

Transportation Requirements for Radiography Sources



Learning Objectives

Explain the significance of USDOT requirements for shipment of industrial radiography sources

- Special form & normal form
- Type A & Type B quantities
- Package classification
- Packaging
- Marking
- Labeling
- Placarding
- Shipping papers
- Dose rate limits
- Exclusive use vehicle

Regulatory Agencies & Regulations



- The lead federal agency responsible for regulation of rad. material transportation is the U.S. DOT
- DOT regulations: 49 CFR Parts 100-185



- U.S. NRC regulations also address RAM transport, primarily focusing on packages
- NRC transportation regulations are contained in 10 CFR Part 20 & Part 71

Regulatory Agencies & Regulations

U.S. Department of Transportation



Title 49 CFR — Transportation



Chapter I — Research & Special Programs Admin., Dept. of Transportation

Subchapter C — Hazardous Materials Regulations (HMR)

The HMR prescribe requirements governing the offering of haz. materials for transport, & transport of hazmat in interstate, intrastate & foreign commerce by rail car, aircraft, motor vehicle, or vessel

Regulatory Agencies & Regulations

Title 49 CFR, Chapter I

Subchapter C – Hazardous Materials Regulations (HMR)

- Part 171** General Information, Regulations & Definitions
- Part 172** Haz. Materials Table, Special Provisions, Haz. Materials Communications, Emergency Response Information & Training Requirements
- Part 173** General Requirements for Shipments & Packagings
- Part 175** Carriage by Aircraft
- Part 177** Carriage by Public Highway

Regulatory Agencies & Regulations

U.S. Nuclear Regulatory Commission

Title 10 CFR — Energy



Chapter I — Nuclear Regulatory Commission

Part 71 — Packaging & Transportation of Radioactive Material

- Establishes requirements for packaging, preparation for shipment & transportation of licensed radioactive material
- Establishes procedures & standards for NRC approval of packaging & shipping procedures for licensed RAM in excess of Type A quantities (i.e., NRC Certificates of Compliance)

Regulatory Agencies & Regulations

Packages used to ship RAM must be tested for compliance with 10 CFR Part 71 requirements & have a valid CoC

NRC FORM 616 (9-2000) 10 CFR 71		U.S. NUCLEAR REGULATORY COMMISSION			
CERTIFICATE OF COMPLIANCE FOR RADIOACTIVE MATERIAL PACKAGES					
1. CERTIFICATE NUMBER	2. REVIEW NUMBER	3. SOCKET NUMBER	4. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
9269	3	71-9269	USA/9269/B(U)-85	1	OF 2

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO (Name and Address)

AEA Technology/QSA Inc.
40 North Avenue
Burlington, MA 01803

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

AEA Technology/QSA Inc. application dated July 23, 1999, as supplemented.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5. (a) Packaging

(1) Model No.: 650L

(2) Description

A welded stainless steel enclosed, uranium shielded, Iridium-192 source changer. Primary components consist of a steel or stainless steel housing, internal supports, depleted uranium shield, and a titanium "U" tube. The tube is crimped in the middle of the "U" to provide a positive stop for the source assembly. Additionally, the Model No. 650L has two source locking assemblies mounted on the top cover plate. These assemblies are used to secure the radioactive source in a shielded position during transport. The unit resembles a rectangular box approximately 10-inches long, 13.25-inches high and 8.25-inches wide. The maximum weight of the package is 90 pounds.

(3) Drawings

The packaging is constructed in accordance with the AEA Technology/QSA Inc. Drawing No. R65006, Rev. G, Sheets 1-4.

(b) Contents

(1) Type and form of material

Iridium-192 as sealed sources which meet the requirements of special form radioactive material.

NRC FORM 616 (9-2000) 10 CFR 71		U.S. NUCLEAR REGULATORY COMMISSION			
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5. (b) Contents (continued)

(2) Maximum quantity of material per package

240 curies (output)

Output curies are determined in accordance with American National Standard N432-1980, "Radiological Safety for the Design and Construction of Apparatus for Gamma Radiography."

6. The source shall be secured in the shielded position of the packaging by the source assembly. The source assembly must be fabricated of materials capable of resisting a 1475°F fire environment for one-half hour and maintaining its positioning function. The cable of the source assembly must engage the source hold-down assembly. The flexible cable of the source assembly must be of sufficient length and diameter to provide positive positioning of the source at the crimp of the "U" tube.

