National Nuclear Security Administration

Transportation and Traffic Management

Qualification Standard
Reference Guide

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PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a National Nuclear Security Administration (NNSA) technical employee to successfully complete the Transportation and Traffic Management Functional Area Qualification Standard. In some cases, information essential to meeting the qualification requirements is provided. 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 has been developed to address the competency statements in the September 2002 edition of DOE-STD-1155-2002, Transportation and Traffic Management Functional Area Qualification Standard. 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. The qualification standard for Transportation and Traffic Management contains 28 competency statements. This reference guide will address all the statements; however, performance-based skills and abilities within those competencies will not be covered.

Every effort has been made to provide the most current information and references available as of December 2006. However, the candidate is advised to verify the applicability of the information provided.

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

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
Substances, such as paint, detergent, or insecticide, packaged under pressure with a gaseous propellant for release as a spray of fine particles.

Boiling Point
The temperature at which a liquid boils at a fixed pressure, especially under standard atmospheric conditions.

Characteristic Waste
A waste exhibits the characteristic of ignitability if the waste exhibits in the following forms:
- A liquid, other than an aqueous solution containing less than 24 percent alcohol by volume, with a flash point below 140ºF
- A non-liquid, which under standard conditions is capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns in a manner that creates a hazard;
- An ignitable compressed gas, which includes gases that form flammable mixtures at a

concentration of 13 percent or less in air; or
- An oxidizer, such as permanganate, inorganic peroxide, or nitrate, that readily stimulates combustion of organic materials

A waste exhibits the characteristic of corrosivity if the waste
- is aqueous and has a pH less than or equal to 2, or greater than or equal to 12.5, using Environmental Protection Agency (EPA)-specified or approved test methods; or
- is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 millimeters (mm) (0.250 inches [in.]) per year at a test temperature of 130º.

A waste exhibits the characteristics of reactivity if the waste
- is normally unstable and readily undergoes violent change without detonation;
- reacts violently with water;
- forms potentially explosive mixtures with water;
- when mixed with water, generates toxic gases, vapors, or fumes in a quantity sufficient to present a danger;
- is a cyanide or sulfide-bearing waste that generates toxic gases, vapors, or fumes at a pH between 2 and 12.5;
- is capable of detonation or explosive reaction when subject to a strong initiating source or if heated in confinement;
- is readily capable of detonation, explosive decomposition, or reaction at standard temperature and pressure; or
- is an explosive, as defined in 49 CFR 173.51 or 173.53.

A waste exhibits the characteristic of toxicity when EPA-defined test procedures indicate that an extract derived from the waste contains certain toxicants. The toxicants to be tested for are arsenic; barium; benzene; cadmium; carbon tetrachoride; chlordane; chlorobenzene; chloroform; chromium; o-, m- and p-cresol; 2,4-D; 1,4-dichlorobenzene; 1,2-dichloroethane; 1,1-dichlorethylene; 2,4-dinitrotoluene; endrin; heptachlor (and its hydroxide); hexachlorobenzene; hexachlorobutadiene; hexachloroethane; lead; lindane; mercury; methoxychlor; methyl ethyl ketone; nitrobenzene; pentachlorophenol; pyridine; selenium; silver; tetrachlorethylene, 2,4,5- and 2,4,6-trichlorophenol; 2,4,5-TP (silvex); and vinyl chloride.

Combustible Liquid
A liquid that gives off flammable vapors at temperatures between 80°F and 150°F. Most solvents used in plastics processing are combustible according to this definition.

Compressed Gases
A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 pounds per square inch (psi) at 70°F.

Corrosive Material
A corrosive material is one that causes damage to skin, eyes, or other parts on the body on contact. The technical definition is written in terms of "... destruction, or irreversible damage to living tissue at the site of contact." Often this damage is caused directly by the chemical, but the action of some corrosive materials is a consequence of inflammation that they may cause. Concentrated acids are obvious examples of corrosive materials, but even dilute

solutions of bases such as sodium or ammonium hydroxide may also be very corrosive, particularly in contact with the eyes.

Density
The mass per unit volume of a substance under specified conditions of pressure and temperature.

Explosive
A substance that undergoes decomposition or combustion with great rapidity, evolving much heat, and producing a large volume of gas. The reaction products fill a much greater volume than that occupied by the original material and exert an enormous pressure, which can be used for blasting and for propelling.

Flammable Gas, Liquid, Solid
A flammable gas is any material which is a gas at 68ºF or less and 14.7 psi of pressure (that is, a material which has a boiling point of 68ºF or less at 14.7 psi) and that

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

A flammable liquid is a liquid that has a flash point of between 21°C and 55°C.

Flammable solid is any of the following 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 either in 49 CFR 172.101 or have been assigned a shipping name and hazard class by the Associate Administrator under the provisions of an exemption issued under subchapter A of 49 CFR 173; or an approval issued under 49 CFR 173.56(i).
- Self-reactive materials are materials that are thermally unstable and that can undergo a strongly exothermic decomposition even without participation of oxygen (air).

Flash Point
The lowest temperature at which the vapor of a combustible liquid can be made to ignite momentarily in air.

Gas
The state of matter distinguished from the solid and liquid states by relatively low density and viscosity, relatively great expansion and contraction with changes in pressure and temperature, the ability to diffuse readily, and the spontaneous tendency to become distributed uniformly throughout any container.

Infectious Substance
A viable micro-organism, or its toxin, that causes or may cause disease in humans or animals.

The following are examples of infectious substances:

- All cultures containing or suspected of containing an agent that may cause infection
- Human or animal samples that contain such an agent in quantities sufficient to cause

infection, should an exposure to them occur
- Sample(s) from a patient with a serious disease of unknown cause
- Other specimens not included above and designated as infectious by a qualified person, e.g. a physician, scientist, nurse, etc.

Inhalation Hazard
Release of liquefied product may create atmospheres that can rapidly exceed lethal levels. Acute low level exposure that exceeds the permissible exposure limit will result in irritation of the nose and throat, headache, dizziness, nausea, and nervousness.

Liquid
The state of matter in which a substance exhibits a characteristic readiness to flow, little or no tendency to disperse, and relatively high incompressibility.

Mixture
A composition of two or more substances that are not chemically combined with each other and are capable of being separated.

Nonflammable Gas
Any product, including compressed gas, liquefied gas, pressurized cryogenic gas and compressed gas in solution, that is required to be shipped as United Nations (UN) class 2.2 under 49 CFR 173.115 (b). This means a non-flammable, non-poisonous compressed gas material (or mixture) that exerts in the packaging a pressure of 41 pounds per square inch absolute (psia) or higher at 68ºF, and does not meet the definition of a flammable gas, a poison gas, a corrosive gas, or an oxidizing gas.

Oxidizer
A substance that oxidizes another substance, especially one that supports the combustion of fuel; an oxidizing agent.

Poisonous Materials
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 with a lethal dose, 50% (LD_{50}) of <500 milligrams/kilogram (mg/kg) or a solid with an LD_{50} of <200 mg/kg
  - Dermal toxicity: a material with an LD_{50} of <1,000 mg/kg
  - Inhalation toxicity: a dust or mist with a lethal concentration, 50%, LC_{50} <10 m/ liter (L); or a material with a saturated vapor concentration in air at 20ºC of more than 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 <5,000 milliliters/cubic meter (mL/m^3)
- has properties similar to tear gas that causes extreme irritation, especially in confined spaces

Pyrophoric
Spontaneously igniting in air.

Radioactive Material
Any material whose radioactive activity exceeds 2 nCi/g (n designates 10^{-9}) or 70 Bq/g.

Solid
A substance having a definite shape and volume; one that is neither liquid nor gaseous.

Solution
A homogeneous mixture of two or more substances, which may be solids, liquids, gases, or a combination of these.

Vapor
The state of a substance that exists below its critical temperature and that may be liquefied by application of sufficient pressure.

Waste Codes (F, K, P, U,)
F codes are used for listed hazardous wastes and are used if the process is descriptive, no matter what the concentration of hazardous constituent is in the total resultant waste (e.g., a disposable pad used to apply trichloroethylene for the purpose of degreasing metal would be coded F001).

K code wastes come from industrial or manufacturing wastes where the specific process is known. These codes are not likely in typical building wastes.

U listed wastes include old, off-specification or discarded commercial chemicals. For example, a process or lab chemical that has exceeded its shelf life and can't be used may be a U waste.

Like U wastes, P wastes are also old, off-specification or discarded commercial chemicals. The P wastes are, however, more toxic than U wastes.

Waste Stream
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
A water reactive substance is one that spontaneously undergoes a chemical reaction with water. Notable examples include the alkali metals sodium through caesium. Water reactive substances are classified as R2 under the UN classification system and as hazard 4.3 by the U.S. Department of Transportation (DOT). Some water reactive substances are also pyrophoric.

Reference: www.answers.com

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 mean, in general terms, is the average value of the data set.

An average is a value that is typical or representative of a set of data. The mean of a set of quantitative data is defined as the sum of the measurements divided by the number of measurements contained in the data set.

The arithmetic mean, or briefly the mean, of a set of N numbers $x_1, x_2, x_3, \ldots, x_N$ is denoted by $\bar{x}$ (read "x bar") for a sample, or the symbol μ for a population, and is defined as

$$\bar{x} = \frac{x_1 + x_2 + x_3 + \cdots + x_n}{N} = \frac{\sum_{j=1}^{N} x_j}{N} = \frac{\sum x}{N}$$

Example:

For the data set consisting of 7, 3, 5, 8, 8, 5, 4, 5, 9, the mean is calculated as follows:

$$\frac{7+3+5+8+8+5+4+5+9}{9} = \frac{54}{9} = 6$$

Variance

One of the most commonly used measures of data variation is the variance, which is termed σ^2 (the notation s^2 is also used) for a population and S^2 for a sample. The formulas are as follows:

Population

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

Sample

$$S^2 = \frac{\sum (x-\bar{x})^2}{N-1}$$

To calculate a sample variance, follow these steps:

1. Compute the sample mean.
2. Compute the deviation of each measurement from the mean: ($x - \bar{x}$).
3. Square each deviation: $x - \bar{x}^{\,2}$.

4. Sum the square deviations: $\sum (x - \bar{x})^2$.
5. Divide the sum by (the number of measurements – 1): (N – 1).

Standard Deviation of the Mean
Mathematicians have shown that the uncertainty of the mean value of a normal distribution is much smaller than the standard deviation of the entire distribution. They have proven that there is about a 2/3 probability that the true value will lie within $\pm(\sigma/\sqrt{n})$ (where σ is the standard deviation of the data, and n is the number of data values) of the mean value, and about a 95% probability that the true value will lie within twice this distance from the mean value. This number $\pm(\sigma/\sqrt{n})$ is called the standard deviation of the mean, and whenever we say standard deviation in reference to a mean value, we mean standard deviation of the mean.

Example:

Trial	**Group A**	**Group B**
1	9.7	16.4
2	9.9	4.6
3	10.5	2.6
4	10.1	20.3
5	9.6	5.2
6	9.7	
7	9.4	
8	9.8	
9	10.0	
10	9.6	
Mean value	**9.8**	**9.8**
Standard deviation	**0.3**	**8.0**
Standard deviation of the mean	**0.1**	**3.6**

The table above shows some (contrived) data for two fictitious groups, group A and group B. In this experiment, group A has run ten trials for a measurement and calculated a mean value of 9.8 (in some units). Group B has run five trials, and their mean value is also 9.8.

Most (but not all) of the data falls within one standard deviation of the mean value, and just

about all of the data falls within two standard deviations of the mean. In the example above, only group A's trial 3, 10.5, is more than two standard deviations from the mean. This means that it is an unusual value.

Group A has not only taken more data than group B, but their data values are much more closely grouped, as indicated by the much smaller standard deviation of their data (which possibly indicates more care and skill in gathering the data). Notice, too, that their data produces a much smaller standard deviation of the mean, which means that their experiment can provide a much better test.

