National Nuclear Security Administration

Transportation & Traffic Management

Qualification Standard

Reference Guide

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Acronyms	
A1	special form radionuclides
A2	normal form radionuclides
AEA	Atomic Energy Act
AHA	activity hazard analysis
ALARA	as low as is reasonably achievable
ALI	annual limit on intake
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
C	celsius
CAMP	corrective action management plan
CAP	corrective action plan
CAS	cost accounting standard
CATS	corrective action tracking system
CCP	commercial chemical product
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
Ci	curie
CIRIA	Construction Industry Research and Information Association
cm	centimeter
cm^2	centimeters square
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
EM	environmental management
EO	executive order
EPA	U.S. Environmental Protection Agency
ES&H	environment, safety, and health
eV	electron volts
F	Fahrenheit
FAQS	functional area qualification standard
FOB	free on board
ft	foot, feet
ft^3	cubic feet
g	gram
gal	gallon
GOCO	government-owned, contractor-operated
GSA	General Services Administration
Gy	gray
h	hour
HAZMAT	hazardous materials
HLW	high-level waste
HMTA	Hazardous Materials Transportation Act
IAEA	International Atomic Energy Agency

Acronyms	
IATA	International Air Transport Association
in	inch
IP	industrial packaging
ISO	International Organization of Standardization
JHA	job hazard analysis
kg	kilogram
kJ	kilojoule
kPa	kilopascal
KSA	knowledge, skill, and ability
L	liter
LD_{50}	median lethal dose
lb	pound
LC	lethal concentration
LSA	low specific activity
m	meter
m^3	cubic meters
mg	milligram
MIL	military
mL	milliliter
mm	millimeter
MORT	management oversight and risk tree
mrem	millirem
mrem/h	millirem per hour
mSv	millisieverts
mSv/h	millisievert per hour
MSDS	material safety data sheet
NA	North America
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NPR	NASA procedural requirements
NRC	Nuclear Regulatory Commission
NUREG	nuclear regulations
NWPA	Nuclear Waste Policy Act of 1982
ORM	other regulated material
ORM-D	miscellaneous dangerous goods
ORPS	occurrence reporting and processing system
OSHA	Occupational Safety and Health Administration
PLPRP	public law
psia	pounds per square inch absolute
P(x)	poisson
rad	roentgen absorbed dose
RCRA	Resource Conservation and Recovery Act

Acronyms	
rem	roentgen equivalent man
RQ	reportable quantity
SARA	Superfund Amendments and Reauthorization Act
SARP	safety analysis report for packaging
SCBA	self-contained breathing apparatus
SD	standard deviation of the mean
SED	shipper's export declaration
SLAC	Stanford Linear Accelerator Center
SNF	spent nuclear fuel
SNM	special nuclear material
Sv	sievert
TBq	terrabecquerel
TI	transportation index
TRANSCOM	DOE Satellite Tracking and Communication System
TRR	technical review report
TSCA	Toxic Substances Control Act
UN	United Nations
U.S.	United States
U.S.C.	United States Code

PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a Department of Energy (DOE)/National Nuclear Security Administration (NNSA) technical employee to successfully complete the Transportation & Traffic Management Functional Area Qualification Standard (FAQS). Information essential to meeting the qualification requirements is provided; however, some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

SCOPE

This reference guide addresses the competency statements in the September 2002 edition of DOE-STD-1155-2002, *Transportation and Traffic Functional Area Qualification Standard*. The qualification standard contains 28 competency statements.

Please direct your questions or comments related to this document to the NNSA Learning and Career Development Department.

PREFACE

Competency statements and supporting knowledge and/or skill statements from the qualification standard are shown in contrasting bold type, while the corresponding information associated with each statement is provided below it.

A comprehensive list of acronyms and abbreviations is found at the beginning of this document. It is recommended that the candidate review the list prior to proceeding with the competencies, as the acronyms and abbreviations may not be further defined within the text unless special emphasis is required.

The competencies and supporting knowledge, skill, and ability (KSA) statements are taken directly from the FAQS. Most corrections to spelling, punctuation, and grammar have been made without remark, and all document-related titles, which variously appear in roman or italic type or set within quotation marks, have been changed to plain text, also mostly without remark. Capitalized terms are found as such in the qualification standard and remain so in this reference guide. When they are needed for clarification, explanations are enclosed in brackets.

Every effort has been made to provide the most current information and references available as of April 2010. However, the candidate is advised to verify the applicability of the information provided. It is recognized that some personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the Technical Qualification Program.

In the cases where information about an FAQS topic in a competency or KSA statement is not available in the newest edition of a standard (consensus or industry), an older version is referenced. These references are noted in the text and in the bibliography.

Only significant corrections to errors in the technical content of the discussion text source material are identified. Editorial changes that do not affect the technical content (e.g., grammatical or spelling corrections, and changes to style) appear without remark.

TECHNICAL COMPETENCIES

1. **Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of chemical terms related to transportation as defined in 49 CFR and 40 CFR as applicable.**

   a. **Discuss the following terms:**
      - **Aerosols**
      - **Boiling point**
      - **Characteristic waste (reactive, corrosive, toxic, flammable)**
      - **Combustible liquid**
      - **Compressed gases**
      - **Corrosive material**
      - **Density**
      - **Explosive**
      - **Flammable gas, liquid, solid**
      - **Flash point**
      - **Gas**
      - **Infectious substance**
      - **Inhalation hazard**
      - **Liquid**
      - **Mixture**
      - **Nonflammable gas**
      - **Oxidizer**
      - **Poisonous materials (toxic)**
      - **Pyrophoric**
      - **Radioactive material**
      - **Solid**
      - **Solution**
      - **Vapor**
      - **Waste codes (F, K, P, U,)**
      - **Waste stream**
      - **Water reactive**

Aerosols

The following is taken from 49 CFR 173.115.

An aerosol must be assigned to Division 2.1 if the contents include 85 percent by mass or more flammable components and the chemical heat of combustion is 30 Kilojoule (kJ)/gram (g) or more.

An aerosol must be assigned to Division 2.2 if the contents contain 1 percent by mass or less flammable components and the heat of combustion is less than 20 kJ/g.

Aerosols not meeting the provisions of the previous two paragraphs must be classed in accordance with the appropriate tests of the United Nations (UN) Manual of Tests and Criteria.

Boiling Point

The following is taken from DOE-HDBK-1101-2004.

The boiling point is the initial temperature at which a liquid begins to pass into the gaseous phase at a pressure of 1.01 x 10^6 dynes/cubic centimeters (cm2) (14.7 pounds per square inch absolute (psia)).

Characteristic Waste

The following is taken from the United States (U.S.) Environmental Protection Agency (EPA), Characteristic Wastes.

Waste that has not been specifically listed may still be considered a hazardous waste if it exhibits one of the four characteristics defined in 40 CFR 261, ignitability, corrosivity, reactivity, and toxicity.

Combustible Liquid

The following is taken from DOE-HDBK-1015/2-93.

Combustible liquids are those with flash points at or above 100° Fahrenheit (F), but below 200^OF. Although combustible liquids do not ignite as easily as flammable liquids, they must be handled with caution because of their ability to ignite under certain condition.

Compressed Gases

The following is taken from 49 CFR 173.115.

A gas, which when packaged under pressure for transportation is entirely gaseous at -50° Celsius (C) (-58^oF) with a critical temperature less than or equal to -50^oC (-58^oF), is considered to be a non-liquefied compressed gas. A gas, which when packaged under pressure for transportation is partially liquid at temperatures above -50°C (-58°F), is considered to be a liquefied compressed gas.

Corrosive Material

The following is taken from 49 CFR 173.136.

Corrosive material means a liquid or solid that causes full thickness destruction of human skin at the site of contact within a specified period of time. A liquid that has a severe corrosion rate on steel or aluminum based on the criteria in 49 CFR 173.137, "Assignment of Packing Group," is also a corrosive material.

Density

The following is taken from DOE-HDBK-1012/1-92.

The density of a substance is the total mass of that substance divided by the total volume occupied by that substance.

Explosive

The following is taken from 49 CFR 173.50.

An explosive means any substance or article, including a device that is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or which, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion.

Flammable Gas, Liquid, Solid

Flammable Gas

The following is taken from 49 CFR 173.115.

A flammable gas means any material which is a gas at 20°C (68°F) or less and 101.3 kilopascal (kPa) of pressure (a material which has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia) of pressure which, 1) is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air; or 2) has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit.

Flammable Liquid

The following is taken from 49 CFR 173.120.

A flammable liquid means a liquid having a flash point of not more than 60°C (140°F), or any material in a liquid phase with a flash point at or above 37.8°C (100°F) that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging.

Flammable Solid

The following is taken from 49 CFR 173.124.

A flammable solid means any of the following three types of materials:

- Desensitized explosives that
  - when dry, are explosives of class 1 other than those of compatibility group A, which are wetted with sufficient water, alcohol, or plasticizer to suppress explosive properties; and
  - are specifically authorized by name or have been assigned a shipping name and hazard class by the Associate Administrator under the provisions of
    - a special permit;
    - an approval issued 49 CFR 173.56, "New Explosives—Definition and Procedures for Classification and Approval."
- Self-reactive materials are materials that are thermally unstable and that can undergo a strongly exothermic decomposition even without participation of oxygen (air).

- Readily combustible solids are materials that
  - Are solids which may cause a fire through friction, such as matches;
  - Show a burning rate faster than 2.2 millimeters (mm) (0.087 inches (ins)) per second when tested according to the UN Manual of Tests and Criteria; and
  - Include any metal powders that can be ignited and react over the whole length of a sample in 10 minutes or less, when tested according to the UN Manual of Tests and Criteria.

Flash Point

The following is taken from 49 CFR 173.120.

Flash point means the minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.

Gas

The following is taken from 49 CFR 173.115.

A flammable gas (division 2.1) means any material that is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psia) of pressure (a material which has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia)) which

- is ignitable at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air; or
- has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit.

A gas poisonous by inhalation (division 2.3) means a material that is a gas at 20°C (68°F) or less and a pressure of 101.3 kPa (14.7 psia) (a material which has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia)) and which

- is known to be so toxic to humans as to pose a hazard to health during transportation; or
- in the absence of adequate data on human toxicity, is presumed to be toxic to humans because when tested on laboratory animals it has a lethal concentration $(LC)_{50}$ value of not more than 5000 milliliter (mL)/cubic meters $(m)^3$.

Infectious Substance

The following is taken from 49 CFR 173.196.

Infectious substances must be packaged according to the following requirements, depending on the physical state and other characteristics of the material.

- Infectious substances shipped at ambient temperatures or higher. Primary receptacles must be made of glass, metal, or plastic. Positive means of ensuring a leak proof seal must be provided, such as heat seal, skirted stopper, or metal crimp seal. If screw caps are used, they must be secured by positive means, such as with adhesive tape, paraffin sealing tape, or manufactured locking closure. Lyophilized substances may also be transported in primary receptacles that are flame-sealed with glass ampoules or rubber-stoppered glass vials fitted with metal seals.

- Infectious substances shipped refrigerated or frozen (ice, pre-frozen packs, dry ice). Ice, dry ice, or other refrigerant must be placed around the secondary packaging or in an overpack with one or more complete packages marked in accordance with 49 CFR 178.503, "Marking of Packagings." Interior supports must be provided to secure the secondary packaging in the original position after the ice or dry ice has dissipated. If ice is used, the outer packaging or overpack must be leak proof. If dry ice is used, the outer packaging or overpack must permit the release of carbon dioxide gas and otherwise meet the provisions in 49 CFR 173.217. "Carbon Dioxide, Solid (Dry Ice)." The primary receptacle and the secondary packaging must maintain their integrity at the temperature of the refrigerant used, as well as the temperatures and pressures of transport by aircraft to which they could be subjected if refrigeration were lost.
- Infectious substances shipped in liquid nitrogen. The primary receptacle and the secondary packaging must maintain their integrity at the temperature of the liquid nitrogen as well as the temperatures and pressures of transport by aircraft to which they could be subjected if refrigeration were lost. Refrigerated liquid nitrogen packagings must be metal vacuum insulated vessels or flasks vented to the atmosphere to prevent any increase in pressure within the packaging. The use of safety relief valves, check valves, frangible discs, or similar devices in the vent lines is prohibited. Fill and discharge openings must be protected against the entry of foreign materials that might cause an increase in the internal pressure. The package orientation markings specified in 49 CFR. 172.312, "Liquid Hazardous Materials in Non-Bulk Packagings," must be marked on the packaging. The packaging must be designed to prevent the release of any refrigerated liquid nitrogen irrespective of the packaging orientation.

Inhalation Hazard

The following is taken from 49 CFR 173.196.

49 CFR 172.101, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans," includes a list of inhalation hazards for regulatory purposes. Chemicals must be either gases or volatile liquids and must meet certain toxicity thresholds to be placed on the U.S. Department of Transportation (DOT) list.

Liquid

The following is taken from DOE-HDBK-1015/1-93.

Liquids have definite volumes but indefinite shapes and are slightly compressible. Liquids take the shape of their containers. The forces that keep a liquid's molecules or atoms together are weaker than in the solids.

Mixture

The following is taken from DOE-HDBK-1015/1-93.

Mixtures consist of two or more substances intermingled with no constant percentage composition. Each component retains its original properties.

The following is taken from the FedCenter, Hazardous Waste Identification Flowchart.

The "mixture rule" states that mixtures of solid waste and listed hazardous waste must be regulated as hazardous waste. There are two ways to determine if a material is regulated under the mixture rule:

- The material is a mixture of a solid waste and a hazardous waste, and the mixture exhibits one or more of the characteristics of hazardous waste.
- The material is a mixture of a solid waste and a listed waste. The mixture rule is intended to discourage generators from mixing wastestreams. More information can be reviewed at 40 CFR 261.3, "Definition of Hazardous Waste."

Nonflammable Gas

The following is taken from 49 CFR 173.115.

A nonflammable, nonpoisonous compressed gas (division 2.2) is a material that

- Exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) or greater at 20°C (68°F), or is a cryogenic liquid;
- Does not meet the definition of division 2.1 or 2.3.

Oxidizer

The following is taken from 49 CFR 173.127.

Oxidizer means a material that may, generally by yielding oxygen, cause or enhance the combustion of other materials.

Poisonous Materials

The following is taken from 49 CFR 173.132.

Poisonous material means a material, other than a gas, known to be so toxic to humans as to pose a health hazard during transportation, or which, in the absence of adequate human toxicity data

- is presumed to be toxic to humans because it is within one of the following when tested on laboratory animals:
  - Oral toxicity: a liquid or solid with a median lethal dose (LD_{50}) for acute oral toxicity of not more than 300 milligrams/kilogram (mg/kg)
  - Dermal toxicity: a material with an LD_{50} of not more than 1,000 mg/kg
  - Inhalation toxicity: a dust or mist with an LC_{50} for acute toxicity on inhalation of not more than 4 mg/L; or a material with a saturated vapor concentration in air at 20ºC (68ºF) greater than or equal to 1/5 of the LC_{50} for acute toxicity on inhalation of vapors and with an LC_{50} for acute toxicity on inhalation of vapors of not more than 5,000 milliliter (mL)/cubic meters (m^3); or an irritating material,

with properties similar to tear gas, which causes extreme irritation, especially in confined spaces

Pyrophoric

The following is taken from 49 CFR 173.124.

A pyrophoric material is a liquid or solid that, even in small quantities and without an external ignition source, can ignite within five (5) minutes after coming in contact with air when tested according to UN Manual of Tests and Criteria.

Radioactive Material

The following is taken from 49 CFR 173.403.

Radioactive material means any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in the table in 49 CFR 173.436, "Exempt Material Activity Concentrations and Exempt Consignment Activity Limits for Radionuclides," or values derived according to the instructions in 49 CFR 173.433, "Requirements for Determining Basic Radionuclide Values, and for the Listing of Radionuclides on Shipping Papers and Labels."

Solid

The following is taken from DOE-HDBK-1015/1-93.

Solids are characterized as having a definite shape and a definite volume. In a solid, the forces that keep the molecules or atoms together are strong. Therefore, a solid does not require outside support to maintain its shape.

Solution

The following is taken from DOE-HDBK-1015/1-93.

A solution is a homogeneous mixture of two or more substances. The reason solutions are classified as mixtures rather than as compounds is because the composition is not of fixed proportion.

Vapor

The following is taken from DOE-HDBK-1122-2009.

Vapors are considered the gaseous phase of a substance that is normally a solid or liquid under normal conditions of temperature and pressure.

Waste Codes (F, K, P, U)

The following is taken from the FedCenter, Hazardous Waste Identification Flowchart.

The U.S. EPA lists hazardous wastes that fall into four categories:

- F-listed wastes: The F list includes wastes from common industrial processes. Because they are not specific to one type of industry, they are called wastes from non-specific sources. This list includes many types of spent (or used) solvents. See

40 CFR 261.31, "Hazardous Wastes from Non-Specific Sources," to see if your waste is F-listed.

- K-listed wastes: The K list includes wastes from specific industrial processes, such as wood preservation, organic chemical production, and pesticide manufacturing. See 40 CFR 261.32, "Hazardous Wastes from Specific Sources," for the complete list of manufacturing process wastes to see if your facility might have a K-listed waste.
- P- and U-listed wastes: These two lists designate certain commercial chemical products (CPPs) as hazardous when disposed of unused. These unused chemicals may become wastes in a number of ways. Some can be spilled while in use while others can be intentionally discarded if out of specification. For a waste to qualify as a P- or U-listed waste, it must meet all three of the following criteria:
  - The formulation must contain at least one chemical on the P or U list;
  - The chemical in the waste must be unused; and
  - The chemical in the waste must be in the form of a CCP. A CCP is a chemical that is of technical (commercial) grade, 100% pure, and the only active ingredient in the formulation.

Waste Stream

The following is taken from the EPA, Terms of Environment: Glossary, Abbreviations and Acronyms.

The total flow of solid waste from homes, businesses, institutions, and manufacturing plants that is recycled, burned, or disposed of in landfills, or segments thereof, such as the residential waste stream or the recyclable waste stream.

Water Reactive

The following is taken from Department of Transportation (DOT) National Transportation Library, *Hazardous Materials Transportation Guides*.

Water reactives are any solid substances (including sludges and pastes) which react with water by igniting or giving off dangerous quantities of flammable or toxic gases.

2. Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of solving problems involving probability and simple statistics.

a. State the definition of the following statistical terms:

- **Mean**
- **Variance**
- **Standard deviation of the mean**
- **Median**
- **Mode**
- **Standard deviation**

Mean

The following is taken from DOE-HDBK-1014/2-92.

One of the most common uses of statistics is the determination of the mean value of a set of measurements. The term "mean" is the statistical word used to state the average value of a set of data. The mean is mathematically determined in the same way as the average of a group of numbers is determined.

The arithmetic mean of a set of N measurements, x_1, x_2, x_3, … x_n is equal to the sum of the measurements divided by the number of data points, N. Mathematically, this is expressed by the following equation:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

where
$\bar{x}$ = the mean
n = the number of values (data)
x_1 = the first data point, x_2 = the second data point …x_i = the ith data point

The symbol sigma (Σ) is used to indicate summation, and i = 1 to n indicates that the values of x_i from i = 1 to $i = n$ are added. The sum is then divided by the number of terms added, n.

Variance

The following is taken from DOE-HDBK-1014/2-92.

This spread, or distance, of each data point from the mean is called the variance. The variance of each data point is calculated by:

$$\text{Variance} = \bar{x} - x_i$$

where
x_i = each data point
$\bar{x}$ = the mean

The variance of each data point does not provide us with any useful information. But if the mean of the variances is calculated, a very useful number is determined. The mean variance is the average value of the variances of a set of data. The mean variance is calculated as follows:

$$\text{Mean Variance} = \bar{x} = \frac{1}{n}\sum_{i=1}^{n}\left|x_i - \bar{x}\right|$$

Standard Deviation of the Mean

[Note: The standard deviation of the mean is also referred to as the standard error of the mean.]

The following is taken from StatsDirect Statistical Software.

The standard deviation of the mean (SD) is the most commonly used measure of the spread of values in a distribution and is calculated as the square root of the variance (the average squared deviation from the mean).

Variance in a population is:

$$\sigma^2 = \frac{\sum (x-\mu)^2}{n}$$

[x is a value from the population, m is the mean of all x, n is the number of x in the population, S is the summation.]

Variance is usually estimated from a sample drawn from a population. The unbiased estimate of population variance calculated from a sample is:

$$s^2 = \frac{\sum (x-\bar{x})^2}{n-1}$$

[x is an observation from the sample, x-bar is the sample mean, n (sample size) -1 is degrees of freedom, S is the summation.]

The spread of a distribution is also referred to as dispersion and variability. All three terms mean the extent to which values in a distribution differ from one another.

The SD is the best measure of spread of an approximately normal distribution. This is not the case when there are extreme values in a distribution or when the distribution is skewed; in these situations interquartile range or semi-interquartile are preferred measures of spread. Interquartile range is the difference between the 25th and 75th centiles. Semi-interquartile range is half of the difference between the 25th and 75th centiles. For any symmetrical (not skewed) distribution, half of its values will lie one semi-interquartile range either side of the median, (i.e., in the interquartile range). When distributions are approximately normal, SD is a better measure of spread because it is less susceptible to sampling fluctuation than (semi-) interquartile range.

If a variable y is a linear (y = a + bx) transformation of x then the variance of y is b^2 times the variance of x and the standard deviation of y is b times the variance of x.

The standard error of the mean is the expected value of the SD of several samples; this is estimated from a single sample as:

$$sem = \frac{s}{\sqrt{n}}$$

[s is standard deviation of the sample mean, n is the sample size.]

Median

The following is taken from DOE-HDBK-1122-2009.

The median is the center value in a data set arranged in ascending order.

Mode

The following is taken from DOE-HDBK-1122-2009.

An individual data point that is repeated the most in a particular data set.

Standard Deviation

The following is taken from DOE-HDBK-1122-2009.

The standard deviation is the square root of the mean variance. It is denoted by the symbol σ. The standard deviation of a population is defined mathematically as:

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$$

where σ = standard deviation of the population,
x_i = each data point,
$\bar{x}$ = the mean, and
n = number of data points

b. Explain the structure and function of distributions.

The following is taken from DOE-HDBK-1122-99.

Statistics is a branch of mathematics that deals with the organization, analysis, collection, and interpretation of statistical data. Over the years, various methods and observations have identified three models that can be applied to observations of events that have two possible outcomes (binary processes). Most observations can be defined in terms of two possible outcomes. For example, look at table 1.

Table 1. Probability of success

Trial	Definition of Success	Probability of Success
Tossing a coin	"heads"	1/2
Rolling a die	"a six"	1/6
Observing a given radioactive nucleus for a time, *t*	*The nucleus decays during the observation*	$1-e^{-\lambda t}$

Source: DOE-HDBK-1122-99

For each of the trials or tests there are two possible outcomes (a success and a failure), and the probability of observing the defined success.

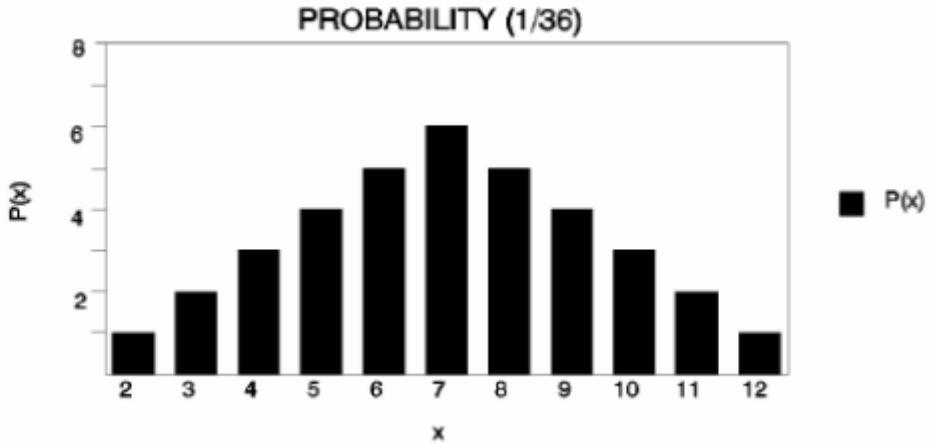
Now consider the possibilities when throwing two dice. There are 36 possible outcomes when throwing two dice, as indicated in table 2.

Table 2. Possibilities in rolling dice

Result	Possibilities	Number of possibilities
2	1&1	1
3	1&2, 2&1	2
4	1&3, 2&2, 3&1	3
5	1&4, 2&3, 3&2, 4&1	4
6	1&5, 2&4, 3&3, 4&2, 5&1	5
7	1&6, 2&5, 3&4, 4&3, 5&2, 6&1	6
8	2&6, 3&5, 4&4, 5&3, 6&2	5
9	3&6, 4&5, 5&3, 6&3	4
10	4&6, 5&5, 6&4	3
11	5&6, 6&5	2
12	6&6	1

Source: DOE-HDBK-1122-99

If success is defined as throwing a number between 2 and 12, the outcome is academic. All trials will be successful, and the probability of throwing any individual number between the range of 2 and 12 inclusive would add up to 1. If success is defined as throwing a particular number, the probability of success can be defined in terms of the number of possible outcomes that would give that number in comparison to the total number of possible outcomes. If the dice is rolled a large number of times a graph of the results would produce a curve such as the one shown in figure 1.



Source: DOE-HDBK-1122-99

Figure 1. Probability of a binary process

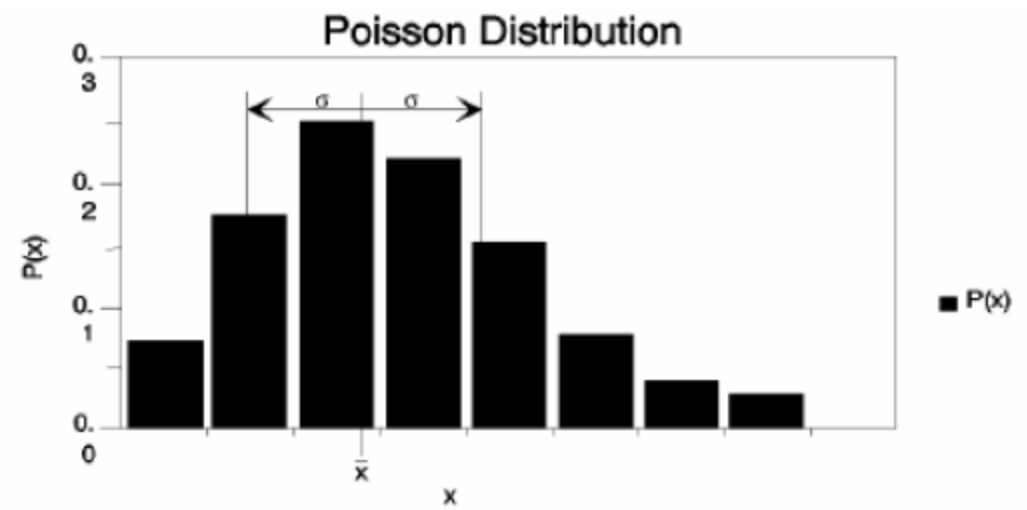
The area under the curve can be mathematically determined and would correspond to the probability of success of a particular outcome. For example, to determine the probability of throwing a particular number between 2 and 12 we would calculate the area under the curve between 2 and 12. The results of that calculation would be 36. This is what statistics is all about; random binomial processes that should produce results in certain patterns that have been proven over the years. The three models that are used are distribution functions of binomial processes with different governing parameters. These functions and their restrictions are discussed in the following paragraphs.

Binomial Distribution

This is the most general of the statistical models and is widely applicable to all processes with a constant probability. It is not widely used in nuclear applications because the mathematics is too complex.

Poisson Distribution

A simplified version of binomial distribution is the Poisson (pronounced "pwusówn") distribution, which is valid when the probability of success, P(x), is small. A graph of a Poisson distribution function would show the predicted number of successes at the lower end of the curve, with successes over the entire range if sufficient trials were attempted. Thus, the curve would appear as seen in figure 2.



Source: DOE-HDBK-1122-99

Figure 2. Predicted success for Poisson

The Poisson model is used mainly for applications involving counting system background and detection limits, where the population is small.

Gaussian Distribution

Also called the normal distribution, the Gaussian distribution is a further simplification that is applicable if the average number of successes is relatively large, but the probability of success is still low. A graph of a Gaussian distribution function is shown in figure 3.

Source: DOE-HDBK-1122-99

Figure 3. Predicted success for Gaussian

Note that the highest number of successes is at the center of the curve, the curve is a bell shaped curve, and the relative change in success from one point to the adjacent is small. Also note that the mean, or average number of successes, is at the highest point, or at the center of the curve.

The Gaussian, or normal, distribution is applied to counting applications where the mean success is expected to be greater than 20. It is used for counting system calibrations and operational checks, as well as for normal samples containing activity.

c. Calculate the mathematical mean of a given set of data.

d. Calculate the mathematical standard deviation of the mean of a given set of data.

e. Given the data, calculate the probability of an event.

Elements ‘c’ through ‘e’ are performance-based KSAs. The Qualifying Official will evaluate their completion.

f. Describe how measures of samples (i.e., measures of central tendency and variability) are used to estimate population parameters through statistical inference.

The following is taken from DOE-STD-1153-2002.

Arithmetic mean is the sum of all the values of a set divided by the number of values in the set.

Variability is a general term for the dispersion of values in a data set. Variance is a measure of the variability of samples within a subset or the entire population.

g. Discuss type I and type II decision errors and the relationship to sampling and confidence levels.

The following is taken from EPA, *Resource Conservation & Recovery Act (RCRA) Waste Sampling Draft Technical Guidance, Planning, Implementation, and Assessment.*

There are two types of decision error. A type I or false rejection decision error occurs if you reject the null hypothesis when it is true. (The null hypothesis is simply the situation presumed to be true or the working assumption.) A type II or false acceptance decision error occurs if you accept the null hypothesis when it is false.

Table 3 summarizes the four possible situations that might arise when a hypothesis is tested. The two possible true conditions correspond to the two columns of the table: the null hypothesis or baseline assumption is either true or the alternative is true. The two kinds of decisions are shown in the body of the table. Either you decide the baseline is true, or you decide the alternative is true. Associated with these two decisions are the two types of risk: the risk of making a type I (false rejection) error (denoted by α) and the risk of making a type II (false acceptance) error (denoted by β). You can improve your chances of making correct decisions by reducing α and β (which often requires more samples or a different sampling design) and by using field sampling techniques that minimize errors related to sampling collection and handling.

Table 3. Conclusions and consequences for a test of hypotheses

		True Condition	
		Baseline is True	**Alternative is True**
Decision Based on Sample Data	Baseline is True	Correct Decision	Type II (false acceptance) error (probability β)
	Alternative is True	Type I (false rejection) error (probability α)	Correct Decision

Source: EPA, *RCRA Waste Sampling Draft Technical Guidance, Planning, Implementation, and Assessment*

3. Transportation and traffic management personnel shall demonstrate a working level knowledge of converting international to U.S. measurements and vice versa.

The following conversions are taken from 49 CFR 171.10.

a. Convert curies to terabecquerels and terabecquerels to curies.

1 terabecquerel (TBq) = 27 curies (Ci)

b. Convert pounds to kilograms and kilograms to pounds.

1 kg = 2.204622 pounds (lb)

c. Convert inches to millimeters and millimeters to inches.

1 in. = 25.4 mm

d. Convert rem/hr to Sievert/hr.

1 sievert (Sv) = 100 roentgen equivalent man (rem)

e. Convert cubic meters to cubic feet and cubic feet to cubic meters.

1 m^3 = 35.31466 cubic feet (ft^3)

f. Convert gallons to liters and liters to gallons.