7. The nameplates shall be fabricated of materials capable of resisting the fire test of 10 CFR Part 71 and maintaining their legibility.

8. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) The package shall be prepared for shipment in accordance with the Operating Procedures of Chapter 7 of the application; and

(b) Each package must meet the Acceptance Tests and Maintenance Program of Chapter 8 of the application.

9. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR §71.12.

10. Expiration date: November 30, 2005.

REFERENCES

AEA Technology/QSA Inc. application dated July 23, 1999.

Supplements dated November 19, 1999, October 2 and October 31, 2000.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

E. William Brach
E. William Brach, Director
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Date: November 17, 2000

NRC Certificate of Compliance (CoC) for AEA Model 650L Overpack

Airline Organizations

International Civil Aviation Organization (ICAO)



International Air Transport Association (IATA)



While not regulatory agencies, ICAO & IATA publications
should be treated as "parallel regulations"
to 49 CFR for air shipments

Airline Organizations

International Air Transport Association (IATA)



"Dangerous Goods Regulations"



- Issued annually; only available by purchase from IATA
- DGR are not regs; they are a "field reference guide for shipping dangerous goods by air" — i.e., procedures used by the airlines (but might as well be regs, because noncompliance will get a package rejected)
- IATA regs are "upward compatible" with ICAO "Technical Instructions" (i.e., ICAO requirements may be over & above what IATA requires, so don't ignore either one)
- For the most part, IATA is compatible with the USDOT HMR, but there are some significant additional requirements

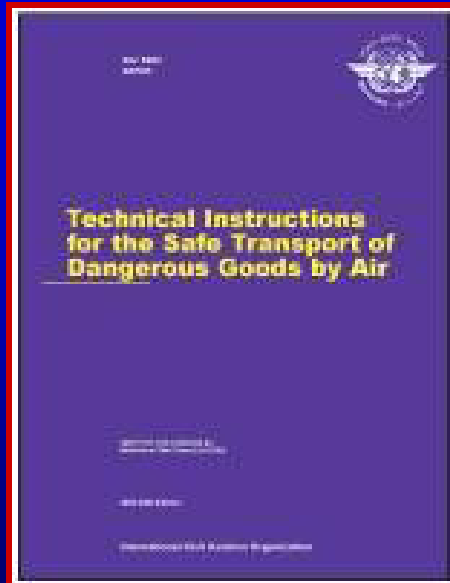
Airline Organizations

International Civil Aviation Organization (ICAO)



"Technical Instructions for the Safe Transport of Dangerous Goods"

- Issued annually; only available by purchase from ICAO
- Requirements generally match IATA, but there are often subtle differences in wording, & occasionally different requirements



RAM = Hazardous Material

- Radioactive materials may be classified as hazardous materials (hazmat), depending on activity
- **Hazard Class** for radioactive materials: **Class 7**
- **Proper shipping name** for radiography sources is typically:

Radioactive material, Type B(U) package

Special Form vs. Normal Form

Special form

Double encapsulated & tested sealed sources of radioactive material



All industrial radiography sources are **special form** sources

Normal Form

Rad. material that doesn't qualify as special form (i.e., everything else)



Special Form Classification

- Special form requirements are: (1) contained in a solid piece or a sealed capsule the can only be opened by destroying the capsule (2) has at least one dimension not less than 5 mm; (3) satisfies requirements of 49 CFR 173.469: does not break, melt, or leak after being subjected to the following tests:
 - a) 9 m drop test
 - b) percussion test
 - c) bending test
 - d) heat test of 800° C for 10 min; leach tested by immersion in 50° Celsius water with pH of 6-8 & 10 micromho/cm conductivity for 4 hrs., then stored for 7 days in air at 30° Celsius

Fissile vs. Non-fissile Material

Fissile Material

Elements capable of nuclear fission
(U-233, U-235 & Pu-239)



Their atoms can be split by bombarding them with neutrons, with the fission process releasing enormous amounts of energy; fissile isotopes are used as fuel in nuclear power plants & to make nuclear bombs, so they have lots of regulatory controls – thus, their own category

Non-fissile Material

Elements incapable of nuclear fission
(i.e., everything else)