Median
The median of a set of numbers — arranged in order of magnitude — is either the middle value for a data set with an odd number of members, or the average of the two middle values if the data set contains an even number of members.

Example:

	Odd Number of Members	**Even Number of Members**
Data set	7, 3, 5, 9, 7, 5, 4, 5, 9	2, 3, 6, 4, 2, 7, 2, 7, 9, 8
Ordered data set	3, 4, 5, 5, **5,** 7, 7, 9, 9	2, 2, 2, 3, **4, 6,** 7, 7, 8, 9
Median	**5**	**(4 + 6) / 2 = 5**

Mode
The mode of a set of numbers is that value which occurs with the greatest frequency. The mode may not exist, and even if it does exist, it may not be unique.

Example:

	Example 1	**Example 2**	**Example 3**
Data set	3, 4, **5, 5, 5,** 7, 8, 8, 9	3, 5, 8, 10, 12, 15, 16	2, 3, **4, 4, 4,** 5, 5, **7, 7, 7,** 9
Mode	**5**	**No mode**	**4 and 7, bimodal**

Standard Deviation
The standard deviation is the square root of variance. The formulas for standard deviation (σ for a population and S for a sample) are as follows:

Population	**Sample**
$\sigma = \sqrt{\dfrac{\sum (x-\mu)^2}{N}}$	$S = \sqrt{\dfrac{\sum (x-\bar{x})^2}{N-1}}$

Example:

The standard deviation of age for a group of children aged 5, 6, 8, and 9 is calculated as follows:

$$S = \sqrt{S^2} = \sqrt{\frac{\sum (x-\bar{x})^2}{N-1}} = \sqrt{2.5} = 1.58$$

Reference: DOE-HDBK-1014/2-92, DOE Fundamentals Handbook, Mathematics, volume 2

b) Explain the structure and function of distributions.

If a variable x can only assume a discrete set of values $x_1, x_2, \ldots, x_K$ with corresponding probabilities of $p_1, p_2, \ldots, p_K$, where the sum of $p_1, p_2, \ldots p_K = 1$, a discrete probability distribution for x, called the probability function or frequency function of x, has been defined.

Because x can only assume specific values with associated probabilities, it is often called a discrete random variable. This is opposed to x values that can assume any value contained in one or more intervals and for which the associated probability function is continuous.

The probability distribution for a discrete random variable is a graph, table, or formula that correlates the probability associated to each possible value the discrete random variable can assume. The form of the probability distribution for a continuous random variable is a smooth curve. The areas under a probability distribution correspond to probabilities for x. Also, because areas over intervals represent probabilities, the total area under the probability distribution is equal to 1.

The bell curve is one of the most commonly observed continuous random variable probability distributions. Its probability distribution is a normal distribution. The normal distribution is symmetric about its mean value μ, and it has a spread that is determined by σ, its standard deviation. The formula for the normal probability distribution is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(1/2)[(x-\mu)/\sigma]^2}$$

where:
μ = mean of the normal random variable x
σ = standard deviation

$\pi = 3.1416$
$e = 2.71828$

In probabilistic risk assessment, normal distributions are frequently used to describe equipment which has increasing failure rates with time. A log-normal distribution is similar to a normal distribution with the exception that the logarithms of the values of the random variables, rather than the values themselves, are assumed to be normally distributed. Thus, all values are positive, the distribution is skewed to the right, and the skew is a function of an error factor. Log-normal distributions are encountered frequently in metal fatigue testing, maintainability data (time to repair), and chemical process equipment failures and repairs.

A distribution is called a discrete distribution if it is defined on a countable, discrete set, such as a subset of the integers. A distribution is called a continuous distribution if it has a continuous distribution function, such as a polynomial or exponential function. Most distributions of practical importance are either discrete or continuous, but there are examples of distributions which are neither.

Important discrete distributions include the binomial distribution, the Poisson distribution, and the negative binomial distribution.

Important continuous distributions include the normal distribution and the exponential distribution.

Binomial Distribution
The binomial distribution is applicable in defining the probability of r occurrences in n trials of an event which has a probability of occurrences of p on each trial. The formula for a binomial distribution is

$$y = \frac{n!}{r!(n-r)!} p^r q^{n-r}$$

where:
n = number of trials
r = number or occurrences
p = probability of occurrence
q = 1-p
! = product of all integers up to the given number

Poisson Distribution
The Poisson distribution is the same as the binomial distribution but is particularly applicable when there are many opportunities of the occurrence of an event, but a low probability (less than 0.10) on each trail. The formula for the Poisson distribution is

$$y = \frac{(n\mathrm{p})^r e^{-n\mathrm{p}}}{r!}$$

where:
n = number of trials

r = number or occurrences
p = probability of occurrence
e = 2.71828

Negative Binomial Distribution
The negative binomial distribution is applicable in defining the probability that r occurrences will require a total of $r + s$ trials of an event which has a probability of occurrence of p on each trial. The formula for the negative binomial distribution is

$$y = \frac{(r+s-1)!}{(r-1)!(s!)} p^r q^s$$

where:
r = number of occurrences
s = difference between number of trials and number of occurrences
p = probability of occurrence
q = 1-p
! = product of all integers up to the given number

Normal Distribution
The normal distribution is applicable when there is a concentration of observations about the average and it is equally likely that observations will occur above and below the average. Variation in observations is usually the result of many small causes. The formula for the normal distribution is

$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{(x-\mu)^2}{2\pi^2}}$$

where:
μ = mean
σ = standard deviation
π = 3.1416
e = 2.71828
x = each observation

Exponential Distribution
The exponential distribution is applicable when it is likely that more observations will occur below the average than above. The formula for the exponential distribution is

$$y = \frac{1}{\mu} e^{-\frac{x}{\mu}}$$

where:
μ = mean
e = 2.71828

x = each observation

Reference: DOE-HDBK-1014/2-92, DOE Fundamentals Handbook, Mathematics, volume 2

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.

Items "c" through "e" are performance-based competencies. The qualifying official will evaluate the completion of these competencies.

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

Most frequency distributions exhibit a central tendency, i.e., a shape such that the bulk of the observations pile up in the area between the two extremes. Central tendency is one of the two most fundamental concepts in statistical analysis. The measures of central tendency are the mean, the median, and the mode.

Data are always scattered around the zone of central tendency, and the extent of this scatter is called variation. A measure of variation is the second of the two most fundamental measures in statistical analysis. There are several measures of variation. The simplest is the range, which is the difference between the maximum and minimum values in the data. The most important measure of variation is the standard deviation. The square of the standard deviation is the variance.

Reference: DOE-HDBK-1014/2-92, DOE Fundamentals Handbook, Mathematics, volume 2

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

There are two kinds of errors that can be made in significance testing: (1) a true null hypothesis can be incorrectly rejected, and (2) a false null hypothesis can fail to be rejected. The former error is called a type I error and the latter error is called a type II error. The probability of a type I error is designated by the Greek letter alpha (α) and is called the type I error rate; the probability of a type II error (the type II error rate) is designated by the Greek letter beta (ß). A type II error is only an error in the sense that an opportunity to reject the null hypothesis correctly was lost. It is not an error in the sense that an incorrect conclusion was drawn since no conclusion is drawn when the null hypothesis is not rejected.

A type I error, on the other hand, is an error in every sense of the word. A conclusion is drawn that the null hypothesis is false when, in fact, it is true. Therefore, type I errors are generally considered more serious than type II errors. The probability of a type I error (α) is called the significance level and is set by the experimenter. There is a tradeoff between type I and type II errors. The more an experimenter protects him or herself against type I errors by choosing a low level, the greater the chance of a type II error. Requiring very strong evidence to reject the null

hypothesis makes it very unlikely that a true null hypothesis will be rejected. However, it increases the chance that a false null hypothesis will not be rejected, thus lowering power. The type I error rate is almost always set at .05 or at .01, the latter being more conservative since it requires stronger evidence to reject the null hypothesis at the .01 level then at the .05 level.

Reference: DOE-HDBK-1014/2-92, DOE Fundamentals Handbook, Mathematics, volume 2

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

   a) **Convert curies to terabecquerels and terabecquerels to curies.**

   1 terabecquerel (TBq) = 27 curie (Ci)

   b) **Convert pounds to kilograms and kilograms to pounds.**

   1 kg = 2.202 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)

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

   1 m^3 = 35.314 cubic feet (ft^3)

   f) **Convert gallons to liters and liters to gallons.**

   1 gallon (gal) = 3.785 L

   Reference: http://www.onlineconversion.com/

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**

   NUREG-1609 includes appendices that describe various package types. For each package type, general guidance is provided on the safety functions of the package. Safety features are described, and specific areas of technical review are identified. Technical review should focus on these features. Components and features that provide a safety function should be clearly identified, with sufficient specificity, on packaging drawings. The degree of specificity should be commensurate with its safety function, and the sensitivity of package

performance with the particular feature. For a spent nuclear fuel package, NUREG-1617 provides guidance on components and features that should be identified with sufficient specificity on packaging drawings.

In general, 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, therefore, 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 performance of each packaging, but it also provides flexibility for reasonable variation in the fabrication of the packagings. Furthermore, it is important for demonstrating compliance and facilitating inspection activities. For example, when tolerances are not specified, any slight deviation in dimensions could cause the package to be out of compliance, even though the deviation may not affect safety. Thus, drawings that are well-prepared and which include appropriate tolerances facilitate the inspection process.

Engineering drawings often include features that may not contribute to safety, but are part of the package design. These features may be important for other reasons (e.g., ease of handling radioactive material within a facility, product protection, or cosmetic reasons). It is important that flexibility be allowed for these non-safety features, to eliminate unnecessarily restricting or regulating non-safety significant design features. However, it is often necessary to show the features, to ensure that the package configuration is authorized. For these cases, a general representation may be noted, or optional configurations may be included in the drawings.

Because of the variety of transportation package types, the safety importance of certain package features also varies. For example, the O-ring seals on a spent fuel cask provide a safety function (containment), but for a fresh fuel package, the O-ring seals only provide weather protection for product cleanliness. The specificity of the sealing system design for these two packages would therefore be significantly different. The reviewer should verify that the drawings for the spent fuel cask show the seal surface and O-ring groove details, including surface finish, groove dimensions within strict tolerances, O-ring size, type, and material. For the fresh fuel package, the drawing may note the presence of a gasket, but its use may be considered optional for safety in transport. Some examples of package features that may be safety related for some designs, but not for other designs, include: paint and coatings; seals, spacers, and dunnage; supplemental radiation shielding; inner containers; outer packagings; or overpacks. For those package features that are not safety related in a design, detailed information need not be shown in the drawings.

NUREG/CR-5502, “Engineering Drawings for 10 CFR 71 Package Approvals,” contains information useful for the technical review of packaging designs and engineering drawings.

NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," also contains useful information about the safety significance of packaging components and features. These documents may be useful in judging whether the information provided is sufficiently detailed.

Reference: http://www.nrc.gov/reading-rm/doc-collections/isg/isg-20.pdf

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

There are many things that should be addressed during the performance of a barrier analysis. The questions listed below are designed to aid in determining what barrier failed, thus resulting in the occurrence:

- What barriers existed between the second, third, etc., condition/situation and the second, third, etc., problems?
- If there were barriers, did they perform their functions? How?
- Did the presence of any barriers mitigate or increase the occurrence severity? Why?
- Were any barriers not functioning as designed? Why?
- Was the barrier design adequate? Why?
- Were there any barriers in the condition/situation source(s)? Did they fail? Why?
- Were there any barriers on the affected component(s)? Did they fail? Why?
- Were the barriers adequately maintained?
- Were the barriers inspected prior to expected use?
- Why were any unwanted energies present?
- Is the affected system/component designed to withstand the condition/situation without the barriers? Why?
- What design changes could have prevented the unwanted flow of energy? How?
- What operating changes could have prevented the unwanted flow of energy? How?
- What maintenance changes could have prevented the unwanted flow of energy? How?
- Could the unwanted energy have been deflected or evaded? How?
- What other controls are the barriers subject to? Why?
- Was this event foreseen by the designers, operators, maintainers, anyone?
- Is it possible to have foreseen the occurrence? How?
- Is it practical to have taken further steps to have reduced the risk of the occurrence?
- Can this reasoning be extended to other similar systems/components?
- Were adequate human factors considered in the design of the equipment?
- What additional human factors could be added? Should be added?
- Is the system/component user friendly?

