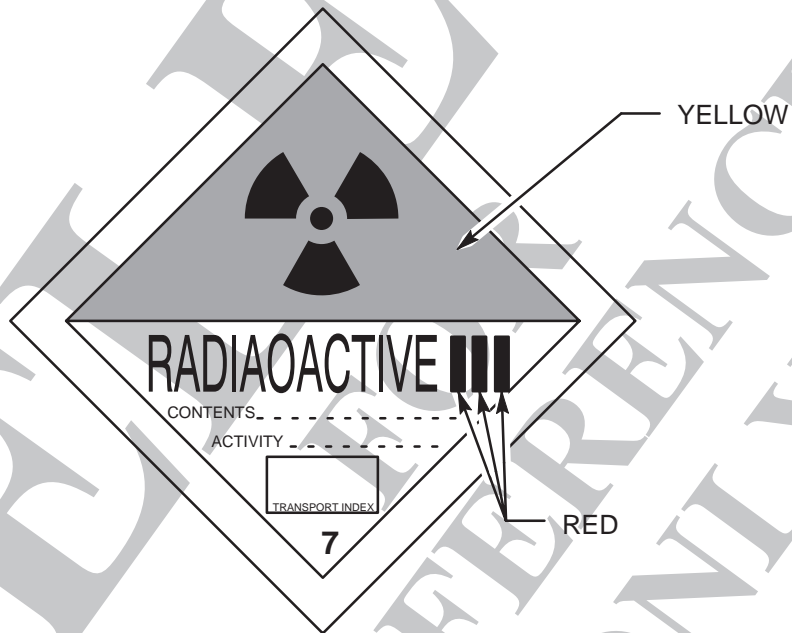


Figure 3. Radioactive Label Category III (Yellow) 49CFR 172.440(a)

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Figure 4. Radioactive Placard (Yellow) 49CFR 172.556(a)

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Table 2			
RADIOACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS, AND ARTICLES			
Nature of Contents	Instruments and Articles		Materials Package Limits
	Instrument and Article Limits¹	Package Limits	
Solids:			
Special form	10-2 _{A1}	A1	10-3 _{A1}
Other forms	10-2 _{A2}	A2	10-3 _{A2}
Liquids:			
Tritiated water:			
<0.1 Ci/liter			1000 Curies
0.1 Ci to 1.0 Ci/l			100 Curies
>1.0 Ci/liter			1 Curie
Other liquids	10-3 _{A2}	10-1 _{A2}	10-4 _{A2}
Gases:			
Tritium ²	20 Curies	200 Curies	20 Curies
Special form	10-3 _{A1}	10-2 _{A1}	10-3 _{A1}
Other forms	10-3 _{A2}	10-2 _{A2}	10-3 _{A2}

¹For mixture of radionuclides see 173,433(b).
²These values also apply to tritium in activated luminous paint and tritium absorbed on solid carriers.

4.0 SHIPMENT OF RADIOACTIVE MATERIALS

4.1 General Requirements

CAUTION: STRINGENT LAWS/REGULATIONS GOVERNING THE HANDLING, PACKAGING, STORING, DISPOSAL, TRANSPORT AND CONTAINER DESIGN CRITERIA ARE IN EFFECT. SEVERE PENALTIES MAY RESULT FOR VIOLATIONS THEREOF.

EACH INTENDED CONSIGNEE MUST HAVE A CURRENT RADIOACTIVE MATERIALS LICENSE ISSUED BY NRC OR BY AGREEMENT STATE. IN ADDITION, LMSC IHC OFFICE MUST HAVE A COPY OF THIS LICENSE ON FILE PRIOR TO EFFECTING SHIPMENT.

- 4.1.1 Each supplier/shipper is responsible for full compliance with International Civil Aviation Organization (ICAO) regulations, International Air Transport Association (IATA) regulations and Department of Transportation (DOT) Regulations, 49CFR Subchapter C – Hazardous Materials Regulations, Parts 171 through 177. Additionally, the Nuclear Regulatory Commission (NRC) under 10CFR Part 71 has established requirements for the safe transport of radioactive materials. Each user (licensee) of radioactive material shall have a Quality Assurance Program requiring commission approval prior to shipment of radioactive material. The program applies to the design, fabrication, assembly, testing, use and maintenance of transportation packages.
- 4.1.2 U.S. Postal Service Publication No.6 limits the package activity of a mailable radioactive package containing a limited quantity or exempt device to one-tenth (1/10) of the quantities specified in Table 2 .