1 gallon (gal) = 3.785412 liters (L)

4. Transportation and traffic management personnel shall demonstrate the ability to read and interpret engineering drawings, including the information contained in the title block, the notes and legend, the revision block, and the drawing grid.

a. Identify the information used on engineering drawings for packaging preparation:

- **Blocking and bracing**
- **Dimensions**
- **DOT specification**
- **DOT/U.S. Nuclear Regulatory Commission (NRC) testing requirements**
- **Flanges**
- **Gasket material**
- **Lifting points**
- **Material specifications**
- **Relief valves**
- **Torque requirements**

Blocking and Bracing

The following is taken from the 2005 Commercial Driver's License Manual.

Blocking is used in the front, back, and/or sides of a piece of cargo to keep it from sliding. Blocking is shaped to fit snugly against cargo. It is secured to the cargo deck to prevent cargo movement. Bracing is also used to prevent movement of cargo. Bracing goes from the upper part of the cargo to the floor and/or walls of the cargo compartment.

Dimensions

The following is taken from the Spent Fuel Project Office, Interim Staff Guidance—20, *Transportation Package Design Changes Authorized Under 10 CFR Part 71, Without Prior NRC Approval*.

The engineering drawings define the design that is authorized for shipment of radioactive material. The packagings used for shipment must conform in all ways to the engineering drawings that are referenced in the certificate of compliance. It is important that the drawings capture the safety features that are needed to ensure package performance under normal and accident conditions. The reviewer should ensure that reasonable tolerances for dimensions and weights are specified because packaging features may be subject to some variability in fabrication. Not only does this assure the safety dispersability of the material under normal and accident conditions, to demonstrate that the package provides adequate containment.

DOT Specification

The following is taken from 49 CFR 178.3.

Each packaging represented as manufactured to a DOT specification or a UN standard must be marked on a non-removable component of the packaging with specification markings conforming to the applicable specification, and with the following:

- In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).
- Unless otherwise specified in this part, with the name and address or symbol of the packaging manufacturer or, where specifically authorized, the symbol of the approval agency certifying compliance with a UN standard. Symbols, if used, must be registered with the associate administrator. Duplicative symbols are not authorized.
- The markings must be stamped, embossed, burned, printed, or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.
- Unless otherwise specified letters and numerals must be at least 12.0 mm (0.47 ins) in height except that for packagings of less than or equal to 30 L (7.9 gals) capacity for liquids or 30 kgs (66 lbs) capacity for solids the height must be at least 6.0 mm (0.2 ins). For packagings having a capacity of 5 L (1 gal) or 5 kg (11 lbs) or less, letters and numerals must be of an appropriate size.
- For packages with a gross mass of more than 30 kg (66 lbs), the markings or a duplicate thereof must appear on the top or on a side of the packaging.
- Where packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

DOT/U.S. Nuclear Regulatory Commission (NRC) Testing Requirements

The following is taken from NASA Procedural Requirements (NPR) 6000.1G, *Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components*.

Testing of packages, packing materials, and materials shall be in accordance with design engineering requirements. When specific guidance is not provided, tests shall be performed as specified in appendix B of MIL-STD-2073-1D, *Standard Practice for Military Packaging*. In all instances, only standardized packaging testing techniques will be utilized.

Shipping contractors shall ensure that all special testing data is furnished, as required by the contract.

Preproduction tests shall be performed in accordance with the design requirements of the contract. The necessity for such testing will be determined by considering the following factors:

- The contractor has data or other evidence to indicate that prior successful tests were conducted and are accepted by the contracting officer as being equivalent to those now being proposed.
- The packaged item has been subjected to similar tests as a part of other testing programs.
- The container for a specific item of equipment is developed under the end-item specification, with engineering and testing approval through configuration management procedures and reviews.
- Detailed packaging instructions are imposed by the procuring activity.
- Provisions for the testing of hoisting and material handling equipment shall be performed as required.

The following is taken from DOT, Federal Motor Carrier Safety Administration, *How to Comply with Federal HM Regulations*.

Package testing consists of the following: 49 CFR 178.601(c)(1), "Design Qualification Testing;"§178.601(c)(2), "Periodic Retesting;" §178.601(c)(3), "Production Testing;" §178.601(e), "Frequency of Periodic Testing;" and §178.601(f), "Test Samples."

The person who manufactures a package subject to the requirements of the hazardous materials regulations is responsible to ensure the package is in conformance with the requirements contained in 49 CFR 178, "Specifications for Packagings." When a package is required to be marked with a UN standard or DOT specification, the package must meet all the requirements of the regulation, including testing. The manufacturer or person certifying that the package is in compliance with 49 CFR 178 must inform in writing each person to whom the packaging is transferred of all requirements of 49 CFR 178 not met at time of transfer, and all actions that need to be taken for the package to conform to requirements of 49 CFR 178. The written statements must be retained by the manufacturer for at least one year per 49 CFR 178.2(c), "Notification." When filling packages with hazardous materials the shipper must comply with these written instructions.

Flanges

The following is taken from 49 CFR 178.320.

Flange means the structural ring for guiding or attachment of a pipe or fitting with another flange (companion flange), pipe, fitting or other attachment.

Companion flange means one of two mating flanges where the flange faces are in contact or separated only by a thin leak-sealing gasket and are secured to one another by bolts or clamps.

Welded flange means a flange attached to the tank by a weld joining the tank shell to the cylindrical outer surface of the flange, or by a fillet weld joining the tank shell to a flange shaped to fit the shell contour.

Gasket Material

The following is taken from Raske, D.T., Argonne National Laboratory, *How to Avoid Errors in the Design and Fabrication of Transportation Packages*.

Gasket or seal materials must be selected to withstand both the low- and high-temperature transportation environment without allowing release rates that exceed the regulatory limits. This may impose additional requirements for the composition of the gasket materials and for qualification tests to demonstrate the ability to function at the temperature extremes. The bolting must have sufficient low-temperature toughness to resist brittle fracture during drops or impacts. If a non-code bolting material is used, a safety analysis report for packaging (SARP) must provide proof that the bolts possess adequate toughness. Similarly, the impact-mitigating materials must not become hard at low temperatures and thus increase the impact loading to the packaging and contents. In addition, precautions should be taken to eliminate water from permeating into the foam, wood, or other porous materials used as impact-limiters. If thermal vent holes are provided in the metal covers that protect soft impact-mitigating materials, these holes should be sealed so moisture cannot enter.

Lifting Points

The following is taken from the Construction Industry Research and Information Association, Publication number: W002, *Chemical Storage Tank Systems—Good Practice Guide*.

Lifting points must be adequate to ensure that the unit can be lifted safely, and should be to the design specification or, in its absence, in line with appropriate standards. As a minimum, the lifting points should be capable of taking the weight of the unit, with an additional allowance for safety (for eventualities such as an unequal load distribution between the lifting points of lifting strap or chain failure), and be positioned so that stress on the unit is minimized.

Material Specifications

The following is taken from Nuclear Regulations (NUREG)/CR-5502, *Engineering Drawings for 10 CFR Part 71 Package Approvals*.

Drawings should specify the name, materials of construction, and quantity required for each design feature, component, or part, as applicable. This information may be provided by a parts list or other appropriate designation. Materials of construction should include a code or standard (e.g., American Society of Mechanical Engineers (ASME), American Society for Testing and Materials (ASTM), military (MIL)) commercial equivalent, or other appropriate specification for the material. If this designation does not sufficiently define all material properties affecting the package evaluation, additional specifications should be provided by a drawing note or similar means.

Relief Valves

The following is taken from NUREG/CR-6407, *Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance of Safety*.

The pressure relief device is used to limit the internal pressure of low specific activity packaging. This device could include rupture disks or pressure relief valves. In addition, this device is also used to maintain packaging containment under normal and accident conditions.

Torque Requirements

The following is taken from *Quality Assurance Related to Fastener Torque Requirements*, Office of Quality Assurance Programs (EH-31).

For torque requirements, particularly in the case of new or unique applications, diligence is required by all who are in the chain from initial concept to use in the field. Many fabrication and construction drawings refer to general reference drawings that have requirements that would be impractical to list on every drawing. Thus, it is important that workers' training emphasizes the importance of being aware when such reference drawings exist and to use them. A similar practice is providing tables of torque values and relying on field personnel to interpret the tables. This is accepted practice. However, when the application is nuclear safety-related, regardless of whether the specifications are on a general drawing or in a generic table on the specific drawing, prudent practice would be for the engineer/designer to determine the specific torque requirements and explicitly state them on the drawing or in the procedure being addressed.

5. Transportation and traffic management personnel shall demonstrate a working level knowledge of problem analysis principles and techniques necessary to identify problems, determine potential causes of the problems, and identify corrective actions(s).

a. Describe and explain the application of problem analysis techniques, including the following:
- **Barrier analysis**
- **Causal factor analysis**
- **Change analysis**
- **Management oversight risk tree (MORT) analysis**
- **Root cause**

Barrier Analysis

The following is taken from DOE G 225.1A-1.

The basic premise of barrier analysis is that there is energy flow associated with all accidents. This energy may be kinetic, potential, electromagnetic, thermal, steam, other pressurized gases or liquids, or a myriad of other types of energy. It is the isolation, shielding, and control (barriers) of this energy (hazard) from people, property, or the environment (targets) that prevent accidents. Barriers generally fall in the following categories: equipment, design, administrative (procedures and work processes), supervisory/management, warning devices, knowledge and skills, and physical. Therefore, identifying the energy sources and the failed or deficient barriers and controls in an accident investigation provides the means for identifying the causal factors of the accident.

If barriers were installed and one failed partially or totally, an investigator would examine the secondary safety systems, if any, that were in place to mitigate the failure. The investigator would also determine what events led up to and through the failure sequence, paying particular attention to changes made in the system. To accomplish this, the entire sequence of events can be broken down into a logical flow from the beginning to the end of an accident. Questions are asked about the practicality of the barriers and why the controls selected failed, or why none were selected for use.

The principal benefit of barrier analysis is that it identifies safety system elements that failed, and the results can be succinctly presented. Another benefit of barrier analysis is that the results can easily be presented graphically. A graphical flowchart (diagram) can clearly and concisely portray the energy flows and failed or unused barriers that led to the accident. Thus, barrier analysis is valuable in understanding the accident and the sequence of events that led to it.

Causal Factor Analysis

The following is taken from DOE G 225.1A-1.

Identifying systemic causal factors requires understanding the sequence of events over time and the interaction of those events and their causal factors. This sequence proceeds from an initiating event through the final loss-producing occurrence. A meticulous tracing of unwanted energy transfers and their relationships to each other and to the people, plant, procedures, and controls involved in an incident will usually reveal a definable sequence for an accident.

Two basic principles are helpful in defining and understanding these sequences of events, causal factors, and energy transfers:

- Accidents result from a set of successive events that produce unintentional harm (e.g., personal injury, property damage).
- The accident sequence occurs during the conduct of some work activity (i.e., a series of events directed toward some anticipated or intended outcome other than injury or damage).

Events and causal factors charting is an integral and important part of the DOE accident investigation process. It is used in conjunction with other key tools (such as root cause analysis, change analysis, and barrier analysis) to achieve optimal analytical results in accident investigation.

An events and causal factors chart is a graphic representation that produces a picture of the accident: both the sequence of events that led to the accident and the conditions that were causal factors.

Events and causal factors analysis is an effective means of integrating other analytical techniques into a concise and complete investigative summary. Events and causal factors analysis depicts, in logical sequence, the necessary and sufficient events and conditions for accident occurrence. It provides a systematic accident analysis tool to aid in collecting, organizing, and depicting accident information; validating information from other analytical techniques; writing and illustrating the accident investigation report; and briefing management on the results of the investigation.

Change Analysis

The following is taken from DOE G 225.1A-1.

Change analysis is a systematic approach to problem-solving that can help identify accident causes. Change analysis is a simple, straightforward process that is relatively quick and easy to learn and apply.

Change is a necessary ingredient for progress; however, changes to systems and their impact also contribute to errors, loss of control, and accidents. The purpose of change analysis is to identify and examine all changes systematically and to determine the significance or impact of the changes. The use of this technique in accident investigation is particularly well-suited for finding quick answers and identifying causal factors that are not otherwise obvious.

It has been demonstrated that, when problems arise for any functional system that has been operating satisfactorily (i.e., up to some standard), changes and differences associated with personnel, plant and hardware, or procedures and managerial controls are actual causal factors in creating these problems. Change can be thought of as stress on a system that was previously in a state of dynamic equilibrium. Change can also be viewed as anything that disturbs the planned or normal functioning of a system.

Accident investigators need to carefully evaluate all the changes identified during the investigation. Did the change really cause the result, or did the change merely bring an existing system deficiency to light? The investigation must focus on the systemic deficiencies that allowed the accident to happen and not just accept the changes identified as being the sole cause of the accident. Often, change analysis will lead to further insight into areas that must be explored by other analytical techniques.

Management Oversight and Risk Tree

The following is taken from DOE-NE-STD-1004-92.

Management oversight and risk tree analysis is used to prevent oversight of the identification of causal factors. It lists, on the left side of the tree, specific factors relating to the occurrence, and on the right side of the tree, the management deficiencies that permit specific factors to exist. The management factors all support each of the specific barrier/control factors. Included is a set of questions to be asked for each of the factors on the tree. As such, it is useful in preventing oversight and ensuring that all potential causal factors are

considered. It is especially useful when there is a shortage of experts to ask the right questions. However, because each of the management factors may apply to the specific barrier/control factors, the direct linkage or relationship is not shown but is left up to the analyst. For this reason, events and causal factor analysis and MORT should be used together for serious occurrences: one to show the relationship, the other to prevent oversight.

Root Cause

The following is taken from DOE G 225.1A-1.

DOE O 225.1A requires that root causes of each accident be identified. Root cause analysis is used in accident investigations to identify those deficiencies, including management systems factors that, if corrected, would prevent recurrence of the accident (i.e., the root cause(s) of an accident).

Root causes of an accident can be determined using numerous automated and manual techniques. A manual version of root cause analysis—such as compliance/noncompliance or tier diagramming—is acceptable. Commercially available automated techniques are widely used in the DOE complex. Whatever technique is used, investigators should ensure that actual root causes are determined, not just contributing causes. The contributing causes are important; however, the need to find concise and justified root causes should be the main intent of using these analytical techniques.

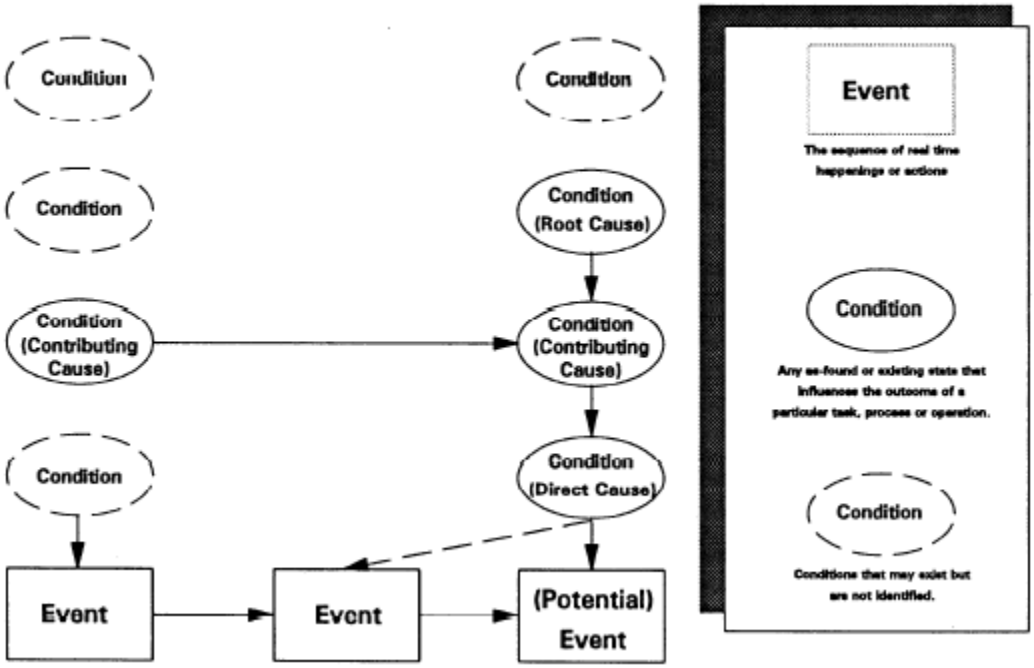
b. Describe and explain the application of the following root cause analysis processes in the performance of occurrence investigations:
- **Events and causal factors charting**
- **Root cause coding**
- **Recommendation generation**

Events and Causal Factors Charting

The following is taken from DOE G 225.1A-1.

Events and causal factors charting is an integral and important part of the DOE accident investigation process. It is used in conjunction with other key tools (such as root cause analysis, change analysis, and barrier analysis) to achieve optimal analytical results in accident investigation.

An events and causal factors chart is a graphic representation that produce a picture of the accident: both the sequence of events that led to the accident and the conditions that was causal factors.



Source: DOE-NE-STD-1004-92

Figure 4. Causal factor relationships

Root Cause Coding

The following is taken from MCO P5102.1B, *Navy and Marine Corps Mishap and Safety Investigation Reporting and Record Keeping Manual*.

The cause code is the reason a mishap occurred or the chain of events that led to the mishap was started, not necessarily the blame for the mishap. There is normally one main event cause but there may be numerous causes associated with the people and equipment involved in the mishap.

Recommendation Generation

The following is taken from Rooney, James and Lee N. Vanden Heuvel, *Root Cause Analysis for Beginners*.

Following identification of the root causes for a particular causal factor, achievable recommendations for preventing its recurrence are then generated.

The root cause analyst is often not responsible for the implementation of recommendations generated by the analysis. However, if the recommendations are not implemented, the effort expended in performing the analysis is wasted. In addition, the events that triggered the analysis should be expected to recur.

c. Compare and contrast type A and type B accident investigations and discuss an example of the application of each.

The following is taken from DOE O 225.1A.

A type A investigation is conducted for the more serious accidents and is appointed and managed by the Office of the Assistant Secretary for Environment, Safety and Health; a type B investigation is appointed and managed at the field level. However, the elements of the investigation and the report format are the same.

The following is taken from DOE G 225.1A-1.

The heads of DOE field elements are responsible for promptly reporting and categorizing all accidents to determine whether a type A or type B investigation is required. Not properly categorizing an accident investigation can result in wasted resources (over-categorization) or the failure to prevent similar or more serious accidents because of unresolved or unidentified causes (under-categorization). Table 4 contains the criteria for determining whether an accident investigation should be categorized as type A or type B.

Table 4. Investigation categorization summary

Categorization Criteria	Type of Investigation	
	Type A	**Type B**
Human Effects	Any fatal or likely to be fatal • injury (49 CFR 830.2) • chemical exposure • biological exposure Any one accident requiring hospitalization of three or more individuals incurring a serious injury (serious injury is defined in 49 CFR 830.2 as any injury that requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; results in severe hemorrhages, nerve, muscle, or tendon damage; involves severe damage to an internal organ; or involves second- or third-degree burns affecting more than nine percent of the body surface); or with a high probability of realizing a permanent total disability due to injuries, chemical exposures, or biological exposures received. One individual radiation exposure (see 10 CFR 835.202) of • 25 rem or more total • 75 rem or more to the eye • 250 rem or more to skin or extremity (shallow dose) • 250 rem or more for external exposure (deep dose) or to organ or tissue (committed dose) for other than lens of the eye • 2.5 rem or more dose to embryo or fetus of pregnant woman	Any accident that results in the hospitalization of one or more DOE, contractor, or subcontractor employees, or members of the public for five continuous days or longer due to • serious injury • occupational illness (except members of the public) • chemical exposure • biological exposure Any one accident resulting in five or more lost workday cases A series of accidents involving five or more lost-workday cases occurring within a one-year time period that involve identical or similar • facilities • systems • equipment • materials • procedures A single radiation exposure to an individual that results in: • 10 rem but <25 rem total dose • 30 rem but <75 rem dose to the lens of the eye • 100 rem but <250 rem shallow dose to skin or an extremity • 100 rem but <250 rem sum of deep dose and dose to organ or tissue (other than lens of the eye) • 1 rem but <2.5 rem dose to embryo or fetus of declared pregnant woman
Environmental Effects	Any release greater than five times the reportable limits in 40 CFR Part 302 of a hazardous substance, material, waste, or radionuclide resulting in serious environmental damage	Any release over two times but less than five times the reportable limits in 40 CFR 302 of hazardous substance, material, waste, or radionuclide resulting in serious environmental damage

Table 4. Investigation categorization summary (continued)

Property Effects	Loss or damage* of ≥ $2.5 million in property, including costs for • cleaning • decontaminating • renovating • replacing or • rehabilitating structures, equipment, or property Apparent loss, explosion, or theft involving radioactive or hazardous material in quantities or circumstances likely to constitute a hazard to health, safety, or property Any unplanned nuclear criticality *When estimating loss or damage, follow the methods in DOE G 430.1-1, COST ESTIMATING GUIDE.	Loss or damage* of over $1 million but less than $2.5 million in property, including costs for • cleaning • decontaminating • renovating • replacing or • rehabilitating structures, equipment, or property The operation of a nuclear facility beyond its authorized limits resulting in the consequences identified in columns 2, 3, or 4 of this table *When estimating loss or damage, follow the methods in DOE G 430.1-1, COST ESTIMATING GUIDE.
Other Effects	Any accident or series of accidents deemed appropriate by the Secretary or the Assistant Secretary for Environment, Safety and Health	Any accident or series of accidents deemed appropriate by the • Secretary; • Assistant Secretary for Environment, Safety and Health; • Associate Deputy Secretary for Field Management; • Cognizant Secretarial Officer; or • Heads of field elements

Source: DOE G 225.1A-1

d. Explain the necessity for and differences between the immediate, short-term, and long-term actions taken as the result of a problem identification or occurrence. [Note: Corrective actions are no longer classified as short term and long term.]

The following is taken from DOE G 225.1A-1.

The final report is submitted by the appointing official to senior managers of organizations identified in the judgments of need in the report, with a request for the organizations to prepare corrective action plans (CAPs). These plans contain actions for addressing judgments of need identified in the report and include milestones for completing the actions.

Corrective actions fall into the following categories:

- Immediate corrective actions that are taken by the organization managing the site where the accident occurred to prevent a second or related accident.
- Corrective actions required to satisfy judgments of need identified by the board in the final report. These corrective actions are developed by the heads of field elements and/or contractors responsible for the activities resulting in the accident and are designed to prevent recurrence and correct system problems.

- Corrective actions determined by the appointing official to be appropriate for DOE-wide application. The appointing official recommends these corrective actions when the report is distributed.
- DOE headquarters corrective actions that result from discussions with senior management. These actions usually address DOE policy.

e. Explain and apply problem analysis techniques to the identification of potential problems and/or the prevention of problems. Include data gathering techniques and the use of trending/history in your explanation.

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

6. Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of the Occupational Safety and Health Act (OSH Act) requirements in the following documents:

- **DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees**
- **29 CFR 1910, Occupational Safety and Health Standards**
- **29 CFR 1926, Safety and Health Regulations for Construction**

[Note: DOE O 440.1A has been superseded by DOE O 440.1B.]

a. Discuss the application and impact of OSHA on Department transportation.

The following is taken from Department of Labor (DOL), Trucking Industry*, Other Federal Agencies*.

The Occupational Safety and Health Administration (OSHA) has jurisdiction over off-highway loading and unloading, such as warehouses, plants, grain handling facilities, retail locations, marine terminals, wharves, piers, and shipyards. DOT has jurisdiction over interstate highway driving, commercial driving licensing, the hours of service and roadworthiness of the vehicles. EPA has jurisdiction over the natural environment and pollution prevention programs. OSHA has jurisdiction unless preempted by another Federal agency such as DOT or EPA, but can only be preempted in a specified activity or task. OSHA has the ultimate responsibility for the safety and health of all employees.

b. Identify the requirements in the OSH Act that form the basis of authority for transportation personnel in the oversight and management of an activity.

The following is taken from the Memorandum of Understanding between the U.S. Department of Labor and the U.S. Department of Energy.

OSHA requirements are granted:

- Where feasible, and if resources are available, the DOL will provide technical assistance and consultation to DOE in the establishment of its occupational safety and health training programs.
- Where feasible, and where resources permit, they will provide to each other's technical data, information systems, and libraries. DOL will provide DOE with access to the OSHA Computerized Information System.

- With mutual consent and where resources permit, DOL will conduct onsite visits to DOE headquarters, field offices, and government-owned contractor-operated (GOCO) facilities for the purpose of making performance-type reviews of DOE's occupational safety and health programs for GOCO facilities.
- DOL and DOE agree that Federal employees are covered under Executive Order (EO) 12196.
- Both agencies agree to provide opportunities for the temporary interagency reassignment of personnel, wherever it is mutually beneficial.

c. Discuss the requirements for the performance of a preliminary hazard analysis and an activity hazard analysis. Include in the discussion each of the following elements:
- **Responsibility for the performance of these analyses**
- **Purpose and content of the analyses**
- **When the analyses are required to be performed**

Preliminary Hazard Analysis

The following is taken from DOE O 413.3A Chg 1.

Responsibility for the Performance of These Analyses

Projects involving facilities that are below hazard category 3 threshold as defined in 10 CFR 830, subpart B, must prepare a preliminary hazard analysis report to identify and evaluate all potential hazards and establish a preliminary set of safety controls.

Purpose and Content of the Analysis

A preliminary documented safety analysis report is prepared and updates the safety information in the preliminary safety design report and identifies and justifies changes from the design approach described in the preliminary safety design report. Technical safety requirements are developed to document and establish specific parameters and requisite actions for safe facility operation. Hazardous chemicals are analyzed according to DOE P 450.4, *Safety Management System Policy*; 29 CFR 1910.119, "Process Safety Management of Highly Hazardous Chemicals;" and 40 CFR 68, "Chemical Accident Prevention Provisions."

When the Analyses Are Required To Be Performed

Following the definition phase, preliminary design activities mark the beginning of the execution phase. During this phase, the initial design concepts and the preliminary design are developed into detailed and final designs and plans.

Activity Hazard Analysis

The following is taken from DOE-STD-1163-2003.

Responsibility for the Performance Of This Analysis

DOE-STD-1163-2003 is intended to provide DOE and contractor safety personnel with a resource to support the planning, technical review, or conduct of hazard analysis activities.

Purpose and Content of the Analysis

DOE O 440.1B, *Worker Protection Management for DOE (Including the National Nuclear Security Administration) Federal Employees*, requires an analysis of design activities for new facilities or modification to existing ones, operations and procedures, equipment, product and services. Impacts from exposure to chemical, physical, biological, or ergonomic hazards must be accomplished through the hazards analysis and exposure monitoring activities. Activity-level hazard analysis addresses the hazards associated with individual job functions and tasks.

One type of activity hazards analysis (AHA) is the job hazard analysis (JHA). A JHA involves a breakdown of work tasks and assessment of the hazards associated with each step of a work task.

When the Analysis Is Required To Be Performed

An AHA should be conducted during the planning stage for new operations and procedures, as well as prior to implementation of changes to existing operations and procedures and continue to be updated throughout the execution phase.

d. Discuss the contractor's responsibility for providing necessary training to employees in the area of safety and health on the worksite.

The following is taken from DOE O 426.Y.

The operating contractor must establish one or more organizations to be responsible for the training of all applicable personnel. This organization(s) must be held accountable for providing the support necessary to ensure that personnel are qualified to safely and effectively meet job requirements. The responsibilities, qualifications, and authority of training organization personnel must be documented, and managerial roles, responsibilities, authority, and accountability clearly defined.

A training program must be established for operations, maintenance, and technical staff personnel using the systematic approach to training process. The basic elements of a systematic approach to training include

- a systematic analysis of the jobs to be performed; learning objectives derived from the analysis of the job that describe desired performance after training;
- training design, development, and implementation based on the learning objectives; evaluation of trainee mastery of the objectives during training; and
- evaluation and revision of the training based on the performance of trained personnel in the job setting.

e. Discuss the transportation and traffic manager's responsibility for on-site safety and health inspections.

The following is taken from DOE Order 5480.3 (archived).

The transportation and traffic manager responsibilities are to

- grant DOE approval when required for packages that meet the standards, and that are to be used for the transportation of fissile or other radioactive materials in greater than type A quantities, and issue certificates of compliance for approved designs.
- perform an independent objective review and evaluation of contractors' safety analysis reports for packaging designs.
- grant DOE approval for shipments made under the National Security Exemption provided to the DOE and the Department of Defense under the 49 CFR 173.7b.
- grant such alternatives to the requirements as will provide equivalent protection to life or property and to the common defense and security; and within 30 days after granting an alternative, provide the director of operational safety, a detailed report of the reasons for granting it. The granting of such alternative is in no way to be construed as the granting of exemptions or exceptions from or to the DOT or other regulatory agency requirements.
- conduct periodic appraisals to determine the adequacy of contractor performance in the implementation of the requirements.

f. Discuss the contractor's required response to an identified safety and/or health hazard.

The following is taken from DOE O 440.1B.

For hazards identified either in the facility design or during the development of procedures, controls must be incorporated in the appropriate facility design or procedure.

For existing hazards identified in the workplace, abatement actions prioritized according to risk to the worker must be promptly implemented, interim protective measures must be implemented pending final abatement, and workers must be protected immediately from imminent danger conditions.

7. Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of the requirements for the use of personal protective equipment.

a. Describe the principles governing the selection, use, and limitations of the following:

- **Respirators**
- **Protective clothing**

Respirators

The following is taken from DOE-STD-1098-2008.

Respiratory protection equipment includes respirators with particulate or gas-filtering cartridges, supplied air respirators, self-contained breathing apparatus (SCBA), and airline supplied-air suits and hoods.

General provisions for respirators:

- Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source.
- 29 CFR 1910.134, "Respiratory Protection," establishes requirements for a respiratory protection program that are applicable to most DOE facilities. ANSI Z88.2, *Practices for Respiratory Protection*, provides acceptable detailed guidance for implementation of the respiratory protection program and associated training of personnel.
- Respirators shall be issued only to individuals who are trained, fitted, and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually.
- Positive controls should be maintained for the issue, use, and return of respirators to ensure that only qualified individuals wear respirators.
- 29 CFR 1910.134 mandates that breathing air meet the specifications of ANSI/Compressed Gas Association (CGA) G-7.1, *Commodity Specification for Air*.
- Compressed air supplied to respirators shall be tested quarterly. Compressors shall be of the breathing air type and shall not allow oil or other chemicals and fumes to enter the breathing air supply. Special attention shall be focused on the location of compressor air supply intakes.
- Facility safety analyses should not take credit for use of respiratory protection for routine work involving potential exposure to airborne radioactive materials.

Each prospective respirator wearer shall have a medical assessment prior to being fit-tested. The medical assessment shall determine if an employee's medical condition precludes the use of respirators and should follow the guidance in ANSI Z88.6 on frequency and content of the examination. The ability of an employee to accommodate the additional stress placed on the body when working in a respirator is part of this assessment.

The use of respiratory protection devices can impair worker mobility and vision and cause worker discomfort and stress. For these reasons, the issue and use of respiratory protective devices must be controlled.

Individuals using respiratory protection shall

- perform fit checks of close-fitting respirators to ensure a proper seal before entering areas requiring a respirator;
- be clean shaven in the area of fit, if applicable;
- use corrective lenses, if needed, that are approved for respirators;
- be trained to leave the work area when experiencing respirator failure;
- be trained to remove their respirators to avoid life-threatening situations when exiting an area after respirator failure.

Protective Clothing

The following is taken from DOE-STD-1098-2008.