- Is the system/component adequately labeled for ease of operation?
- Is there sufficient technical information for operating the component properly? How do you know?
- Is there sufficient technical information for maintaining the component properly? How do you know?
- Did the environment mitigate or increase the severity of the occurrence? How?
- What changes were made to the system/component immediately after the occurrence?
- What changes are planned to be made? What changes might be made?
- Have these changes been properly/adequately analyzed for effect?
- What related changes to operations and maintenance have to be made now?
- Are expected changes cost effective? Why? How do you know?
- What would you have done differently to have prevented the occurrence, disregarding all economic considerations (as regards operation, maintenance, and design)?
- What would you have done differently to have prevented the occurrence, considering all economic concerns (as regards operation, maintenance, and design)?

Barrier analysis is a systematic process that can be used to identify physical, administrative, and procedural barriers or controls that should have prevented the occurrence. This technique should be used to determine why these barriers or controls failed and what is needed to prevent recurrence.

Causal Factor Analysis
Causal factor analysis is used for multi-faceted problems or long, complex causal factor chains. Cause and effects diagrams describe the time sequence of a series of tasks and/or actions and the surrounding conditions leading to an event. The event line is a time sequence of actions or happenings, while the conditions are anything that shapes the outcome, and ranges from physical conditions (such as an open valve or noise) to attitude or safety culture. The events and conditions as given on a chart describe a causal factor chain.

Change Analysis
Change analysis looks at a problem by analyzing the deviation between what is expected and what actually happened. The evaluator essentially asks what differences occurred to make the outcome of this task or activity different from all the other times this task or activity was successfully completed. This technique consists of asking the questions: What? When? Where? Who? How?

Answering these questions should provide direction toward answering the root-cause determination question: Why? Primary and secondary questions included within each category will provide the prompting necessary to thoroughly answer the overall question. Some of the questions will not be applicable to any given condition. Some amount of redundancy exists in the questions to ensure that all items are addressed. Several key elements to be addressed include the following:

- Consider the event containing the undesirable consequences.
- Consider a comparable activity that did not have the undesirable consequences.
- Compare the condition containing the undesirable consequences with the reference activity.
- Set down all known differences, whether they appear to be relevant or not.
- Analyze the differences for their effects in producing the undesirable consequences.

This must be done with careful attention to detail, ensuring that obscure and indirect relationships are identified (e.g., a change in color or finish may change the heat transfer parameters and consequently affect system temperature).

- Integrate information into the investigative process relevant to the causes of, or the contributors to, the undesirable consequences.

Change analysis is a good technique to use whenever the causes of the condition are obscure, you do not know where to start, or you suspect a change may have contributed to the condition. Not recognizing the compounding of change (e.g., a change made 5 years previously combined with a change made recently) is a potential shortcoming of change analysis. Not recognizing the introduction of gradual change as compared with immediate change also is possible. This technique may be adequate to determine the root cause of a relatively simple condition. In general, though, it is not thorough enough to determine all the causes of more complex conditions.

MORT

MORT 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

Root cause analysis includes the following basic steps:

- Identify the problem. Actuation of a protective system constitutes the occurrence but is not the real problem; the unwanted, unplanned condition or action that resulted in actuation is the problem to be solved. For example, dust in the air actuates a false fire alarm. In this case, the occurrence is the actuation of an engineered safety feature. The smoke detector and alarm functioned as intended; the problem to be solved is the dust in the air, not the false fire alarm. Another example is when an operator follows a defective procedure and causes an occurrence. The real problem is the defective procedure; the operator has not committed an error. However, if the operator had been correctly trained to perform the task and, therefore, could reasonably have been expected to detect the defect in the procedure, then a personnel problem may also exist.
- Determine the significance of the problem. Were the consequences severe? Could they be next time? How likely is recurrence? Is the occurrence symptomatic of poor attitude, a safety-culture problem, or other widespread program deficiency? Base the level of effort of subsequent steps of the assessment upon the estimation of the level of significance.
- Identify the causes immediately preceding and surrounding the problem. Then identify the reasons why the causes in the preceding identification step existed, working back to the root cause (the fundamental reason that, if corrected, will prevent

recurrence of this and similar occurrences. This root cause is the stopping point in the assessment of causal factors. It is the place where, with appropriate corrective action, the problem will be eliminated and will not recur.

DOE G 231.1-2, Occurrence Reporting Causal Analysis Guide, and DOE G 225.1-1A provides detailed descriptions of each technique.

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
An events and casual factors chart is a cause and effects diagram that describes the time sequence of a series of tasks and/or actions and the surrounding conditions leading to an event. The event line is a time sequence of actions or happenings while the conditions are anything that shape the outcome and that range from physical conditions (such as an open valve or noise) to attitude or safety culture. The events and conditions as given on the chart describe a causal factor chain. The direct, root, and contributing cause relationships in the causal factor chain may be shown in flowcharts.

Root Cause Coding
Root cause coding is used to assign codes to the root causes of an event. Codes are assigned based on categories. Three major categories of root causes are
- technical (equipment, software, forms)
- organizational (policies, procedures, and protocols)
- human (knowledge-based, rule-based, and skill based)

Root cause coding is an application that is used in most types of software for root cause analysis.

Recommendation Generation
Recommendation generation is the process of developing recommendations for correcting causes as identified in a root cause investigation. As issues arise in the root-cause analysis, potential recommendations for correcting the root cause may be identified.

DOE G 231.1-2, Occurrence Reporting Causal Analysis Guide, and DOE G 225.1-1A provides detailed descriptions of each technique.

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

DOE O 225.1A, Accident Investigations, provides an accident investigation categorization algorithm as attachment 2. This algorithm provides the criteria for categorizing an accident investigation as either a type A or a type B investigation. The following tabular representation of the algorithm breaks the criteria into four different categories of effects: human, environmental, property, and other.

Type A Investigation	Type B Investigation
Human Effects	
Any fatal, or likely to be fatal, injury or chemical or biological exposure to an employee or a member of the public	Any one or series of injuries, chemical exposures, or biological exposures that results in hospitalization of one or more employees or members of the public for more than five continuous days
Any one accident that requires the hospitalization for treatment of three or more individuals	Any one or series of injuries, chemical exposures, or biological exposures that results in permanent partial disability of one or more employees or members of the public
Any one accident that has a high probability of resulting in the permanent total disability due to injuries, chemical exposures, or biological exposures of U.S. Department of Energy (DOE), contractor, or subcontractor employees or members of the public	Any one accident or series of accidents within a one-year time period resulting in five or more lost-workday cases, or any series of similar or related accidents involving five or more persons, one or more of which is a lost-workday case
A single radiation exposure to an individual resulting in a. a total effective dose equivalent of >25 rem b. a dose equivalent to the lens of the eye of >75 rem c. a shallow dose equivalent to an extremity or skin of >250 rem d. the sum of the deep dose equivalent for external exposure and the committed dose equivalent to any organ or tissue other than the lens of the eye of >250 rem e. a dose equivalent to the embryo or fetus of a declared pregnant worker of >2.5 rem	A single radiation exposure to an individual resulting in a. a total effective dose equivalent of 10 but <25 rem b. a dose equivalent to the lens of the eye of 30 but <75 rem c. a shallow dose equivalent to an extremity or skin of >100 but <250 rem d. the sum of the deep dose equivalent for external exposure and the committed dose equivalent to any organ or tissue other than the lens of the eye of >100 rem but <250 rem e. a dose equivalent to the embryo or fetus of a declared pregnant worker of >1.0 but <2.5 rem
Environmental Effects	
Release of a hazardous substance, material, waste, or radionuclide from a DOE facility (onsite or offsite) in an amount greater than five times the reportable quantities specified in 40 CFR 302, that results in serious environmental damage	Release of a hazardous substance, material, waste, or radionuclide from a DOE facility (onsite or offsite) in an amount greater than or equal to two times but less than five times the reportable quantities specified in 40 CFR 302, that results in serious environmental damage

Type A Investigation	Type B Investigation
Property Effects	
Estimated loss of, or damage to, DOE or other property, including aircraft damage, greater than or equal to $2.5 million or requiring estimated costs greater than or equal to $2.5 million for cleaning, decontaminating, renovating, replacing, or rehabilitating structures, equipment, or property	Estimated loss of, or damage to, DOE or other property, greater than $1 million but less than $2.5 million, including aircraft damage, and costs of cleaning, decontaminating, renovating, replacing, or rehabilitating structures, equipment, or property
Any apparent loss, explosion, or theft involving radioactive or hazardous material under the control of DOE, contractors, or subcontractors in such quantities and under such circumstances as to constitute a hazard to human health and safety or private property	The operation of a nuclear facility beyond its authorized limits
Any unplanned nuclear criticality	
Other Effects	
Any accident or series of accidents for which a type A investigation is deemed appropriate by the Secretary or the Assistant Secretary of Environment, Safety, and Health	Any accident or series of accidents for which a type B investigation is deemed appropriate by the Secretary or the Assistant Secretary of Environment, Safety, and Health; the Associate Deputy Secretary for Field Management; the cognizant Secretarial Officer; or the head of the field element, (This includes departmental crosscutting issues and issues warranting the attention of local news or interest groups.)

Reference: DOE G 225.1A-1, Implementation Guide for use with DOE O 225.1 Accident Investigations, November 1997

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.

Immediate actions are usually those required to fix or mediate the problem and prevent re-occurrence. The time frame for completion of short-term and long-term corrective actions depends on many factors, including priority (urgency), available budget and personnel, and technology.

Reference: DOE Facility Representative Reference Guide, June 2006

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 competency. The qualifying official will evaluate the completion of this competency.

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**

a) Discuss the application and impact of OSH Act on Department transportation activities.

DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees
The objective of this Order is to establish the framework for an effective worker protection program that will reduce or prevent injuries, illnesses, and accidental losses by providing DOE federal and contractor workers with a safe and healthful workplace.

29 CFR 1910, Occupational Safety and Health Standards
This section covers the following operations, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards:

- Clean-up operations required by a governmental body, whether federal, state, local, or other, involving hazardous substances, that are conducted at uncontrolled hazardous waste sites, including, but not limited to, the EPA's National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, and initial investigations of government-identified sites that are conducted before the presence or absence of hazardous substances has been ascertained
- Corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 United States Code [U.S.C.] 6901 et seq.)
- Voluntary clean-up operations at sites recognized by federal, state, local, or other governmental bodies as uncontrolled hazardous waste sites
- Operations involving hazardous wastes that are conducted at treatment, storage, and disposal (TSD) facilities regulated by 40 CFR parts 264 and 265 pursuant to RCRA, or by agencies under agreement with the EPA to implement RCRA regulations
- Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

Refer to 29 CFR 1910.120 for information related to key terms, essential elements, and personnel responsibilities and authorities, at

http://www.access.gpo.gov/nara/cfr/waisidx_05/29cfr1910_05.html.

29 CFR 1926, Safety and Health Regulations for Construction
This part contains the general rules of the Secretary of Labor for interpreting and applying the construction safety and health provisions of section 107 of the Contract Work Hours and Safety Standards Act. Section 107 requires as a condition of each contract that is entered into under legislation and that is for construction, alteration, and/or repair, including painting and decorating, that no contractor or subcontractor contracting for any part of the contract work shall require any laborer or mechanic employed in the performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety, as determined under construction safety and health standards promulgated by the Secretary by regulation.