Quantity: A_1 or A_2

A_1 Designation for the max. activity of special form Class 7 material permitted in a Type A package

A_2 Max. activity of other than special form (LSA or SCO) permitted in a Type A package

Iridium-192

A_1 27 Ci (1 TBq)

A_2 13.5 Ci (0.5 TBq)

Cobalt-60

A_1 10.8 Ci (0.4 TBq)

A_2 10.8 Ci (0.4 TBq)

Quantity for special form sources is designated by the A_1 limit; for Ir-192, A_1 limit is > for normal form (A_2) quantity limit; for Co-60, A_1 & A_2 limits are equal (because of high external radiation hazard created by high energy photons from Co-60)

Packages: Type A & Type B

- Type A packages may not contain more than the A_1 or A_2 quantity of Class 7 materials
- Radiography sources are typically greater than this limit, so they must be in Type B packages
- Type B packages must meet NRC requirements specified in 10 CFR Part 71; use must be in accordance with 49 CFR 173.471 (requirements for NRC-approved packages)



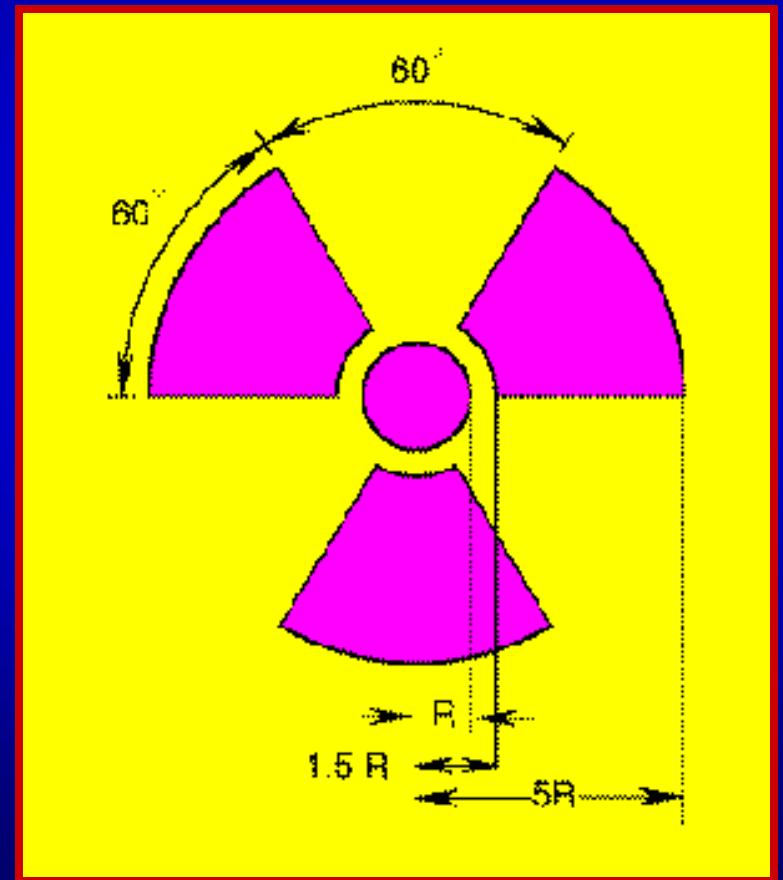
Reportable Quantity (RQ)

- Reportable Quantities (RQ) for radionuclides are listed in 49 CFR 172.101, App. A, Table 2

<u>Nuclide</u>	<u>RQ</u>
Ir-192	10 Ci (0.37 TBq)
Co-60	10 Ci (0.37 TBq)

Radiation Symbol – Trefoil

- Radiation symbol (trefoil) must be on placards & labels
- There are specific requirements for the symbol's dimensions, as noted in App. B to 49 CFR 172



USDOT Hazard Communications System

Four components:

- Shipping Papers
 - Markings
 - Warning Labels
 - Placards

HAZCOM

Shipping Papers

Contents:

- Must be legible & printed in English
- May not contain any code or abbreviation, unless authorized or required (ex.: "RQ")
- May contain additional info, provided it is consistent with, & comes after the required description
- May consist of more than one page, if each page is consecutively numbered & the first page bears a notation specifying the total no. of pages
- Must contain an emergency response information telephone no. as prescribed in 49 CFR Part 172, Subpart G
- Copy must be retained for 2 years beyond date of shipment