Individuals shall wear protective clothing during work in contamination and high contamination areas and should wear protective clothing during the following activities:

- Handling of contaminated materials with removable contamination in excess of the levels listed in DOE-STD-1098-2008, table 2-2
- Work in airborne radioactivity areas
- As directed by the radiological control organization or as required by the radiological work permit or other work authorization

Protective clothing and shoes designated for radiological control should be distinctive and used only for their intended purposes.

Workers should proceed directly to the designated area after donning personal protective equipment (PPE) and clothing.

The use of labcoats as radiological protective clothing is appropriate for limited applications, where the potential for personal contamination is limited to the hands, arms, and upper front portion of the body. Labcoats should not be used as protective clothing for performing physical work activities in contamination, high contamination, or airborne radioactivity areas where contamination of the lower legs is likely.

As appropriate for the work conditions, the radiological control organization should consider posting instructions for donning and removing protective clothing at the dress-out areas and step-off pad(s) for the affected work areas.

The use of PPE or clothing beyond that authorized by the radiological control organization or other cognizant safety authorities detracts from work performance and is contrary to as low as is reasonably achievable (ALARA) principles and waste minimization practices. Such use should not be authorized.

For radiological control purposes, company-issued clothing that is not specifically intended to protect individuals from contamination hazards should be considered the same as personal clothing.

b. Describe the various types of equipment (devices or clothing) worn to protect a worker from exposure to hazardous substances and physical injury.

The following is taken from 29 CFR 1910.120, appendix B.

Personal protective equipment protects well against some hazardous substances and poorly, or not at all, against others. In many instances, PPE cannot be found that will provide continuous protection from a particular hazardous substance. In these cases, the breakthrough time of the protective material should exceed the work durations. Other factors to be considered are matching the PPE to the employee's work requirements and task-specific conditions. The durability of PPE materials, such as tear strength and seam strength, should be considered in relation to the employee's tasks. The effects of PPE in relation to heat stress and task duration are a factor in selecting and using PPE. In some cases, layers of PPE may be necessary to provide sufficient protection, or to protect expensive PPE inner garments, suits, or equipment.

The more that is known about the hazards at the site, the easier the job of PPE selection becomes. As more information about the hazards and conditions at the site becomes available, the site supervisor can make decisions to upgrade or downgrade the level of PPE protection to match the tasks at hand.

The following are guidelines that an employer can use to begin the selection of the appropriate PPE. The site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. It should be cautioned that the listing below does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site, and that PPE selection, evaluation, and re-selection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

Personal protective equipment is divided into four categories based on the degree of protection afforded.

Level A

Level A PPE should be selected when the greatest level of skin, respiratory, and eye protection is required. The following constitute level A equipment:

- Positive pressure, full-face-piece SCBA, or positive pressure, supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH)
- Totally encapsulating chemical-protective suit
- Coveralls
- Long underwear
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, chemical-resistant, steel toe and shank
- Hard hat
- Disposable protective suit, gloves, and boots

Level B

Level B PPE should be selected when the highest level of respiratory protection is necessary, but a lesser level of skin protection is needed. The following constitute level B equipment:

- Positive pressure, full-face-piece SCBA, or positive pressure, supplied air respirator with escape SCBA (NIOSH approved)
- Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one- or two-piece chemical-splash suit; disposable chemical-resistant overalls)
- Coveralls
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, outer, chemical-resistant, steel toe and shank
- Boot-covers, outer, chemical-resistant (disposable)
- Hard hat
- Face shield

Level C

Level C PPE should be selected when the concentration(s) and type(s) of airborne substance(s) are known, and the criteria for using air purifying respirators are met. The following constitute level C equipment:

- Full-face or half-mask air purifying respirators (NIOSH approved)
- Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls)
- Coveralls
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots (outer), chemical-resistant, steel toe and shank
- Boot-covers, outer, chemical-resistant (disposable)
- Hard hat
- Escape mask
- Face shield

Level D

Level D PPE should be selected when all that is needed is a work uniform, affording minimal protection, for nuisance contamination only. The following constitute level D equipment:

- Coveralls
- Gloves
- Boots/shoes, chemical-resistant, steel toe and shank
- Boots, outer, chemical-resistant (disposable)
- Safety glasses or chemical-splash goggles
- Hard hat
- Escape mask
- Face shield

Examples of hazards for which levels A, B, C, and D protection are appropriate are described below.

Level A protection should be used when

- the hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system, based on either the measured (or potential for) high concentration of atmospheric vapors, gases, or particulates;
- the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the skin;
- substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible;
- operations are being conducted in confined, poorly ventilated areas, and the absence of conditions requiring level A have not yet been determined.

Level B protection should be used when

- the type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection;
- the atmosphere contains less than 19.5 percent oxygen;

- the presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin. Note: This involves atmospheres with immediately dangerous to life or health concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard, or that do not meet the criteria specified for the use of air-purifying respirators.

Level C protection should be used when

- the atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;
- the types of air contaminants have been identified, concentrations have been measured, and an air-purifying respirator is available that can remove the contaminants;
- all criteria for the use of air-purifying respirators are met.

Level D protection should be used when

- the atmosphere contains no known hazard;
- work functions preclude splashes, immersion, or the potential for unexpected inhalation of, or contact with, hazardous levels of any chemicals.

Combinations of PPE other than those described for levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

c. Describe the four levels of protection for workers at hazardous waste sites or for those workers conducting emergency response activities as defined by OSHA 29 CFR 1910.120.

See KSA "7b" above for a discussion of the four levels of protection.

8. Transportation and traffic management personnel shall demonstrate a working level knowledge of the safety-related requirements for hazardous materials.

a. Discuss the hazards associated with corrosives (acids and alkalis).

The following is taken from DOE-HDBK-1015/2-93.

Acids are corrosive in any form, and in high concentrations destroy body tissue and cause severe burns on contact with the skin. The eyes are very susceptible, and permanent damage or loss of sight may result from contact with acids. The inhalation of excessive concentrations of vapor or mist is extremely irritating to the respiratory system and to mucous membranes in particular. Accidental swallowing of concentrated acids may result in severe irritation of, and damage to, the throat and stomach which, in some cases, may prove fatal. Some of these materials are specifically poisonous as well as irritating. In lower concentrations, repeated skin contact may result in inflammation.

Concentrated aqueous solutions of acids are not in themselves flammable. The potential hazard is the danger of their mixture with other chemicals or combustible materials which

may result in fire or explosion. Acids also react with many metals resulting in the liberation of hydrogen, a highly flammable gas, which upon ignition in air may cause an explosion. Some of the acids are strong oxidizing agents and can react destructively and violently when in contact with organic or other oxidizable materials.

Personnel exposure requiring immediate action usually involves direct contact of the acid with the body or eyes of the individual, inhalation of acid vapors or decomposition products, and ingestion of acid. The initial treatment in all cases of local contact is immediate removal of the acid with a large amount of water. This treatment must be prolonged until all traces of acid have been removed, usually a minimum washing time of 15 minutes.

The alkalies, whether in solid form or concentrated liquid solution, are more destructive to tissue than most acids, Alkali dusts, mists, and sprays may cause irritation of the eyes and respiratory tract and lesions of the nasal septum. Strong alkalies combine with tissue, causing severe burns, frequently deep ulceration, and ultimate scarring. Severe burns result not only from contact with solid alkalies, but also from solutions of these compounds. Potassium and sodium hydroxide are the most active materials in this group. Even dilute solutions of the stronger alkalies tend to soften the epidermis (skin) and emulsify or dissolve the skin fats. Exposure to atmospheres contaminated with alkalies may result in damage to the upper respiratory tract and to lung tissue, depending upon the severity of the exposure. The effects of inhalation may vary from mild irritation of the nasal mucous membranes to severe inflammation of the lungs.

Ingestion causes severe damage to mucous membranes or deeper tissues with which contact is made. Perforation of these tissues may follow, or there may be severe and extensive scar formation. Death may result if penetration into vital areas occurs.

b. Describe the general safety precautions necessary for the handling and storage of corrosives.

The following is taken from DOE-HDBK-1015/2-93.

In handling bottles, barrels, or drums containing corrosives, the following guidelines must be followed:

- Carefully inspect containers prior to handling.
- Use PPE.
- Use equipment specifically designed for the purpose of transporting and dispensing the chemical in question.
- Label all containers into which the chemical is transferred.

c. Discuss the general safety precautions regarding toxic compounds.

The following is taken from DOE-HDBK-1015/2-93.

There are some general precautions that should be universally employed regarding toxic compounds. Many of these precautions are consistent with those concerning corrosives. Proper ventilation, appropriate hygienic practices, housekeeping, protective clothing, and training for safe handling and storage will diminish many of the hazards that exist.

The toxicity of a material is not synonymous with its health hazard. Toxicity is the capacity of a material to produce injury or harm to a living organism.

d. Describe the criteria used to determine if a compound is a health hazard and discuss the methods by which toxic compounds may enter the body.

The following is taken from DOE-HDBK-1015/2-93.

Hazard is the possibility that a material will cause injury when a specific quantity is used under specific conditions. Several key elements are considered when evaluating a health hazard:

- Toxicity of the materials used
- Physical properties of these materials
- Absorption probabilities of these materials by individuals
- Extent and intensity of exposure to these materials
- Control measures used

Toxic compounds may enter the body through the following processes:

- Inhalation
- Ingestion
- Absorption

e. Discuss the general safety precautions regarding the handling and storage of compressed gases, including specifically hydrogen, oxygen, argon, and acetylene.

The following is taken from DOE-HDBK-1015/2-93.

Compressed and liquefied gases are widely useful due to properties including high heat output in combustion for some gases, high reactivity in chemical processing with other gases, extremely low temperatures available from some gases, and the economy of handling them all in compact form at high pressure or low temperature. These same properties, however, also represent hazards if the gases are not handled with full knowledge and care.

Practically all gases can act as simple asphyxiates by displacing the oxygen in air. The chief precaution taken against this potential hazard is adequate ventilation of all enclosed areas in which unsafe concentrations may build up. A second precaution is to avoid entering unventilated areas that might contain high concentrations of gas without first putting on a breathing apparatus with a self-contained or hose-line air supply. A number of gases have characteristic odors which can warn of their presence in air. Others, however, like the atmospheric gases, have no odor or color. Warning labels are required for compressed and liquefied gas shipping containers. Similar warning signs are placed at the approaches to areas in which the gases are regularly stored and used.

Some gases can also have a toxic effect on the human system through inhalation via high vapor concentrations, or by liquefied gas coming in contact with the skin or the eyes. Adequate ventilation of enclosed areas serves as the chief precaution against high concentrations of gas. In addition, for unusually toxic gases, automatic devices can be purchased or built to constantly monitor the gas concentration and set off alarms if the

concentration approaches a danger point. Precautions against skin or eye contact with liquefied gases that are toxic or very cold, or both, include thorough knowledge and training for all personnel handling such gases, the development of proper procedures and equipment for handling them, and special protective clothing and equipment (for example, protective garments, gloves, and face shields).

With flammable gases, it is necessary to guard against the possibility of fire or explosion. Ventilation, in addition to safe procedures and equipment to detect possible leaks, represents a primary precaution against these hazards. If fire breaks out, suitable fire extinguishing apparatus and preparation will limit damage. Care must also be taken to keep any flammable gas from reaching any source of ignition or heat (such as sparking electrical equipment, sparks struck by ordinary tools, boiler rooms, or open flames).

Oxygen poses a combustible hazard of a special kind. Although oxygen does not ignite, it lowers the ignition point of flammable substances and greatly accelerates combustion. It should not be allowed closer than 10 ft to any flammable substance, including grease and oil, and should be stored no closer than 10 ft to cylinders or tanks containing flammable gases.

Proper storage and handling of containers avoids many possible incidents. Hazards resulting from the rupture of a cylinder or other vessel containing gas at high pressure are protected against by careful and secure handling of containers at all times. Cylinders should not be dragged or rolled across the floor; they should be moved by a hand truck. Also, when they are upright on a hand truck, floor, or vehicle, they should be chained securely to keep them from falling over. Moreover, cylinders should not be heated to the point at which any part of their outside surface exceeds a temperature of 125ºF, and they should never be heated with a torch or other open flame. Initial protection against the possibility of vessel rupture is provided by the demanding requirements and recommendations that compressed gas containers fulfill in their construction, testing, and retesting.

f. Discuss the safety precautions for working with cryogenic liquids.

The following is taken from DOE-HDBK-1015/2-93.

Many safety precautions that must be taken with compressed gases also apply to liquefied gases. However, some additional precautions are necessary because of the special properties exhibited by fluids at cryogenic temperatures.

The properties of cryogenic liquids affect their safe handling and use:

- Always handle cryogenic liquids carefully. They can cause frostbite on skin and exposed eye tissue. When spilled, they tend to spread, covering a surface completely and cooling a large area. The vapors emitted by these liquids are also extremely cold and can damage tissues. The vapor boil-off may inert the immediate vicinity.
- Stand clear of boiling or splashing liquid and its vapors. Boiling and splashing occurs when a warm container is charged or when warm objects are inserted into a liquid. These operations should always be performed slowly to minimize boiling and splashing. If cold liquid or vapor comes in contact with the skin or eyes, first aid should be given immediately.

- Never allow an unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast to the surface and tear when withdrawn. Touching even nonmetallic materials at low temperatures is dangerous.

Tongs, or a similar device, should be used to withdraw objects immersed in a cryogenic liquid. Materials that are soft and pliable at room temperature become hard and brittle at extremely low temperatures and will break easily.

Workers handling cryogenic liquids should use eye and hand protection to protect against splashing and cold-contact burns. Safety glasses are also recommended. If severe spraying or splashing is likely, a face shield or chemical goggles should be worn. Protective gloves should always be worn when anything that comes in contact with cold liquids and their vapors is being handled. Gloves should be loose fitting so that they can be removed quickly if liquids are spilled into them. Trousers should remain outside of boots or work shoes.

g. Explain the difference between a flammable liquid and a combustible liquid.

The following is taken from DOE-HDBK-1015/2-93.

Flammable liquids have a flash point below 100ºF and have a vapor pressure not exceeding 40 psia at 100ºF. Combustible liquids are those with flash points at or above 100ºF, but below 200ºF.

h. Describe the general safety precautions regarding the handling and storage of flammable and combustible liquids.

The following is taken from DOE-HDBK-1015/2-93.

General safety precautions regarding the use, handling, and storage of flammable and combustible liquids include the following:

- The vapor-air mixture formed from the evaporation of the liquid poses a hazard; therefore, exposures of large liquid surface areas and sources of heat shall be avoided or prevented during handling or storage of these liquids.
- Accidental mixture of flammable and combustible liquids shall be avoided.
- Fill and discharge lines and openings, as well as control valves associated with flammable and combustible systems, shall be identified by labels, color coding, or both to prevent mixing different substances.
- All storage tanks shall be clearly labeled with the name of the contents.
- Transfer lines from different types and classes of flammable products should be kept separate, and preferably, different pumps should be provided for individual products.
- When handling quantities of flammable liquids up to 5 gallons, a portable approved container should be used. The container should be clearly labeled.
- Smoking, the carrying of strike-anywhere matches, lighters, and other spark-producing devices should not be permitted in a building or area where flammable liquids are stored, handled, or used.

i. Discuss the hazards associated with explosives.

The following is taken from DOE M 440.1-1A.

Explosives materials, explosives components (additives or adhesives), and materials such as organic solvents used in explosives processing can be toxic when inhaled, ingested or absorbed through the skin. The most frequently reported effect from working with explosives is a skin rash resulting from skin contact with explosives materials, or with solvents and adhesives used with explosives operations. This is the most frequently reported effect from working with these materials.

The following general precautions should be used to prevent overexposure to these materials during explosives processing and handling:

- Know the health hazard and controls before beginning operations.
- Evaluate the operation during startup to ensure that occupational exposure limits are not exceeded; routine operations should be monitored periodically.
- Handle materials in a well-ventilated area; local exhaust ventilation is preferred.
- Avoid skin contact; use appropriate protective clothing.
- Practice good personal cleanliness; wash before eating, smoking, or using toilet facilities; end-of-shift showers may be required for some operators.

j. Discuss the hazards associated with pyrophorics.

The following is taken from DOE-HDBK-1081-94.

Pyrophoric substances ignite instantly upon exposure to air (atmospheric oxygen). A pyrophoric substance may be a solid, liquid, or gas. Most materials are not pyrophoric unless they are in a very finely divided state. Although there are some pyrophoric liquids and gases, most pyrophoric materials are metals. Pyrophoricity is a special case of a hypergolic reaction because the oxidizing agent is restricted to atmospheric oxygen. Where pyrophoricity is concerned only with the spontaneous combustion of a material when exposed to air (atmospheric oxygen), a hypergolic reaction describes a material's ability to spontaneously ignite or explode upon contact with any oxidizing agent.

k. Discuss the hazards associated with dangerous when wet materials.

The following is taken from MSDS Hyper Glossary, Water Reactive.

Water reactive substances are dangerous when wet because they undergo a chemical reaction with water. This reaction may release a gas that is flammable or presents a toxic health hazard. In addition, the heat generated when water contacts such materials is often enough for the item to spontaneously combust or explode.

l. Discuss the hazards associated with oxidizers.

The following is taken from DOE-HDBK-1081-94.

The degree of hazard of oxidizing agents may be evaluated by consideration of the National Fire Protection Association (NFPA) classification for oxidizers. NFPA identifies four classes of

oxidizers with class 1 nominally the least hazardous and class 4 the most hazardous. The four classes of oxidizers are as follows:

- Class 1 oxidizer: An oxidizing material whose primary hazard is that it may increase the burning rate of combustible material with which it comes in contact
- Class 2 oxidizer: An oxidizing material that will moderately increase the burning rate or that may cause spontaneous ignition of combustible material with which it comes in contact
- Class 3 oxidizer: An oxidizing material that will cause a severe increase in the burning rate of combustible material with which it comes in contact or that will undergo vigorous self-sustained decomposition when catalyzed or exposed to heat
- Class 4 oxidizer: An oxidizing material that can undergo an explosive reaction when catalyzed or exposed to heat, shock, or friction

9. Transportation and traffic management personnel shall demonstrate a working level knowledge of 29 CFR 1910.1096, Ionizing Radiation, and 10 CFR 835, Occupational Radiation Protection.

a. Given appropriate data, classify an area as a "controlled area" and state the reasons for the classification.

The following is taken from 10 CFR 835.2.

Any area that is managed in order to protect individuals from exposure to radiation and/or radioactive materials is posted as a controlled area. Access points to a controlled area are clearly marked by signs, ropes, or other barriers.

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

b. Discuss the requirements related to the exposure of individuals to radiation in controlled areas; include any applicable dose limits.

The following is taken from 10 CFR 835.602.

Each access point to a controlled area shall be posted whenever radiological areas or radioactive material areas exist in the area. Individuals who enter only controlled areas without entering radiological areas or radioactive material areas are not expected to receive a total effective dose of more than 0.1 rem (0.001 Sv) in a year.

Signs used for this purpose may be selected by the contractor to avoid conflict with local security requirements.

The following is taken from 10 CFR 835.208.

The total effective dose limit for members of the public exposed to radiation and/or radioactive material during access to a controlled area is 0.1 rem (0.001 Sv) in a year.

c. Discuss the requirements related to the exposure of individuals to airborne radioactive material, include any applicable precautionary measures and personal monitoring requirements.

The following is taken from DOE G 441.1-1C.

Under 10 CFR 835, "Occupational Radiation Protection," air monitoring results are required to measure the concentrations of airborne radioactive material, determine posting requirements, determine the effectiveness of the engineered controls and barriers used to contain and confine radioactive material, determine appropriate protective equipment and measures, and provide warnings of significantly elevated levels of airborne radioactive materials. In addition, air monitoring results may be used to estimate individual intake. 10 CFR 835 establishes the basic elements of an air monitoring program: periodic air samples to assess actual and potential individual exposures and real-time air monitoring to provide immediate warning of increases in airborne radioactive material concentrations.

Monitoring of airborne radioactivity is required where an individual is likely to receive an exposure of 40 or more derived air concentration-hours in a year or as necessary to characterize the airborne radioactivity hazard where respiratory protective devices for protection against airborne radionuclides have been prescribed. Real-time air monitoring is required to be performed, as necessary, to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material.

Respiratory protective equipment is used to reduce an individual's intake of airborne radioactive materials. Each respiratory protective device is assigned a protection factor that indicates the degree of protection afforded by the respirator. Respiratory protective devices should be chosen based on the protection factor and actual or potential airborne radioactivity levels, taking into ALARA considerations, other industrial hazards, and worker safety. DOE requires its respiratory protection programs to be conducted, for DOE contactors according to 10 CFR 851, "Worker Safety and Health Program," and for DOE Federal employees according to DOE O 440.1B, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*. 10 CFR 851 and DOE O 440.1B require adherence to ANSI Z88.2, *Practices for Respiratory Protection*, and 29 CFR 1910.134.

d. Discuss the requirements for posting the various types of radiation areas; include the requirements for exceptions to the posting requirements.

The following is taken from DOE G 441.1-1C.

10 CFR 835 establishes requirements for three areas that shall be posted to provide warning of external radiation fields - radiation areas, high radiation areas, and very high radiation areas. The need to post these areas is contingent upon two factors:

- Area accessibility
- The radiation field intensity and duration, such that an individual's dose may exceed the specified threshold in one hour

The posting thresholds established in 10 CFR 835 are based on the radiation field intensity measured at a specified distance from the radiation source or from any surface penetrated by the radiation (12 ins) for radiation and high radiation areas and (39 ins) for very high radiation areas). To ensure continuing compliance with the posting requirements, a degree of conservatism should be established in the local posting requirements. The desired degree of conservatism may be established by

- posting affected areas at an exposure rate lower than that specified in 10 CFR 835;
- measuring the exposure rate at a distance less than that specified in 10 CFR 835; or
- both of the above.

The degree of conservatism established in the posting regimen for external radiation hazards should be adequate to address issues of monitoring equipment variability and likely variations in area radiological conditions.

Accessible areas may be excepted from the radiological area and radioactive material area posting requirements for periods of <8 continuous hours' duration when the area is placed under the observation and control of individuals who are knowledgeable of and empowered to implement required access and exposure control measures. The observing/controlling individual(s) should be stationed to provide line of sight surveillance of the area boundaries and verbal warnings. For situations that require only simple access control measures, such as entry prevention, a minimally-trained individual would suffice. For situations that require more complicated access and exposure control measures, a radiological control technician should be used. A sufficient number of individuals should be used to provide for adequate access and exposure control.

The following accessible areas are excepted from the radioactive material area posting requirements:

- Radiological areas posted according to 10 CFR 835.603, "Radiological Areas and Radioactive Material Areas," paragraphs (a) through (f). In this case, the radiological area posting provides adequate warning of the area hazards.
- Areas in which each item or container of radioactive material is clearly and adequately labeled according to 10 CFR 835, subpart G, "Posting and Labeling," such that individuals entering the area are made aware of the hazard. In this case, the radioactive material labels provide adequate warning of the area hazards.
- Areas in which the radioactive material of concern consists solely of structures or installed components which have been activated (e.g., such as by being exposed to neutron radiation or particles produced in an accelerator).
- Areas containing only packages received from transportation need not be posted according to 10 CFR 835.603 until the packages are monitored according to 10 CFR 835.405, "Receipt of Packages Containing Radioactive Material." For ALARA purposes, the time between package receipt and monitoring should be minimized.

Even though certain areas may be excepted from posting according to the conditions provided in 10 CFR 835, appropriate controls should be established over these areas as necessary to limit exposures consistent with the ALARA controls required under 10 CFR 835.1001, "Design and Control." Decisions regarding the omission of radiological hazard postings should be made in full consideration of the information provided in DOE G 440.1-1C, section 12.2.

e. Discuss the requirements for exemptions for radioactive materials packaged for shipment.

The following is taken from 41 CFR 50-204.26.

Radioactive materials packaged and labeled according to regulations of the DOT shall be exempt from the labeling and posting requirements during shipment, provided that the inside containers are labeled according to the provisions of 41 CFR 50-204.24.

f. Discuss the requirements related to notification of incidents.

The following is taken from 10 CFR 20.2202.

Immediate Notification

Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source, or special nuclear material (SNM) possessed by the licensee that may have caused or threatens to cause any of the following conditions:

- An individual to receive
  - a total effective dose equivalent of 25 rems (0.25 Sv) or more.
  - a lens dose equivalent of 75 rems (0.75 Sv) or more.
  - a shallow-dose equivalent to the skin or extremities of 250 roentgen absorbed dose (rad) (2.5 gray (Gy)) or more.
- The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake five times the annual limit on intake (ALI).

Twenty-Four Hour Notification

Each licensee shall, within 24 hours of discovery of the event, report any event involving loss of control of licensed material possessed by the licensee that may have caused, or threatens to cause, any of the following conditions:

- An individual to receive, in a period of 24 hours
  - a total effective dose equivalent exceeding 5 rem (0.05 Sv).
  - a lens dose equivalent exceeding 15 rem (0.15 Sv).
  - a shallow-dose equivalent to the skin or extremities exceeding 50 rem (0.5 Sv).
- The release of radioactive material, inside or outside of a restricted area, so that, had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational ALI.

The licensee shall prepare any report filed with the NRC pursuant to 10 CFR 20.2202, "Notification of Incidents," so that the names of the individuals who have received exposure to radiation or radioactive materials are stated in a separate and detachable part of the report.

Reports made by licensees in response to the requirements of 10 CFR 20.2202 must be made as follows:

- Licensees having an installed emergency notification system shall prepare the reports required by immediate or 24-hour notification to the NRC operations center in

accordance with 10 CFR 50.72, "Immediate Notification Requirements for Operating Nuclear Power Reactors."

- All other licensees shall report any event as required by 10 CFR 20.2202, paragraphs (a) and (b) by telephone to the NRC operations center.

g. Compare and contrast the terms "non-ionizing radiation" and "ionizing radiation."

The following is taken from EPA, Radiation Protection, *Ionizing and Non-Ionizing Radiation*.

Non-Ionizing Radiation

The properties of non-ionizing radiation for common tasks include;

- microwave radiation—telecommunications and heating food;
- infrared radiation—infrared lamps to keep food warm in restaurants;
- radio waves—broadcasting.

Non-ionizing radiation ranges from extremely low frequency radiation through the audible, microwave, and visible portions of the spectrum into the ultraviolet range.

Extremely low-frequency radiation has very long wave lengths and frequencies in the range of 100 hertz or cycles per second or less. Radio frequencies have wave lengths of between 1 and 100 ms and frequencies in the range of 1 million to 100 million hertz. Microwaves that we use to heat food have wavelengths that are about 1 hundredth of a meter long and have frequencies of about 2.5 billion Hertz.

Ionizing Radiation

Higher frequency ultraviolet radiation begins to have enough energy to break chemical bonds. X-ray and gamma ray radiation, which are at the upper end of magnetic radiation have very high frequency—in the range of 100 billion billion Hertz--and very short wavelengths—1 million millionth of a meter. Radiation in this range has extremely high energy. It has enough energy to strip off electrons or, in the case of very high-energy radiation, break up the nucleus of atoms.

Ionization is the process in which a charged portion of a molecule is given enough energy to break away from the atom. This process results in the formation of two charged particles or ions: the molecule with a net positive charge, and the free electron with a negative charge.

Each ionization releases approximately 33 electron volts (eV) of energy. Material surrounding the atom absorbs the energy. Compared to other types of radiation that may be absorbed, ionizing radiation deposits a large amount of energy into a small area. In fact, the 33 eV from one ionization is more than enough energy to disrupt the chemical bond between two carbon atoms. All ionizing radiation is capable, directly or indirectly, of removing electrons from most molecules.

There are three main kinds of ionizing radiation:

- Alpha particles, which include two protons and two neutrons
- Beta particles, which are essentially electrons
- Gamma rays and x-rays, which are pure energy (photons)

10. Transportation and traffic management personnel shall demonstrate a working level knowledge of the purpose and requirements of 49 CFR 173.400, Subpart I-Class 7 (Radioactive) Materials, as it pertains to radiological controls.

a. Discuss the DOT's objectives regarding the protection of the public and the environment from radiation.

The following is taken from DOE Order 5400.5 chg 2.

It is DOE's objective to operate its facilities and conduct its activities so that radiation exposures to members of the public are maintained within the limits established in this Order and to control radioactive contamination through the management of real and personal property. It is also a DOE objective that potential exposures to members of the public be ALARA and that DOE facilities have the capabilities, consistent with the types of operations conducted, to monitor routine and non-routine releases and to assess doses to members of the public.

In addition to providing protection to members of the public, it is DOE's objective to protect the environment from radioactive contamination to the extent practical.

b. Define the following terms:

- **Beta and gamma emitters**
- **Contamination control**
- **Fissile materials**
- **Fixed contamination**
- **Low-toxicity alpha emitters**
- **Non-fixed radioactive contamination**
- **Radiation level**
- **Radiation level limitations**
- **Specific activity**

Beta Emitters

The following is taken from EPA, Radiation Protection, *Beta Particles*.

Beta particle emission occurs when the ratio of neutrons to protons in the nucleus is too high. In this case, an excess neutron transforms into a proton and an electron. The proton stays in the nucleus and the electron is ejected energetically.

This process decreases the number of neutrons by one and increases the number of protons by one. Since the number of protons in the nucleus of an atom determines the element, the conversion of a neutron to a proton actually changes the radionuclide to a different element.

Gamma Emitters

The following is taken from EPA, Radiation Protection, *Gamma Rays*.

Gamma radiation emission occurs when the nucleus of a radioactive atom has too much energy. It often follows the emission of a beta particle.

Contamination Control

The following is taken from DOE-STD-1098-2008.

Control of radioactive contamination is achieved by using engineering controls and worker performance to contain contamination at the source, reducing existing areas of contamination, and promptly decontaminating areas that become contaminated.

Fissile Material

The following is taken from 49 CFR 173.403.

Fissile material is plutonium^{239}, plutonium^{241}, uranium^{233}, uranium^{235}, or any combination of these radionuclides. This term does not apply to material containing fissile nuclides, unirradiated natural uranium and unirradiated depleted uranium, or to natural uranium or depleted uranium that has been irradiated in thermal reactors only.

Fixed Contamination

The following is taken from 49 CFR 173.403.

Fixed radioactive contamination is radioactive contamination that cannot be removed from a surface during normal conditions of transport.

Low-Toxicity Alpha Emitters

The following is taken from 49 CFR 173.403.

Low toxicity alpha emitters means natural uranium; depleted uranium; natural thorium; uranium-235 or uranium-238; thorium-232; thorium-228 and thorium-230 when contained in ores or physical and chemical concentrates; and alpha emitters with a half-life of less than 10 days.

Non-Fixed Radioactive Contamination

The following is taken from 49 CFR 173.403.

Non-fixed radioactive contamination is radioactive contamination that can be removed from a surface during normal conditions of transport.

Radiation Level

The following is taken from 49 CFR 173.403.

Radiation level means the radiation dose-equivalent rate expressed in millisieverts per hour (mSv/h) or millirems per hour or (mrem/h).

Radiation Level Limitations

The following is taken from 49 CFR 713.441.

Except as provided in paragraph (b) of 49 CFR 173.441, “Radiation Level Limitations and Exclusive Use Provisions,” each package of class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment so that under conditions normally

incident to transportation, the radiation level does not exceed 2 mSv/h (200 mrem/h) at any point on the external surface of the package, and the transport index does not exceed 10.