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 OSH Act (Public Law [P.L.] 91-596) grants the Occupational Safety and Health Administration (OSHA) the authority to prescribe and enforce standards or regulations affecting the occupational safety and health of private-sector employees. However, section 4(b)(1) of the Act waives OSHA's jurisdiction in cases where another federal agency has exercised its statutory authority to prescribe or enforce occupational safety and health standards. Relying on this section of the Act, the U.S. Department of Labor (DOL), in 1974, explicitly recognized the Atomic Energy Commission's (AEC's) authority to establish and enforce occupational safety and health standards at AEC-sponsored contractor facilities. Subsequently, the DOL and the DOE, the successor agency to the AEC, acknowledged this agreement in the August 10, 1992, memorandum of understanding (MOU) between the two Departments. As specified in the original agreement and in the 1992 MOU, this DOE exemption from OSHA enforcement has applied only to those government-owned, contractor-operated (GOCO) facilities for which DOE exercises its statutory authority pursuant to the Atomic Energy Act (AEA) of 1954. OSHA exercises enforcement authority over all other DOE facilities.

The DOE has exercised its authority over working conditions at its GOCO facilities by developing and promulgating DOE Orders and conducting an extensive program of internal oversight at these facilities. In May 1993, however, Secretary O'Leary announced that DOE would immediately begin the process of shifting from internal oversight of occupational safety and health to external enforcement by OSHA.

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**

DOE O 440.1A requires DOE elements and contractors to identify existing and potential workplace hazards and to evaluate the risk of associated worker injury or illness. There are four components to a hazard analysis: analysis and review; exposure assessment; workplaces and activities; and accident, injury, and illness reporting and data analysis.

Analysis and Review
DOE O 440.1 requires the analysis or review of

- designs for new facilities and for modifications to existing facilities and equipment;
- operations and procedures;
- equipment, product, and service needs;
- the construction phase (to ensure that modifications do not preclude safety and health).

Worker protection professionals should be assigned review and approval authority in all four phases of project design: conceptual design, preliminary design, final design, and inspection. Review during the conceptual design phase, the earliest phase of the project, is critical. Hazard analysis methodologies can be applied to facilities, processes, equipment, and operations throughout their life cycle. Methodologies include

- preliminary hazard analysis
- health hazard analysis
- facility hazard analysis
- process hazard analysis
- safety review

Exposure Assessment
DOE O 440.1A requires assessment of worker exposure to chemical, physical, biological, and ergonomic hazards. This assessment should entail appropriate

- workplace monitoring (including personal, area, wipe, and bulk sampling);
- biological monitoring;
- observation.

Monitoring results should be recorded with documentation that (1) describes the tasks and locations where monitoring occurred, and (2) identifies

- workers monitored or represented by the monitoring,
- sampling methods and durations,
- control measures in place during monitoring (including use of personal protective equipment),
- any other factors that may have affected sampling results.

Samples should be analyzed by a laboratory that is accredited by the American Industrial Hygiene Association. Other detailed guidance on the implementation of this requirement is provided in DOE G 440.1-3, Occupational Exposure Assessment.

Workplaces and Activities
DOE O 440.1A requires routine evaluation of workplaces and activities by workers, supervisors, and managers, and periodic evaluation by qualified worker-protection professionals.

Hazard identification is accomplished most effectively by workers and their supervisors during the course of daily activities, with technical assistance from worker-protection professionals and functional area technical experts, as necessary.

Daily workplace evaluations by workers and supervisors include such things as inspections of tools and equipment, ranging from inspection of manual tools and power tools, forklifts, cranes, slings, and warning systems to inspection of respiratory protective equipment and

other personal protective equipment prior to and during use. Additionally, workplace conditions, housekeeping, utilization of assigned personal protective equipment, and conformance with procedures, work permits, health and safety plans, and other established criteria should be evaluated. Workers and supervisors should consult with worker-protection professionals as necessary to address questions regarding regulatory requirements and compliance or areas where specific technical expertise is needed.

Additionally, daily worker and supervisor evaluations should be supplemented by worker-protection professional evaluations of the workplace. These routine evaluations should include informal, unscheduled walk-through evaluations conducted during worksite visits, and formal, scheduled periodic (annual) workplace evaluations.

Accident, Injury, and Illness Reporting and Data Analysis
DOE 440.1A requires the reporting and investigation of accidents, injuries, and illnesses, and analysis of related data for trends and lessons learned. The collection of detailed, accurate data and information regarding workplace accidents, injuries, and illnesses, and the subsequent analysis of the data and information, are useful in identifying worker-protection problem areas. This type of analysis or trending is used to identify the prevalent types of accidents, injuries, and illnesses and their sources and causes. Information derived from trend analysis can be used to focus worker-protection efforts on the actual sources of injuries and illnesses and to help prioritize hazard abatement activities. Necessary components of accident, injury, and illness data collection and analysis include

- systems and methods to collect, record, compile, and manage accident, injury, and illness data and information, including but not limited to the OSHA 200 log of occupational injuries and illnesses, workers' compensation data, accident reports, incident reports, industrial hygiene and health physics exposure monitoring results, and inspection reports and corrective action tracking entries;
- methodologies to analyze data and information to identify and trend accidents, injuries, and illnesses by type and source;
- a formalized approach to analyze identified trends, to determine root causes, and to develop appropriate control measures.

Worker Hazard Awareness
Workers shall be informed of foreseeable hazards and the required protective measures described within the approved hazard analysis prior to commencement of work on the affected construction operation.

Workplace Inspections and Hazard Abatement
During periods of active construction, the construction contractor shall have a designated representative on site at all times. This individual shall conduct and document daily inspections of the workplace to identify and correct hazards and instances of noncompliance with project safety and health requirements. If immediate corrective action is not possible or the hazard falls outside of the project scope, the construction contractor shall immediately notify affected workers, post appropriate warning signs, implement needed interim control measures, and notify the construction manager of actions taken.

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

DOE O 440.1A requires DOE elements and contractors to provide workers, supervisors, managers, visitors, and worker protection professionals with worker protection training. DOE O 360.1B, Federal Employee Training, and 29 CFR 1960, subpart H, contain training requirements for federal employees. DOE elements should consult the OSH Act requirements (29 CFR 1960) and the DOE Order and the associated implementation guide and technical standards for direction in implementing a successful worker protection training program. Training is required for the following personnel:

- Top management officials
- Supervisors
- Safety and health specialists and inspectors
- Collateral duty safety and health personnel and committee members
- Employees and employee representatives

Contractors should consult 29 CFR 1960, subpart H, for direction in implementing a successful worker protection training program. Training should be included as a component of the written worker protection program.

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

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 Department of Transportation or other regulatory agency requirements.
- Conduct periodic appraisals to determine the adequacy of contractor performance in the implementation of the requirements.

Reference: DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes, July 1985 (Archive)

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

For hazards identified in the workplace, abatement actions, which are prioritized according to risk to the worker, should be promptly implemented, and interim protective measures should be implemented pending final abatement. Workers should be protected immediately from imminent danger conditions. Hazards should be systematically managed and documented through final abatement or control.

Reference: DOE G 440.1-1, Worker Protection Management for DOE Federal And Contractor Employees Guide for use with DOE O 440.1

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
When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection should be used to limit internal exposures. Use of respiratory protection should be considered under the following conditions:
- Entry into airborne radioactivity areas
- During breach of contaminated systems or components
- During work in areas or on equipment with removable contamination levels greater than 100 times the values in table 2-2 of DOE-STD-1098-99, Radiological Control
- During work on contaminated or activated surfaces with the potential to generate airborne radioactivity.

The selection of respiratory protection equipment should include consideration of worker safety, comfort, and efficiency. The use of positive pressure respiratory protection devices is recommended wherever practicable to alleviate fatigue and increase comfort.

In specific situations, the use of respiratory protection may be inadvisable due to physical limitations or the potential for significantly increased external exposure. In such situations, a formal radiological review should be conducted to ensure measures are implemented to assess available options, monitor and reduce worker exposure, and provide for follow-up monitoring, as required. Specific justification of the need to accept the exposure, including a description of measures taken to mitigate the airborne radioactivity, should be documented as part of the review process.

Protective Clothing
Proper protective clothing is required whenever hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered are capable of causing injury or impairment in the function of any part of the body through absorption,

inhalation, or physical contact. The type of protective clothing to be used is based on the type of environment and hazards associated with the hazard.

Reference: DOE-STD-1098-99, Radiological Control, March 2005

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

Personal protective equipment (PPE) 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 self-contained breathing apparatus (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 (under suit)

- Disposable protective suit, gloves, and boots (depending on suit construction, it may be worn over a totally encapsulating suit)

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, fullface-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 (IDLH) 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 personal protective equipment 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.

As an aid in selecting suitable chemical protective clothing, it should be noted that the National Fire Protection Association (NFPA) has developed standards on chemical-protective clothing. The standards include

- NFPA 1991, Standard on Vapor-Protective Suits for Hazardous Chemical Emergencies (EPA Level A Protective Clothing)
- NFPA 1992, Standard on Liquid Splash-Protective Suits for Hazardous Chemical Emergencies (EPA Level B Protective Clothing)
- NFPA 1993, Standard on Liquid Splash-Protective Suits for Non-emergency, Non-flammable Hazardous Chemical Situations (EPA Level B Protective Clothing)

These standards apply documentation and performance requirements to the manufacture of chemical-protective suits. Chemical-protective suits meeting these requirements are labeled as compliant with the appropriate standard. It is recommended that chemical-protective suits that meet these standards be used.

Reference: 29 CFR 1910.120, appendix B

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 element "b" in this competency 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).

Acids and metals react together to form hydrogen, which is a highly flammable gas. Alkalies (bases) are more destructive to the human body than acids. The material causes chemical burns, ulcerations, and scarring. Bases soften and emulsify skin fats and may cause irritation to the eyes and respiratory tract. They can also cause damage to the mucous membranes. When dissolved in water, the chemical reaction releases a great deal of heat, and may cause the solution to boil and splatter.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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

The general safety precautions for handling, storing, and disposing of corrosives are as follows:

- Use personal protective equipment.
- Carefully inspect containers prior to handling.
- Ensure all containers are properly labeled.
- Use proper transporting, handling, and storage containers.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

c) Discuss the general safety precautions regarding toxic compounds.

Because the types of toxic compounds found in industry number in the thousands, and because specific hazards, controls, and corrective measures may vary with the substance, no attempt will be made in this section to address specific compounds. Instead, information of a general nature will be presented on toxic materials. Material Safety Data Sheets (MSDS) are required for all potentially hazardous and toxic materials and should be consulted for specific descriptions and precautions concerning the substance in question.

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.

The purpose of the MSDS is to ensure the individuals working with chemicals and in the vicinity of chemicals have specific information on these chemicals. This form identifies the chemical by its technical and common name and lists the physical/chemical characteristics and fire, explosion, and reactivity hazards. The second page specifies health hazards and recommends first aid procedures. The safe handling and control measures are also supplied. The MSDS is a very helpful document, and personnel working around chemicals should make it a practice to review these sheets frequently for their own safety.

The Code of Federal Regulations recommends that the hazards of all chemicals produced and imported be evaluated and the information concerning the hazards be transmitted to the employers and employees. The MSDS, labels on containers, and employee training should be part of a comprehensive hazards communication program.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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 criteria used to determine if a compound is a health hazard are

- 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

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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

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 feet (ft) to any flammable substance, including grease and oil, and should be stored no closer than 10 feet 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.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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

Many safety precautions that must be taken with compressed gases also apply to liquified 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.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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

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.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

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

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.

Reference: DOE-HDBK-1015/2-93, Chemistry, volume 2

i) Discuss the hazards associated with explosives.

The major hazards from explosives are personal injury, negative environmental impact, and property damage caused by heat, blast, noise, fumes, and flying debris or projectiles from unintentional or inadequately controlled ignition or explosion of such materials. Injuries ranging from minor to fatal could include trauma, lacerations, eye injury, hearing impairment, and burns. Property damage could range from minor to major. Energetic materials are especially vulnerable to elevated temperature, which would be expected for materials exposed to a fire. Possible consequences could range from mild decomposition to vigorous deflagration or detonation.