Shipping Papers:

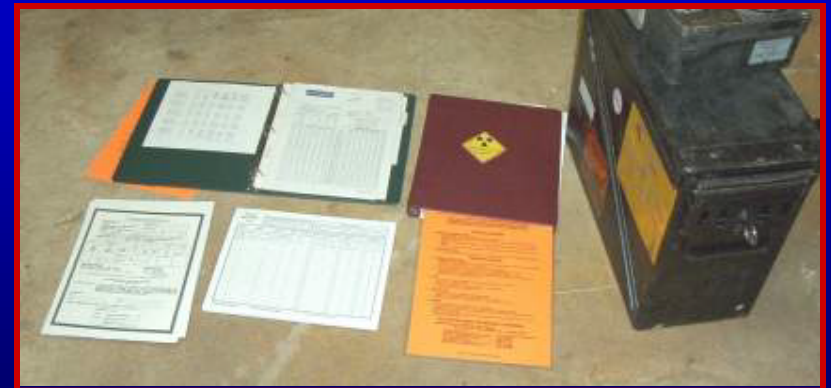
Description:

- Proper shipping name prescribed in Col. 2 of the Haz. Materials Table in 49 CFR 172.101 (radioactive material, Type B(U) package)
- Hazard class for the material (Class 7; the word "Class" may be included))
- ID number as prescribed in Column 4 of the Hazmat Table (UN2916)
- Name of each radionuclide; abbreviations OK (Ir-192, ^{192}Ir)
- Activity in SI units (GBq, TBq); may be followed by customary units (Ci)
- The letters "RQ" either before or after the description
- Label category of label applied to package (Rad. Yellow II, III)

Shipping Papers:

Description:

- Label category of label applied to package (Rad. Yellow II, III)
- Transport index assigned to package
- For packages approved by DOE or NRC, a notation of the package ID marking per the applicable DOE or NRC approval
- When shipping by air, the words "Cargo aircraft only" must be entered after the basic description
- For an export shipment or a shipment in a foreign made package, a notation of the package ID marking per the applicable IAEA Certificate of Competent Authority issued for the package



Shipping Papers

Shipper's Certification

- When offering a RAM package for transport by a third party, the consignor must certify that the material is offered in accordance with the HMR by including on the shipping paper one of the certifications listed below:

"This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation."

"I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations."

- Certification must be legibly signed by a principal, officer, partner, or employee of the shipper or his agent

Shipping Papers

Shipper's Certification

- When offering a RAM package for transport by air, an alternate certification statement may be used, & an additional statement is required (listed below)

Alternate Certification Statement for Air Shipments

"I hereby certify that the contents of this consignment are fully and accurately described above by proper shipping name, and are classified, packaged, marked and labeled, and in proper condition for carriage by air according to applicable national governmental regulations."

Required Statement for Air Shipments

"This shipment is within the limitations prescribed for passenger aircraft/cargo aircraft only (delete non-applicable)."

Emergency Response Information

- Purpose: To provide instructions to first responders (EMTs, police, fire) at a transportation accident scene so they can protect themselves & mitigate the accident's consequences
- ERI must include:
 - basic description & technical name of the hazmat
 - Immediate hazards to health
 - Risks of fire or explosion
 - Immediate precautions to be taken
 - Immediate methods for handling fires
 - Initial methods for handling spills or leak
 - Preliminary first aid measures

Shipping Papers: BoL & ERI



BILL OF LADING



Shipper: NDE, Inc.

Address: 4816 North Clark Avenue, Tampa, FL 33614

RQ, Radioactive Material, Type B(U) Package

Hazard Class 7, Special Form, UN2916

USA/9283/B(U)-85

Package contains:

_____ TBq (_____ Ci)

Radioactive

RADIOACTIVE YELLOW II Label

Transport Index (TI) = _____

24-HR EMERGENCY RESPONSE INFORMATION

CONTACT NO.:

(813) 478-9156

This is to certify that the above-named materials are properly classified, described, packaged, marked and labeled, and are in proper condition for transportation according to the applicable regulations of the U.S. Department of Transportation.