4.2 Radioactive Devices (49CFR 173.422)

- 4.2.1 Manufactured articles such as instruments, clocks, electronic tubes, or apparatus, or other similar devices, having radioactive materials (other than liquids) in a nondispersible form, as a component part, are shippable providing that the following conditions are met:
 - 4.2.2 The radioactive materials must be securely contained within the devices, or securely packaged in strong tight packages, such that there will be no leakage of radioactive materials under conditions normally encountered in routine handling.
 - 4.2.3 The radiation dose rate at four inches from any unpackaged device must not exceed 10 millirem per hour.
 - 4.2.4 The radiation dose rate at any point on the external surface of the outside container does not exceed .5 millirem per hour.
 - 4.2.5 There must be no significant radioactive material on the exterior of the package (49CFR 173.443(a) .
 - 4.2.6 The total radioactivity content of a single package containing radioactive devices must not exceed the quantities shown in Table 2 .
 - 4.2.7 The device is prepared for shipment as specified in 49CFR 173.421-1.

4.3 Type A Packaging

- 4.3.1 Type A packaging is that which must be designed in accordance with the applicable packaging requirements (49CFR 173.411-173.412) and satisfy the following:
 - 4.3.1.1 Radioactive material contents of package are limited to A1 or A2 quantities as specified in 49CFR 173.433 or 173.435.
 - 4.3.1.2 Adequate to prevent the loss or dispersal of radioactive contents.
 - 4.3.1.3 Maintain shielding.
 - 4.3.1.4 Performance criteria to simulate normal conditions of transport.
 - 4.3.1.5 Performance – based DOT specification 7A Type A general package.
 - 4.3.1.6 Shipper required to make own assessment of particular package design against the performance requirements.

- 4.3.1.7 Specific regulatory approval not required for the package design provided that you comply with DOT 7A Performance Specification.
- 4.3.1.8 Shipper of DOT 7A required to maintain on file for at least one year after the latest shipment, a complete certification and supporting safety analysis.
- 4.3.1.9 U.S.A. DOT specification 7A Type A containers authorized for use by LMSC:
 - 4.3.1.9.1 MS 24347 drum per MIL-D-6055
 - 4.3.1.9.2 MS 27683 drum per MIL-D-6054
 - 4.3.1.9.3 MS 27684 drum per MIL-D-6054
 - 4.3.1.9.4 DOT - 12B65 fiber-board box.

4.4 Type B Packaging

- 4.4.1 Type B packaging must be designed to retain the integrity of containment and shielding required by 49CFR 173. Subpart I, when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10CFR Part 71.73.

Table 3	
RADIATION LEVELS	
Radioactive Materials Maximum Radiation Level Limitations	
I.	Radiation level (dose) rate at any point on external surface of any package of any package of RAM may not exceed: <ul style="list-style-type: none"> a. 200 millirem per hour. b. 10 millirem per hour at 1 meter (transport index may not exceed 10).
II.	Unless the packages are transported in an "Exclusive Use" closed transport vehicle (except aircraft) then the maximum radiation levels may be: <ul style="list-style-type: none"> a. 1000 millirem per hour at package surface. b. 200 millirem per hour at external surface of the vehicle. c. 10 millirem per hour at 2 meters from external surface of the vehicle. d. 2 millirem per hour in any position of the vehicle which is occupied by a person.

5.0 QUALITY ASSURANCE

- 5.1 Shipments of radioactive materials received by LMSC not packaged, packed or properly marked in accordance with this standard, shall be subject to rejection and at supplier expense may be held, disposed of, or returned to supplier.

6.0 PRECAUTIONARY HANDLING

- 6.1 Licensee receiving packages containing radioactive material are responsible for expeditious pickup of packages at carrier's terminals, to monitor the package's external surfaces for radioactive contamination or excessive radiation levels, as well as to notify the delivering carrier, the NRC, and the State of California immediately if external radiation or radioactive contamination in excess of that specified is detected.