Reference: Environment, Safety, and Health Manual, Document 22.3, Response Plan for Fire in an Explosives Area, October 2005

j) Discuss the hazards associated with pyrophorics.

Pyrophoric materials are those that ignite spontaneously in air below about 45°C. Consequently, the main hazards arising from the use of such materials involve fire, either

from direct contact with the pyrophoric material or as a result of secondary fires following ignition.

Reference: http://www.chm.bris.ac.uk/safety/chemicalhazards.htm

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

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.

Reference: http://www.ilpi.com/msds/ref/waterreactive.html

l) Discuss the hazards associated with oxidizers.

The hazard communication standard (29 CFR 1910.1200) classifies a chemical as an oxidizer if it is a chemical other than a blasting agent or explosive as defined in 29 CFR 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

An oxidizing agent is a chemical or substance that brings about an oxidation reaction. The agent may provide the oxygen to the substance being oxidized (in which case the agent has to be oxygen or contain oxygen), or it may receive electrons being transferred from the substance undergoing oxidation (e.g., chlorine is a good oxidizing agent for electron-transfer purposes, even though it contains no oxygen).

Oxidizing materials can initiate or greatly accelerate the burning of fuels. The most common oxidizer is atmospheric oxygen. Oxygen-containing chemicals (e.g., hydrogen peroxide and nitrous oxide) and halogens (e.g., bromine, chlorine, and fluorine) can also be strong oxidizers. Some chemicals may be oxidizers with such an extremely fast burning potential that they are classified as explosives or blasting agents rather than oxidizers. Often the fact that a chemical possesses oxidizing potential can be obtained from an examination of its chemical structure.

Reference: 29 CFR 1910.1200, Hazard Communication

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.

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 competency. The qualifying official will evaluate the completion of this competency.

Reference: 10 CFR 835, Occupational Radiation Protection

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

Except for planned special exposures conducted consistent with 10 CFR 835.204 and emergency exposures authorized in accordance with 10 CFR 835.1302, the occupational dose received by general employees shall be controlled such that the following limits are not exceeded in a year:

- A total effective dose equivalent of 5 rem (0.05 sv);
- The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rem (0.5 sv);
- A lens of the eye dose equivalent of 15 rem (0.15 sv); and
- A shallow dose equivalent of 50 rem (0.5 sv) to the skin or to any extremity.
- All occupational doses received during the current year, except doses resulting from planned special exposures conducted in compliance with 10 CFR 835.204 and emergency exposures authorized in accordance with 10 CFR 835.1302, shall be included when demonstrating compliance with 10 CFR 835.202(a) and 835.207.
- Doses from background, therapeutic and diagnostic medical radiation, and participation as a subject in medical research programs shall not be included in dose records or in the assessment of compliance with the occupational dose limits.

Reference: 10 CFR 835, Occupational Radiation Protection

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

Monitoring of airborne radioactivity is required where an individual is likely to receive an exposure of 40 or more derived air concentration (DAC)-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 (10 CFR 835.403.[a]). Real-time air monitoring is required, as necessary, to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material.

The purposes for conducting an air monitoring program can be characterized as the need to assess individual exposures to airborne radioactive material, determine the need for and prescribe appropriate personnel protection from airborne radioactive material, and provide early warning of unexpected increases in airborne radioactivity levels. The type of air monitoring will depend on what the monitoring results are needed for.

Under 10 CFR 835, 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.

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 account as low as reasonably achievable (ALARA) considerations, other industrial hazards, and worker safety.

Reference: DOE G 441.1-8, Air Monitoring Guide for use with Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection, March 1999

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

Radiation Area
Any area, accessible to personnel, in which radiation levels could result in an individual receiving a dose equivalent in excess of 5 millirem (mrem) in 1 hour (h) at 30 centimeters (cm) from the radiation source or from any surface that the radiation penetrates.

High Radiation Area
Any area, accessible to personnel, in which radiation levels could result in an individual receiving a dose equivalent in excess of 100 units in mrem in any 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Very High Radiation Area
An area accessible to individuals, in which radiation levels exceed 500 roentgn absorbed dose (rad) (5 gray [Gy]) in 1 hour at 1 meter (m) from the source or from any surface that the radiation penetrates.

Airborne Radioactivity Area
Any room, enclosure, or operating area in which airborne radioactive materials exist or are likely to exist in concentrations to such a degree that an individual present in the area without respiratory protective equipment could exceed during the hours an individual is present in a week, an intake of 0.6 percent of 12 DAC-hours.

Exceptions to the Posting Requirements
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 (10 CFR 835.604[b]):

- Radiological areas posted in accordance with 10 CFR 835.603(a)–(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 in accordance with subpart G of 10 CFR 835 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 (i.e., 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 in accordance with 10 CFR 835.603 until the packages are monitored in accordance with 10 CFR 835.405 (10 CFR 835.604[c]). For ALARA purposes, the time between package receipt and monitoring should be minimized.

Even though certain areas may be excepted from posting in accordance with 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. Decisions regarding the omission of radiological hazard postings should be made in full consideration of the information provided in DOE G 441.1-10.

The exceptions discussed above apply only to radiological area and/or radioactive material area posting requirements and do not apply to the entry control requirements established in 10 CFR 835.501 and 10 CFR 835.502 or to the radiation safety training requirements established in 10 CFR 835.901. Decisions regarding omission of postings should be made in full consideration of the guidance provided in DOE G 441.1-10.

Reference: DOE G 441.1-10, Posting and Labeling for Radiological Control Guide for use with Title 10, Code of Federal Regulations, Part 835, Occupational Radiation Protection, May 1999

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

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

Reference: 41 CFR 50-204.26, Exemptions for Radioactive Materials Packaged for Shipment

f) Discuss the requirements related to notification of incidents.

Immediate Notification
Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source, or special nuclear material 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 rem (0.25 Sv) or more; or
  - A lens dose equivalent of 75 rem (0.75 Sv) or more; or
  - A shallow-dose equivalent to the skin or extremities of 250 rad (2.5 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 (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

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); or
  - A lens dose equivalent exceeding 15 rem (0.15 Sv); or
  - 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 annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

The licensee shall prepare any report filed with the Commission pursuant to 10 CFR 20.2202 so that names of individuals who have received exposure to radiation or radioactive material 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 make the reports required by immediate or 24-hour notification to the NRC Operations Center in accordance with 10 CFR 50.72; and
- all other licensees shall make the reports required by immediate or 24-hour notification by telephone to the NRC Operations Center (301) 816-5100.

Reference: 10 CFR 20.2202, Notification of Incidents

g) Compare and contrast the terms “non-ionizing radiation” and “ionizing radiation.”

Ionizing radiation includes alpha rays, beta rays, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other atomic particles; but such term does not include

sound or radio waves, or visible light, or infrared or ultraviolet light, which are called non-ionizing radiation.

Ionizing radiation is produced by radioactive decay, nuclear fission and nuclear fusion, by extremely hot objects (the hot sun, e.g., produces ultraviolet), and by particle accelerators that may produce, e.g., fast electrons or protons or bremsstrahlung or synchrotron radiation.

In order for radiation to be ionizing, the particles must both have a high enough energy and interact with electrons. Photons interact strongly with charged particles, so photons of sufficiently high energy are ionizing. The energy at which this begins to happen is in the ultraviolet region; sunburn is one of the effects of this ionization. Charged particles such as electrons, positrons, and alpha particles also interact strongly with electrons. Neutrons, on the other hand, do not interact strongly with electrons, and so they cannot directly ionize atoms. They can interact with atomic nuclei, depending on the nucleus and their velocity, these reactions happen with fast neutrons and slow neutrons, depending on the situation. Neutron radiation often produces radioactive nuclei, which produce ionizing radiation when they decay.

The negatively charged electrons and positively charged ions created by ionizing radiation may cause damage in living tissue. If the dose is sufficient, the effect may be seen almost immediately, in the form of radiation poisoning. Lower doses may cause cancer or other long-term problems. The effect of the very low doses encountered in normal circumstances (from both natural and artificial sources, like cosmic rays, medical X-rays and nuclear power plants) is a subject of current debate. A 2005 report released by the National Research Council (the BEIR VII report, summarized in [1]) indicated that the overall cancer risk associated with background sources of radiation was relatively low.

Radioactive materials usually release alpha particles which are the nuclei of helium, beta particles, which are quickly moving electrons or positrons, or gamma rays. Alpha and beta rays can often be shielded by a piece of paper or a sheet of aluminium, respectively. They cause most damage when they are emitted inside the human body. Gamma rays are less ionizing than either alpha or beta rays, but protection against them requires thicker shielding. They produce damage similar to that caused by X-rays such as burns, and cancer through mutations. Human biology resists germline mutation by either correcting the changes in the DNA or inducing apoptosis in the mutated cell.

Non-ionizing radiation is thought to be essentially harmless below the levels that cause heating. Ionizing radiation is dangerous in direct exposure, although the degree of danger is a subject of debate. Humans and animals can also be exposed to ionizing radiation internally: if radioactive isotopes are present in the environment, they may be taken into the body. For example, radioactive iodine is treated as normal iodine by the body and used by the thyroid; its accumulation there often leads to thyroid cancer. Some radioactive elements also bioaccumulate.

Reference: http://en.wikipedia.org/wiki/Ionizing_radiation

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 NRC and the DOT share primary responsibility for approving package designs for transportation of radioactive materials within the United States. NRC regulations for the transportation of radioactive materials are codified in 10 CFR 71, "Packaging and Transportation of Radioactive Material."

The DOT's hazardous materials regulations, which include radioactive material, are codified in 49 CFR 100–199. Requirements for shippers of radioactive materials are given in 49 CFR 173.400 through 173.478. In addition, a provision in the NRC regulations, 10 CFR 71.5, requires that NRC licensees comply with DOT's hazardous materials regulations.

In general, pursuant to 10 CFR Part 71, the NRC approves package designs for shipment of fissile and greater than type A quantities of radioactive material. The design for packages up to type A quantities is subject to the requirements of DOT in 49 CFR 173.

In authorizing the use of NRC-approved packages for transportation of type A quantities of radioactive material, DOT regulations specify, in 49 CFR 173.415, that certain conditions be met. One condition (49 CFR 173.471) is that the shipment of the package be made in compliance with the terms of the NRC approval, i.e., that the shipper comply with all terms and conditions in the NRC certificate of compliance (certificate). For example, a radiographic source changer authorized for a type B quantity of a specific radionuclide in special form is also authorized for a type A quantity of the same specific radionuclide in special form, provided that all the terms and conditions of the certificate are met. Note that NRC approvals include the type and form of material, the maximum quantity of material per package, and operating instructions and maintenance procedures for the package.

Alternatively, an NRC-approved package may be shipped under the provisions of 49 CFR 173.415(a), as a DOT specification 7A package. In this instance, the shipper (if requested) must provide DOT with a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with DOT specification 7A. The shipper is required to maintain this documentation on file at least 1 year after the latest shipment. Thus, a radiographic source changer approved by the NRC for shipment of a specific radionuclide in special form could be used to ship a type A quantity of a different nuclide, provided that the package is re-evaluated under the provisions of 49 CFR 173.415(a).

When an NRC-approved package is used as a DOT specification 7A package, the NRC package identification marking should be covered and new markings ("USA DOT 7A TYPE A" and "radioactive material") affixed to the package, pursuant to 49 CFR173.415(a).

Users of the NRC-approved packages should be aware of the requirements for using NRC-approved packages for low-level radioactive materials exempted under 10 CFR 71.10. In particular, users of NRC-approved packages should

- Determine what provision of 49 CFR 173.415 applies.
- When the shipment is made pursuant to 49 CFR 173.415(a), comply with all requirements in 49 CFR 173.415(a) and 49 CFR 178.350. Note that the use of an NRC-approved package pursuant to 49 CFR 173.415(a) requires that the package be re-evaluated as a DOT specification 7A type A package, and that the shipper maintain the evaluation on file for 1 year after the last shipment.
- When the shipment is made pursuant to 49 CFR 173.415(c), comply with all terms and conditions in the NRC certificate.