A package which exceeds the radiation level limits specified above must be transported by exclusive use shipment, and the radiation levels for such shipment may not exceed the following during transportation:

- 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1,000 mrem/h):
  - The shipment is made in a closed transport vehicle;
  - The package is secured within the vehicle so that its position remains fixed during transportation; and
  - There are no loading or unloading operations between the beginning and end of the transportation.
- 2 mSv/h (200 mrem/h) at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure if used, and on the lower external surface of the vehicle
- 0.1 mSv/h (10 mrem/h) at any point 2 m (6.6 ft) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2 m (6.6 ft) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle)
- 0.02 mSv/h (2 mrem/h) in any normally occupied space, except that this provision does not apply to carriers if they operate under the provisions of a state or federally regulated radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices

For shipments made under the provisions of paragraph (b) of 49 CFR 173.441, the offeror shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions must be included with the shipping paper information. The instructions must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

Packages exceeding the radiation level or transport index prescribed in paragraph (a) of 49 CFR 173.441 may not be transported by aircraft.

Specific Activity

The following is taken from 49 CFR 173.403.

Specific activity of a radionuclide is the activity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

c. List and discuss the factors that must be considered pertaining to the release of materials and equipment having radioactive material as outlined in 49 CFR 173.441 and 173.443, Subpart I—Class 7 (Radioactive) Materials.

49 CFR 173.441, Radiation Level Limitations and Exclusive Use Provisions

Each package of class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment, so that under conditions normally incident to transportation, the radiation level does not exceed 2 mSv/hour (200 mrem/hour) at any point on the external surface of the package, and the transport index does not exceed 10.

A package which exceeds the radiation level limits specified in 49 CFR 173.441(a) must be transported by exclusive use shipment, and the radiation levels for such shipment may not exceed the following during transportation:

- 2 mSv/h (200 mrem/h) on the external surface of the package unless the following conditions are met, in which case the limit is 10 mSv/h (1000 mrem/h):
  - The shipment is made in a closed transport vehicle.
  - The package is secured within the vehicle so that its position remains fixed during transportation.
  - There are no loading or unloading operations between the beginning and end of the transportation.
- 2 mSv/h (200 mrem/h) at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure if used, and on the lower external surface of the vehicle
- 0.1 mSv/h (10 mrem/h) at any point 2m (6.6 feet) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, at any point 2m (6.6 feet) from the vertical planes projected by the outer edges of the vehicle (excluding the top and underside of the vehicle)
- 0.02 mSv/h (2 mrem/h) in any normally occupied space, except that this provision does not apply to carriers if they operate under the provisions of a state or federally regulated radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices

49 CFR 173.443, Contamination Control

The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for transport must be kept ALARA. The level of non-fixed radioactive contamination may not exceed the limits set forth in table 9 of 49 CFR 173.443 and must be determined by either

- wiping an area of 300 square centimeters (cm^2) of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. The amount of radioactivity measured on any single wiping material, divided by the surface area wiped and divided by the efficiency of the wipe procedure (the fraction of removable contamination transferred from the surface to the absorbent material), may not exceed the limits set forth in 10 CFR 173.443, at any time during transport. For this purpose

the actual wipe efficiency may be used, or the wipe efficiency may be assumed to be 0.10; or

- alternatively, the level of non-fixed radioactive contamination may be determined by using other methods of equal or greater efficiency.

Table 5. Non-fixed external radioactive contamination limits for packages

Contaminant	**Maximum Permissible Limits**		
	Bq/cm^2	**µCi/cm^2**	**dpm/cm^2**
Beta and gamma emitters and low toxicity alpha emitters	4	10^{-4}	220
All other alpha emitting radionuclides	0.4	10^{-5}	22

µCi=microcurie
dpm=disintegrations per minute

Source: 49 CFR 173.443

Except as provided in paragraph (d) of this section, in the case of packages transported as exclusive use shipments by rail or public highway only, the removable (non-fixed) radioactive contamination on any package at any time during transport may not exceed ten times the levels prescribed in paragraph (a) of this section. The levels at the beginning of transport may not exceed the levels prescribed in paragraph (a) of this section.

Except as provided in paragraph (d) of this section, each transport vehicle used for transporting class 7 (radioactive) materials as an exclusive use shipment that utilizes the provisions of paragraph (b) of this section must be surveyed with appropriate radiation detection instruments after each use. A vehicle may not be returned to service until the radiation dose rate at each accessible surface is 0.005 mSv/h (0.5 mrem/h) or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

Paragraphs (b) and (c) of this section do not apply to any closed transport vehicle used solely for the transportation by highway or rail of class 7 (radioactive) material packages with contamination levels that do not exceed ten times the levels prescribed in paragraph (a) of this section if

- a survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 0.1 mSv per hour (10 mrem/h) at the surface or 0.02 mSv/h (2 mrem/h) at 1 m (3.3 ft) from the surface;
- each vehicle is stenciled with the words “For Radioactive Materials Use Only” in letters at least 76 mm (3 ins) high in a conspicuous place on both sides of the exterior of the vehicle; and

- each vehicle is kept closed except for loading or unloading.

The recent resumption of transportation of commercial power reactor spent fuel in the U.S. has focused renewed attention on the chronic problem of cask "weeping." This is a phenomena whereby certain casks, after their removal from underwater storage basins (pools) and decontamination, subsequently exhibit an increase in the level of removable radioactive surface contamination during and after transport. This increase is believed to be the result of a "weeping" or "sweating" of previously entrapped activity within surface pores, fissures, etc. Its occurrence and magnitude appear to be dependent on such variables as cleanup methods, surface porosity, types of detergents used, surface treatment history, duration of and temperature during transport, and the period of time between completion of transportation and performance of a contamination survey. Although the levels of contamination that have been observed in cask weeping episodes do not present a significant health and safety problem, the levels have been technically above the regulatory limits, particularly when no further consideration is given to determining the wiping efficiency more precisely than the ten percent efficiency that is assumed within the regulatory limit. Changes to DOT regulations as promulgated in Docket HM-169 have also raised a question because of an apparent unintended revision in the regulatory language relating to averaging of wipe samples. Shippers of radioactive packages, particularly spent fuel casks, are reminded of the continuing need for improving cask decontamination methods and spent fuel pool techniques, so as to maintain removable radioactive surface contamination levels as low as practicable.

11. Transportation and traffic management personnel shall demonstrate working level knowledge of DOE O 232.1, *Occurrence Reporting and Processing of Operations Information*.
[Note: DOE O 232.1 has been cancelled and replaced by DOE O 231.1A Chg 1, *Environment, Safety, and Health Reporting*. The information related to occurrence reporting procedures is now available in DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*. The information provided here is from DOE M 231.1-2.]

a. State the purpose of the Order.

The following is taken from DOE M 231.1-2.

DOE M 231.1-2 provides detailed information for reporting occurrences and managing associated activities at DOE facilities, including NNSA facilities. It complements DOE O 231.1A chg 1, *Environment, Safety, and Health Reporting*, and its use is required by that Order.

Information gathered in response to the requirements in this Order and manual is used for analysis of the Department's performance in environmental protection and the safety and health of its workers and the public. This information is also used to develop lessons learned and document events that impact DOE operations.

b. Define the following terms:
- **Condition**
- **Event**

- **Facility**
- **Notification report**
- **Occurrence report**
- **Reportable occurrence**

The following definitions are taken from DOE M 231.1-2.

Condition

Any as-found state, whether or not resulting from an event, that may have adverse safety, health, quality assurance, operational, or environmental implications. A condition is usually programmatic in nature; for example, errors in analysis or calculation; anomalies associated with design or performance; or items indicating a weakness in the management process are all conditions.

Event

Something significant and real-time that happens (e.g., pipe break, valve failure, loss of power, environmental spill, earthquake, tornado, flood).

Facility

A facility is any equipment, structure, system, process, or activity that fulfills a specific purpose. Examples include accelerators, storage areas, fusion research devices, nuclear reactors, production or processing plants, coal conversion plants, magneto hydrodynamic experiments, windmills, radioactive waste disposal systems and burial grounds, environmental restoration activities, testing laboratories, research laboratories, transportation activities, and accommodations for analytical examinations of irradiated and unirradiated components.

Notification Report

The initial documented report, to the Department, of an event or condition that meets the reporting criteria defined in DOE M 232.1-2.

Occurrence Report

A documented evaluation of an event or condition that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or employed to correct the condition or to avoid recurrence.

Reportable Occurrence

Occurrence to be reported in accordance with the criteria defined in DOE M 231.1-2.

c. Discuss the Department's policy regarding the reporting of occurrences as outlined in the Order.

The following is taken from DOE M 231.1-2.

For reportable occurrences, contractors must categorize the occurrences, notify DOE as required, and prepare and submit occurrence reports. At sites with more than one facility management contractor, contractors may make arrangements for one of the contractors to

prepare and submit reports for the entire site. However, each contractor is responsible for ensuring that occurrence reports are submitted for activities within its scope of work.

The documentation and distribution requirements will be satisfied by utilization of a centralized unclassified DOE operational database, the computerized occurrence reporting and processing system (ORPS). However, under no circumstances will occurrence reports containing classified information or unclassified controlled nuclear information be entered into the ORPS database. Requirements regarding security classification are provided in section 3 of DOE M 231.1-2.

Occurrences involving foreign personnel, governments, organizations, entities, or influence must be reported by the contractor to the Office of Counterintelligence or the Office of Defense Nuclear Counterintelligence, as appropriate. Such reporting is not intended to interfere with or delay any actions directed toward protection of personnel or property.

d. State the different categories of reportable occurrences and discuss each.

The following is taken from DOE M 231.1-2.

The following are the reporting criteria, categorized into ten major groups and appropriate subgroups related to DOE operations. This list provides a minimum set of requirements necessary to develop local procedures and report occurrences applicable to local operations.

Categorization of occurrences must be done at the criterion level. Site/contractor corrective action programs will manage actions for important events that do not meet the ORPS reporting herein (as well as significance category 4 occurrences, whose corrective actions are not managed through ORPS).

Security events are no longer reported in ORPS unless they involve other consequences that meet the ORPS reporting criteria presented herein.

Major Criteria Groups

The ten major groups of categorized occurrences are as follows:

- Group 1 - Operational Emergencies
- Group 2 - Personnel Safety
- Group 3 - Nuclear Safety Basis
- Group 4 - Facility Status
- Group 5 - Environmental
- Group 6 - Contamination/Radiation Control
- Group 7 - Nuclear Explosive Safety
- Group 8 - Transportation
- Group 9 - Noncompliance Notifications
- Group 10—Management Concerns/Issues

See DOE M 232.1-2, pages 21-37, for a detailed discussion regarding ORPS categories.

e. Refer to Attachment 1 to DOE O 232.1, Occurrence Reporting and Processing of Operations Information, and discuss the role of transportation personnel in transportation-related reportable occurrences.
[Note: DOE O 232.1 has been cancelled and replaced by DOE O 231.1A, Environment, Safety, and Health Reporting. The information related to occurrence reporting procedures is now available in DOE M 231.1-2, Occurrence Reporting and Processing of Operations Information. The information provided here is from DOE M 231.1-2.]

The following is taken from DOE M 231.1-2.

The following incidents must be reported in ORPS:

- Any offsite transportation incident involving hazardous materials that would require immediate notice, namely:
  - As a direct result of hazardous materials
    - a person is killed;
    - a person receives injuries requiring hospitalization;
    - estimated property damage exceeds $50,000;
    - an evacuation of the general public occurs lasting 1 hour or more;
    - one or more transportation arteries or facilities are closed or shut down for 1 hour or more.
  - Fire, breakage, spillage, or suspected radioactive contamination occurs involving the shipment of radioactive materials.
  - Fire, breakage, spillage, or suspected contamination occurs involving the shipment of infectious substances (etiologic agents).
  - There has been a release of a marine pollutant in a quantity exceeding 450 L (119 gal) for liquids or 400 kg (882 lbs) for solids.
  - The operational flight pattern or routine of an aircraft is altered.

- Any offsite or onsite transport of hazardous material, including radioactive material, whose quantity or nature is different than intended, such that the receiving organization's operations were impacted/disrupted or the transport resulted in the initiation of corrective actions by the originating organization.
- Any onsite transport of hazardous material, including radioactive material, whose quantity or nature (e.g., physical or chemical composition) is different than intended, such that the receiving organization's operations were impacted/disrupted or the transport resulted in the initiation of corrective actions by the originating organization.
- Any packaging or transportation activity involving the onsite release of radioactive materials, etiologic agents, hazardous substances, hazardous waste, or marine pollutants.

12. Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of nuclear safety management, as it relates to transportation activities, that is referenced in 10 CFR 830, Nuclear Safety Management.

a. Discuss the exclusions of this rule.

The following is taken from 10 CFR 830.2.

This part does not apply to

- activities that are regulated through a license by the NRC or a state under an agreement with the NRC, including activities certified by the NRC under section 1701 of the Atomic Energy Act (AEA);
- activities conducted under the authority of the Director, Naval Nuclear Propulsion Program, pursuant to EO 12344;
- transportation activities which are regulated by the DOT;
- activities conducted under the Nuclear Waste Policy Act (NWPA) of 1982, as amended, and any facility identified under section 202(5) of the Energy Reorganization Act of 1974, as amended; and
- activities related to the launch approval and actual launch of nuclear energy systems into space.

b. Discuss the definition of a nonreactor nuclear facility and how it applies to transportation.

The following is taken from 10 CFR 830.3.

Nonreactor nuclear facilities are those facilities, activities, or operations that involve, or will involve, radioactive and/or fissionable materials in such form and quantity that a nuclear or a nuclear explosive hazard potentially exists to workers, the public, or the environment, but does not include accelerators and their operations and does not include activities involving only incidental use and generation of radioactive sources in research and experimental and analytical laboratory activities, electron microscopes, and x-ray machines.

The materials management section shall prepare fissionable materials for offsite shipment and transfer the material onsite between facilities. The Hazardous Waste Management Division shall prepare waste containing fissionable materials for offsite shipment or onsite transfer between facilities.

c. Discuss applicability of safety basis requirements to transportation and packaging.

The following is taken from 10 CFR 830.2.

Safety basis requirements do not apply to:

- Activities that are regulated through a license by the Nuclear Regulatory Commission (NRC) or a state under an agreement with the NRC, including activities certified by the NRC under section 1701 of the AEA

- Activities conducted under the authority of the Director, Naval Nuclear Propulsion, pursuant to EO 12344, as set forth in Public Law (PL) 106-65, *National Defense Authorization Act for Fiscal Year 2000*
- Transportation activities which are regulated by the DOT
- Activities conducted under the Nuclear Waste Policy Act of 1982, as amended, and any facility identified under section 202(5) of the Energy Reorganization Act of 1974, as amended
- Activities related to the launch approval and actual launch of nuclear energy systems into space

d. Discuss applicability of quality assurance requirements to transportation and packaging.

The following is taken from DOE O 460.1B.

Each person who participates in the design, fabrication, procurement, use, or maintenance of a hazardous materials packaging shall

- have an approved quality assurance program that
  - for type B and fissile radioactive materials packagings, satisfies the requirements of 10 CFR 71, subpart H; "Quality Assurance," and
  - for all other radioactive and hazardous materials packagings, satisfies the requirements of DOE O 414.1C, *Quality Assurance.*
- report to the Assistant Secretary for Environmental Management or the responsible Secretarial Officer/Deputy Administrator, NNSA, within 30 days of
  - any instance in which there is significant reduction in the effectiveness of any approved type B, or fissile, packaging during use;
  - details of any defects with safety significance in type B, or fissile, packaging after first use, with the means employed to repair the defects and prevent their recurrence; or
  - instances in which the conditions of approval in the certificate of compliance were not observed in making a shipment.

e. Discuss the basic premises of the Price Anderson Amendments Act and applicability to onsite transportation activities.

The following is taken from the American Nuclear Society, *The Price-Anderson Act, Background Information*.

The main purpose of the Price-Anderson Act is to ensure the availability of a large pool of funds (currently about $10 billion) to provide prompt and orderly compensation of members of the public who incur damages from a nuclear or radiological incident no matter who might be liable.

The Act provides "omnibus" coverage, that is, the same protection available for a covered licensee or contractor extends through indemnification to any persons who may be legally liable, regardless of their identity or relationship to the licensed activity. Because the Act channels the obligation to pay compensation for damages, a claimant need not sue several parties but can bring its claim to the licensee or contractor.

The Price-Anderson Act requires NRC licensees and DOE contractors to enter into agreements of indemnification to cover personal injury and property damage to those harmed by a nuclear or radiological incident, including the costs of incident response or precautionary evacuation and the costs of investigating and defending claims and settling suits for such damages. The scope of the Act includes nuclear incidents in the course of the operation of power reactors; test and research reactors; DOE nuclear and radiological facilities; and transportation of nuclear fuel to and from a covered facility. Public liability arising out of nuclear waste activities funded by the nuclear waste fund would be compensated from the fund. DOE indemnification covers activities relating to a repository for civilian nuclear spent fuel, including the transportation, storage, or disposal of nuclear waste. Price-Anderson also covers any nuclear incident in the U.S. during the transport of nuclear material, including evacuation.

13. Transportation and traffic management personnel shall demonstrate a familiarity level knowledge of traffic management regulations referenced in 41 CFR 109-40.

a. Discuss the applicability of the regulation to DOE and DOE contractors.

The following is taken from 41 CFR 109-40.000 and 109-40.000-50.

41 CFR 109-40, "Transportation and Traffic Management," describes DOE regulations governing transportation and traffic management activities. It also covers arrangements for transportation and related services by bill of lading. These regulations are designed to ensure that all transportation and traffic management activities will be carried out in the manner most advantageous to the government in terms of economy, efficiency, service, environment, safety, and security.

41 CFR 109-40 should be applied to cost-type contractors' transportation and traffic management activities. Departure by cost-type contractors from the provisions of these regulations may be authorized by the contracting officer provided the practices and procedures followed are consistent with the basic policy objectives in these regulations and DOE O 460.2A, *Departmental Materials Transportation and Packaging Management*, except to the extent such departure is prohibited by statute or EO.

b. Discuss traffic management administrative functions.

The following is taken from 41 CFR 109-40.301.

The DOE traffic management functions are accomplished by established field traffic offices under provisions of appropriate departmental directives and headquarters' staff traffic management supervision.

14. Transportation and traffic management personnel shall demonstrate a working level knowledge of packaging hazardous materials.

a. Describe the procurement process, including:
- **Vendor qualifications**
- **Quality assurance**

- **Receipt inspection**
- **Material and package compatibility**
- **Packaging specifications and testing requirements**

Vendor Qualifications

The following is taken from DOE G 414.1-2A.

The objective of evaluating suppliers or vendors is two-fold: 1) to verify the supplier has implemented a quality assurance program that conforms to contract requirements; and 2) to verify that the supplier is capable of providing the items or services identified in the contract. Prospective suppliers should be evaluated to verify their capability to meet performance and schedule requirements. An effective evaluation method is an assessment conducted at the supplier's facilities. The assessment may include personnel, technical and equipment capabilities, and processes. This method may be used in combination with

- a review of the supplier's history of providing identical or similar items or services,
- a review of shared supplier quality information (e.g., DOE Consolidated Audit Program, DOE Laboratory Accreditation Program),
- an evaluation of certifications or registrations awarded by nationally accredited third parties, and
- an evaluation of documented qualitative and quantitative performance information provided by the supplier.

The method or combination of methods chosen is intended to provide adequate confidence that the supplied item or service will meet requirements.

Potential suppliers should be identified as early as possible in the design and procurement process in order to determine their capabilities.

Quality Assurance

The following is taken from DOE G 460.1-1.

The organization shall ensure that procured items and services meet established requirements and perform as specified. Prospective suppliers shall be evaluated and selected on the basis of specified criteria. The organization shall ensure that approved suppliers can continue to provide acceptable items and services.

This criterion should be applied to the procurement of test apparatus and any other items procured in support of this program. Each test facility organization should have a documented procurement program to accomplish this. Documentation of the procurement program for the test facility organization should be provided to environmental management (EM) for review as part of the approval process for the test facility.

Receipt Inspection

The following is taken from DOE G 460.1-1.

Inspection and acceptance testing of specified items and processes shall be conducted using established acceptance and performance criteria. Equipment used for inspections and tests

shall be calibrated and maintained. Inspection and acceptance testing of test apparatus should be specifically addressed in the test procedures, where appropriate.

Material and Package Compatibility

The following is taken from DOE M 460.2-1A.

Characterization and classification of the material to be shipped are necessary to ensure that the material is shipped safely and in compliance with applicable regulations and that the material is compatible with the packaging selected for shipment. DOE is responsible for properly characterizing and classifying the material in accordance with DOT requirements and in sufficient detail to permit identification of appropriate packaging. Material characterization and classification are performed by DOE or contractor technical staff who possess detailed knowledge of the material and who have been properly trained on the DOT regulations pertaining to classification.

DOE identifies the need to ship, the materials to be shipped, the origin, the destination, the schedule on which shipments should be made, and other programmatic needs. DOE is responsible for identifying applicable regulatory requirements based on characterization of the material to be shipped.

Packaging selection depends on the DOT material classification and the chemical and physical characteristics of the material. The shipper is responsible for identifying the proper packaging and taking steps to ensure that the packagings are available when needed for shipment. For type B packagings, the appropriate certificate of compliance must be checked to ensure that it is current and that the proposed contents have been approved. Packaging selection is performed by the shipper's or contractors' technical staff that has been properly trained on DOT and/or international packaging regulations.

Packaging Specifications and Test Requirements

The following is taken from DOE G 460.1-1.

DOE O 460.1B, *Packaging and Transportation Safety*, required the establishment of a test and evaluation program for DOT specification 7A type A radioactive material package designs. The program should be established to ensure that testing and supporting documentation is of consistently high quality. Under this program and in accordance with DOE O 460.1B, type A packagings developed by DOE facilities will undergo testing by a DOE-approved test facility and then be approved by EM before use by DOE or its contractors.

To have a package design evaluated, an applicant is required to open a docket with EM and then submit a design packet and packaging prototypes to the test facility assigned to the docket by EM. The test facility evaluates the documentation provided by the applicant before performing the type A tests. Comments generated from the review are provided to the applicant by the test facility and in normal circumstances should be resolved before testing is performed. Copies of the comments and their resolution are forwarded by the test facility to EM.

The regulations of 49 CFR 173.462, "Preparations for Specimens for Testing," should be followed prior to testing each specimen to identify and record faults or damage. The testing

of the proposed type A packaging involves subjecting the prototype containing simulated radioactive contents to the prescribed tests. The packaging test facility must ensure that the hardware tested complies with the design specifications and that the simulated contents impose a maximum stress on the feature being tested. After each of the applicable tests specified in DOE G 460.1-1, attachment 4, *Capability of Test Facilities for Testing Type A Packaging*, the packaging and shielding should be tested as required by 49 CFR 173.463, "Packaging and Shielding—Testing for Integrity" (archived). It is the responsibility of the packaging test facility to ensure the adequacy of the techniques used to analyze the package design. This includes verifying that tested prototypes complied with the design and that test results support a determination of successfully passing the tests.

b. Describe the following different types of packaging and their use:

- **Bulk packaging**
- **Cargo tank**
- **Combination packaging for liquids and solids**
- **Composite packaging**
- **Empty**
- **Excepted packaging**
- **Freight container**
- **Industrial packaging**
- **Inner packaging**
- **Non-bulk packaging**
- **Outer packaging**
- **Overpack**
- **Type B package**
- **Salvage**
- **Single packaging**
- **Specification packaging**
- **Strong outside container**
- **Strong-tight package**

The following definitions are taken from 49 CFR 171.8, unless stated otherwise.

Bulk Packaging

Bulk packaging is a packaging, other than a vessel or a barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has

- a maximum capacity greater than 450 L (119 gals) as a receptacle for a liquid;
- a maximum net mass greater than 400 kg (882 lbs) and a maximum capacity greater than 450 L (119 gals) as a receptacle for a solid; or
- a water capacity greater than 454 kg (1,000 lbs) as a receptacle for a gas as defined in 49 CFR 173.115.

Cargo Tank

Cargo tank is a bulk packaging that is

- a tank intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures;
- permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which, by reason of its size, construction, or

attachment to a motor vehicle, is loaded or unloaded without being removed from the motor vehicle; and

- not fabricated under a specification for cylinders, portable tanks, tank cars, or multi-unit tank car tanks.

Combination Packaging for Liquids And Solids

Combination packaging is a combination of packaging, for transport purposes, consisting of one or more inner packagings secured in a non-bulk outer packaging. It does not include a composite packaging.

Composite Packaging

Composite packaging is a packaging consisting of an outer packaging and an inner receptacle, so constructed that the inner receptacle and the outer packaging form an integral packaging. Once assembled, the composite packaging remains an integrated single unit; it is filled, stored, shipped, and emptied as such.

Empty

The following is taken from 49 CFR 173.29.

An empty means packaging containing only the residue of a hazardous material.

Excepted Packaging

The following is taken from DOE, MERRTT, *Radioactive Material Shipping Packages*.

Excepted packaging is used to transport material with extremely low levels of radioactivity. Excepted packagings are authorized for limited quantities of radioactive material that would pose a very low hazard if released in an accident. Examples of material typically shipped in excepted packaging include consumer goods such as smoke detectors. Excepted packagings are excepted (excluded) from specific packaging, labeling, and shipping paper requirements; they are, however, required to have the letters "UN" and the appropriate four-digit UN identification number marked on the outside of the package. Requirements for excepted packaging are addressed in 49 CFR 173.421, "Excepted Packages for Limited Quantities of Class 7 (Radioactive) Materials."

Freight Container

Freight container is a reusable container having a volume of 64 Ft^3 or more, designed and constructed to permit being lifted with its contents intact and intended primarily for containment of packages (in unit form) during transportation.

Industrial Packaging

The following is taken from DOE, MERRTT, *Radioactive Material Shipping Packages*.

Industrial packaging (IP) is used in certain shipments of low activity material and contaminated objects, which are usually categorized as radioactive waste. Most low-level radioactive waste is shipped in these packages. DOT regulations require that these packages allow no identifiable release of the material to the environment during normal transportation and handling. There are three categories of industrial packages: IP-1, IP-2, and IP-3. The

category of package will be marked on the exterior of the package. Requirements for industrial packaging are addressed in 49 CFR 173.411, "Industrial Packagings."

Inner Packaging

Inner packaging is a packaging for which an outer packaging is required for transport. It does not include the inner receptacle of a composite packaging.

Non-bulk Packaging

Non-bulk packaging is a packaging that has

- a maximum capacity of 450 L (119 gals) or less as a receptacle for a liquid;
- a maximum net mass of 400 kg (882 lbs) or less and a maximum capacity of 450 L (119 gals) or less as a receptacle for a solid; or
- a water capacity of 454 kg (1,000 lbs) or less as a receptacle for a gas as defined in 49 CFR 173.115.

Outer Packaging

Outer packaging is the outermost enclosure of a composite or combination packaging together with any absorbent materials, cushioning, and any other components necessary to contain and protect inner receptacles or inner packagings.

Overpack

Overpack is an enclosure that is used by a single consignor to provide protection or convenience in handling of a package or to consolidate two or more packages. Overpack does not include a transport vehicle, freight container, or aircraft unit load device. Examples of overpacks are one or more packages

- placed or stacked onto a load board such as a pallet and secured by strapping, shrink wrapping, stretch wrapping, or other suitable means; or
- placed in a protective outer packaging such as a box or crate.

Type B Package

The following is taken from DOE, MERRTT, *Radioactive Material Shipping Packages*.

Type B packaging is designed to transport material with the highest levels of radioactivity. Type B packagings range from small hand-held radiography cameras to heavily shielded steel casks that weigh up to 125 tons. Examples of material transported in type B packagings include spent nuclear fuel (SNF), high-level radioactive waste, and high concentrations of other radioactive material such as cesium and cobalt. These package designs must withstand all type A tests, and a series of tests that simulate severe or "worst-case" accident conditions. Accident conditions are simulated by performance testing and engineering analysis. Life-endangering amounts of radioactive material are required to be transported in type B packages.

Salvage

Salvage packaging is a special packaging conforming to 49 CFR 173.3, "Packaging and Exceptions," into which damaged, defective, leaking, or non-conforming hazardous materials packages, or hazardous materials that have spilled or leaked, are placed for purposes of transport for recovery or disposal.

Single Packaging

Single packaging is a non-bulk packaging other than a combination packaging.

Specification Packaging

Specification packaging is a packaging conforming to one of the specifications or standards for packagings in 49 CFR 178, "Specifications for Packagings," or 49 CFR 179, "Specifications for Tank Cars."

Strong Outside Container

Strong outside container is the outermost enclosure which provides protection against the unintentional release of its contents under conditions normally incident to transportation.

Strong-Tight Package

The following is taken from the NRC, Technical Training Center, *Transportation of Radioactive Material.*

A strong-tight container is designed to survive normal transportation handling. In essence, if the material makes it from point X to point Y without being released, the package is a strong-tight container.

c. Identify the different packaging groups and associated dangers.

The following is taken from the U.S. Postal Service, Appendix D, *Hazardous Materials Definitions*.

Packaging group is the DOT grouping assignment that is based on the degree of danger present in an individual hazardous material:

- Packing group I indicates a great danger.
- Packing group II indicates that there is a medium degree of danger.
- Packing group III designation minor danger.

Not every hazard class uses packing group assignments. Miscellaneous Dangerous Goods (ORM-D) materials most often fall within packing group III.

d. Describe the package selection process for a given material.

The following is taken from DOE M 460.2-1A.

Packaging selection depends on the DOT material classification and the chemical and physical characteristics of the material. The shipper is responsible for identifying the proper packaging and taking steps to ensure that the packagings are available when needed for shipment. For type B packagings, the appropriate certificate of compliance must be checked to ensure that it is current and that the proposed contents have been approved. Packaging selection is performed by the shipper's or contractors' technical staff who have been properly trained on DOT and/or international packaging regulations.

e. Describe the process for acquiring and using a DOT package exemption and Party-to-Exemption.

Exemptions

The following is taken from 49 USC 5117.

As provided under procedures prescribed by regulation, the Secretary of Transportation may issue an exemption from a regulation to a person transporting, or causing to be transported, hazardous material in a way that achieves a safety level

- at least equal to the safety level required under 49 United States Code (U.S.C.) 5117, "Exemptions and Exclusions;" or
- consistent with the public interest if a required safety level does not exist.

An exemption is effective for not more than 2 years and may be renewed on application to the Secretary.

When applying for an exemption or renewal of an exemption, the person must provide a safety analysis prescribed by the Secretary that justifies the exemption. The Secretary shall publish in the Federal Register notice that an application for an exemption has been filed and shall give the public an opportunity to inspect the safety analysis and comment on the application.

The Secretary shall issue or renew the exemption for which an application was filed or deny such issuance or renewal within 180 days after the first day of the month following the date of the filing of such application, or the Secretary shall publish a statement in the Federal Register of the reason why the Secretary's decision on the exemption is delayed, along with an estimate of the additional time necessary before the decision is made.

Party-To-Exemption

The following is taken from 49 CFR 107.107.

Any person eligible to apply for an exemption may apply to be made party to an application or an existing exemption, other than a manufacturing exemption. Each application filed under this section must

- be submitted in duplicate;
- identify by number the exemption application or exemption to which the applicant seeks to become a party;
- state the name, street, and mailing address, e-mail address, and telephone number of the applicant;
- if the applicant is not a resident of the U.S., provide a designation of agent for service according to 49 CFR 105.40, "Designated Agents for Non-Residents."

f. Describe the proper loading and tie-down of the package on the conveyance prior to shipment.

The following is taken from the Wastren, Inc., Packaging and Transportation Manual, *Packaging and Transportation of Hazardous and Radioactive Waste*.