Shipper: _____ Date: _____
(Signature)

Form 5-5, 9/24/03 Rev. 0



EMERGENCY RESPONSE INFORMATION



POTENTIAL HAZARDS

IMMEDIATE HAZARDS TO HEALTH

- External radiation hazard from unshielded radioactive material.
- Potential internal radiation hazard from inhalation, ingestion, or breaks in skin, but only if special form capsule is breached.
- Radioactive material; degree of hazard will vary greatly, depending on type and quantity.
- Materials in special form or in Type B packaging are not expected to cause contamination in accidents.

FIRE OR EXPLOSION

- No risk of fire or explosion; radioactivity will not change flammability or other properties of materials.

EMERGENCY ACTION

IMMEDIATE PRECAUTIONS

- Isolate hazard area to at least a 150-foot radius and restrict access; greater distances may be necessary if advised by the qualified Radiation Control Agency.
- Enter hazard area only to save life; limit entry to shortest possible time.
- Emergency response actions may be performed prior to any measurement of radiation.
- Notify local authorities and Radiation Control Agency of accident conditions.
- Detain uninjured persons, isolate equipment with suspected contamination, and delay cleanup until instruction from the Radiation Control Agency.

EMERGENCY RESPONSE INFORMATION

FIRE

- Do not move damaged containers; move undamaged containers out of fire zone.
- Fight fire from maximum distance.
- Small fire: Dry chemical, CO₂, Halon, water spray, or standard foam
- Large fire: Water spray, fog (flooding amounts)

SPILL OR LEAK

- Do not touch damaged containers or exposed contents.
- Damage to outer container may not affect primary inner container.
- Special form capsules are not expected to leak as a result of an accident or fire.

FIRST AID

- Use first aid treatment according to the nature of the injury.
- Advise medical personnel that victim may be contaminated with radioactive material.
- If not affecting injury, remove and isolate potentially contaminated clothing and shoes. Wrap victim in blanket before transporting.
- Except for the injured, detain persons exposed to radioactive material until arrival or instruction of the Radiation Control Agency.

CALL THE FOLLOWING FOR EMERGENCY ASSISTANCE:

24-HR EMERGENCY RESPONSE INFORMATION: **(813) 478-9156**

LOCAL AUTHORITIES.....911, police, sheriff, fire department
FLORIDA BUREAU OF RADIATION CONTROL.....(407) 297-2095
U.S. DEPT. OF TRANSPORTATION.....(800) 424-8802
AEA TECHNOLOGY QSA.....(617) 272-2000

Form 5-5, 9/24/03 Rev. 0

Accessibility of Shipping Papers & ERI

- The driver is responsible for ensuring that the shipping paper & emergency response information are readily available to, & recognizable by, authorities in the event of accident or inspection
- The driver must clearly distinguish the shipping paper, if it is carried with other papers, by either distinctively tabbing it or by having it appear first




Accessibility of Shipping Papers & ERI

- When **driver is at the vehicle's controls**, shipping paper shall be:
 - (A) Within immediate reach while restrained by the lap belt; &
 - (B) Either readily visible to a person entering the driver's compartment or in a holder mounted to the inside of the door on the driver's side
- When **driver is not at the vehicle's controls**, the papers must be:
 - (A) In a holder mounted to the inside of the door on the driver's side; or
 - (B) On the driver's seat in the vehicle

Shipping Papers - Air Shipments


IATA & ICAO call shipping papers used for RAM packages the "Shipper's Declaration for Dangerous Goods" form ("Shipper's Declaration")


- Shipper Declaration form must be printed on std. letter (8½" x 11") or ledger (16½" x 11") paper
- Declaration form must be printed on white paper, either in black & red ink, or in red ink only
- Form must bear diagonal hatchings ("candy stripes") printed vertically in the left & right margins, printed in red ink

SHIPPER'S DECLARATION FOR DANGEROUS GOODS						(Provide at least three copies to FedEx Express)	
Shipper				Air Waybill No.			
Consignee				Page of Pages Shipper's Reference Number (optional)			
Two completed and signed copies of this Declaration must be handed to the operator.							
TRANSPORT DETAILS				WARNING			
This shipment is within the limitations prescribed for (delete non-applicable)				Failure to comply in all respects with the applicable Dangerous Goods Regulations may be in breach of the applicable law, subject to legal penalties. This Declaration must not, in any circumstances, be completed and/or signed by a consolidator, a forwarder or an IATA cargo agent.			
PASSENGER AND CARGO AIRCRAFT				AIRPORT OF DEPARTURE			
AIRPORT OF DESTINATION				SHIPMENT TYPE: (delete non-applicable) NON-RADIOACTIVE RADIOACTIVE			
NATURE AND QUANTITY OF DANGEROUS GOODS							
Dangerous Goods Identification							
Proper Shipping Name	Class or Division	UN or ID No.	Packing Group	Subsidiary Risk	Quantity and Type of packing	Packing Inst.	Authorization
Additional Handling Information							
Emergency Telephone Number				Name/Title of Signatory			
I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked, and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.				Place and Date			
				Signature (see warning above)			
IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT							