Reference: 49 CFR 173.400 Information Notice No. 90-82: Requirements for Use of Nuclear Regulatory Commission-(NRC-) Approved Transport Packages for Shipment of Type A Quantities Of Radioactive Material

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 and Gamma Emitters
A beta emitter is a radioactive substance emitting beta particles. Some common beta emitters are strontium, tritium, carbon, and phosphorus.

Strontium-90 is a commonly used beta emitter in industrial sources. It has also been used as a thermal power source in radioisotope thermoelectric generator power packs. Such power packs were deployed by the former Union of the Soviet Socialist Republic for use at remote sites such as lighthouses. These powerpacks are of concern as each contains more strontium-90 than that released from the Chernobyl fire. Strontium-89 is a short lived beta emitter that has been used as a treatment for bone tumors in palliative care in terminal cancer cases. Both strontium-89 and strontium-90 are fission products.

Tritium is commonly used as a radiotracer in research and in tracers and some “glow-in-the dark” paints. This is a beta emitter that has a very low energy. The electrons from beta emission from tritium are so low in energy that a Geiger counter cannot be used to detect them. Note that one of the first-aid treatments for the intake of tritium (as tritiated water) in a human is to give the human plenty of water to drink. Many people find it very difficult to drink 10 pints of water per day, so in some cases persons who have been exposed to tritiated water have been advised to drink 10 pints of beer. The alcohol in the beer also increases the rate of urine production, which helps to wash the tritium oxide from the body.

Tritium can also be found in metal work in the form of a tritiated rust; this can be treated by heating the steel in a furnace to drive off the tritium-containing water. Tritium can be made by the neutron irradiation of lithium.

Carbon-14 is also commonly used as a beta source in research; it is commonly used as a radiotracer in organic compounds. While the energy of the beta particles is higher than those of tritium they are still quite low in energy. For instance, the walls of a glass bottle are able to absorb it. Carbon-14 is made by the np reaction of nitrogen-14 with neutrons. It is generated in the atmosphere by the action of cosmic rays on nitrogen. Also a large amount was generated by the neutrons from the atmospheric nuclear bomb tests that were conducted in the 20th century. The specific activity of atmospheric carbon increased as a result of the nuclear testing, but due to the exchange of carbon between the air and other parts of the carbon cycle, it has now returned to a very low value. For small amounts of carbon-14, one of the favored disposal methods is to burn the waste in a medical waste incinerator. The idea is that by dispersing the radioactivity over a very wide area, the threat to any one human is very small.

Phosphorus-32 is a short-lived high energy beta emitter, which is used in research in radiotracers. It can be used in DNA research. Phosphorus-32 can be made by the neutron irradiation (np reaction) of sulfur-32 or from phosphorus-31 by neutron capture.

Retrieved from http://en.wikipedia.org/wiki/Common_beta_emitters

Most alpha and beta emitters also emit gamma rays as part of their decay process. However, their is no such thing as a "pure" gamma emitter. Important gamma emitters are technetium-99m which is used in nuclear medicine, and cesium-137 which is used for calibration of nuclear instruments.

Contamination Control

The primary reasons for contamination control are

- Protection of the worker
  - Measures to control radioactive contamination are implemented to protect workers by minimizing the chance of inhalation or ingestion of radioactive/hazardous material, eliminating or reducing external radiation dose rates, and reducing worker discomfort by minimizing the use of personal protective clothing and/or respirators.
  - Radioactive materials may enter the body by inhalation (the most common pathway), cuts/wounds (e.g., sharp instrument punctures), absorption (skin, mucous membranes, eyes), ingestion (biting nails, applying cosmetics, eating, drinking or smoking in the controlled area or outside without monitoring or washing hands).
- Protection of the environment
  - Measures to control radioactive contamination are implemented to protect the environment by controlling the release of radioactivity in the environment, or minimizing the amount of radioactive waste generated.

- Protection of the facility and programs
  - Measures to control radioactive contamination are implemented to protect facilities and programs by eliminating or minimizing the spread of contamination, preventing cross-contamination and the loss of experimental results, or meeting regulatory requirements.

Contamination control measures should address

- Characteristics of radionuclides used
  - Type of radiation emitted
  - Energy of radiation emitted
  - Half-life
- Preparation of areas and materials, including
  - Marking, labeling, and posting of areas and materials
  - Personnel protective equipment type, availability, and use
  - Storage and containment of radioactive/hazardous material
- Good work practices, including
  - Special precautions for handling liquids
  - Special precautions for handling sharps
  - Cleaning up the work area at the end of the job or end of the day, whichever is first
- Radioactive waste management
- Radiation monitoring (including interpretation of meter readings) during and at completion of work.
- Decontamination
- Regulatory requirements
- Training requirements

Additional information regarding contamination control is available in DOE-HDBK-1106-1997, Radiological Contamination Control Training for Laboratory Research.

Fissile Material
Fissile material is plutonium 239, plutonium241, uranium233, uranium235, 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.

Reference: 49 CFR 173.403, Definitions

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

Reference: 49 CFR 173.403, Definitions

Low-Toxicity Alpha Emitters
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.

Reference: 10 CFR 173.403, Definitions

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

Reference: 49 CFR 173.403, Definitions

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

Reference: 49 CFR 173.403, Definitions

Radiation Level Limitations
Except as provided in paragraph (b) of 49 CFR 173.441, 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 millisievert (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); and
- 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.

Reference: 49 CFR 172.441, Radiation Level Limitations and Exclusive Use Provisions

Specific Activity
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.

Reference: 49 CFR 173.403, Definitions

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.

See element b, "Raditional Level Limitations," of this competency for information related to 49 CFR 173.441.

49 CFR 173.443, Contamination Control
a. The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for transport must be kept as low as reasonable achievable. The level of non-fixed radioactive contamination may not exceed the limits set forth in table 9 of this section 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 table 9 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 9 in 49 CFR 173.443 is as follows:

Non-fixed External Radioactive Contamination Limits for Packages

Contaminant	Maximum Permissible Limits		
	Bq/cm^2	**m-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

MCi-microcurie
Dpm-disintegrations per minute

b. 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.

c. 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 per hour (0.5 mrem per hour) or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

d. 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 per hour) at the surface or 0.02 mSv per hour (2 mrem per hour) 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 in.) 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.

Reference: 49 CFR 173.443, Contamination Control

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 (48 FR 10218, March 10, 1983, and 48 FR 31214, July 7, 1983) 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.

Reference: U.S. Nuclear Regulatory Commission, Information Notice No. 85-46: Clarification of Several Aspects of Removable Radioactive Surface Contamination Limits for Transport Packages, June 10, 1985

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 canceled and replaced by DOE O 231.1A, Environment, Safety, and Health Reporting. The information related to occurrence reporting procedures is not 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.

This Manual provides detailed information for reporting occurrences and managing associated activities at DOE facilities, including NNSA facilities. It complements DOE O 231.1A, 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**

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
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, magnetohydrodynamic 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.

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 the manual.

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 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).

The reporting of safeguards and security events is addressed by DOE N 471.3, Reporting of Events of Security Concern. Such events are no longer reported in ORPS unless they involve other consequences that met 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

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.

In the performance of this contract, the contractor is required to establish an Occurrence Reporting Program for the timely identification, categorization, notification, and reporting of operations information related to DOE-owned or operated facilities and for the processing of that information to identify the root cause, provide for appropriate corrective actions, and prevent similar occurrences through the identification of good practices and lessons learned.

The facility-specific Occurrence Reporting Program shall be developed in accordance with DOE M 232.1-2, Occurrence Reporting and Processing of Operations Information.

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.

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;
- activities conducted under the authority of the Director, Naval nuclear propulsion, pursuant to Executive Order 12344, as set forth in P.L. 106-65;
- 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; and
- activities related to the launch approval and actual launch of nuclear energy systems into space.

Reference: 10 CFR 830, Nuclear Safety Management

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

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.

Offsite Shipment. Fissionable materials shall be packaged and transported in a manner that will prevent a criticality accident. The shipment shall be maintained in its original approved condition during transport, and any special restrictions shall be communicated to the driver or other responsible persons. Approved U.S. Department of Defense (DoD), DOE, DOT, and NRC packages shall be shipped in accordance with federally approved standards. Some shipments may require a criticality safety statement or a one-time shipping request, which will be provided by the criticality safety group upon request.

Transport of NELAs. Nuclear explosive-like assemblies (NELAs) containing mock high explosive and live fissionable materials shall be shipped in DoD shipping containers in accordance with TP-20-7, Nuclear Safety Criteria, requirements or have the appropriate criticality safety statement for the corresponding warhead.

Onsite Shipments between Facilities. Fissionable materials to be transported onsite between facilities shall be either

- packaged and transported in accordance with approved DoD, DOE, DOT, or NRC regulations for offsite shipments; or
- packaged and transported in accordance with an approved safety plan or an approved onsite transportation safety manual.

Onsite Transfers within Facilities. Fissionable materials to be transferred within facilities shall be packaged and transported in accordance with an approved safety plan. The plan shall include

- requirements specifying approved container types
- requirements for maintaining a safe spacing between fissionable material in transit and all other nearby fissionable material
- the fissionable material mass limits for each transport movement
- limits for the maximum number of simultaneous transfers
- requirements for assuring that the transfer complies with all controls of the destination location
- posting requirements
- designation of responsible personnel

Reference: ES&H Manual, document 20.6, Criticality Safety

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

Safety basis requirements apply to onsite transportation activities that do not meet DOT requirements, but not to offsite transportation activities that are covered by DOT requirements.

Reference: 10 CFR 830, Nuclear Safety Management

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

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; and
  - for all other radioactive and hazardous materials packagings, satisfies the requirements of DOE O 414.1C.
- 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.

Reference: DOE O 460.1B, Packaging and Transportation Safety

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

The Price-Anderson Act was enacted into law in 1957 and has been revised several times. It constitutes Section 170 of the Atomic Energy Act. The latest revision was enacted through the Energy Policy Act of 2005, and extended it through December 31, 2025.

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.

Reference: http://www.ans.org/pi/ps/docs/ps54-bi.pdf

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.

This rule 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.

The rule 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 460.2, Departmental Materials Transportation and Packaging Management, except to the extent such departure is prohibited by statute or executive order.

b) Discuss traffic management administrative functions.

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

Reference: 10 CFR 41.109.40, Transportation and Traffic Management

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 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.

Reference: DOE G 414.1-2A, Quality Assurance Management System Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance, section 4.7.3

Quality Assurance
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.

Reference: DOE G 460.1-1A, Packaging and Transportation Attachments, attachment A, Criteria 7

Receipt Inspection
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.

Reference: DOE G 460.1-1A, Packaging and Transportation Attachments, attachment A, Criteria 8

Material and Package Compatibility
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 contractor's technical staff who have been properly trained on DOT and/or international packaging regulations.

Reference: DOE M 460.2.1, Radioactive Material Transportation Practices, section 2.2.1-2.2.3

Packaging Specifications and Test Requirements
The Hazardous Materials Regulations address packagings suitable for shipping radioactive materials at 49 CFR 173 and 49 CFR 178. Packaging for type A quantities of radioactive materials may be either DOT-specification packagings, type A packagings designed and tested commercially, type B certified (DOE or NRC) packagings, or DOE-designed and-tested type A packagings. DOT permits DOE to certify type B and fissile packagings for its own use (49 CFR 173.7). In addition, DOT regulations invoke the NRC regulations, 10 CFR 71, for certification of type B and fissile packagings.

DOE O 460.1A 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 460.1A, 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 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 attachment 4, DOE G 460.1-1 ATT, the packaging and shielding should be tested as required. 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.