Tie-down assemblies, systems, and materials used to restrain packages must meet the requirements of 49 CFR 393.102. Acceptable guidelines for procedures consistent with good industrial practices include, but are not limited to, the following:

- Individual components of a tie-down system must not be utilized other than in the manner intended. The use of plastic or fiber rope, any damaged material, or any material of unknown strength is prohibited. Materials used in tie-downs must be considered for their elastic properties. They must be protected from excessive exposure to contaminants (i.e., dirt, chemicals, water, etc.) and inclement weather conditions when not in use.
- The principal tie-down forces should be transmitted to the vehicle frame and not to the wood or metal decking. The rub-rail (located alongside the trailer bed framework) must never be used as a tie-down attachment point. Its strength is unknown and normally insufficient for load bearing. The hook, bolt, weld, or other connector by which the tie-down assembly is attached to the vehicle and the mounting place shall be at least as strong as the strength of the tie-down assembly when the connector is attached in any direction in which the assembly may be applied.

ANSI N-14.2, *Tiedowns for Truck Transport of Radioactive Materials*, is a source of specific information for securing radioactive waste. In addition, each transport vehicle shall conform to the applicable requirements of 49 CFR 393.100, "Which Types of Commercial Motor Vehicles are Subject to the Cargo Securement Standards of this Subpart, and What General Requirements Apply?," §393.102, "What are the Minimum Performance Criteria for Cargo Securement Devices and Systems?;" §393.104, "What Standards Must Cargo Securement Devices and Systems Meet in Order to Satisfy the Requirements of this Subpart?;" and §393.106, "What are the General Requirements for Securing Articles of Cargo?;" for protection against falling or shifting cargo, securing systems, blocking, bracing, and front-end structures.

Each vehicle transporting hazardous or radioactive waste shall be equipped with devices against shifting or falling cargo that meet the requirements of one of the following options.

- The vehicle must have sides, side-boards, or stakes, and a rear tail gate, end-board, or stakes. Those devices must be strong enough, and high enough to assure that any packages do not shift upon, or fall from the vehicle. Those devices must have no aperture large enough to permit the packages in contact with one or more of the devices to pass through it.
- The vehicle must have at least one tie-down assembly that meets the requirements of 49 CFR 393.102 for each 10 linear feet of lading or fraction thereof.

Hazardous and radioactive waste must be loaded safely and secured with blocking, bracing, and tie-downs to prevent cargo from shifting or falling during transportation. Loading, unloading, blocking, bracing, and tie-down requirements are found in 49 CFR 392.9, "Inspection of Cargo, Cargo Securement Devices and Systems," §393, subpart I, "Protection Against Shifting and Falling Cargo," and §177, subpart B, "Loading and Unloading."

15. Transportation and traffic management personnel shall demonstrate a working level knowledge of traffic management.

a. Define the following terms and explain the seller and buyer obligations as identified in 48 CFR 47:

- **Free on board (FOB) origin, freight collect**
- **FOB origin, freight prepaid and charged back**
- **FOB destination, freight prepaid**
- **FOB destination, freight collect and allowed**

The following is taken from the State of North Dakota, *Freight Matrix*.

Table 6. Terms of sale and responsibility for freight cost and transit risk

Code	Terms of Sale	Responsibility for Freight Cost and Transit Risk
01	FOB Destination, freight prepaid	Seller - Pays freight charges Seller - Bears freight charges Seller - Owns goods in transit Seller - Files claims (if any)
02	FOB Destination, freight collect	Buyer - Pays freight charges Buyer - Bears freight charges Seller - Owns goods in transit Seller - Files claims (if any)
03	FOB Destination, freight collect and allowed	Buyer - Pays freight chg & deducts from invoice Seller - Bears freight charges Seller - Owns goods in transit Seller - Files claims (if any)
04	FOB Origin, freight prepaid	Seller - Pays freight charges Seller - Bears freight charges Buyer - Owns goods in transit Buyer - Files claims (if any)
05	FOB Origin, freight collect	Buyer - Pays freight charges Buyer - Bears freight charges Buyer - Owns goods in transit Buyer - Files claims (if any)
06	FOB Origin, freight prepaid and charged back	Seller - Pays freight charges and adds to invoice Buyer - Bears freight charges Buyer - Owns goods in transit Buyer - files claims (if any)
07	FOB Destination, freight prepaid and charged back	Seller - Pays freight charges and adds to invoice Buyer - Bears freight charges Seller - Owns goods in transit Seller - files claims (if any)

Source: State of North Dakota, *Freight Matrix*

b. Explain the limits of carrier liability and identify carrier insurance requirements.

The following is taken from DOE G 460.2-1.

Consistent with the government's self-insurance policy, funds should not be expended to insure property against loss, damage, or destruction while in transit. When the governing tariff limits carrier liability to a value per pound or a value per shipment and provides an additional charge for shipments exceeding that value, the DOE shipper should declare the highest value the carrier will honor without additional charge or enter no value declared if the limiting value is unknown.

c. Describe the administrative controls governing the distribution of hazardous material onsite.

The following is an example of administrative controls taken from Standford Linear Accelerator Center (SLAC), *Onsite Hazardous Materials Transportation Safety Document*.

Radioactive Materials

The movement of all radioactive materials within SLAC requires radiological surveys performed of the material by radiation protection personnel prior to the transportation of the material. All material transported shall have a radioactive material label attached to the material. Radiation protection personnel also provide guidance on packaging for safe transportation when necessary.

Controls for transporting all radioactive materials:

- Personnel performing transport shall be in general employee radiological training-qualified and wear personal dosimeters.
- Personnel shall review labels regarding dose rates and contamination levels.
- Items shall be secured during transportation to ensure material does not shift.
- Materials with radioactive contamination shall at least be double-bagged and if heavy or if puncture points are possible, have a durable outer covering.
- The destination shall be properly identified and posted to receive material and may need to be indoors.
- The destination's area manager or building manager will be notified if the receipt of the material may impact other work or personnel in the area.
- When transporting liquids, the transporter shall inspect the container to ensure all closures are secured to prevent an inadvertent spill.

Hazardous and Radiological Waste Transportation

Onsite transportation of DOT-regulated wastes requires the most comprehensive documentation, oversight and control due to regulatory requirements from agencies such as the EPA and NRC. Declaration forms are used to classify the waste and document its generation and track its progress through disposal. The Hazardous Waste Management Group and the Radioactive Waste Management Group provide container specifications, packaging guidelines, segregation, and load-bracing requirements as needed. All waste packages are marked and labeled as needed with SLAC internal numbers, hazardous waste labels, asbestos notifications/certifications, and radiation survey information.

The Hazardous Waste Management Group is a good resource for transporting hazardous waste onsite and should be used whenever possible. The requirements for transporting hazardous waste onsite are:

- Follow guidelines in SLAC-I-720-0A86Z-002-R000, ES&H Manual, chapter 13, *Traffic and Vehicular Safety*.
- Use only DOE or SLAC equipment for transporting hazardous waste.
- Personnel transporting hazardous wastes shall be hazardous waste management-qualified and wear appropriate PPE.
- Obtain clearance from waste management personnel to move hazardous waste to a new location.
- Contain the waste in compatible and properly sealed containers that are labeled appropriately.
- Always secure heavy loads with proper support and proper tie downs for hazardous equipment and always use proper equipment for securing drums on forklifts.
- Use carrying cases, racks, and trays, where appropriate for smaller containers.
- Cushion glass containers to prevent breaking during transport.
- Never drive faster than is safe for the driving conditions and load being handled and use caution when rounding corners, driving over speed bumps, and be especially cautious when crossing busy intersections.

Radioactive and mixed waste transportation controls:

- Only DOE or SLAC equipment shall be used for transporting radioactive and mixed waste.
- Personnel performing transport shall be qualified and wear personal dosimeters.
- Receiving facility shall be notified of intended transport.
- Personnel shall review labels regarding dose rates and contamination levels, to ensure they are within the limits specified.
- Waste shall be compatible with the container. Though contaminated items shall at a minimum be double-bagged, sharp or heavy objects require more durable containerization.
- Containers or items are marked with declaration form identification number, tagged with radiological surveys, or other required notices.
- Packages shall be secured during transportation to ensure items do not shift.

d. Identify and evaluate the types of information required for developing transportation cost data for budgeting purposes.

The following is taken from the DOE National Transportation Program Cost-Estimating Model.

Packaging Acquisition Cost—This cost factor provides the cost of purchasing the packages needed for a given campaign. The number of packages required for the campaign is calculated based on the travel time, loading and unloading times, refurbishment downtime, capacity of the packages, and amount of material to be transported in a given period of time. It is assumed that each campaign requires new packages; that assumption may overestimate the costs associated with a campaign whose packagings can be reused or with situations where the packagings are already available at no or reduced cost.

Packaging Lease Cost—This cost factor is the alternative to acquiring packagings. This factor provides the cost per month to lease a packaging, and the model includes lease costs for the times involved in transit between facilities and in loading and unloading the packagings.

Packaging Maintenance Cost—This cost factor provides the estimated cost of refurbishing the package after a predetermined number of uses. This would include parts and labor for seal replacement, minor damage repair, painting, fastener replacement, etc. This value is assumed to be zero when a packaging is leased, since the maintenance cost for each packaging is assumed to be included in the lease cost.

Vehicle Lease Cost—This cost factor provides the cost of leasing the vehicle for the campaign. It is based on the number of vehicles needed for the campaign (calculated) and the lease cost per vehicle.

Carriage Cost—This cost factor provides the "per mile" charge of the carrier and the round-trip mileage. This includes fuel, driver labor, etc.

Labor Cost—This cost factor provides a rough-order-of-magnitude estimate of the labor cost for package preparation, loading, and unloading and securing packages to vehicles.

Management and Administrative Cost—This cost factor provides a rough-order-of-magnitude cost of administration and management, including contracting for carriers, hazardous material shipping document preparation, record keeping, etc.

Travel Time—The travel time between the sites selected and the mode selected by the user.

Campaign Time—The Transportation Routing Geographical Information System (System) calculates the duration of the campaign based on the quantity of material to be moved, packaging selected, trip time, vehicle capacity, and the like.

Number of Packages Needed—The System calculates the number of packages required to move the material in a specified time period.

Number of Vehicles Needed— The System calculates the number of vehicles required to move the material in the specified time period.

Accessorial Charges — The System also allows the inclusion of accessorial charges to be included on a per-mile basis (such as a fuel surcharge) or a trip basis (such as special equipment required).

Additional Transit Time— The System also allows the inclusion of additional transit time required for each trip.

e. Determine that an adequate base of transportation services exists to support present and future programs.

f. Use/input data into automated transportation management system to obtain and/or issue reports.

g. Assess impacts of changes in industry services, regulations, and cost structure through appropriate trade magazines, Internet, etc.

Elements 'e' through 'g' are performance-based KSAs. The Qualifying Official will evaluate their completion.

h. Compare and contrast the terms listed below:

- **Carrier**
- **Commercial motor vehicle**
- **Demurrage**
- **Intermodal**
- **Less than truckload**
- **Mode**
- **Precious metals**
- **Premium transportation**

Carrier

The following is taken from DOE G 460.2-1.

A carrier is any person engaged in the transportation of passengers or property as a common, contract, for-hire, or private carrier, or as a freight forwarder, as those terms are used in Federal statutes and regulations, as amended; or the U.S. Postal Service; or as officers, agents, and employees of such carriers.

Commercial Motor Vehicle

The following is taken from 49 CFR 350.105.

Commercial motor vehicle means a motor vehicle that has any of the following characteristics:

- A gross vehicle weight, gross vehicle weight rating, gross combination weight, or gross combination weight rating of 10,001 pounds or more
- Regardless of weight, is designed or used to transport 16 or more passengers, including driver
- Regardless of weight, is used in the transportation of hazardous materials and is required to be placarded

Demurrage

The following is taken from slide presentation, *Freight Transportation and Logistics*, CE 410/510.

Demurrage is penalty charges assessed by a carrier to a shipper or consignee for holding transportation equipment, (i.e., trailers, containers, railcars) longer than a stipulated time for loading or unloading.

Intermodal

The following is taken from slide presentation, *Freight Transportation and Logistics*, CE 410/510.

Intermodal means transportation that uses a specialized container that can be transferred from the vehicle of one mode to the vehicle of another; a single freight bill is used for the shipment, (e.g., ocean shipping containers which can be hauled by trucks on chassis, railcars, ocean vessels, and barges).

Less Than Truckload

The following is taken from slide presentation, *Freight Transportation and Logistics*, CE 410/510.

Less than truckload shipment is when a shipper contracts for the transportation of freight that will not require an entire truck. Less than truckload shipments are priced according to the weight of the freight, its commodity class, and mileage within designated lanes.

Mode

The following is taken from DOE G 460.2-1.

Modes of transportation are rail, highway, air, or water.

Precious Metals

The following is taken from DOE G 460.2-1.

For the purposes of DOE O 460.2A, precious metals are defined as gallium, gold, iridium, osmium, palladium, platinum, rhodium, ruthenium, silver, or any combination of these metals.

Premium Transportation

The following is taken from DOE G 460.2-1.

Premium transportation is the transport of any commodity between two points by any method other than the most economical practical means. When complying with all applicable laws, rules, regulations, and security requirements, transportation requirements are specific and are not considered "premium."

16. Transportation and traffic management personnel shall demonstrate a working level knowledge of shipping activities.

a. Describe the process for tracing and expediting urgent sensitive shipments.

The following is taken from DOE, Transportation Tracking and Communication System (TRANSCOM), Fact Sheet, *Transportation Tracking and Communication System*.

TRANSCOM is the DOE unclassified tracking and communications system used to monitor the progress of various high visibility shipments, such as: SNF, foreign research reactor fuel, and transuranic waste. With a demonstrated 99.8 percent reliability, this nationwide 24-hour per day tracking system combines satellite and ground-based communications to monitor the progress of DOE truck, rail, barge, and ocean vessel shipments in near-real time. TRANSCOM has been used to monitor over 12,000 DOE high-visibility shipments since its deployment in September 2001.

TRANSCOM uses onboard satellite global positioning systems to track truck and rail shipments as they make their way from origin to destination. Authorized users access the

TRANSCOM system from their organization's personal computers, and connect to the TRANSCOM website through the Internet.

Satellites poll the shipments at near-real time frequency and relay positional and message information to the TRANSCOM communication center database. Shipment position and messaging data is made available over the Web at 4-7 minute intervals and can be viewed by authorized Federal, state and tribal customers across the United States.

TRANSCOM can provide position accuracy within 1,000 ft of a stopped vehicle.

TRANSCOM incorporates multiple layers of security including unique usernames and passwords, a public facing firewall, network and application authentication, and data encryption.

Specific shipment information available to authorized users includes bill of lading, shipment notes, routes, messages, positional information, and mapping functions that display shipment position information.

b. Review or assist in the review of freight charges on carrier bills and/or vendor invoices.

c. Negotiate demurrage agreements and detention with the carrier.

d. Provide for the import/export of goods through customs and determine duty/duty-free status, including obtaining appropriate license.

e. Coordinate loading arrangements, including oversize loads requiring special equipment.

f. Direct or assist in the preparation of transportation shipping papers and documentation records.

g. Review contractor arrangements for the transportation of household goods.

Elements 'b' through 'g' are performance-based KSAs. The Qualifying Official will evaluate their completion.

h. Identify the documents required by DOE O 534.1 for audits conducted by General Services Administration (GSA).

The following is taken from the DOE Accounting Handbook.

For transportation services, legible copies of all paid freight bills/invoices, commercial bills of lading, and supporting documentation must be submitted by the contractor to GSA for audit.

GSA granted DOE an exception requiring the submission of only those bills and invoices greater than $50. Bills/invoices for $50 or less will be retained onsite and made available for GSA onsite audits. The contractor must promptly forward any original transportation bill

requested by GSA. Original paid bills must be retained for the period of time specified by applicable Federal requirements.

17. Transportation and traffic management personnel shall demonstrate a working level knowledge of the preparation and applicability of transportation documents.

a. Determine when the following documents are required:

- **Claim form**
- **Commercial straight form bill of lading**
- **Dangerous goods declaration**
- **Export declaration**
- **Express air bill**
- **Freight bill**
- **Government bill of lading**
- **Material safety data sheet**
- **Tender**
- **Weight ticket**

Claim Form

The following is taken from the DOE Accounting Handbook.

The contractor shall promptly process claims exceeding $50 against the carrier for loss or damage to a shipment while in transit and for unearned freight charges on the property lost or damaged beyond repair under the following circumstances:

- When loss or damage is noted by a carrier on the carrier's delivery receipt and acknowledged by the driver, the carrier should be invited to inspect the damaged property within 7 days of delivery. If the carrier does not make or waives the inspection, the contractor should document that fact and file a claim immediately.
- If loss or damage is discovered subsequent to delivery, the delivering carrier shall be notified by telephone, and an inspection shall be requested. Unless there are extenuating circumstances, the notification and request for inspection shall be made within 15 days of delivery.

Commercial Straight Form Bill of Lading

The following is taken from 41 CFR 109-40.5003.

DOE's cost-type contractors using commercial bills of lading in making shipments for the account of DOE shall include the following statement on all commercial bills of lading: "This shipment is for the account of the U.S. Government, which will assume the freight charges, and is subject to the terms and conditions set forth in the standard form of the U.S. Government bills of lading and to any available special rates or charge."

Where practicable, commercial bills of lading shall provide for consignment of a shipment to DOE c/o the cost-type contractor or by the contractor for the DOE. Commercial bills of lading exceeding $10,000 issued by cost-type contractors shall be annotated with a typewritten, rubber stamped, or similar impression containing the following wording: "Equal employment opportunity. All provisions of EO 111246, as amended by EO 11375, amended by EO 11478,

and of the rules, regulations, and relevant orders of the Secretary of Labor are incorporated herein."

Declaration of Dangerous Goods

The following is taken from slide presentation, *Hazardous Cargo Orientation*, UMODA04.

A declaration of dangerous goods form is goods shipping paper/declaration and emergency response information for hazardous materials transported by government vehicles, containers, or vessels. It is used when transporting hazardous materials on government vehicles or in any shipping container that is placed on a government vehicle for transportation.

Export Declaration

The following is taken from 15 CFR 30.2.

Shipper's export declarations (SEDs) shall be filed by the U.S. principal party in interest or the authorized agent in accordance with the definitions, specifications, and requirements of 15 CFR 30, "Foreign Trade Regulations," for all commodities, gold, and silver, except as specifically exempted herein, shipped as follows:

- To foreign countries or areas, including foreign trade zones located therein, from any of the following:
  - The U.S., including the 50 states and the District of Columbia
  - Puerto Rico
  - Foreign trade zones in the U.S. or Puerto Rico
  - The Virgin Islands of the U.S.
- Between non-foreign areas as specified below:
  - To Puerto Rico from the U.S.
  - To the U.S. from Puerto Rico
  - To the Virgin Islands of the U.S. from the U.S. or Puerto Rico

Note: SEDs are not required for shipments from the U.S. or Puerto Rico to the U.S. possessions, except to the Virgin Islands of the U.S., or from a U.S. possession destined to the United States, Puerto Rico, or another U.S. possession.

SEDs shall be filed for merchandise moving as described above regardless of the method of transportation.

Express Air Bill

The following is taken from Export 911, Air Waybills.

The air bill serves as a receipt for goods and an evidence of the contract of carriage, but it is not a document of title to the goods. Hence, the air bill is non-negotiable.

The goods in the air consignment are consigned directly to the party (the consignee) named in the letter of credit. Unless the goods are consigned to a third party like the issuing bank, the importer can obtain the goods from the carrier at destination without paying the issuing

bank or the consignor. Therefore, unless a cash payment has been received by the exporter or the buyer's integrity is unquestionable; consigning goods directly to the importer is risky.

For air consignment to certain destinations, it is possible to arrange payment on a cash on delivery basis and consign the goods directly to the importer. The goods are released to the importer only after the importer makes the payment and complies with the instructions in the air bill.

In air freight, the exporter (the consignor) often engages a freight forwarder or consolidator to handle the forwarding of goods. The consignor provides a shipper's letter of instructions that authorizes the forwarding agent to sign certain documents on behalf of the consignor.

The air bill must indicate that the goods have been accepted for carriage, and it must be signed or authenticated by the carrier or the named agent for or on behalf of the carrier. The signature or authentication of the carrier must be identified as carrier, and in the case of agent signing or authenticating, the name and the capacity of the carrier on whose behalf the agent signs or authenticates must be indicated.

Freight Bill

The following is taken from the DOT, *Glossary of Shipping Terms*.

A freight bill is a document issued by the carrier based on the bill of lading and other information; used to account for shipment operationally, statistically, and financially. A freight bill is an invoice.

Government Bill of Lading

The following is taken from 48 CFR 47.001.

A government bill of lading is an accountable transportation document, authorized and prepared by a government official.

Material Safety Data Sheet

The following is taken from the U.S. Chamber of Commerce, Small Business Nation, *OSHA Form 174: Material Safety Data Sheet (MSDS)*.

Federal law dictates that employers must provide information to their employees about hazardous materials and chemicals that employees may be exposed to in the workplace. The vehicle for that information is the material safety data sheet.

Tender

The following is taken from the DOT, *Glossary of Shipping Terms*.

Tender is the offer of goods for transportation or the offer to place cars or containers for loading or unloading.

Weight Ticket

The following is taken from the EPA, Enforcement, Potentially Responsible Party (PRP) Specific.

A weight ticket is a ticket specifying the weight of goods transported. The weight can be taken at the beginning and/or end of the route.

18. Transportation and traffic management personnel shall demonstrate a working level knowledge of routing freight.

a. Evaluate carrier service characteristics, including carrier capability, carrier performance record, transit time, equipment requirements, site preference, and specialty services.

b. Arrange for physical protection of shipments as necessary.

Elements 'a' and 'b' are performance-based KSAs. The Qualifying Official will evaluate their completion.

c. Identify the advantages/disadvantages of the different modes of transportation, including rail, water, air, and motor carrier.

The following is taken from Michigan State University, *Transportation*.

Tables 7 and 8 provide a comparison of the costs and operating characteristics for the different modes of transportation.

Table 7. Cost comparison of basic modes of transportation

Basic Modes of Transportation			
	Fixed Costs	**Variable Costs**	**Traffic Composition**
Rail	High	Low	Bulk food, mining, heavy manufacturing
Motor	Low	Medium	Consumer goods, medium/light manufacturing
Air	Low	High	High-value goods, rush shipments
Water	Medium	Low	Bulk food, mining, chemicals

Source: Michigan State University, *Transportation*

Table 8. Comparison of operating characteristics

Relative Operating Characteristics				
Operating Characteristics	**Rail**	**Motor**	**Water**	**Air**
Speed	3	2	4	1
Availability	2	1	4	3
Dependability	3	2	4	5
Capability	2	3	1	4
Frequency	4	2	5	3
1 = best, 5 = worst				

Source: Michigan State University, *Transportation*

19. Transportation and traffic management personnel shall demonstrate a working level knowledge of selecting carriers.

a. Review and approve terms of sale affecting transportation services.

b. Evaluate the transportation fleet equipment maintenance programs.

c. Review specifications for truck and rail equipment.

Elements 'a' through 'c' are performance-based KSAs. The Qualifying Official will evaluate their completion.

d. Explain the legal authorization of carrier selection for the government (41 CFR 109-40).

The following is taken from 41 CFR 109-40.103-1.

Preferential treatment, normally, shall not be accorded to any mode of transportation (motor, rail, air, water) or to any particular carrier when arranging for domestic transportation services. However, where, for valid reasons, a particular mode of transportation or a particular carrier within that mode must be used to meet specific program requirements and/or limitations, only that mode or carrier shall be considered. Examples of valid reasons for considering only a particular mode or carrier are

- where only a certain mode of transportation or individual carrier is able to provide the needed service or is able to meet the required delivery date; and
- where the consignee's installation and related facilities preclude or are not conducive to service by all modes of transportation.

The following factors are considered in determining whether a carrier or mode of transportation can meet DOE's transportation service requirements for each individual shipment:

- Availability and suitability of carrier equipment
- Carrier terminal facilities at origin and destination
- Pickup and delivery service, if required
- Availability of required or accessorial and special services, if needed
- Estimated time in transit
- Record of past performance of the carrier
- Availability and suitability of transit privileges

U.S.-Flag Ocean Carriers. Arrangements for international ocean transportation services shall be made in accordance with the provisions of section 901(b) of the Merchant Marine Act of 1936, as amended concerning the use of privately owned U.S.-flag vessels.

U.S.-Flag Certificated Air Carriers. Arrangements for international air transportation services shall be made in accordance with the provisions of section 5(a) of the International Air Transportation Fair Competition Practices Act of 1974 (PL 93-623), which requires the use of U.S.-flag certificated air carriers for international travel of persons or property to the extent that services by these carriers is available.

e. Review and evaluate DOT carrier safety records.

This is a performance-based KSA. The Qualifying Official will evaluate its completion.

20. Transportation and traffic management personnel shall demonstrate a working-level knowledge of handling freight claims.

a. File overage, loss, or damage claims when appropriate and promote claims prevention in accordance with DOE negotiated tariffs.

b. File undercharge/overcharge claims/correct carrier billings prior to offset payment.

Elements 'a' and 'b' are performance-based KSAs. The Qualifying Official will evaluate their completion.

21. Transportation and traffic management personnel shall demonstrate a working-level knowledge of carrier operations in the modes of motor carrier, air, rail, and vessel transport.

a. Determine if a shipment meets air transport requirements per 49 CFR 175.

b. Determine if a shipment meets vessel transport requirements per 49 CFR 176.

c. Determine if a shipment meets rail transport requirements per 49 CFR 174.

d. Determine if a shipment meets motor transport requirements per 49 CFR Parts 177 and 350-399.

Elements 'a' through 'd' are performance-based KSAs. The Qualifying Official will evaluate their completion.

22. Transportation and traffic management personnel shall demonstrate the ability to coordinate with procurement on purchasing strategies.

a. Develop transportation cost and logistics analysis to purchasing for bid evaluation.

b. Assist in the negotiation of freight rates, transportation contracts, and transportation services.

c. Coordinate acquisition of transportation services.

Elements 'a' through 'c' are performance-based KSAs. The Qualifying Official will evaluate their completion.

d. Discuss policies and procedures for transportation and traffic management considerations in the acquisition of supplies and services per 48 CFR 47.

The following is taken from 48 CFR 47.101.

The contracting officer shall obtain traffic management advice and assistance in the consideration of transportation factors required for

- solicitations and awards;
- contract administration, modification, and termination; and
- transportation of property by the government to and from contractors' plants.

The preferred method of transporting supplies for the government is by commercial carriers. However, government-owned, leased, or chartered vehicles, aircraft, and vessels may be used if they are available and not fully utilized; their use will result in substantial economies, and their use is in accordance with all applicable statutes, agency policies and regulations.

If the three circumstances listed above apply, government vehicles may be used for purposes such as local transportation of supplies between government installations; pickup and delivery services that commercial carriers do not perform in connection with line-haul

transportation; transportation of supplies to meet emergencies; and accomplishment of program objectives that cannot be attained by using commercial carriers.

Agencies shall not accord preferential treatment to any mode of transportation or to any particular carrier either in awarding or administering contracts for the acquisition of supplies or in awarding contracts for the acquisition of transportation.

Agencies shall place with small business concerns purchases and contracts for transportation and transportation-related services as prescribed in part 19.

Agencies shall comply with the Fly America Act (49 U.S.C. 40118), the Cargo Preference Act (10 U.S.C. 2631), and related statutes Air Transportation by U.S.-Flag Carriers, section 47.4, and Ocean Transportation by U.S.-Flag Vessels, section 47.4.

23. Transportation and traffic management personnel shall demonstrate a working-level knowledge of 31 CFR and 41 CFR and related documents associated with tenders and contracts.

a. Identify unallowable costs associated with contracts and transportation shipments.

The following is taken from 48 CFR 31.201-2.

Determining Allowability

A cost is allowable only when the cost complies with all of the following requirements:

- Reasonableness
- Allocability
- Standards promulgated by the cost accounting standards (CAS) board, if applicable, otherwise, generally accepted accounting principles and practices appropriate to the circumstances
- Terms of the contract
- Any limitations set forth in the following paragraphs

Certain cost principles incorporate the measurement, assignment, and allocability rules of selected CAS and limit the allowability of costs to the amounts determined using the criteria in those selected standards. Only those CAS or portions of standards specifically made applicable by the cost principles in subpart 31.2 are mandatory unless the contract is CAS-covered. Business units that are not otherwise subject to these standards under a CAS clause are subject to the selected standards only for the purpose of determining allowability of costs on government contracts. Including the selected standards in the cost principles does not subject the business unit to any other CAS rules and regulations. The applicability of the CAS rules and regulations is determined by the CAS clause, if any, in the contract and the requirements of the standards themselves.

When contractor accounting practices are inconsistent with regulations, costs resulting from such inconsistent practices in excess of the amount that would have resulted from using practices consistent with this subpart are unallowable.

A contractor is responsible for accounting for costs appropriately and for maintaining records, including supporting documentation, adequate to demonstrate that costs claimed have been incurred, are allocable to the contract, and comply with applicable cost principles in subpart 31.2 and agency supplements. The contracting officer may disallow all or part of a claimed cost that is inadequately supported.

Determining Reasonableness

The following is taken from 48 CFR 31.201-3.

A cost is reasonable if, in its nature and amount, it does not exceed that which would be incurred by a prudent person in the conduct of competitive business. Reasonableness of specific costs must be examined with particular care in connection with firms or their separate divisions that may not be subject to effective competitive restraints. No presumption of reasonableness shall be attached to the incurrence of costs by a contractor. If an initial review of the facts results in a challenge of a specific cost by the contracting officer or the contracting officer's representative, the burden of proof shall be upon the contractor to establish that such cost is reasonable.

What is reasonable depends upon a variety of considerations and circumstances, including

- whether it is the type of cost generally recognized as ordinary and necessary for the conduct of the contractor's business or the contract performance;
- generally accepted sound business practices, arm's-length bargaining, and federal and state laws and regulations;
- the contractor's responsibilities to the government, other customers, the owners of the business, employees, and the public at large; and
- any significant deviations from the contractor's established practices.

Determining Allocability

The following is taken from 48 CFR 31.201-4.

A cost is allocable if it is assignable or chargeable to one or more cost objectives on the basis of relative benefits received or other equitable relationship. Subject to the foregoing, a cost is allocable to a government contract if it

- is incurred specifically for the contract;
- benefits both the contract and other work, and can be distributed to them in reasonable proportion to the benefits received; or
- is necessary to the overall operation of the business, although a direct relationship to any particular cost objective cannot be shown.

b. Determine the contractual qualifications for selecting carriers to perform transportation and traffic management movements.

The following is taken from 41 CFR 109-40.103-1.

Preferential treatment, normally, shall not be accorded to any mode of transportation (motor, rail, air, water) or to any particular carrier when arranging for domestic transportation services. However where, for valid reasons, a particular mode of transportation or a particular carrier within that mode must be used to meet specific program requirements and/or

limitations, only that mode or carrier shall be considered. Examples of valid reasons for considering only a particular mode or carrier are

- where only a certain mode of transportation or individual carrier is able to provide the needed service or is able to meet the required delivery date; and
- where the consignee's installation and related facilities preclude or are not conducive to service by all modes of transportation.

The following factors are considered in determining whether a carrier or mode of transportation can meet DOE's transportation service requirements for each individual shipment:

- Availability and suitability of carrier equipment
- Carrier terminal facilities at origin and destination
- Pickup and delivery service, if required
- Availability of required or accessorial and special services, if needed
- Estimated time in transit
- Record of past performance of the carrier
- Availability and suitability of transit privileges

c. Assist in negotiating tenders and contracts appropriate for transportation and traffic management services.

KSA 'c' is a performance-based KSAs. The Qualifying Official will evaluate its completion.