Shipping Papers - Air Shipments

- 3 copies must be completed & signed; one presented to the shipper, one forwarded with the shipment, & one retained on file for 2 yrs. after shipment date
- If shipment consists of more than one package, a separate declaration form is required for each package

	I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked, and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.	Name/Title of Signatory
		Place and Date
		Signature (see warning above)
IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT		



Markings

- Proper shipping name [Radioactive Material, Type B/B(U)/B(M) package] & ID No. (preceded by "UN")
- The letters "RQ" in association with the shipping name (but usually ends up as a separate round label)
- Radiation symbol (conforming to requirements of 49 CFR Part 172, App. B)
- Gross weight [for packages over 50 kg (110 lb)]
- Packages destined for export must be marked "USA"
- Must be marked with the Certificate of Compliance / Competent Authority certificate number



Markings

Must Be:

- Durable, in English & printed on or affixed to package surface, or on a label, tag, or sign
- Displayed on a background or sharply contrasting color
- Unobscured by labels or attachments
- Located away from other markings (such as ads) that could substantially reduce effectiveness



Radioactive Warning Labels

- Purpose: To identify specific hazards of package
- Applied on two opposite sides of package
- Category is based on greater of TI or surface dose rate

Label Category	Surface Dose Rates	Transport Index
White I	$D \leq 0.5$	N/A (Bkgd.)
Yellow II	$0.5 < D \leq 50$	≤ 1.0
Yellow III	$50 < D \leq 200$	$1.0 < TI \leq 10.0$



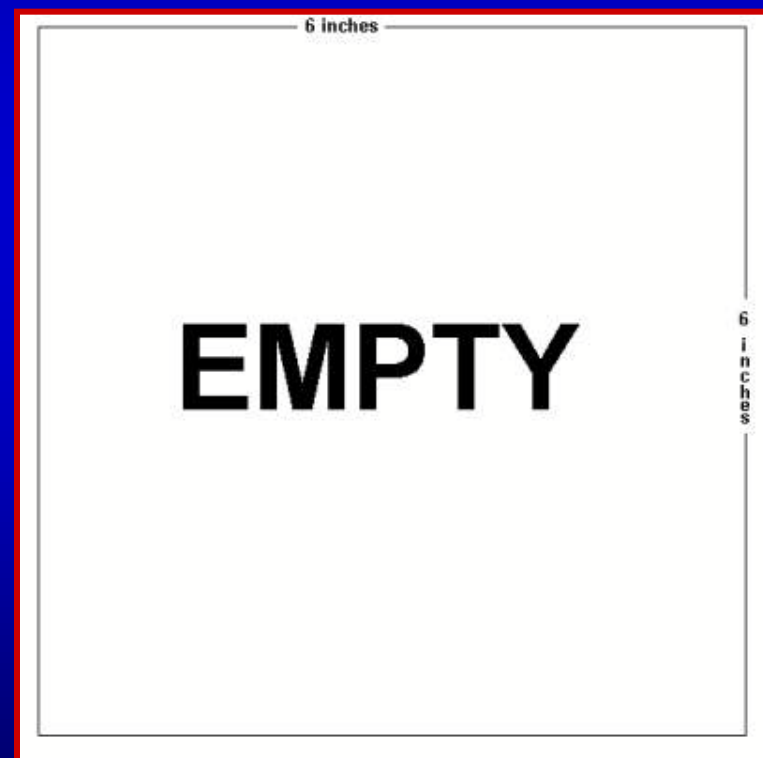
Cargo Only Label

- Purpose: To identify package as being barred from shipment on passenger aircraft
- Applied on at least one side of package
- Must meet 40 CFR Part 172 specifications