Reference: G 460.1-1, Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety

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**

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

Reference: 49 CFR 171.8, Definitions and Abbreviations

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

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 it remains thereafter an integrated single unit; it is filled, stored, shipped, and emptied as such.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Empty
A package that contains no material.

Excepted Packaging
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.

Reference:
http://www.teppinfo.com/TrainingProgramSchedule/DraftModules/Mod06_SG.pdf

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Industrial Packaging
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.

Reference:
http://www.teppinfo.com/TrainingProgramSchedule/DraftModules/Mod06_SG.pdf

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Non-Bulk Packaging
Non-bulk packaging is a packaging that has

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

Reference: 49 CFR 171.8, Definitions and Abbreviations

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Overpack
Overpack, except as provided in subpart K of 49 CFR 78, 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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Type B Package
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, 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. Requirements for type B packaging are addressed in 49 CFR 173.411, 49 CFR 173.413, and 10 CFR 71.

Reference:
http://www.teppinfo.com/TrainingProgramSchedule/DraftModules/Mod06_SG.pdf

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

Reference: 49 CFR 171.8, Definitions and Abbreviations

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

Reference: 49 CFR 171.8, Definitions and Abbreviations

Specification Packaging
Specification packaging is a packaging conforming to one of the specifications or standards for packagings in 49 CFR 178 or 49 CFR 179.

Reference: 49 CFR 171.8, Definitions and Abbreviations

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Strong-Tight Package
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.

Reference: http://www.nrc.gov/reading-rm/basic-ref/teachers/11.pdf

c) Identify the different packaging groups and associated dangers.

There are three packing groups, each having a different set of criteria:

- A material assigned to packing group I indicates that there is a high degree of danger associated with that chemical.
- A material assigned to packing group II indicates that there is a medium degree of danger associated with that chemical.
- A packing group III designation indicates the least amount of danger considering that the material is still hazardous.

The general packaging requirements are delineated in 49 CFR 178.

Reference: http://www-safety.deas.harvard.edu/shipping.html

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

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 contractor's technical staff who have been properly trained on DOT and/or international packaging regulations.

Reference: DOE M 460.2-1, Radioactive Material Transportation Practices, section 2.2.3

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

As provided under procedures prescribed by regulation, the Secretary of Transportation may issue an exemption from a regulation prescribed under section 49 U.S.C. 5103(b), 5104, 5110, or 5112 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 U.S.C. 5117; 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.

Reference: 49 USC 5117, Exemptions and Exclusions

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

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 10 cm (4 in.).
- Containment and shielding are 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 must include 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, 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 kilopascals (kPa) (3.6 psi).
- 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 or using any of the methods authorized by 49 CFR 173.461(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 49 CFR 173.412 when subjected to the tests specified in 49 CFR 173.466 or evaluated against these tests by any of the methods authorized by 49 CFR 173.461(a); and
  - Either-- (i) 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 (ii) 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 40 TBq (1,080 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(a).

Reference: 49 CFR 173.412, Additional Design Requirements for Type A Packages

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**

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)

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

Limits of Carrier Liability

The carrier is not liable in a claim for loss or damage to articles in the following situations:

- Change in condition or flavor of perishables
- Loss or damage caused by the shipper, including improper packing
- Defect or inherent vice of the article, such as susceptibility to atmospheric changes
- Insects, moths, vermin, ordinary wear and tear, or gradual deterioration
- Mechanical or electrical derangement of musical instruments, electronic components or appliances, if there is no sign of exterior damage

- Loss or damage caused as a result of any strike, lockout, labor disturbance, riot, civil commotion, or any act of any person or persons taking part in any such occurrence or disorder
- Hostile or warlike action in time of peace or war
- Breakage caused by normal handling of china, glassware, bric-a-brac, or other similar items, unless packed by the carrier
- Liability of carrier for loss or damage shall be subject to compliance with the rules for filing claims.

Carrier Insurance Requirements
No motor carrier may operate upon or use the public streets or highways of the state until it has filed with the commission evidence of security for the protection of the public. The security may be in the form of insurance with an insurance company authorized to do business in the state or surety bonds undertaken either by firms authorized to do business in the state or by at least two individual sureties, or the security may be by qualification as a self-insured.

The security for a motor carrier of property shall be in the following amounts:
- Liability coverage for bodily injury or death, per person, in an amount no less than $250,000;
- Liability coverage for bodily injury or death, per accident, in an amount no less than $750,000; and
- Liability coverage for property damage, per accident, in an amount no less than $250,000.

Reference: http://www.cpuc.ca.gov/hhgfaq/limitationsonthecarriersliability2.htm

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

Administrative controls include written procedures, employee training, establishing designated or restricted areas, chemical procurement procedures, and preventive maintenance.

Reference: http://www.lbl.gov/ehs/chsp/html/materials.shtml#Administrative

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

The following are examples of the types of information required for budgeting transportation costs.

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.

48 CFR 47.306 states, "When requesting the transportation officer to assist in evaluating offers, the contracting officer shall give the transportation officer all pertinent data, including the following information:

- A complete description of the commodity being acquired, including packaging instructions.
- Planned date of award.
- Date of initial shipment.
- Total quantity to be shipped, including weight and cubic content, when appropriate.
- Delivery schedule.
- Contract period.
- Possible use of transit privileges, including stopoffs for partial loading or unloading, or both.

References: 48 CFR 47.306, Transportation Cost Determinations, and The DOE National Transportation Program Cost-Estimating Model
http://www.ornl.gov/~webworks/cppr/y2001/pres/111943.pdf

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 competencies. The qualifying official will evaluate the completion of these competencies.

h) Compare and contrast the terms listed below:

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

Carrier
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.

Reference: DOE O 460.2A, Departmental Materials Transportation and Packaging Management

Commercial Motor Vehicle
Commercial motor vehicle means any self-propelled or towed motor vehicle used on a highway in interstate commerce to transport passengers or property when the vehicle

- has a gross vehicle weight rating or gross combination weight rating, or gross vehicle weight or gross combination weight, of 4,536 kg (10,001 lb) or more, whichever is greater; or
- is designed or used to transport more than 8 passengers (including the driver) for compensation; or
- is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation; or
- is used in transporting material found by the Secretary of Transportation to be hazardous under 49 U.S.C. 5103 and transported in a quantity requiring placarding under regulations prescribed by the Secretary under 49 CFR, subtitle B, chapter I, subchapter C.

Reference:
http://www.teamster.org/resources/sh/hottopics/defofcommercialmotorvehicle.htm

Demurrage
Demurrage is a charge required as compensation for the delay of a ship or freight car or other cargo beyond its scheduled time of departure.

Reference: http://www.thefreedictionary.com/demurrage

Intermodal
"Intermodal" means involving transportation by more than one form of carrier during a single journey.

Reference: http://www.loadmatch.com/what_is_intermodal.htm

Less Than Truckload
Less than truckload is a shipment that does not completely fill a truck or that weighs less than the weight required for the application of the truckload freight rate (which is usually a lower freight rate than applied to less-than-truckload cargo).

Reference: http://www.teachmefinance.com/Financial_Terms/less_than_truckload.html

Mode
The modes of transportation are road (trucking, transit, and ground passenger), rail, water,

air, and pipeline. These are further subdivided according to the way in which businesses in each mode organize their establishments.

Reference: http://hazmat.dot.gov/pubs/inc/data/2005/2005scause.pdf

Precious Metals
Precious metals are defined as gallium, gold, iridium, osmium, palladium, platinum, rhodium, ruthenium, silver, or any combination of these metals.

Reference: DOE O 460.2A, Departmental Materials Transportation and Packaging Management

Premium Transportation
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."

Premium transportation should be used only when the additional cost is clearly justified. When premium transportation, including exclusive use of vehicle, is used for shipments weighing 500 pounds or more, a justification supporting the use of such transportation should be retained in a hard-copy or data file at the contractor site or field element location.

Reference: DOE O 460.2A, Departmental Materials Transportation and Packaging Management

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.

DOE monitors the progress of some unclassified high-visibility shipments using the Transportation Tracking and Communications system (TRANSCOM). TRANSCOM utilizes onboard state-of-the-art global positioning system equipment to provide near real-time tracking of truck, rail, ship, and barge shipments as they make their way from origin to destination. Satellites poll the enroute shipments on a 2- to 4-minute near real-time frequency and relay positional and message information to a ground station located in the western United States. This shipment data is then relayed to the TRANSCOM Communications Center database and made available over the Web to a network of more than 300 trained and authorized federal, state, and tribal customers across the United States. TRANSCOM can provide position accuracy within 1,000 feet of a stopped vehicle.

Authorized users can access the TRANSCOM system and obtain shipment information concerning current and scheduled future shipments. The scheduling module of TRANSCOM allows future shipments to be scheduled and viewed by DOE site, shipment campaign, or shipment corridor. Only one copy of shipment information is allowed in the system, ensuring that all users view the same information. Specific shipment information available to authorized users includes bill of lading, bill of lading notes, routes, messages, positional information, emergency contact information, and a state-of-the-art mapping function that auto displays shipment position information.

Reference: TRANSCOM http://web.em.doe.gov/otem/ntp/htdocs/ftplink/transcom1101.pdf

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" and "g" are performance-based competencies. The qualifying official will evaluate the completion of these competencies.

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

For transportation services for which the United States will assume the charges that have been paid by a federal agency's contractor and/or their first-tier subcontractor under a cost reimbursement contract, legible copies of all paid freight bills and invoices, commercial bills of lading (CBLs), and supporting documentation must be submitted to GSA for audit. GSA granted DOE an exception that requires submission of only those bills and invoices that are for $50 or more. Such documents of $50 or less shall be retained onsite and made available for GSA onsite audits. The contractor shall forward promptly any original transportation bill requested by GSA. The contractor shall hold in record status all original bills paid for such periods of time as specified by applicable federal requirements and by DOE O 200.1, Information Management Program. Such bills may be subject to periodic onsite examination by GSA personnel (41 CFR 101–41.807–4).

Reference: DOE Accounting Handbook

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 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.

Reference: DOE Accounting Handbook

Commercial Straight Form Bill of Lading
Integrated contractors using CBLs when making shipments for DOE shall include the following statement, or one that is substantially the same, on all CBLs: "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."

Integrated contractors shall ensure that, where practicable, CBLs shall provide for consignment of shipments to DOE, care of the integrated contractor or by the contractor "for DOE."

Integrated contractors issuing CBLs that exceed $10,000 shall annotate the CBLs with the following: "Equal Employment Opportunity, all provisions of Executive Order 11246, as amended by Executive Order 11375, and of the rules, regulations, and relevant orders of the Secretary of Labor are incorporated herein."

Reference: DOE Accounting Handbook

Declaration of Dangerous Goods
The International Air Transport Association (IATA) requires that a shipper's declaration for dangerous goods be completed for each consignment of dangerous goods.

The shipper is responsible for the completion of the form. For each shipment containing dangerous goods the shipper must

- use only the correct form in the correct manner
- complete the form accurately and legibly
- ensure that the form is properly signed when the shipment is presented to the operator for shipment
- ensure that the shipment has been prepared in accordance with the IATA regulations

Reference: http://www.unzco.com/storefront/Dangerous.html

Export Declaration
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 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, (see §. 30.58 for exemptions for shipments from the United States to Canada) from any of the following:
  - The United States, including the 50 states and the District of Columbia
  - Puerto Rico
  - Foreign trade zones in the United States or Puerto Rico
  - The Virgin Islands of the United States

- Between non-foreign areas as specified below:
  - To Puerto Rico from the United States
  - To the United States from Puerto Rico
  - To the Virgin Islands of the United States from the United States or Puerto Rico

Note: Shipper's export declarations are not required for shipments from the United States or Puerto Rico to the United States possessions, except to the Virgin Islands of the United States, 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. Instructions for the filing of SEDs for vessels, aircraft, railway cars, etc., when sold foreign appear in 10 CFR 30.33.