24. Transportation and traffic management personnel shall demonstrate a working-level knowledge of the following DOE Directives and other documents:

- **DOE O 460.1B, Packaging and Transportation Safety**
- **DOE O 460.2A, Departmental Materials Transportation and Packaging Management**
- **DOE M 460.2-1, Radioactive Materials Transportation Practices Manual**
- **DOE O 461.1A, Packaging and Transfer or Transportation of Materials of National Security Interest**
- **DOE O 470.1, Safeguards and Security Program**
- **DOE O 414.1C, Quality Assurance**
- **DOE G 1324.5B, Implementation Guide for 36 CFR Chapter XII - Subchapter B**
- **DOE Order 5632.1C, Protection and Control of Safeguards and Security Interests**
- **DOE O 151.1C, Comprehensive Emergency Management System**
- **DOE O 471.2A, Information Security Program**

[Note: The following DOE Directives have been cancelled: DOE O 470.1, DOE O 471.2A, and DOE Order 5632.1C. DOE M 460.2-1 has been superseded by O 460.2-1A.]

a. Explain how the above documents apply to the transportation and traffic management operations within DOE, its sub-contractors, and facilities.

DOE O 460.1B, Packaging and Transportation Safety

The objective of DOE O 460.1B is to establish safety requirements for the proper packaging and transportation of DOE/NNSA offsite shipments and onsite transfers of hazardous materials and for modal transport. (Offsite is any area within or outside a DOE site to which

the public has free and uncontrolled access; onsite is any area within the boundaries of a DOE site or facility to which access is controlled.)

DOE O 460.2A, Departmental Materials Transportation and Packaging Management

The objectives of DOE O 460.2A are to establish requirements and responsibilities for management of DOE/NNSA materials transportation and packaging, and to ensure the safe, secure, efficient packaging and transportation of hazardous and non-hazardous materials.

DOE M 460.2-1A, Radioactive Materials Transportation Practices Manual

DOE M 460.2-1A establishes a set of standard transportation practices for U.S. DOE programs to use in planning and executing offsite shipments of radioactive materials, including radioactive waste.

DOE O 461.1A, Packaging and Transfer or Transportation of Materials of National Security Interest

The objective of DOE O 461.1A is to establish requirements and responsibilities for offsite shipments of naval nuclear fuel elements, category I and category II SNM, nuclear explosives, nuclear components, special assemblies, and other materials of national security interest; onsite transfers of naval nuclear fuel elements, category I and II SNM, nuclear components, special assemblies, and other materials of national security interest; and certification of packages for category I and II SNM, nuclear components, and other materials of national security interest.

DOE O 414.1C, Quality Assurance

DOE O 414.1C provides the criteria that are used in contractor testing facilities that are responsible for conducting tests on packages.

DOE G 1324.5B, Implementation Guide for 36 CFR Chapter XII-Subchapter B

The requirement for transportation records creation and maintenance, adequate documentation, and proper records disposition of certain DOE records can be found in DOE G 1324.5B.

DOE O 151.1C, Comprehensive Emergency Management System

DOE/NNSA sites/facilities, including DOE/NNSA transportation activities, DOE/NNSA offices in the field, and DOE HQ offices, must develop and participate in an integrated and comprehensive emergency management system.

25. Transportation and traffic management personnel shall demonstrate a working-level knowledge of the following federal and international regulations associated with hazardous material transportation:

- **49 CFR 100–185**
- **40 CFR 260, 261, 262, 263, 266, 279, 302**
- **10 CFR 71 and 73**
- **IAEA, International Atomic Energy Agency, "Regulations for the Safe Transport of Radioactive Materials"**
- **ICAO, International Civil Aviation Organization, "Technical Instructions for the Safe Transport of Dangerous Goods by Air"**

- **IATA (industry requirement), International Air Transport Association, "Dangerous Goods Regulations"**
- **IMDG Code, "International Maritime Dangerous Goods"**
- **Superfund Amendments and Reauthorization Act (SARA), Title III**
- **40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPS)**

a. Determine the hazardous classification of the material being shipped.

The following is taken from the DOT, Federal Highway Administration, *Traffic Incident Management in Hazardous Materials Spills in Incident Clearance*.

The DOT has broad authority to regulate hazardous materials that are in transport, including the discretion to decide which materials shall be classified as hazardous. These materials are placed in one of nine categories, based on their chemical and physical properties. The hazard classes may be further subdivided into divisions based on their characteristics. Additionally, some materials may be reclassified as combustible materials or ORM-D because of limited hazard during transport. These properties and characteristics are crucial in understanding the dynamics of a spill during a traffic incident. Therefore, it is important for response personnel to understand the hazard classes, their divisions, and reclassified materials:

- Class 1: Explosives
  - Division 1.1: Explosives with a mass explosion hazard
  - Division 1.2: Explosives with a projection hazard
  - Division 1.3: Explosives with predominantly a fire hazard
  - Division 1.4: Explosives with no significant blast hazard
  - Division 1.5: Very insensitive explosives
  - Division 1.6: Extremely insensitive explosive articles
- Class 2: Gases
  - Division 2.1: Flammable gases
  - Division 2.2: Nonflammable gases
  - Division 2.3: Poison gas
  - Division 2.4: Corrosive gases
- Class 3: Flammable liquids
  - Division 3.1: Flashpoint below -18ºC (0ºF)
  - Division 3.2: Flashpoint -18ºC and above, but less than 23ºC (73ºF)
  - Division 3.3: Flashpoint 23ºC and up to 61ºC (141ºF)
- Class 4: Flammable solids; spontaneously combustible materials; and materials that are dangerous when wet
  - Division 4.1: Flammable solids
  - Division 4.2: Spontaneously combustible materials
  - Division 4.3: Materials that are dangerous when wet
- Class 5: Oxidizers and organic peroxides
  - Division 5.1: Oxidizers
  - Division 5.2: Organic peroxides

- Class 6: Poisons and etiologic materials
  - Division 6.1: Poisonous materials
  - Division 6.2: Etiologic (infectious) materials

- Class 7: Radioactive Materials
  - Any material that spontaneously gives off ionizing radiation where the activity concentration or total activity exceeds the values specified for certain radionuclides in the high medium range.
- Class 8: Corrosives
  - A material, liquid, or solid, that causes visible destruction or irreversible alteration to human skin; or a liquid that has a severe corrosion rate on steel or aluminum.

- Class 9: Miscellaneous
  - A material which presents a hazard during transport, but which is not included in any other hazard class (such as a hazardous substance or a hazardous waste).

- ORM-D
  - A material which, although otherwise subjected to regulations, presents a limited hazard during transportation due to its form, quantity, and packaging.

b. Determine the proper packaging for the material being shipped.

The following is taken from DOE, Office of Health, Safety, and Security, *Hazardous Materials Transportation Act (HMTA)*.

Hazardous materials' packaging regulations were formulated to meet two criteria:
- Packaging of hazardous material must be adequate in strength and quality to withstand normal transportation; and
- Packaging used must be compatible with the hazardous material and adequate considering the level of risk presented by the material.

Upon determining the proper shipping name (i.e., the name of the hazardous material shown in hazardous materials table located in 49 CFR 172.101, "Purpose and Use of Hazardous Materials Table," specify the correct packaging. Packaging authorized for the transportation of hazardous materials is either manufactured to DOT standards or does not meet DOT standards, but is approved for shipments of less hazardous materials and limited quantities. The shipper is responsible for determining the shipping name. The shipper must also ascertain the hazard class, UN identification number, labels, packaging requirements, and quantity limitations.

The HMTA is enforced by use of compliance orders, civil penalties, and injunctive relief. The HMTA preempts state and local governmental requirements that are inconsistent with the statute, unless that requirement affords an equal or greater level of protection to the public than the HMTA requirement.

Requirements for the transportation of radioactive materials by carriers and shippers are found in 49 CFR 173, "Shippers—General Requirements for Shipments and Packagings." Packaging and transportation of radioactive materials are covered in 10 CFR 71, "Packaging

and Transportation of Radioactive Material." 49 CFR 173.412, "Additional Design Requirements for Type A Packages," sets forth additional design requirements for type A packages, which do not require competent authority approval. These requirements include seals, containment systems, material compatibility, and testing.

Several agencies have overlapping authorities for regulating shipments of radioactive materials. The DOT regulates the shipment of hazardous materials, including radioactive materials. The NRC regulates commercial activities of nuclear power plants. The DOE ships commercial radioactive waste for storage and defense nuclear waste and weapons for storage or use.

The DOE and the EPA share responsibility for transportation of hazardous wastes or radioactive and hazardous waste mixtures generated at facilities operated by DOE under the authority of the AEA. The DOE agreed to comply with RCRA requirements for hazardous waste transporters that require transporters to obtain an EPA identification number for the waste, comply with the manifest system, and deal with hazardous waste discharges. These regulations incorporate and require compliance with DOT provisions for labeling, marking, placarding, proper container use, and discharge reporting.

c. Determine the appropriate entries that are required for the shipping paper/waste manifest.

The following is taken from the DOT, Bilingual Hazardous Materials General Awareness Training, Volume II, *Shipping Papers*.

Whenever a hazardous material is offered for transport, it must be accompanied by proper shipping papers, which fully identify the hazards involved.

The description must fulfill the following requirements:

- If a hazardous material and a non-hazardous material are described on the same shipping papers, the hazardous material must be
  - named first,
  - shown in contrasting (highlighted) color on all copies of the form,
  - identified with an "X" in the column marked "HM."
- The shipping description must furnish
  - proper shipping name;
  - hazard class or division (this from column 4 of the Hazardous Materials Table);
  - identification number (this from column 5 of the Hazardous Materials Table);
  - packing group (this from column 6 of the Hazardous Materials Table);
  - except for empty packages, the total quantity, including unit for measurement, of the hazardous material.
- Entry must be legible and in English.
- Unless specifically authorized or required, the description may not contain codes or abbreviations.
- Additional information must follow the basic description.
- Must contain the name of the shipper when transported by water.

- If more than one page is required, the first page must indicate multiple pages, (i.e., "page 1 of 3").
- Shipping paper must show an emergency response telephone number.
- Shipping paper must contain shipper's certification. An example of the shipping paper entry is shown in figure 5.

Hazardous Material Shipping Papers								
TO: **Consignee** **Street** **Destination Zip**			**FROM:** **Shipper** **Street** **Origin Zip**					
Route:			Vehicle Number		**US DOT Hazmat Reg.No.**			
No. Shipping Units	HM	Kind of Packages, Description of Articles (IF HAZARDOUS MATERIALS - PROPER SHIPPING NAME)	Hazard Class	I.D. Number	Packing Group	WEIGHT (subject to correction)	Rate	LABELS REQUIRED (or exemption)

Source: DOT, Introduction, *Hazardous Materials Transportation Act*.

Figure 5. Hazardous material shipping papers

The following is taken from 49 CFR 172.101.

The hazardous materials table in 49 CFR 172.101, "Purpose and Use of Hazardous Materials Table," designates the materials listed therein as hazardous materials for the purpose of transportation of those materials. For each listed material, the table indentifies the hazard class or specifies that the material is forbidden in transportation, and gives the proper shipping name or directs the user to the preferred proper shipping name. In addition, the table specifies or references requirements pertaining to labeling, packaging, and quantity limits aboard aircraft, and stowage of hazardous materials aboard vessels.

d. Determine the appropriate markings required for the package being shipped.

The following is taken from 49 CFR 172.304.

The markings must be durable, in English, and printed on or affixed to the surface of a package or on a label, tag, or sign.

They must be displayed on a background of sharply contrasting color.

They must be unobscured by labels or attachments.

The markings must be located away from any other marking (such as advertising) that could substantially reduce their effectiveness.

The following is taken from the DOT, Introduction, *Hazardous Materials Transportation Act (HTMA)*.

Each person offering a hazardous material for transport must ensure the package, container, or vehicle carries the markings appropriate for the corresponding hazard. The following are general requirements.

Markings should include the proper shipping name and the proper identification number (preceded by UN or North American (NA) as appropriate). The identification number, when required, may be displayed separately from the warning placard. If so, it must consist of black writing on an orange background. If the notification number is displayed on the warning placard itself, it shall be black writing on a white background and will replace the warning wording on the placard, but not the graphic. The identification number must be affixed to each side and each end if the packaging has a capacity of 1,000 gals or more. It must be affixed on opposite ends if the packaging capacity is less than 1,000 gals.

In addition to the above general requirements, some materials require that specific markings be displayed on packages and on vehicles when offered for transport. The guidelines for these materials are as follows:

- For radioactive materials, each package must have its weight clearly marked on the outside of the package. The packaging type (type A or type B) must be clearly marked on the outside of the package.
- Liquid hazardous materials in non-bulk packaging must be packaged with the closures upward and be legibly marked with package orientation markings pointing in the correct upright direction. Markings that depict arrows for purposes other than to indicate the upward position may not be used on hazardous liquid materials. This requirement does not apply to packaging where the interior package is a metal cylinder.

Bulk packages that contain materials that are poisonous if inhaled must be marked with the warning "Inhalation Hazard" on two opposing sides. Non-bulk packages must be marked with the word "POISON" within 6 inches of the closure.

Non-bulk packages of materials classified as ORM-D must be marked on at least one side or end with the ORM-D designation directly below the proper shipping name of the material. This marking is certification by the person offering the material for transport that the description, classification, packaging, marking, and labeling are all correct and appropriate for the material.

e. Determine the appropriate labels required for the package being shipped.

The following is taken from 49 CFR 172.402.

Each package containing a hazardous material

- shall be labeled with primary and subsidiary hazard labels as specified in column 6 of the 49 CFR 172.101 table (unless excepted in 49 CFR 172.402, "Additional Labeling Requirements," paragraph (a)(2)); and

- for other than class 1 or class 2 materials (for subsidiary labeling requirements for class 1 or class 2 materials see 49 CFR 172.402(e), (f), and (g)), if not already labeled under 49 CFR 172.402(a)(1), shall be labeled with subsidiary hazard labels according to 49 CFR 172.402(2) table, Subsidiary Hazard Labels.

The appropriate hazard class or division number must be displayed in the lower corner of a primary hazard label and a subsidiary hazard label. A subsidiary label meeting the specifications of 49 CFR 172.402(b) which were in effect on September 30, 2001, such as a label without the hazard class or division number displayed in the lower corner of the label, may continue to be used as a subsidiary label in domestic transportation by rail or highway, provided the color tolerances are maintained and are according to the display requirements in 49 CFR 172.402(b).

Each person who offers for transportation or transport by aircraft a package containing a hazardous material which is authorized on cargo aircraft only shall label the package with a Cargo Aircraft Only label specified in 49 CFR 172.448, "CARGO AIRCRAFT ONLY Label."

Except as otherwise provided in this paragraph, each containing class 7 material that also meets the definition of one or more additional hazard classes must be labeled as a class 7 material as required by 49 CFR 172.403 and for each additional hazard:

- For a package containing a class 7 material that also meets the definition of one or more additional hazard classes, whether or not the material satisfies 49 CFR 173.4(a)(1)(iv), a subsidiary label is not required on the package if the material conforms to the remaining criteria in 49 CFR 173.4, "Small Quantity Exceptions."
- Each package or overpack containing fissile material, other than fissile-excepted material must bear two Fissile labels, affixed to opposite sides of the package or overpack, which conforms to the figure shown in 49 CFR 172.441, "FISSILE Label;" such labels, where applicable, must be affixed adjacent to the labels for radioactive materials.

For class I (explosive materials), in addition to the label specified in column 6 of the 49 CFR 172.101 table, each package of class 1 material that also meets the definition for

- division 6.1, packing group I or II, shall be labeled Poison or Poison Inhalation Hazard, as appropriate; and
- class 7 shall be labeled according to 49 CFR 172.403.

For division 2.2 materials, in addition to the label specified in column 6 of the 49 CFR 172.101 table, each package of division 2.2 material that also meets the definition for an oxidizing gas must be labeled Oxidizer.

For division 2.3 materials, in addition to the label specified in column 6 of the 49 CFR 172.101 table, each package of division 2.3 material that also meets the definition for

- division 2.1 must be labeled Flammable Gas;
- division 5.1 must be labeled Oxidizer; and
- class 8 must be labeled Corrosive.

f. Determine the appropriate placards for the conveyance.

The following is taken from DOT, Introduction, *Hazardous Materials Transportation Act*.

Placards are used to represent the hazard classes of materials contained within freight containers, motor vehicles, or a train car. Labels communicate the same hazards for smaller containers and packages offered for transport. Examples of the placards and labels used for the various hazard classes follow.

This placard or label is used to designate explosive materials, specifically class 1.1, 1.2, and 1.3 explosives. Explosives that belong to classes 1.4, 1.5, and 1.6 will have that specified, with the class designation replacing the exploding ball.

This placard is required when transporting any quantity of a class 1.1, 1.2, or 1.3 explosive, or over 1,001 lb of a class 1.4 or 1.5 explosive.

These placards and labels are used to designate compressed gases. Given the diverse chemical properties of compressed gases, this class is subdivided into flammable gases (class 2.1), nonflammable gases or oxygen (class 2.2), and poisonous gases (class 2.3).

This placard is required when transporting over 1,001 lb of class 2.1 or 2.2, or when transporting **ANY** quantity of poisonous (class 2.3) gas.

This is the label or placard used to designate flammable liquids. Certain common flammable liquids have their own placards, where the name of the material (such as gasoline and fuel oil) replaces the word "FLAMMABLE." Also, materials that fit the definition of a combustible material have the word "COMBUSTIBLE" replacing the word "FLAMMABLE."

This placard is required when transporting over 1,001 lbs of flammable materials.

The placards and labels shown below are used to indicate the cargo contains flammable solids (class 4.1), materials that are pyrophoric, and those that react adversely when exposed to water (class 4.3).

These placards are required when transporting over 1,001 lbs of class 4.1 or 4.2 materials, or when transporting **ANY** quantity of a water-reactive material (class 4.3).

This placard or label is used to designate a cargo that contains oxidizing materials (class 5.1). In addition, this class contains materials that are classified as organic peroxides (class 5.2), and in that case the label would read "ORGANIC PEROXIDES" rather than "OXIDIZER."

Placards are required when transporting over 1,001 lbs of oxidizers or organic peroxides.

This class contains poisonous liquids that are designated as inhalation hazards. If the material is toxic, but not an inhalation hazard it is placed in class 6.1. Materials in these classes may **NOT** be transported in the same cargo as foodstuffs, feed, or any other edible substances intended for humans or animals. In addition to the POISON label, packages of 110 gallon capacity or less, and that are recognized as "inhalation hazards," must also be marked "INHALATION HAZARD."

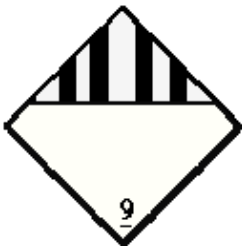
Placarding is required when transporting **ANY** quantity of class 6 material, and when transporting over 1,001 lbs of a class 6.1 material.

This label is required on all radioactive materials and equipment. Packages containing radioactive species must be clearly labeled with two labels on opposite sides of the package. This class is divided into three divisions — I, II, and III.

Placarding is required on **ANY** quantity of radioactive material rated as III; it is not required on materials rated as I or II.

This placard/label is used to designate any corrosive liquid.

Placarding is required whenever the quantity exceeds 1,001 lbs of a corrosive liquid.



Class 9 materials are those that have not been placed in a hazard class, but may still pose some degree of danger in transport.

Placarding is not required for materials that are not classified. However, a material that presents a hazard during transport and weighs more than 1,001 lbs may be placarded.

This applies to placarding only and is required when 1,001 lbs or more of material is transported, and it is composed of two or more hazard categories. It will replace the specific placards for the individual classes. An exception is when one single class in a multiple class transport exceeds 5,000 lbs, in which case the placard for the large load class must be displayed.

g. Determine the appropriate emergency response information that is required.

The following is taken from 29 CFR 1910.120.

The following required information to the extent available shall be obtained by the employer prior to allowing employees to enter a site:

- Location and approximate size of the site
- Description of the response activity and/or the job task to be performed
- Duration of the planned employee activity
- Site topography and accessibility by air and roads
- Safety and health hazards expected at the site
- Pathways for hazardous substance dispersion
- Present status and capabilities of emergency response teams that would provide assistance to onsite employees at 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," paragraph (c)(4)(viii)
- Hazardous substances and health hazards involved or expected at the site and their chemical and physical properties

h. Determine the appropriate training requirements for personnel involved in the transportation activity.

The following is taken from DOE G 460.2-1.

DOT hazardous materials regulations state that a hazardous materials employee must be trained. Contractors should be knowledgeable, and must be trained, in order to comply with applicable requirements. DOE sponsors training courses to provide a uniform and consistent approach to complying with regulations governing transportation and packaging. Training schedules may be obtained from FaxBack, the Internet, or EM-76. This training assists DOE and contractor employees in meeting DOE policy and ensures compliance with DOT requirements that shippers and carriers of hazardous materials train personnel commensurate with their responsibilities.

i. Determine pre-notification and physical security requirements for spent nuclear fuel and high-level waste.

The following is taken from DOE M 460.2-1A

DOE or its contractors will provide advance notification of non-classified shipments of SNF and high-level waste (HLW) according to applicable requirements as shown in the following table. DOE will strive to ensure that affected jurisdictions are provided with general knowledge several weeks in advance of upcoming shipments. The Nuclear Waste Policy Act of 1982, section 180(b), requires the Offices of Environmental Management; Nuclear Energy, Science and Technology; and Civilian Radioactive Waste Management to abide by NRC regulations regarding advance notification of state and local governments prior to transportation of SNF or HLW to a NWPA-authorized facility.

The notification requirements are described in table 9.

Table 9. Notification requirements

Requirements	Type of Shipment		
	Non-Classified DOE SNF And HLW not subject to NRC regulation	**SNF subject to NRC regulation, in excess of 100g net weight and over 100 rems per hour at 3 feet**	**SNF subject to NRC regulation, less than 100g net weight or under 100 rems per hour at 3 feet and HLW subject to NRC regulation**
Sources	DOE O 460.2	10 CFR 73.37	10 CFR 71.97
Who is notified	Governors or designees and designated tribal points of contact	Governors or designees	Governors or designees
Time of notification	Postmarked at least 7 days before shipment of mailed, 4 days by messenger	Postmarked at least 7 days before shipment if mailed, 4 days by messenger	Postmarked at least 7 days prior to 7 day period when shipment departure is estimated, 4 days by messenger
Notification of schedule change	By telephone if greater than 6 hours	By telephone if greater than 6 hours	By telephone if outside of 7-day period
Information to be included in notification	1. name, address, and telephone number of shipper, carrier, and receiver 2. description of shipment 3. a list of routes to be used within the state or through tribal jurisdictions 4. estimated date and time of departure from point of origin 5. estimated date and time of entry into the Governor's state or into tribal lands 6. estimated date and time of departure from Governor's state or tribal jurisdiction (when the destination is not within the state)	1. name, address, and telephone number of shipper, carrier, and receiver 2. description of shipment 3. a list of routes to be used within the state 4. estimated date and time of departure from point of origin 5. estimated date and time of entry into the Governor's state 6. statement on safeguarding schedule information	1. name, address, and telephone number of shipper, carrier, and receiver 2. description of the shipment 3. point of origin and 7-day period when departure is estimated 4. 7-day period during which arrival at state is estimated 5. destination and 7-day period when arrival is estimated 6. point of contact
Safeguard requirements	None	Schedule information for 10 days after shipment per 10 CFR 73.21 (b)(2)(ii)	None

Source: DOE M 460.2-1A

Classified national security shipments that meet safeguards and security requirements, including naval spent fuel shipments, do not provide shipment prenotifications. The Atomic Energy Act of 1954 provides security requirements for the protection of information related to nuclear weapons and SNM shipments. The DOT exemption for national security shipments is stated in 49 CFR 173.7, "U.S. Government Material," paragraph (b).

j. Determine the appropriate requirements for shipping RCRA and Toxic Substances Control Act (TSCA) waste.

The following is taken from Environment, Safety, and Health Online, *Transportation of Hazardous Wastes—Regulations and Licensed Companies*.

Under the authority of the RCRA, the EPA regulates the transportation of hazardous wastes. The EPA coordinates its transportation ordinances with the requirements of the HMTA and any statutes promulgated by DOT pursuant to HMTA. The EPA has set forth these standards applicable to transporters of hazardous wastes in 40 CFR 263. These EPA standards incorporate and require compliance with the DOT provisions on labeling, marking, placarding, using proper containers, and reporting discharges. The EPA's adoption of these DOT standards ensures consistency among the requirements as well as avoids establishing conflicting rules. The DOT's regulations are documented in 49 CFR 171-180 and they are implemented by the Research and Special Programs Administration within the DOT. In summary, the EPA is directed by RCRA to establish certain standards for transporters of hazardous materials and to coordinate regulatory activities with the DOT.

According to the EPA regulations, a transporter must perform the following tasks:

- Obtain an EPA identification number prior to transporting hazardous waste.
- Comply with the manifest system.
- Maintain the appropriate records for three years.
- Take immediate action in the case of a discharge to protect human health and the environment.
- In the event of a hazardous waste discharge, notify the National Response Center and submit a report to the DOT Office of Hazardous Materials Regulations.
- Clean up any discharges to the environment and take any actions required by the appropriate government officials for mitigating the discharge effects on human health and environment.

States are authorized to administer and enforce their own hazardous waste programs if their regulations are consistent with and at least as stringent as the Federal programs. The EPA would declare a state policy inconsistent with Federal standards if the program unreasonably restricted the free movement of hazardous materials across state lines. The HTMA specifically allows DOT to preempt inconsistent state and local requirements.

Under HMTA, Congress has empowered the DOT to promulgate regulations for the transportation and handling of hazardous wastes and reportable quantities of hazardous substances. These regulations focus on the transportation of hazardous materials by

- carriers by rail, aircraft, and vessel;
- interstate and foreign carriers by motor vehicle; and
- intrastate carriers by motor vehicle so far as the regulations relate to hazardous wastes, hazardous substances, and flammable cryogenic liquids in portable tanks and cargo tanks.

They also deal with the manufacture, fabrication, marking, maintenance, reconditioning, repairing, or testing of packaging or containers which are represented, marked, certified, or sold for use in such transportation.

Additional regulations applicable to the acceptance and transportation of hazardous materials by motor vehicles are documented in the 49 CFR 177, “Carriage by Public Highway.” Among these are that the packages must be secured against movement within the vehicle and that the packages must be braced so as to prevent relative motion between containers. Furthermore, some hazardous materials must not be loaded, transported, or stored together. 49 CFR 177.848, “Segregation of Hazardous Materials,” should be followed when loads of different hazardous materials are mixed. All shipments of hazardous materials must be transported without unnecessary delay. RCRA hazardous waste loads which cannot be delivered within forty-eight (48) hours after arrival at their destination must be promptly disposed of by return to the generator or delivered to an alternate facility at the direction of the generator.

Transporters of hazardous wastes must also adhere to all of the Federal Motor Carrier Safety Regulations which DOT has adopted under the Motor Carrier Safety Act of 1984. The Motor Carrier Safety Act was passed for the purpose of promoting the safe operation of commercial vehicles and protecting the safety of the drivers of those vehicles. It was also implemented to reaffirm the scope of DOT's authority to regulate safety in this area. The Motor Carrier Safety Act is applicable to all commercial motor vehicles, including those which transport hazardous waste.

The Motor Carrier Safety Act specifies more requisites that apply to the transport vehicle and the driver. Among them are concise specifications for vehicle parts and accessories, such as lighting devices, brakes, glazing and windows, fuel systems, tires, and horns. Additional requirements concerning inspection, repair, and maintenance are enumerated. Special driving and parking rules which relate to hazardous materials transportation are also indicated. Standards for drivers identify minimum qualifications, including physical qualifications, background and character profiles, and pertinent examinations. Also included among these rules are testing requirements for alcohol and controlled substances such as marijuana, cocaine, opiates, amphetamines, and phencyclidine. Other regulations pertaining to drivers comprise of standards for the driving of vehicles, stopping, fueling, the use of lamps, the reporting of accidents, and the monitoring of a driver's hours of service.

In addition to the regulatory duties of the EPA and DOT, several other agencies conduct non-regulatory functions that deal with the transportation of hazardous materials. These non-regulatory tasks are intended to provide for the safety of the public as well as the environment. The Interstate Commerce Commission investigates interstate carriers to ensure that the services, equipment, and facilities that they furnish will satisfactorily meet all necessary regulations. The Federal Emergency Management Agency supplies the required assistance to state and local governments in response to a hazardous materials emergency. If a discharge of hazardous materials does occur, the National Transportation Safety Board investigates the accident to determine the probable causes.

A crucial first step for transporters of hazardous waste is to properly identify and classify the substances involved. DOT's Hazardous Materials Tables, which are given in 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plan," designate the proper shipping names and descriptions for hazardous materials, their hazard classes, identification numbers, and relevant packaging and labeling provisions. The generator or individual who supplies the substance for transportation is responsible for determining its composition and properties as well as for correctly classifying it.

k. Compare and contrast the terms listed below as applied in the regulations above.

- **Cargo aircraft only**
- **Cargo tank**
- **Competent authority**
- **Detention**
- **Domestic transportation**
- **Drum**
- **Exclusive use**
- **Gross weight or gross mass**
- **Hazard class**
- **Hazardous material**
- **Hazardous substance**
- **Hazardous waste**
- **Hazmat employee**
- **Highway route controlled quantity**
- **Limited quantity**
- **Marine pollutant**
- **Mixture**
- **Packing group**
- **Portable tanker**
- **Preferred route**
- **Primary hazard**
- **Proper shipping name**
- **Reportable quantity**
- **Residue**
- **Shipping paper**
- **State**
- **Technical name**
- **Transport vehicle**

The following definitions are taken from 49 CFR 171.8.

Cargo Aircraft Only

Cargo aircraft only is an aircraft that is used to transport cargo and is not engaged in carrying passengers.

Cargo Tank

Cargo tank is a bulk packaging that is

- A tank intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures;

- permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which, by reason of its size, construction, or attachment to a motor vehicle is loaded, or unloaded without being removed from the motor vehicle;
- not fabricated under a specification for cylinders, intermediate bulk containers, multi-unit tank car tanks, portable tanks, or tank cars.

Competent Authority

Competent authority is a national agency responsible under its national law for the control or regulation of a particular aspect of the transportation of hazardous materials (dangerous goods). The term "appropriate authority," as used in the International Civil Aviation Organization technical instructions, has the same meaning as competent authority.

Detention

Detention is compensation assessed against a shipper for the delayed return of carrier's equipment beyond allowable free time. This is usually equipment picked up by the shipper at the load port for the purpose of stuffing the container for shipment and held at the shipper's plant or warehouse for an excessive period of time. Detention charges may also be assessed against the consignee who fails to return stripped containers to the carriers within allowable free time.

Domestic Transportation

Domestic transportation is transportation between places within the United States other than through a foreign country.

Drum

A drum is a flat-ended or convex-ended cylindrical packaging made of metal, fiberboard, plastic, plywood, or other suitable materials. This definition also includes packagings of other shapes made of metal or plastic (e.g., round taper-necked packagings or pail-shaped packagings) but does not include cylinders, jerricans, wooden barrels, or bulk packagings.

Exclusive Use

Exclusive use is 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 the consignee. The consignor and the carrier must ensure that any loading or unloading is performed by personnel having radiological training and resources appropriate for safe handling of the consignment. The consignor must issue specific instructions in writing, for maintenance of exclusive use shipment controls, and include them with the shipping paper information provided to the carrier by the consignor.

Gross Weight or Gross Mass

Gross weight or gross mass is the weight of a packaging plus the weight of its contents.