Empty Label

- Purpose: To identify package as not currently containing any hazmat
- Applied on at two sides of package, covering rad. warning labels
- Must meet 40 CFR Part 172 specifications



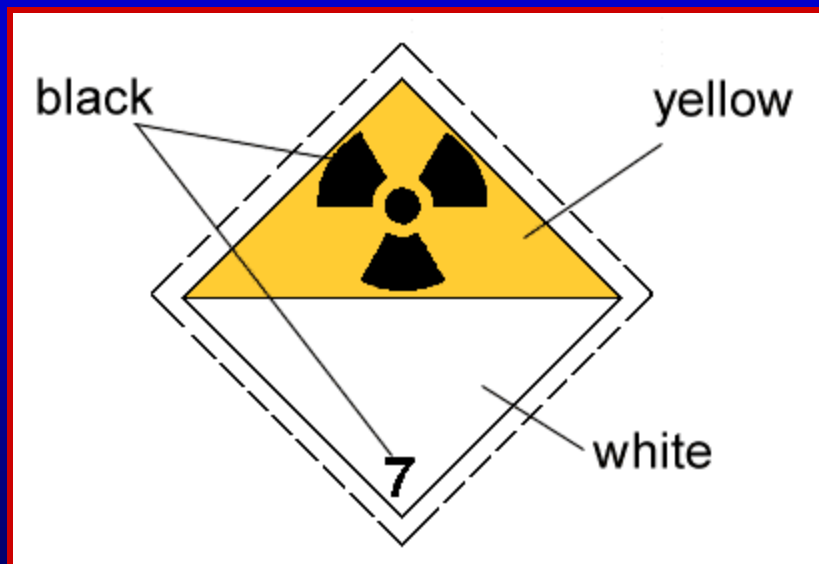
Placards

- Placards are required for vehicles transporting radioactive material packages labeled "Radioactive Yellow III"
- Placards must be on each side & each end of transport vehicle (49 CFR 172.504)
- Radiation symbol must comply with design specifications in App. B to 49 CFR 172



Placards

- Placards must be visible, able to withstand 30 days of open exposure, 273 mm on each side, have a solid line 12.7 mm from each edge, letters must be 41 mm in height, bkgd. color must be white in lower portion with yellow in upper portion; yellow portion must be 29 +/- 5 mm above the placard horizontal center line
- The symbol, text, class number & inner border must be black



Radioactive Placards

- Activity $> 3,000 \times A_1$ or $> 3,000 \times A_2$
- Black border with white bkgd.
- Rad. Yellow III labels
- Highway Route Control Quantity
- Type B Packaging



Package Integrity & Security

- Outside package must be sealed to prevent tampering
- Secured, braced & blocked to prevent shifting during normal transport
- Min. distances between packages & passengers
- Shipper must ensure package is in good physical condition, closure devices are in place, external radiation & contamination levels are within allowable limits



B & B



Overpacks

- An overpack can be used to reduce package dose rate so it is Rad. Yellow-II rather than Yellow-III, thereby eliminating placard & CDL requirements



Overpacks

- Requirements for overpacks:
 - Shipment must be secured;
 - Overpack must be labeled with contents on the label, the activity, and the transport index (TI). For rigid overpacks, the TI can be determined by direct measurement of the overpack
 - Overpacks must be marked in accordance with the proper shipping name & ID number

Hazmat Employees/Employers

- A **hazmat employee** is a person who is employed by a hazmat employer & who in the course of employment directly affects hazmat transportation safety
- A **hazmat employer** is a person who uses one or more of its employees in connection with:
 - Transporting hazmat in commerce;
 - Causing hazmat to be transported or shipped in commerce; or
 - Representing, marking, certifying, selling, offering, reconditioning, testing, repairing, or modifying packagings as qualified for use in the transportation of hazmat



Hazmat Employees/Employers

The Short Version:

A **hazmat employer** is anyone who uses employees in connection with transporting hazmat in commerce, causing them to be transported, or mfrg. or offering hazmat packagings for transportation

A **hazmat employee** is anyone who directly affects hazmat transportation safety, either by being responsible for the safety of transporting hazmat or by direct actions

So: **Radiography licensees are hazmat employers...**
radiographic personnel are hazmat employees...
& they must receive initial & 3-yr. refresher HET training per 40 CFR Part 172, Subpart H

Transportation



Questions?