Hazard Class

Hazard class is the category of hazard assigned to a hazardous material under the definitional criteria of 49 CFR 173 and the provisions of the 49 CFR 172.101 table. A material may meet the defining criteria for more than one hazard class but is assigned to only one hazard class.

Hazardous Material

Hazardous material is a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous. The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the hazardous materials table, and materials that meet the defining criteria for hazard classes and divisions in 49 CFR 173.

Hazardous Substance

Hazardous substance is a material, including its mixtures and solutions, that

- is listed in appendix A to 49 CFR 172.101;
- is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) listed in appendix A to 49 CFR 172.101; and
- when in a mixture or solution
  - for radionuclides, conforms to paragraph 7 of appendix A to 49 CFR 172.101;
  - for other than radionuclides, is in a concentration by weight which equals or exceeds the concentration corresponding to the RQ of the material, as shown in table 10.

Table 10. Concentrations corresponding to the RQ of hazardous substance

RQ pounds (kilograms)	Concentration by Weight	
	Percent	PPM
5,000 (2,270)	10	100,000
1,000 (454)	2	20,000
100 (45.40	0.2	2,000
10 (4.54)	0 02	200
1 (0.454)	0.002	20

Source: 49 CFR 171.8

The term "hazardous substance" does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance in 49 CFR 172.101, appendix A, "Office of Hazardous Materials Transportation Color Tolerance Charts and Tables," and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas).

Hazardous Waste

Hazardous waste is any material that is subject to the hazardous waste manifest requirements of the EPA specified in 40 CFR 262, "Standards Applicable to Generators of Hazardous Waste."

HAZMAT Employee

HAZMAT employee is a person who is employed by a HAZMAT employer and who in the course of employment directly affects hazardous materials transportation safety. This term includes an owner-operator of a motor vehicle which transports hazardous materials in commerce. This term includes an individual, including a self-employed individual, employed by a HAZMAT employer who, during the course of employment

- loads, unloads, or handles hazardous materials;
- manufactures, tests, reconditions, repairs, modifies, marks, or otherwise represents containers, drums, or packagings as qualified for use in the transportation of hazardous materials;
- prepares hazardous materials for transportation;
- is responsible for safety of transporting hazardous materials; or
- operates a vehicle used to transport hazardous materials.

Highway Route Controlled Quantity

If the amount is greater than 3,000 times the special form (A1) or normal form (A2) value (depending on the form) but less than 27,000 curies, then the material is a highway route controlled quantity, which requires a type B package, and the carrier must have special training. State officials must be notified if the material is radioactive waste.

A1 radionuclides are usually encapsulated sources which would only pose an external radiation hazard, not a contamination hazard, if the package was ruptured.

A2 radionuclides are usually not securely encapsulated and could yield significant contamination if the package was ruptured. These materials could pose an internal hazard to people at the scene of an accident. Normal form materials are typically liquids and powders.

Limited Quantity

Limited quantity, when specified as such in a section applicable to a particular material, is the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.

Marine Pollutant

Marine pollutant is a material that is listed in 49 CFR 172.101, appendix B, “Trefoil Symbol,” and, when in a solution or mixture of one or more marine pollutants, is packaged in a concentration that equals or exceeds

- 10 percent by weight of the solution or mixture for materials listed in the appendix; or
- 1 percent by weight of the solution or mixture for materials that are identified as severe marine pollutants in the appendix.

Mixture

Mixture is a material composed of more than one chemical compound or element.

Packing Group

Packing group is a grouping according to the degree of danger presented by hazardous materials. Packing group I indicates great danger; packing group II, medium danger; packing group III, minor danger.

Portable Tanker

Portable tanker is a bulk packaging (except a cylinder having a water capacity of 1,000 lbs or less) designed primarily to be loaded onto, or on, or temporarily attached to a transport vehicle or ship and equipped with skids, mountings, or accessories to facilitate handling of the tank by mechanical means. It does not include a cargo tank, tank car, multi-unit tank car tank, or trailer carrying 3AX, 3AAX, or 3T cylinders.

Preferred Route

Preferred route or preferred highway is a highway for shipment of highway route controlled quantities of radioactive materials so designated by a state routing agency, and any interstate system highway for which an alternative highway has not been designated by such state agency as provided by 49 CFR 397.103, "Requirements for State Routing Designations."

Primary Hazard

Primary hazard is the hazard class of a material as assigned in the 49 CFR 172.101 table.

Proper Shipping Name

Proper shipping name is the name of the hazardous material shown in roman print (not italics) in 49 CFR 172.101.

Reportable Quantity

Reportable quantity is the quantity specified in column 2 of the appendix to 49 CFR 172.101 for any material identified in column 1 of the appendix.

Residue

Residue is the hazardous material remaining in a packaging, including a tank car, after its contents have been unloaded to the maximum extent practicable and before the packaging is either refilled or cleaned of hazardous material and purged to remove any hazardous vapors.

Shipping Paper

Shipping paper is a shipping order, bill of lading, manifest, or other shipping document serving a similar purpose and containing the information required by 49 CFR 172.202, "Description of Hazardous Material on Shipping Papers," 49 CFR 172.203, "Additional Description Requirements," and 49 CFR 172.204, "Shipper's Certification."

State

State is a state of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Virgin Islands, American Samoa, Guam, or any other territory or possession of the United States designated by the Secretary.

Technical Name

Technical name means a recognized chemical name or microbiological name currently used in scientific and technical handbooks, journals, and texts. Generic descriptions are authorized for use as technical names provided they readily identify the general chemical group, or microbiological group. Examples of acceptable generic chemical descriptions are organic phosphate compounds, petroleum aliphatic hydrocarbons, and tertiary amines. For

proficiency testing only, generic microbiological descriptions such as bacteria, mycobacteria, fungus, and viral samples may be used. Except for names that appear in 49 CFR 172, subpart B, "Table of Hazardous Materials and Special Provisions," trade names may not be used as technical names.

Transport Vehicle

Transport vehicle is a cargo-carrying vehicle such as an automobile, van, tractor, truck, semitrailer, tank car, or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.

I. Explain the relationship between IAEA regulations and DOT regulations.

The following is taken from the DOT*, Pipeline and Hazardous Materials Safety Administration, Docket No. PHMSA-07-28590 (Notice No. 07-6)*.

The International Atomic Energy Agency (IAEA) established and maintains an international standard, TS-R-1, *Regulations for the Safe Transport of Radioactive Material*, to promote the safe and secure transportation of radioactive material. The IAEA periodically revises its regulation for the safe transport of radioactive material to reflect new information and accumulated experience.

The DOT is the U.S. competent authority before the IAEA for radioactive material transportation matters. The NRC provides technical support to the DOT in this regard, particularly with regard to type B and fissile transportation packages.

The IAEA recently initiated the review cycle for a potential 2011 edition of its regulations. To ensure opportunity for public participation in the international regulatory development process, the DOT and the NRC are soliciting comments and information concerning issues or problems with the IAEA regulations.

The focus of this solicitation is to identify issues or problems with the 2005 edition of TS-R-1. While it is helpful to identify potential changes or solutions to resolve the identified issues or problems, you need not provide a proposed change to accompany each identified issue or problem. This information will assist the DOT and the NRC to consider the full range of views as the agencies develop the proposed issues the U.S. will submit to the IAEA.

26. Transportation and traffic management personnel shall demonstrate working-level knowledge of the transportation of radioactive material as defined in 49 CFR 173.400 and 10 CFR 71 & 73.

a. Define the following terms and how they apply to radioactive shipments:

- **Empty**
- **Excepted quantity**
- **Fissile**
- **Fissile excepted**
- **Highway route controlled quantity**
- **Industrial packaging**
- **Limited quantity**
- **Low specific activity**

- **Normal form**
- **Radioactive instruments and articles**
- **Radioactive material**
- **Special form**
- **Surface contaminated object**
- **Transportation index**
- **Type A package**
- **Type B package**

Empty

The following is taken from 49 CFR 173.29.

Empty means a package that only contains residue from hazardous material.

Excepted Quantity

The following is taken from the University of California, Berkeley, Excepted Quantities.

Table 11 lists the chemicals that can be shipped under the laws for excepted quantities.

Table 11. Excepted quantities

Class/ Division	Description	Criteria for excepted quantities*	Examples
3	Flammable liquids	IATA – all Packing Groups DOT – Packing Group II or III only (see page 6 for examples)	Ethanol, methanol, isopropyl alcohol, formaldehyde solutions that are flammable, pyridine
5.1	Oxidizing substances	Packing Group II or III; if MSDS says material is an oxidizer, but does not give a Packing Group in 'Section 14-Transportation', contact EH&S for assistance	Atypical for biological shipments (inorganic: bromates, chlorites, hypochlorites, nitrates, nitrites, perchlorates, permanganates, peroxides, and persulphates)
5.2	Organic peroxide	Only when contained in a chemical kit** or first aid kit	Only when contained in a chemical kit** or first aid kit
6.1	Toxic substances (IATA), Poisonous materials (DOT)	Packing Group II or III; if MSDS says material is a toxic or poisonous material, but does not give a Packing Group in 'Section 14-Transportation', contact EH&S for assistance	Some alkaloids, arsenic compounds, inorganic cyanides, lead compounds, mercury compounds, pesticides, sodium azide > 1.5% v/v, toxins
8	Corrosive material	Packing Group II or III, i.e. only those that cause full thickness destruction of intact skin tissue in > 3 minutes but ≤ 4 hours in ≤ 14 days, or are corrosive to stainless steel/aluminum at a rate of > 6.25 mm a year at 55 °C	Bleach (hypochlorite solution), some formaldehyde solutions (> 25% formaldehyde, but non-flammable) Gallium and mercury are not allowed.
9	Miscellaneous hazardous material	Restricted to: 'aviation regulated liquids' (UN3334), toxics for the aquatic environment only, chemical kits**, first aid kits	Isoflurane liquid, sodium azide solutions ≤ 1.5% v/v, formaldehyde solutions < 25% v/v

* Some materials are not allowed on passenger aircraft; do not deviate from this Addendum.
** Per IATA, chemical kits are defined as "boxes, cases, etc., containing small amounts of one or more compatible items of dangerous goods used for analytical or other purposes."

Source: University of California, Berkeley, *Excepted Quantities*

Fissile

The following is taken from 49 CFR 173.403.

Fissile material means plutonium^{239}, plutonium^{241}, uranium^{233}, uranium^{235}, or any combination of these radionuclides. This term does not apply to material containing fissile nuclides, unirradiated natural uranium and unirradiated depleted uranium, or to natural uranium or depleted uranium.

Fissile Excepted

The following is taken from 49 CFR 173.453.

Fissile materials meeting the requirements of at least one of the paragraphs (a) through (f) of this section are excepted from the requirements for fissile materials:

- An individual package containing 2 gs or less of fissile material.
- An individual or bulk packaging containing 15 gs or less of fissile material provided the package has at least 200 gs of solid non-fissile material for every gram of fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass for solid non-fissile material.
- Low concentrations of solid fissile material commingled with solid non-fissile material, provided that
  - there is at least 2000 gs of non-fissile material for every gram of fissile material; and
  - there is no more than 180 gs of fissile material distributed within 360 kg of contiguous non-fissile material. Lead, beryllium, graphite, and hydrogenous material enriched in deuterium may be present in the package but must not be included in determining the required mass of solid non-fissile material.
- Uranium enriched in uranium^{-235} to a maximum of 1 percent by weight, and with total plutonium and uranium^{-233} content of up to 1 percent of the mass of uranium^{-235}, provided that the mass of any beryllium, graphite, and hydrogenous material enriched in deuterium constitutes less than 5 percent of the uranium mass.
- Liquid solutions of uranyl nitrate enriched in uranium^{-235} to a maximum of 2 percent by mass, with a total plutonium and uranium^{-233} content not exceeding 0.002 percent of the mass of uranium, and with a minimum nitrogen to uranium atomic ratio of 2. The material must be contained in at least a DOT type A package.
- Packages containing, individually, a total plutonium mass of not more than 1000 gs, of which not more than 20 percent by mass may consist of plutonium^{-239}, plutonium^{-241}, or any combination of these radionuclides.

Highway Route Controlled Quantity

The following is taken from 49 CFR 173.403.

Highway route controlled quantity means a quantity within a single package that exceeds

- 3,000 times the A1 value of the radionuclides as specified in 49 CFR 173.435, "Table of A&bdi1; and A&bdi2," values for radionuclides. for special form Class 7 (radioactive) material;

- 3,000 times the A2 value of the radionuclides as specified in 49 CFR. 173.435 for normal form Class 7 (radioactive) material; or
- 27,000 curies, whichever is least.

Industrial Packaging

The following is taken from DOE, MERRTT, *Radioactive Material Shipping Packages*.

Industrial packaging is used in certain shipments of low activity material and contaminated objects, which are usually categorized as radioactive waste. Most low-level radioactive waste is shipped in these packages. DOT regulations require that these packages allow no identifiable release of the material to the environment during normal transportation and handling. There are three categories of industrial packages: IP-1, IP-2, and IP-3. The category of package will be marked on the exterior of the package. Requirements for industrial packaging are addressed in 49 CFR 173.411.

Limited Quantity

The following is taken from 49 CFR 171.8.

Limited quantity, when specified as such in a section applicable to a particular material, is the maximum amount of a hazardous material for which there is a specific labeling or packaging exception.

Low Specific Activity (LSA)

The following is taken from NRC, *Low Specific Activity*.

Low specific activity material means radioactive material with limited specific activity which is non-fissile or is excepted under 10 CFR 71.15, "Exemption from Classification as Fissile Material," and which satisfies the descriptions and limits set forth below. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents. The LSA material must be in one of three groups:

- LSA—I:
  - Uranium and thorium ores, concentrates of uranium and thorium ores, and other ores containing naturally occurring radioactive radionuclides that are not intended to be processed for the use of these radionuclides
  - Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures
  - Radioactive material for which the A2 value is unlimited
  - Other radioactive material in which the activity is distributed throughout and the estimated average specific activity does not exceed 30 times the value for exempt material activity concentration determined in accordance with 10 CFR 71, appendix A, "Determination of A1&A2"
- LSA—II:
  - Water with tritium concentration up to 0.8 TBq/L (20.0 Ci/L)
  - Other material in which the activity is distributed throughout and the average specific activity does not exceed $10^{-4}A_2$/g for solids and gases, and $10^{-5}A_2$/g for liquids

- LSA—III:
  - Solids (e.g., consolidated wastes, activated materials), excluding powders that satisfy the requirements of 10 CFR 71.77, "Qualification of LSA-III Material," in which
    - the radioactive material is distributed throughout a solid or a collection of solid objects, or is essentially uniformly distributed in a solid compact binding agent (such as concrete, bitumen, ceramic, etc.);
    - the radioactive material is relatively insoluble, or it is intrinsically contained in a relatively insoluble material, so that even under loss of packaging, the loss of radioactive material per package by leaching, when placed in water for 7 days, would not exceed 0.1 A_2; and
    - the estimated average specific activity of the solid does not exceed 2 x $10^{-3} A_2$/g.

Normal Form

The following is taken from 10 CFR 71.4.

Normal form radioactive material means radioactive material that has not been demonstrated to qualify as `special form radioactive material.

Radioactive Instruments and Articles

The following is taken from 49 CFR 173.403.

Radioactive instrument or article is any manufactured instrument or article such as an instrument, clock, electronic tube or apparatus, or similar instrument or article having class 7 (radioactive) material in gaseous or non-dispersible solid form as a component part.

Special Form

The following is taken from 49 CFR 173.403.

Special form class 7 (radioactive) material is either an indispersible solid radioactive material or a sealed capsule containing radioactive material that satisfies the following conditions:

- It is either a single solid piece or a sealed capsule containing radioactive material that can be opened only by destroying the capsule.
- The piece or capsule has at least one dimension not less than 0.2 inches.
- It satisfies the test requirements of 49 CFR 173.469, "Tests for Special Form Class 7 (Radioactive) Materials." Special form encapsulations designed in accordance with the requirements in effect on June 30, 1983, and constructed prior to July 1, 1985, and special form encapsulations designed in accordance with the requirements of 49 CFR 173.403 in effect on March 31, 1996, and constructed prior to April 1, 1997, may continue to be used.

Surface Contaminated Object

The following is taken from 49 CFR 173.403.

Surface contaminated object is a solid object which is not itself radioactive but which has radioactive material distributed on its surface.

Transportation Index

The following is taken from 49 CFR 173.403.

Transportation index (TI) is the dimensionless number (rounded up to the next tenth) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The TI is determined by multiplying the maximum radiation level in mSv/h at 3.3 ft from the external surface of the package by 100.

Type APpackage

The following is taken from the NRC Technical Training Center, Reactor Concepts Manual, *Transportation of Radioactive Material*.

A type A container is designed to survive normal transportation handling and minor accidents. Type A packaging is based on performance requirements which means it must withstand or survive certain tests. The shape of the package or material from which it is constructed is irrelevant. A type A package may be a cardboard box, a wooden crate, or a metal drum. The shipper must have documentation which shows that the specific design being used has passed the required tests.

Type B Package

The following is taken from the NRC Technical Training Center, Reactor Concepts Manual, *Transportation of Radioactive Material*.

A type B container must be able to survive severe accidents. A type B package may be a metal drum or a huge, massive shielded transport container. Like type A packages, type B packages must pass certain tests. However, the type B tests are considerably more rigorous than those required for type A packages. Most type B packages have been issued a Certificate of compliance by the NRC.

b. Describe when the following labels are applicable:
- **Empty label**
- **Radioactive white I**
- **Radioactive yellow II**
- **Radioactive yellow III**

The following is taken from Oak Ridge Institute for Science and Education, Guidance for Radiation Accident Management, *Managing Radiation Emergencies*.

All shipments of radioactive material, with the exception of those containing limited quantities or those of low specific activity, bear two identifying warning labels affixed to opposite sides of the outer package. Three different labels — white-I, yellow-II, or yellow-III — are used on the external surface of packages containing radioactive material.

The UN hazard class “7” is on labels of radioactive material.

Package labels specify the radioactive content and the quantity in curies. Yellow-II and yellow-III also specify the transport index.

Table 12. Radiation package labels

Label	Radiation Level Associated With Intact Package	Symbol
Radioactive white-I	Almost no radiation — 0.5 mrem/h (5 µSv/h) maximum on surface	
Radioactive yellow-II	Low radiation levels — 50 mrem/h (0.5 mSv/h) maximum on surface; 1 mrem/h (10 µSv/h) maximum at 1 meter	
Radioactive yellow-III	Higher radiation levels — 200mrem/h (2 mSv/h) maximum on surface; 10 mrem/h (0.1 mSv/h) maximum at 1 meter Also required for fissile class III or large-quantity shipments, regardless of radiation level	

Source: Oak Ridge Institute for Science and Education, Guidance for Radiation Accident Management, *Managing Radiation Emergencies*

c. Describe the general design requirements for type A and type B packages.

Type A Packages

The following is taken from 49 CFR 173.412.

In addition to meeting the requirements prescribed in 49 CFR 173.410, "General Design Requirements," each type A packaging must be designed so that

- the outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.
- the smallest external dimension of the package is not less than 4 inches.

- containment and shielding is maintained during transportation and storage in a temperature range of −40°C (−40°F) to 70°C (158°F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.
- the packaging includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form class 7 (radioactive) material, as demonstrated in accordance with 49 CFR 173.469, "Tests for Special Form Class 7 (Radioactive) Materials," may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.
- for each component of the containment system, account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis.
- the containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 pounds per square inch).
- each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.
- any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield.
- failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions must not impair the ability of the package to meet other requirements.
- when evaluated against the performance requirements and the tests specified in 49 CFR 173.465, "Type A Packaging Tests," or using any of the methods authorized by 49 CFR 173.461, "Demonstration of Compliance With Tests," paragraph (a), the packaging will prevent
  - loss or dispersal of the radioactive contents and
  - a significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

Each packaging designed for liquids will

- be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects, and filling dynamics;
- meet the conditions prescribed in paragraph (j) of this section when subjected to the tests specified in 49 CFR 173.466, "Additional Tests for Type A Packagings Designed for Liquids and Gases," or evaluated against these tests by any of the methods authorized by 49 CFR 173.461; and
- either
  - have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; or
  - have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer component in the event that the primary inner component leaks.

Each package designed for gases, other than tritium not exceeding 1,000 Ci or noble gases not exceeding the A2 value appropriate for the noble gas, will be able to prevent loss or dispersal of contents when the package is subjected to the tests prescribed in 49 CFR 173.466 or evaluated against these tests by any of the methods authorized by 49 CFR 173.461.

Type B Packages

The following is taken from 10 CFR 71.51.

A type B package, in addition to satisfying the requirements of 10 CFR 71.41 through 71.47, must be designed, constructed, and prepared for shipment so that under the tests specified in

- 10 CFR 71.71, "Normal Conditions of Transport," there would be no loss or dispersal of radioactive contents as demonstrated to a sensitivity of 10^{-6} A2 per hour, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging; and
- 10 CFR 71.73, "Hypothetical Accident Conditions," there would be no escape of krypton-85 exceeding 10 A2 in 1 week, no escape of other radioactive material exceeding a total amount A2 in 1 week, and no external radiation dose rate exceeding 10 mSv/h (1 rem/h) at 40 inches from the external surface of the package.

Where mixtures of different radionuclides are present, the provisions of appendix A, paragraph IV shall apply, except that for krypton-85, an effective A2 value equal to 10 A2 may be used.

Compliance with the permitted activity release limits may not depend on filters or on a mechanical cooling system.

For packages that contain radioactive contents with activity greater than 10^5 A2, the requirements of 10 CFR 71.61, "Special Requirements for Type B Packages Containing More Than 10&bds5; A&bdi2," must be met.

d. Describe the general design requirements for industrial packages 1, 2, and 3.

The following is taken from 49 CFR 173.411.

Each industrial packaging must comply with the requirements of 49 CFR 173.411 that specifies packaging tests, and record retention applicable to industrial packaging type 1 (IP-1), industrial packaging type 2 (IP-2), and industrial packaging type 3 (IP-3).

Industrial Packaging Certification and Tests

Each IP-1 must meet the general design requirements prescribed in 49 CFR 173.410.

Each IP-2 must meet the general design requirements prescribed in 49 CFR 173.410 and when subjected to the tests specified in 49 CFR 173.465 or evaluated against these tests by any of the methods authorized by 49 CFR 173.461, must prevent

- loss or dispersal of the radioactive contents, and
- a significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

Each IP-3 packaging must meet the requirements for an IP-1 and an IP-2, and must meet the requirements specified in 49 CFR 173.412(a) through (j).

Tank containers may be used as industrial package types 2 or 3 provided that

- they satisfy the requirements for type IP;
- they are designed to conform to the standards prescribed in chapter 6.7, of the United Nations Recommendations on the Transport of Dangerous Goods, or other requirements at least equivalent to those standards;
- they are capable of withstanding a test pressure of 37.1 pounds per square inch gage; and they are designed so that any additional shielding that is provided is capable of withstanding the static and dynamic stresses resulting from handling and routine conditions of transport and of preventing a loss of shielding integrity that would result in more than a 20 percent increase in the radiation level at any external surface of the tank containers.

Tanks, other than tank containers, including DOT specification IM 101 or IM 102 steel portable tanks may be used as industrial package types 2 or 3 for transporting LSA-I and LSA-II liquids and gases, provided that they conform to established standards.

Freight containers may be used as industrial package types 2 or 3 provided that

- the radioactive contents are restricted to solid materials;
- they satisfy the requirements for type IP; and
- they are designed to conform to the standards prescribed by the International Organization for Standardization (ISO). They shall be designed such that if subjected to the tests prescribed in that document and the accelerations occurring during routine conditions of transport they would prevent
    - loss or dispersal of the radioactive contents; and
    - loss of shielding integrity that would result in more than a 20 percent increase in the radiation level at any external surface of the freight containers.

Metal intermediate bulk containers may also be used as industrial package type 2 or 3 provided that

- they satisfy the requirements for type IP-1 specified in paragraph (b)(1); and
- they are designed to conform to the standards prescribed in chapter 6.5 of the UN *Recommendations on the Transport of Dangerous Goods, for Packing Group I or II*, and if they were subjected to the tests prescribed in that document, but with the drop test conducted in the most damaging orientation, they would prevent
    - loss or dispersal of the radioactive contents; and
    - loss of shielding integrity which would result in more than a 20 percent increase in the radiation level at any external surface of the intermediate bulk containers.

Except for IP-1 packagings, each offeror of an industrial package must maintain on file for at least 1 year after the latest shipment, and shall provide to the Associate Administrator on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.

e. Determine the radiation level limitations as defined by DOT.

The following is taken from 49 CFR 173.441.

Except as provided in 49 CFR 173.441, "Radiation Level Limitations and Exclusive Use Provisions," each package of class 7 (radioactive) materials offered for transportation must be designed and prepared for shipment, so that under conditions normally incident to transportation, the radiation level does not exceed 200 mrem/h at any point on the external surface of the package, and the transport index does not exceed 10.

A package which exceeds the radiation level limits specified in 49 CFR 173.441 must be transported by exclusive use shipment, and the radiation levels for such shipment may not exceed the following during transportation:

- 200 mrem/h on the external surface of the package unless the following conditions are met, in which case the limit is 1,000 mrem/h:
  - The shipment is made in a closed transport vehicle;
  - The package is secured within the vehicle so that its position remains fixed during transportation; and
  - There are no loading or unloading operations between the beginning and end of the transportation;
- 200 mrem/h at any point on the outer surfaces of the vehicle, including the top and underside of the vehicle; or in the case of a flat-bed style vehicle, at any point on the vertical planes projected from the outer edges of the vehicle, on the upper surface of the load or enclosure if used, and on the lower external surface of the vehicle;
- 10 mrem/h at any point 6.6 ft from the outer lateral surfaces of the vehicle; or in the case of a flat-bed style vehicle, at any point 6.6 ft from the vertical planes projected by the outer edges of the vehicle; and
- 2 mrem/h in any normally occupied space, except that this provision does not apply to carriers if they operate under the provisions of a state or federally regulated radiation protection program and if personnel under their control who are in such an occupied space wear radiation dosimetry devices.

For shipments made under the provisions of 49 CFR 173.441, the offeror shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions must be included with the shipping paper information. The instructions must be sufficient so that, when followed, they will cause the carrier to avoid actions that will unnecessarily delay delivery or unnecessarily result in increased radiation levels or radiation exposures to transport workers or members of the general public.

Conveyance limits on the sum of package transport indices are as follows:

- Except for shipments by cargo aircraft or by seagoing vessel, the sum of transport indices for a non-exclusive use shipment may not exceed 50.
- Where a consignment is transported under exclusive use, there is no limit on the sum of the transport indices aboard a single conveyance.
- Provisions for shipments of class 7 (radioactive) materials by air are described in 49 CFR 175.700–175.705.
- Provisions for shipment of class 7 (radioactive) materials by vessel are described in 49 CFR 176.700–176.720.

A package exceeding the maximum surface radiation level or maximum transport index prescribed in 49 CFR 173.441 may not be transported by aircraft.

f. Determine the thermal limitations as defined by DOT.

The following is taken from 49 CFR 173.442.

A package of class 7 (radioactive) material must be designed, constructed, and loaded so that

- the heat generated within the package by the radioactive contents will not, during conditions normally incident to transport, affect the integrity of the package; and
- the temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38ºC (100ºF), exceed either
  - 50ºC (122ºF) in other than an exclusive use shipment; or
  - 85ºC (185ºF) in an exclusive use shipment.

g. Determine the contamination control requirements as defined by DOT.

The following is taken from 49 CFR 173.443.

The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for transport must be kept ALARA. The level of non-fixed radioactive contamination may not exceed the limits set forth in table 11 and must be determined by either

- wiping an area of 300 cm^2 of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements must be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. The amount of radioactivity measured on any single wiping material, divided by the surface area wiped and divided by the efficiency of the wipe procedure (the fraction of removable contamination transferred from the surface to the absorbent material), may not exceed the limits set forth in table 9 of 49 CFR 173.443, at any time during transport. For this purpose the actual wipe efficiency may be used, or the wipe efficiency may be assumed to be 0.10; or
- alternatively, the level of non-fixed radioactive contamination may be determined by using other methods of equal or greater efficiency.

Table 13. Non-fixed external radioactive contamination limits for packages

Contaminant	Maximum Permissible Limits		
	Bq/cm^2	**μCi/cm^2**	**dpm/cm^2**
Beta and gamma emitters and low toxicity alpha emitters	4	10^{-4}	220
All other alpha emitting radionuclides	0.4	10^{-5}	22

Source: 49 CFR 173.443

Except as provided in 49 CFR 173.443, in the case of packages transported as exclusive use shipments by rail or public highway only, the removable (non-fixed) radioactive contamination on any package at any time during transport may not exceed ten times the levels prescribed in 49 CFR 173.443. The levels at the beginning of transport may not exceed the levels prescribed in 49 CFR 173.443.

Except as provided in paragraph 49 CFR 173.443, each transport vehicle used for transporting class 7 (radioactive) materials as an exclusive use shipment that uses the provisions of 49 CFR 173.443 must be surveyed with appropriate radiation detection instruments after each use. A vehicle may not be returned to service until the radiation dose rate at each accessible surface is 0.5 mrem/h or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in 49 CFR 173.443.

Paragraphs (b) and (c) of 49 CFR 173.443 do not apply to any closed transport vehicle used solely for the transportation by highway or rail of class 7 (radioactive) material packages with contamination levels that do not exceed ten times the levels prescribed in paragraph (a) of 49 CFR 173.443 if

- a survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 10 mrem/h at the surface or 2 mrem/h at 3.3 ft from the surface;
- each vehicle is stenciled with the words “For Radioactive Materials Use Only” in letters at least 3 ins high in a conspicuous place on both sides of the exterior of the vehicle; and each vehicle is kept closed except for loading or unloading.

h. Determine the quality control requirements that must be made prior to the shipment of radioactive materials.

The following is taken from 49 CFR 173.475.

Before each shipment of any class 7 (radioactive) materials package, the offeror must ensure, by examination or appropriate tests, that

- the packaging is proper for the contents to be shipped;
- the packaging is in unimpaired physical condition, except for superficial marks;

- each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;
- for fissile material, each moderator and neutron absorber, if required, is present and in proper condition;
- each special instruction for filling, closing, and preparing the packaging for shipment has been followed;
- each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;
- each packaging containing liquid in excess of an A2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 25 kPa, absolute (3.6 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;
- the internal pressure of the containment system will not exceed the design pressure during transportation; and
- external radiation and contamination levels are within the allowable limits specified in 49 CFR 173.475.

i. Describe the routing requirements for class 7 radioactive material, highway route controlled quantities, unclassified high-level radioactive waste shipments, and spent nuclear fuel.

The following is taken from 49 CFR 397.101.

Except as provided in 49 CFR 397.101, "Requirements for Motor Carriers and Drivers," or in circumstances when there is only one practicable highway route available, considering operating necessity and safety, a carrier or any person operating a motor vehicle that contains a class 7 (radioactive) material, as defined in 49 CFR 172.403, for which placarding is required under 49 CFR 172 shall

- ensure that the motor vehicle is operated on routes that minimize radiological risk;
- consider available information on accident rates, transit time, population density and activities, and the time of day and the day of week during which transportation will occur to determine the level of radiological risk; and
- tell the driver which route to take and that the motor vehicle contains class 7 (radioactive) materials.

Except as otherwise permitted, a carrier or any person operating a motor vehicle containing a highway route controlled quantity of class 7 (radioactive) materials, as defined in 49 CFR 173.403, shall operate the motor vehicle only over preferred routes. A preferred route is an interstate system highway for which an alternative route is not designated by a state routing agency; a state-designated route selected by a state routing agency pursuant to 49 CFR 397.103; or both of the above.

The motor carrier or the person operating a motor vehicle containing a highway route controlled quantity of class 7 (radioactive) materials, as defined in 49 CFR 173.403, shall select routes to reduce time in transit over the preferred route segment of the trip.

An interstate system bypass or interstate system beltway around a city, when available, shall be used in place of a preferred route through a city, unless a state routing agency has designated an alternative route.

A motor vehicle may be operated over a route, other than a preferred route, only under the following conditions:

- The deviation from the preferred route is necessary to pick up or deliver a highway route controlled quantity of class 7 (radioactive) materials, to make necessary rest, fuel, or motor vehicle repair stops, or because emergency conditions make continued use of the preferred route unsafe or impossible;
- For pickup and delivery not over preferred routes, the route selected must be the shortest-distance route from the pickup location to the nearest preferred route entry location, and the shortest-distance route to the delivery location from the nearest preferred route exit location. Deviation from the shortest-distance pickup or delivery route is authorized if such deviation
  - is based upon the criteria to minimize the radiological risk; and
  - does not exceed the shortest-distance pickup or delivery route by more than 25 miles and does not exceed five times the length of the shortest-distance pickup or delivery route.

Deviations from preferred routes, or pickup or delivery routes other than preferred routes, which are necessary for rest, fuel, or motor vehicle repair stops or because of emergency conditions, shall be made in accordance with the criteria in this section to minimize radiological risk, unless due to emergency conditions, time does not permit use of those criteria.

A carrier who operates a motor vehicle that contains a package of highway route controlled quantity of class 7 (radioactive) materials, as defined in 49 CFR 173.403, shall prepare a written route plan and supply a copy before departure to the motor vehicle driver and a copy to the shipper. Any variation between the route plan and routes actually used, and the reason for it shall be reported in an amendment to the route plan delivered to the shipper as soon as practicable but within 30 days following the deviation. The route plan shall contain

- a statement of the origin and destination points, a route selected in compliance with this section, all planned stops, and estimated departure and arrival times; and
- telephone numbers which will access emergency assistance in each state to be entered.

No person may transport a package of highway route controlled quantity of class 7 (radioactive) materials on a public highway unless

- the driver has received within the 2 preceding years, written training on
  - requirements in 49 CFR 172, 173, and 177 pertaining to the class 7 (radioactive) materials transported;
  - the properties and hazards of the class 7 (radioactive) materials being transported; and
  - procedures to be followed in case of an accident or other emergency.

- the driver has in his or her immediate possession a certificate of training as evidence of training, and a copy is placed in his or her qualification file showing
  - the driver's name and operator's license number;
  - the dates training was provided;
  - the name and address of the person providing the training;
  - that the driver has been trained in the hazards and characteristics of highway route controlled quantity of class 7 (radioactive) materials; and
  - a statement by the person providing the training that information on the certificate is accurate.
- the driver has in his or her immediate possession the route plan and operates the motor vehicle in accordance with the route plan.

A person may transport irradiated reactor fuel only in compliance with a plan if required under 49 CFR 173.22, "Shipper's Responsibility," that will ensure the physical security of the material. Variation for security purposes from the requirements of this section is permitted so far as necessary to meet the requirements imposed under such a plan, or otherwise imposed by the NRC in 10 CFR 73, "Physical Protection of Plants and Materials."

Except for packages shipped in compliance with the physical security requirements of the NRC in 10 CFR 73, each carrier who accepts for transportation a highway route controlled quantity of class 7 (radioactive) material, must, within 90 days following the acceptance of the package, file the following information concerning the transportation of each such package with the Office of Enforcement and Compliance, Federal Motor Carrier Safety Administration, 400 Seventh Street SW, Washington, DC 20590-0001:

- The route plan, including all required amendments reflecting the routes actually used
- A statement identifying the names and addresses of the shipper, carrier, and consignee
- A copy of the shipping paper or the description of the class 7 (radioactive) material in the shipment

j. Describe what shipments are subject to the physical security requirements of DOE O 473.1, Physical Protection of Safeguards and Security Interests (draft).

The following is taken from DOE O 473.1.

All shipments are subject to the physical security requirements of DOE O 473.1 except shipments mandated by the Nuclear Waste Policy Act, as amended, and managed by the Office of Civilian Radioactive Waste Management.

k. Describe the procedures for international shipment of nuclear materials in which DOE operations offices or their contractors participate. (Transportation Operations Manual).

The following is taken from the U.S. Department of State, *Convention on the Physical Protection of Nuclear Material*.

The convention on the physical protection of nuclear material provides for certain levels of physical protection during international transport of nuclear material. It also establishes a

general framework for cooperation among states in the protection, recovery, and return of stolen nuclear material. Further, the convention lists certain serious offenses involving nuclear material which state parties are to make punishable and for which offenders shall be subject to a system of extradition or submission for prosecution.

Levels of physical protection for nuclear material during international transport include the following:

- For Category II and III materials, transportation shall take place under special precautions including prior arrangements among sender, receiver, and carrier, and prior agreement between natural or legal persons subject to the jurisdiction and regulation of exporting and importing states, specifying time, place, and procedures for transferring transport responsibility.
- For Category I materials, transportation shall take place under special precautions identified above for transportation of Category II and III materials, and in addition, under constant surveillance by escorts and under conditions which assure close communication with appropriate response forces.
- For natural uranium other than in the form of ore or ore-residue, transportation protection for quantities exceeding 500 kg of uranium shall include advance notification of shipment specifying mode of transport, expected time of arrival, and confirmation of receipt of shipment.

I. Describe the certification process for type B and fissile material packaging.

The following is taken from Liu, Y.Y.; R.D. Carlson, R.W. Carlson, and A. Kapoor, *Overview of the DOE Packaging Certification Process*.

The SARP is a document that provides a comprehensive technical description of the packaging and demonstrates compliance with the NRC safety regulations and standards when the packaging is offered for shipment of radioactive materials. Subcriticality, radiation shielding, and containment are the three basic packaging safety requirements that must be demonstrated in a SARP. The SARP should include a description of the quality assurance program for the design, fabrication, assembly, testing, maintenance, repair, modification, and use of the proposed packaging. The established codes and standards that are proposed for use in the package should be identified, and any specific provisions of the quality assurance program that are applicable to the particular packaging design under consideration should be identified.

After a SARP is prepared, it is usually submitted to the Office of Facility Safety Analysis, under the Assistant Secretary for Environment, Safety, and Health, which has review and certification authority within DOE for non-weapons packagings. The SARP review performed typically involves meetings with the packaging user, written communication of questions and responses between reviewers and the applicant, confirmatory analyses by reviewers, and revision of the SARP by the applicant, when necessary. The end product of the SARP review is a technical review report (TRR), prepared by the SARP review groups, that describes what is done in the technical review and confirmatory analysis, and also documents the results. Based on the information in the TRR, the DOE certifying official then issues a certificate of compliance for the packaging, along with a safety evaluation report that

documents that the packaging described in the SARP complies with 10 CFR 71 and other applicable federal regulations.

m. Determine empty package requirements.

The following is taken from 49 CFR 173.29.

An empty packaging containing only the residue of a hazardous material shall be offered for transportation and transported in the same manner as when it previously contained a greater quantity of that hazardous material.

Notwithstanding the requirements of 49 CFR 173.29, "Empty Packaging," paragraph (a) an empty packaging is not subject to any other requirements of 49 CFR 173.29 if it conforms to the following provisions:

- Any hazardous material shipping name and identification number markings, any hazard warning labels or placards, and any other markings indicating that the material is hazardous are removed, obliterated, or securely covered in transportation. This does not apply to transportation in a transport vehicle or a freight container if the packaging is not visible in transportation and the packaging is loaded by the shipper and unloaded by the shipper or consignee.
- The packaging
  - is unused;
  - is sufficiently cleaned of residue and purged of vapors to remove any potential hazard;
  - is refilled with a material which is not hazardous to such an extent that any residue remaining in the packaging no longer poses a hazard;
  - contains only the residue of
    - an ORM-D material; or
    - a division 2.2 non-flammable gas, other than ammonia, anhydrous, and with no subsidiary hazard, at an absolute pressure less than 280 kPa (40.6 psia); at 20°C (68°F); and
    - any material contained in the packaging does not meet the definitions in 49 CFR 173.8, "Exceptions for Non-Specification Packagings Used in Intrastate Transportation," for a hazardous substance, a hazardous waste, or a marine pollutant.

A non-bulk packaging containing only the residue of a hazardous material covered by table 2 of 49 CFR 172.504, "General Placarding Requirements," that is not a material poisonous by inhalation or its residue shipped under the subsidiary placarding provisions of 49 CFR 172.505, "Placarding for Subsidiary Hazards"

- does not have to be included in determining the applicability of the placarding requirements of subpart F of 49 CFR 172, "Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training Requirements, and Security Plans"; and
- is not subject to the shipping paper requirements of this subchapter when collected and transported by a contract or private carrier for reconditioning, remanufacture, or reuse.

Notwithstanding the stowage requirements in column 10a of the 49 CFR 172.101 table for transportation by vessel, an empty drum or cylinder may be stowed on deck or under deck.

Specific provisions for describing an empty packaging on a shipping paper appear in 49 CFR 172.203, "Additional Description Requirements," paragraph (e).

A package which contains a residue of an elevated temperature material may remain marked in the same manner as when it contained a greater quantity of the material even though it no longer meets the definition in 49 CFR 171.8 for an elevated temperature material.

A package that contains a residue of a hazardous substance, class 9, listed in the 49 CFR 172.101 table, appendix A, table 1, that does not meet the definition of another hazard class and is not a hazardous waste or marine pollutant, may remain marked, labeled, and if applicable, placarded in the same manner as when it contained a greater quantity of the material even though it no longer meets the definition in 49 CFR 171.8 for a hazardous substance.

27. Transportation and traffic management personnel shall demonstrate a familiarity-level knowledge of emergency response and reporting.

a. Describe the DOE emergency management system delineated in DOE O 151.1C.

The following is taken from DOE O 151.1C.

DOE/NNSA sites/facilities, including DOE/NNSA transportation activities, DOE/NNSA offices in the field, and DOE headquarters offices, must develop and participate in an integrated and comprehensive emergency management system to ensure that

- the Department can respond effectively and efficiently to operational emergencies and energy emergencies and can provide emergency assistance so that appropriate response measures are taken to protect workers, the public, the environment, and the national security;
- emergencies are recognized, categorized and, as necessary, classified promptly, and parameters associated with the emergency are monitored to detect changed or degraded conditions;
- emergencies are reported and notifications are made; and
- reentry activities are properly and safely accomplished, and recovery and post-emergency activities commence properly.

b. Describe the 49 CFR requirements for emergency information.

The following is taken from 49 CFR 172.602.

The term "emergency response information" means information that can be used in the mitigation of an incident involving hazardous materials and, as a minimum, must contain the following information:

- The basic description and technical name of the hazardous material
- Immediate hazards to health
- Risks of fire or explosion

- Immediate precautions to be taken in the event of an accident or incident
- Immediate methods for handling fires
- Initial methods for handling spills or leaks in the absence of fire
- Preliminary first aid measures

c. Emergency Response Guide

The following is taken from the DOT, Pipeline and Hazardous Materials Safety Administration, *Emergency Response Guidebook*.

The Emergency Response Guidebook was developed jointly by the DOT, Transport Canada, and the Secretariat of Communications and Transportation of Mexico for use by firefighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving a hazardous material. It is primarily a guide to aid first responders in 1) quickly identifying the specific or generic classification of the material(s) involved in the incident, and 2) protecting themselves and the general public during this initial response phase of the incident. The Emergency Response Guidebook is updated every three to four years to accommodate new products and technology. The next version is scheduled for 2012.

28. Transportation and traffic management personnel shall demonstrate a working-level knowledge of assessing transportation and traffic management operations.

a. Describe the role transportation and traffic management personnel have with respect to performance oversight of government-owned, contractor-operated (GOCO) facilities.

The following is taken from DOE O 460.2A.

DOE/NNSA field, service center, site, regional office, and facility managers are responsible for the following:

- Ensure that field organizations and contractors under their purview involved in performing or managing transportation and packaging fully implement and comply with the requirements of DOE O 460.2A, "Department of Materials Transportation and Packaging Management."
- Obtain waivers from state, tribal, and local transportation requirements, as needed to meet programmatic requirements, and provide copies of all such requests and waivers to the Office of Environmental Management and the NNSA Deputy Administrator for Defense Programs for field organizations.
- Secure copies of exemptions and approvals by contractors and provide copies to the Office of Environmental Management or for NNSA organizations to the Deputy Administrator for Defense Programs.
- Issue Price-Anderson Amendments Act indemnity agreement certificates to carriers, upon their request, or notify the requesting carriers and/or the referring organization that a shipment is not covered by an indemnity agreement. Note: When the NRC and the consignor or consignee have entered into a licensee indemnity agreement or when it is not known whether an indemnity agreement exists, refer carriers' certification

requests to the Director of the NRC Regional Office listed in 10 CFR 20, appendix D, "United Stated Nuclear Regulatory Commission Regional Offices."

- Negotiate with carriers or authorize cost-type contractors to negotiate with carriers concerning rates, classification ratings, services, and related transportation matters when only their own field organizations will be affected, and maintain documentation of actions taken.
- Advise other field organizations; the Office of Environmental Management; the Deputy Administrator for Defense Programs; cognizant program secretarial offices, secretarial offices, and lead program secretarial offices; and the NNSA Deputy Administrators of significant freight rate changes and new or changing state, tribal, or local laws, rules, or regulations.
- Issue bills of lading when required and authorize contractor employees to issue bills of lading within prescribed limitations.
- Conduct contractor/subcontractor evaluations of compliance with transportation and packaging requirements at least every 3 years.
- Request a contracting officer to incorporate the requirements of the contractor requirements document into new or existing contracts and delete the requirements of the canceled Order in existing contracts.
- Ensure that all carriers who transport highway route controlled quantities of radioactive material in less-than-truckload or truckload quantities, and hazardous waste in any quantity are evaluated for safety, financial status, security, and compliance with applicable regulations.
- Conduct site-wide transportation planning and develop reports that identify transportation needs.

b. Describe the assessment requirements and limitations associated with the oversight of contractor transportation and traffic management personnel.

The following is taken from DOE G 460.1-1.

DOT regulations are structured so that materials representing a greater hazard are subject to greater containment, communication, and control requirements. DOT regulations may be applied to onsite transfers to ensure compliance with the Order. Where DOT regulations are not used to ensure compliance with DOE O 460.1B onsite movements, a graded approach to compliance may be established.

A site seeking to establish a graded approach to compliance with DOE O 460.1B, *Packaging and Transportation Safety*, should develop a hierarchy in which hazardous materials are grouped into a series of hazard levels. For each hazard level, the performance requirements for the transport system (where the transport system consists of the packaging plus the controls and communication requirements imposed on its transport) should then be established. For materials representing low hazards, the transport system would be expected to prevent loss of containment during normal onsite handling, and may also be expected to survive minor mishaps. For higher hazards, the transport system would be expected to withstand more severe handling without loss of containment. For hazardous materials, such as type B radioactive materials, the transport system would be expected to prevent loss of containment for normal handling and for all credible onsite accidents.

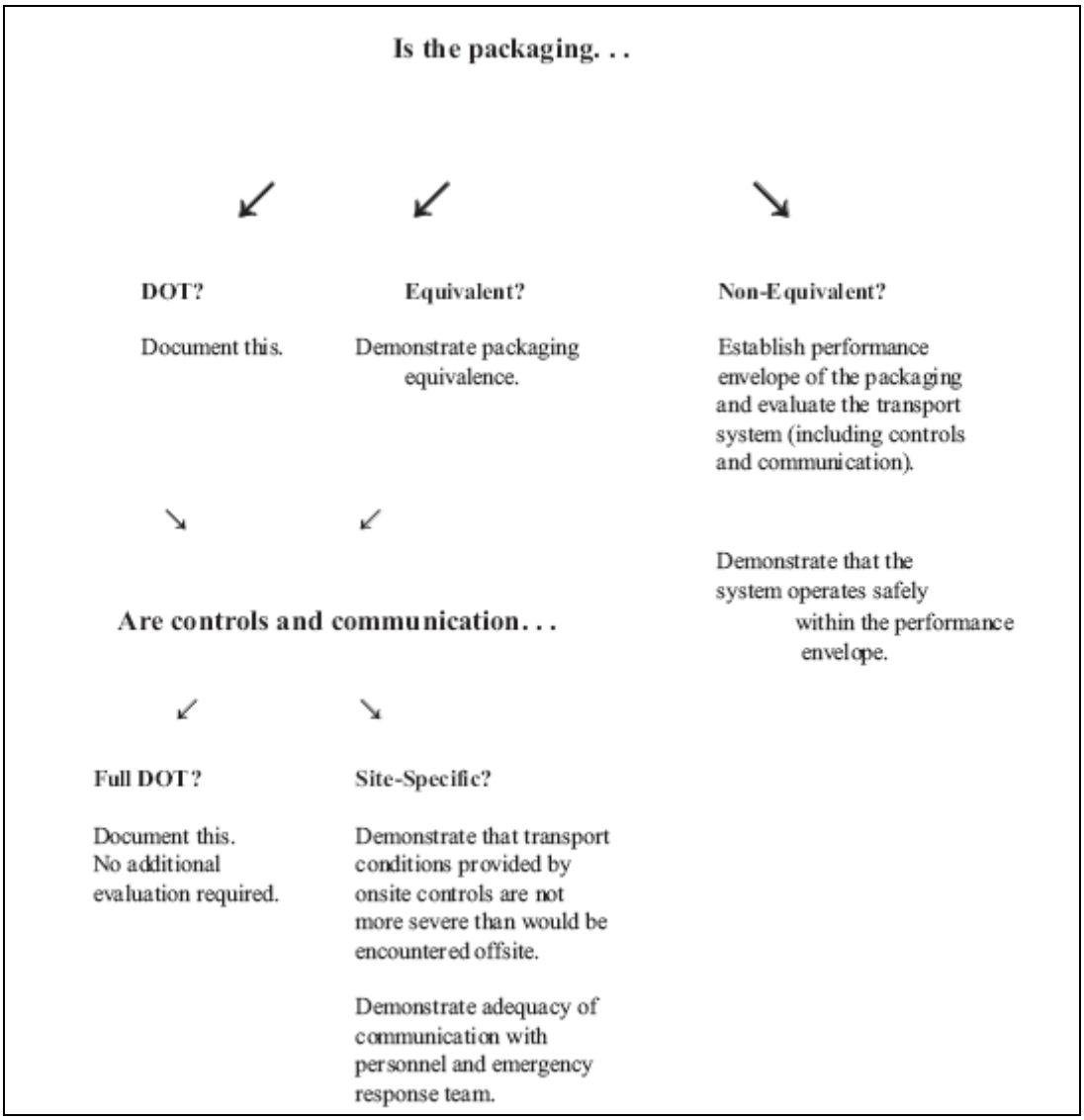
The performance requirements imposed on each hazard level in the hazardous materials hierarchy should be documented in the transportation safety document. This documentation should enable a site to establish containment, control, and communication requirements for onsite movements in a consistent and justifiable manner, and should ensure that requirements established for an onsite movement will be commensurate with the hazard of the material being transported.

Reliance on packaging performance is a preferred way to ensure overall safety; however, an integrated approach that considers the packaging in combination with specified communication and control measures is also acceptable.

Figure 6 presents the options available to a site for complying with DOE O 460.1B, and indicates the evaluations that would support each. As a first step, the packaging should be placed into one of three categories: 1) DOT packaging, 2) equivalent packaging, or 3) nonequivalent packaging. DOT packaging is packaging that meets the regulations of DOT for offsite shipment of the hazardous material to be transported onsite. Equivalent packaging is packaging that can be shown conclusively to provide performance equivalent to packaging meeting the requirements of DOT for offsite shipment. Packaging falling into this category will generally be a slight modification of a DOT packaging. Non-equivalent packaging is any packaging which cannot be demonstrated to be either DOT or equivalent packaging. As the figure shows, DOT packaging requires no special evaluation. It need only be documented as approved packaging. Equivalent packaging should be supported by a documented evaluation in which this equivalence is formally established. Once established, equivalent packaging may be used interchangeably with DOT packaging for onsite movements.

Still following the logic of figure 6, DOT and equivalent packagings may be used onsite in two ways. First, they may be used in compliance with all DOT control and communication requirements for offsite movements. The use of full DOT control and communication requirements should be documented in the TSD. No further evaluation is then required.

Second, these packagings may be used with site-specific control and communication requirements. To ensure that DOE O 460.1B is met, the site-specific requirements should be evaluated to demonstrate that 1) transport conditions provided by the onsite controls are no more severe than would be encountered by a package being transported offsite and 2) personnel potentially involved with the transport and emergency response teams receive adequate communication regarding the hazards involved with the transport. The final option represented in figure 6 involves the use of non-equivalent packaging. Because this packaging has not been demonstrated to function equivalently to DOT packaging, the use of full DOT control and communication requirements may not be adequate for this type of packaging.



Source: DOE G 460.1-1

Figure 6. Available options for complying with DOE O 460.1B

Before non-equivalent packaging may be used for onsite transport, a performance envelope should be established for the packaging and specific control and communication requirements should be developed which ensure that the transport system will operate safely within the performance envelope.

The evaluation of the transport system described in figure 6 should take the form of a safety assessment. The safety assessment may be straightforward or very complex, depending primarily on the packaging to be used for the hazardous materials movement. As a first step, the packaging should be evaluated and placed into one of the three categories described earlier: 1) DOT packaging, 2) equivalent packaging, or 3) non-equivalent packaging. The details of the required evaluation then follow from figure 6.

c. Describe how planning, observations, interviews, and document research are used during an assessment.

The following is taken from DOE G 414.1-1B.

Effective assessments use a combination of tools and techniques to maximize the productivity of the assessment team and resources. Such assessment techniques include document reviews, interviews, and observations. In using these techniques, the assessor should not forget that the objective is to verify accomplishment of an organization's mission. To save time, the assessor should gather only data and information relevant to overall program performance and the achievement of program objectives.

It is generally not acceptable to identify suspicions about the adequacy or inadequacy of a program, system, or process. Investigations should be sufficiently thorough and information gathered with sufficient diligence that accurate, detailed conclusions and issues can be provided to assist the organizations that will receive the final report.

In using any of these techniques, assessors should maintain good records of the assessment results. These may include personal notes or other information to support the assessment and may be included in the checklist information. These records are useful in writing the report and any associated findings and recommendations, and will become invaluable if questions arise during the report review process. All classified notes should be disposed of properly in accordance with established and agreed-upon procedures. A discussion of each of the techniques follows.

Document Review

Document review is used extensively during an assessment to substantiate the information obtained during interviews and observation. During the course of an assessment, questions may arise concerning what is heard and seen. The review of documents, including logs, procedures, work orders, and other data provides a method for answering these questions and validating the assessment results. The drawback of document review is that the accuracy of the records cannot be ascertained by review alone. This technique should be combined with interviews, observation, inspection, and/or performance testing to complete the picture of performance. Records and documents should be selected carefully to ensure they adequately characterize the program, system, or process being assessed.

Interviews

Interviews provide a means to verify the results of observations, document reviews, inspections, and performance testing. In addition, interviews allow the responsible person to explain and clarify those results. The interview helps to eliminate misunderstandings about program implementation, and provides a venue where apparent conflicts or recent changes can be discussed and the organization and program expectations can be described. Tools developed during assessment planning are used to prepare for the interview. Assessors should also prepare questions in advance to keep the interview focused.

Observation

Observation, the viewing of actual work activities, is often considered the most effective technique for determining whether performance is adequate. Assessors should understand the

effect their presence has on the person being observed and convey an attitude that is helpful, constructive, positive, and unbiased. The primary goal during observation is to obtain the most complete picture possible of the performance, which should then be put into perspective relative to the overall program, system, or process.

Before drawing final conclusions, the assessor should verify the results through at least one other technique.

d. Explain the essential elements of a performance-based assessment, including the areas of investigation, fact-finding, and reporting. Include a discussion of the essential elements and processes associated with the following assessment activities:
- **Exit interviews**
- **Closure process**
- **Tracking to closure**
- **Follow-up**
- **Contractor corrective action implementation**

Exit Interviews

The following is taken from DOE G 414.1-1B.

This meeting is used primarily by the assessment team to present the assessment summary. Reasonable time should be allowed to discuss any concerns, but this meeting should not be used to argue the assessment findings or methodology. There should be no surprises during the exit meeting since the assessment team should have taken every effort possible during the conduct of the assessment to ensure that the assessed organization was aware of the team's findings and concerns. Prior to the exit meeting the assessment team should consider combining related findings into a small number of well-supported findings to help focus management's opportunities for improvement.

Follow-Up, Tracking, and Closure Processes

The following is taken from DOE G 414.1-5.

An integral part of a successful corrective action program is the capability to maintain a systematic approach for tracking and reporting the status of the corrective actions to successful closure and implementation. This may be accomplished manually or electronically.

Maintaining and updating this information provides consistent data for tracking and analyzing program status and trends. The process used to track and report corrective action progress should be readily accessible and provide sufficient data to appraise, analyze, and report the status of corrective actions affecting the safety, mission performance, and security of the site/organization.

Characteristics of an effective corrective action tracking and reporting system include the following:
- The number of data elements to enter, track, trend, and report should be standardized and relevant for the reader to fully comprehend what, how, when, and by whom the identified problem will be effectively resolved so it will not recur. An excessive

number of data elements to track and report may become too cumbersome and complicated, and may over-burden the ability of the system to provide qualitative and consistent information.

- The process for populating data elements should be clearly promulgated and enforced.
- The system should employ information technology that implements user-friendly, controlled access to the system and flexible reporting.
- A dedicated, highly reliable, automated database system may be the most cost-effective approach for tracking the CAP implementation, and it may significantly enhance data collection, storage management, and processing of data and information in a timely manner. For the DOE corrective action management plan (CAMP), the corrective action tracking system (CATS) is used.
- A basic and simple process requiring minimal training and easy access to enter and retrieve data by both the computer technical expert and novice entry level member up through senior management will allow for increased participation and involvement by all personnel involved in identifying the findings and implementing corrective actions.
- The system should contain an automated workflow or a relationship capability for linking findings to corrective actions.
- The system should contain a pre-designed reporting capability for generating summary statistics and reporting timely, consistent, and accurate corrective action information.
- The information to be entered into the system should be consistent with simple, well-defined data elements and attributes for the data to be entered. Unorganized and inconsistent data collection significantly reduces the usefulness of the data. Guidance for the type of information to enter into the system should be thorough, clearly defined, and easily understood with a minimum of training and instruction.
- Access security to the data should be an integral component of the system. Access should be limited to only those with a need to know. That may include members involved in the identification of finding and implementing the associated corrective actions. The corrective action information may delineate vulnerabilities of a site or organization and should not be available to the general population. Editor access to the system for updating data should be restricted to those registered personnel authorized by their management to access and enter only data involving the specified sites or organizations for which they have received authority. For the CATS, registration is required for readers and editors.
- The system should possess the capability to pinpoint problem areas and track trends. It should maintain historical data that supports ongoing problem resolution, trend analysis, and recurrence control activities.
- The system should allow flexible reporting, CAP changes and status, and real-time visibility of open and closed findings and corrective actions.
- The system should be able to integrate and link with other applicable databases.

The following is taken from DOE G 414.1-1A.

After a reasonable period of time has elapsed, follow-up activities should be performed to verify the effectiveness of the corrective actions and how they were implemented. The

verification should, at a minimum, sample the corrective actions to determine whether the problem/issue to be addressed has been resolved. The organization's reporting systems (e.g., noncompliance tracking system, ORPS, external oversight reports and regulatory violations, and performance indicators) should be reviewed for evidence of the problem (or a similar problem) recurring. The same techniques used to conduct assessments may be used for verifying corrective actions; however, there are several common ways to verify the implementation of corrective actions, including the following:

- Reassessment of the deficient areas
- Review of new or revised quality-affecting documents such as manuals, procedures, and training records
- Verification during the next scheduled assessment
- Verification by conducting a surveillance covering the areas of concern

Contractor Corrective Action Implementation

The following is taken from DOE G 414.1-5.

In summary, the generalized procedures for development, implementation, completion, and follow-up of a corrective action program are discussed below. The extent and degree of implementing each of these procedures explained below is at the discretion of management based on a graded approach of the significance and criticality of the identified problem finding:

- Upon receipt of an event, observation, or assessment report, the manager responsible for the site/organization conducts a thorough evaluation of the reported findings and determines the causal factors contributing to each.
- Based on the results of the finding evaluation, a CAP should be developed listing the corrective actions to address each finding in the report.
- The CAP should be submitted for approval by the senior manager authorized to provide the resources (funding, personnel, time, etc.) necessary to implement the corrective actions successfully. A specified timeframe for development and senior manager approval of the CAP should be included in the corrective action process. The DOE CAMP requires secretarial officer approval within 60 calendar days from the date of the transmittal forwarding the assessment report.
- The senior manager approves the CAP. If the senior manager does not approve the CAP, it should be returned to the site/organization manager for follow-up action and be resubmitted to the senior manager. Upon approval of the CAP, the site/organization manager should forward a copy to the organization/individual that conducted the assessment/observation for review and feedback. If the assessing organization/individual provides comments concerning the CAP, they should be reviewed by the site/organization manager who will determine if any modifications of the CAP should be made based on the comments. Major modifications involving additional resources may need to be reviewed for approval by the senior manager.
- The responsible site/organization manager implements the approved CAP, enters the findings and associated corrective actions into a tracking system, and ensures the status of corrective actions is effectively tracked and continuously updated to closure.
- Upon completion of all corrective actions in the CAP, the responsible site/organization manager reports completion in the corrective action program tracking system.

- The responsible site/organization manager conducts an independent review of the completed corrective actions implemented for each finding to objectively verify closure and ensure that each finding was effectively resolved and will not recur.
- New or revised CAPs should be documented, approved by the site/organization manager, tracked, and status reported to completion. Upon completion of the revised or new corrective actions for each problem finding, a corrective action effectiveness review of the corrective actions for the specific findings should be conducted, approved and followed up.
- The responsible site/organization manager approves the corrective action effectiveness review and follows up results and recommendations of the review. This may include implementing additional courses of action for partially effective and ineffective corrective actions. The manager should annotate approval and results of the review in the CAP tracking system. Depending on the extent of additional corrective actions determined, the site/organization manager may decide to develop a revised or additional CAP and conduct another corrective action effectiveness review of the new corrective actions for the specific findings.
- The responsible site/organization manager develops and applies lessons learned identified from the observation/assessment findings, corrective actions in response to the findings, and results of the corrective action effectiveness reviews, as applicable. Implementation of lessons learned may occur at any time during the corrective action program process.
- Upon reporting approval of the corrective action effectiveness review and completion of follow-up activities, the responsible site/organization manager closes the CAP.

e. Describe the actions to be taken if the contractor challenges the assessment findings and explain how such challenges can be avoided.

The following is taken from EPA QA/G-3, *Guidance on Assessing Quality Systems*.

Disputes over the assessment findings, the CAP, or its implementation (such as timeliness or adequacy) must be resolved at the lowest possible organizational level. The organization that disagrees with the disposition of a given issue may elevate the dispute for timely resolution. The organization that disagrees with the disposition of a given issue must elevate the dispute in a step-wise manner through the management hierarchy. The dispute must be raised via a deliberate and timely dispute resolution process that provides each party with equal opportunity for input and a subsequent opportunity to appeal decisions up to the Secretary of Energy, if necessary.

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10 CFR 71.4, "Definitions." January 1, 2009.
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10 CFR 835. 1001, "Design and Control." January 1, 2009.
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