Reference: 15 CFR 30, Foreign Trade Statistics

Express Air Bill
Air bill is a document serving for air transportation as a bill of lading does for marine or rail transportation, and includes an air consignment note or air waybill.

Reference: U.C.C. 1-201, General Definitions

Freight Bill
Freight bill is a document for a common carrier shipment. A freight bill gives a description of the freight, its weight, amount of charges, taxes, and whether collect or prepaid. Charges paid in advance are called prepaid freight bills. Charges collected at the destination are called destination or collect freight bills.

Reference: http://www.umich.edu/~trucking/wp/glossary.html

Government Bill of Lading
U.S. government bills of lading (GBLs) are multiuse documents that are essential to the conduct of day-to-day government operations when transportation of supplies, materials, and personal property is required.

The GBL and the U.S. government bill of lading - privately owned personal property, with their various copies and memorandum sheets, are the primary documents used to procure freight and express transportation and related services from commercial carriers, including freight forwarders.

Reference: http://www.wasc.noaa.gov/services/fmd/gbldef.htm

Material Safety Data Sheet
A material safety data sheet (MSDS) is a form containing data regarding the properties of a particular substance. An important component of workplace safety, it is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. The exact format of an MSDS can vary from source to source.

MSDSs are a widely used system for cataloging information on chemicals. MSDS information may include instructions for the safe use and potential hazards associated with a certain chemical. MSDSs can be found anywhere chemicals are being used.

Reference: http://en.wikipedia.org/wiki/Material_safety_data_sheet

Tender
"Tender" means to make the material available to a carrier for transportation in commerce.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Weight Ticket
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.

Reference: http://www.epa.gov/earth1r6/6sf/filestru/np.htm#34.06:Description

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 competencies. The qualifying official will evaluate the completion of these competencies.

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

The following two tables provide a comparison of the costs and operating characteristics for the different modes of transportation.

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

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				

Reprinted from Transportation, Michigan State University, http://www.sonoma.edu/users/a/atkint/BUS416W/winetransportation.ppt#256,1,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 competencies. The qualifying official will evaluate the completion of these competencies.

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

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; and
- 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 (46 U.S.C. 1241[b]) 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 (49 U.S.C. 1517), 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.

Reference: 41 CFR 109.40, Transportation and Traffic Management

e) Review and evaluate DOT carrier safety records.

This is a performance-based competency. The qualifying official will evaluate the completion of this competency.

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 competencies. The qualifying official will evaluate the completion of these competencies.

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 competencies. The qualifying official will evaluate the completion of these competencies.

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 competencies. The qualifying official will evaluate the completion of these competencies.

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

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 (i) they are available and not fully utilized, (ii) their use will result in substantial economies, and (iii) 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 (i) local transportation of supplies between government installations; (ii) pickup and delivery services that commercial carriers do not perform in connection with line-haul transportation; (iii) transportation of supplies to meet emergencies; and (iv) 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, the Cargo Preference Act, and related statutes Air Transportation by U.S.-Flag Carriers, and Ocean Transportation by U.S.-Flag Vessels.

Reference: 48 CFR 47.101, Policies

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.

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
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
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.

Reference: http://accounting.ucr.edu/compliance.htm

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

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; and
- Availability and suitability of transit privileges.

Reference: 41 CFR 109-40-103-1, Domestic Transportation

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

Elements "b" and "c" are performance-based competencies. The qualifying official will evaluate the completion of these competencies.

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**

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 this Order 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 this Order 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 460.2-1, Radioactive Materials Transportation Practices Manual
This manual 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 Transportatin of Materials of National Security Interest
The objective of this Order is to establish requirements and responsibilities for offsite shipments of naval nuclear fuel elements, category I and category II special nuclear material (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 470.1, Safeguards and Security Program
This Order has been canceled and replaced by DOE O 470.4, Safeguards and Security Program. DOE O 470.4 provides for the development of physical protection technology for the transportation of SNM, nuclear weapons, and nuclear weapons components.

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

DOE Order 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 this Order.

DOE Order 5632.1C, Protection and Control of Safeguards and Security Interests
This Order has been canceled.

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.

DOE O 471.2A, Information Security Program
This Order has been canceled and replaced by DOE M 470.4-4. DOE M 470.4-4 includes requirements for commercial carrier services.

References: Various DOE Directives as indicated

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 DOT has broad authority to regulate hazardous materials that are in transport, including the discretion to determine which materials shall be classified as hazardous. These materials are placed in one of nine categories, based on their chemical and physical properties. Based on the classification of the material, the DOT is also responsible for determining the appropriate packaging materials for shipping or transport. Finally, also based on the material classification, strict guidelines are furnished for proper labeling/marking of packages of hazardous materials offered for transport, and for placarding of transport vehicles.

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, or combination of materials, that spontaneously gives off ionizing radiation. It has a specific activity greater than 0.002 microcuries per gram.

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: Other Regulated Material
A material which, although otherwise subjected to regulations, presents a limited hazard during transportation due to its form, quantity, and packaging.

Reference: DOT-Introduction, Hazardous Materials Transportation Act
http://safety.science.tamu.edu/dot.html

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

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 49 CFR 172.101 of the Hazardous Materials Table), the Hazardous Materials Table will specify the correct packaging (49 CFR 173). 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, United Nations identification number (if required), labels, packaging requirements, and quantity limitations.

The Hazardous Materials Transportation Act (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, subpart I. Packaging and transportation of radioactive materials are covered in 10 CFR 71. Title 49 CFR 173.412 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. These responsibilities are delineated in the 1984 DOE/EPA Memorandum of Understanding on Responsibilities for Hazardous and Radioactive Mixed Waste Management. The DOE agreed to comply with RCRA requirements for hazardous waste transporters (40 CFR 263) 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.

Reference: Hazardous Materials Transportation Act
http://www.eh.doe.gov/oepa/laws/hmta.html

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

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 3 of the Hazardous Materials Table);
  - identification number (this from column 4 of the Hazardous Materials Table);
  - packing group (this from column 5 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 as follows:

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)	

Reference: Reference: DOT-Introduction, Hazardous Materials Transportation Act
http://safety.science.tamu.edu/dot.html

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

Each person offering a hazardous material for transport must ensure the package, container, or vehicle carries the markings appropriate for the corresponding hazard. Specific rules and requirements are outlined in 49 CFR 172.300. 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 identification 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 gallons or more. It must be affixed on opposite ends if the packaging capacity is less than 1,000 gallons.

The markings must be durable, in English, and printed legibly.

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

They must be unobscured by labels or attachments.

The markings must be placed sufficiently far from other markings, such as advertising, so as not to detract from them or lessen their effectiveness.

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.

Reference: DOT-Introduction, Hazardous Materials Transportation Act
http://safety.science.tamu.edu/dot.html

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

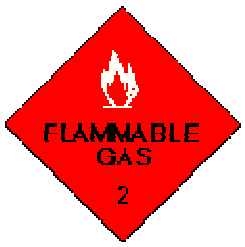
Placards are used to represent the hazard classes of materials contained within freight containers, motor vehicles, or train car. Labels communicate the same hazards for smaller containers and packages offered for transport. Examples of the placards and labels used for the various hazard classes follow.

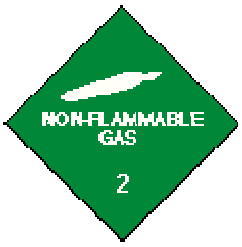
This placard or label is used to designate explosive materials, specifically class 1.1, 1.2, and 1.3 explosives. Explosives that belong to classes 1.4, 1.5, and 1.6 will have that specified, with the class designation replacing the exploding ball.

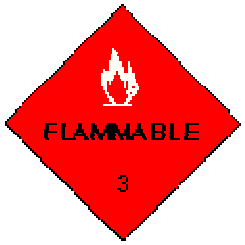
This placard is required when transporting any quantity of a class 1.1, 1.2, or 1.3 explosive, or over 1,001 lb of a class 1.4 or 1.5 explosive.

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.





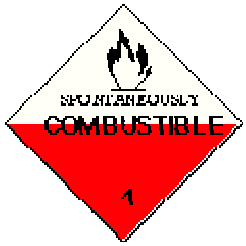


This is the label or placard used to designate flammable liquids. Certain common flammable liquids have their own placards, where the name of the material (such as gasoline and fuel oil) replaces the word "FLAMMABLE." Also, materials that fit the definition of a combustible material have the word "COMBUSTIBLE"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

This placard is required when transporting over 1,001 lb 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 (i.e., ignite in the presence of oxygen) (class 4.2), and those that react adversely when exposed to water (or humidity!) (class 4.3).

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

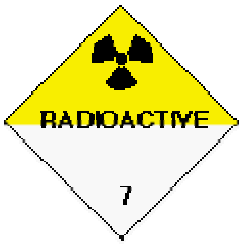


This placard or label is used to designate a cargo that contains oxidizing materials (class 5.1). In addition, this class contains materials that are classified as organic peroxides (class 5.2), and in that case the label would read "ORGANIC PEROXIDES" rather than "OXIDIZER."

Placards are required when transporting over 1,001 lb 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 lb of a class 6.1 material.

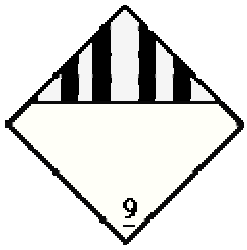


This label is required on all radioactive materials and equipment. Packages containing radioactive species must be clearly labeled with two labels on opposite sides of the package. This class is divided into three divisions — I, II, and III.

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 lb 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 lb may be placarded.

This applies to placarding only and is required when 1,001 lb 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 lb, in which case the placard for the large load class must be displayed.

Reference: DOT-Introduction, Hazardous Materials Transportation Act
http://safety.science.tamu.edu/dot.html

f) Determine the appropriate placards for the conveyance.

See element "e" of this competency for information about placards.

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

Required information. The following 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.120(c)(4)(viii)
- Hazardous substances and health hazards involved or expected at the site and their chemical and physical properties

Reference: 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response

h) Determine the appropriate training requirements for personnel involved in the transportation activity.

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.

Reference: DOE G 460.2-1, Implementation Guide for Use with DOE O 460.2 Departmental Materials Transportation and Packaging Management

i) Determine pre-notification and physical security requirements for spent nuclear fuel and high-level waste.

DOE, its contractors, or its carriers will provide advance notification of non-classified shipments of spent fuel and high-level waste in accordance with applicable requirements as shown in the following table. In addition to the required formal pre-notification, the Department intends that verbal or written notification be provided to state and tribal designated points of contact so that they are informed at least 7 working days prior to actual shipment.

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

Reference: DOE M 460.2-1, Radioactive Material Transportation Practices, section 8.2.1

j) Determine the appropriate requirements for shipping RCRA and Toxic Substances Control Act (TSCA) waste.

A transporter must not transport hazardous wastes without having received an EPA identification number from the EPA administrator. A transporter who has not received an EPA identification number may obtain one by applying to the administrator using EPA Form 8700-12. Upon receiving the request, the administrator will assign an EPA identification number to the transporter.

Requirements for shipping hazardous waste are as follows:

- Label and package wastes according to DOE rules prior to shipment.
- Use a licensed hazardous waste transporter to ship hazardous waste offsite to a licensed, authorized hazardous waste TSD facility.
- Ship hazardous waste, using a hazardous waste manifest, and keep copies of the manifests on-site for at least 3 years.
- Complete a land disposal restriction form and send it with each hazardous waste shipment.
- File an exception report with the Department of Environmental Conservation if the receiving facility manifest copy is not received within 45 days of the waste leaving the facility.

Reference: DOE Health and Safety Hazardous Waste Management ENV 001 and 40 CFR 263.10, Standards Applicable to Transporters of Hazardous Waste

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**

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 intial, 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 under section 5103 of federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), 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 the following table.

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

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 appendix A to 49 CFR 172.101, 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.

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 A1 or 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.

Special form (A1) radionuclides are usually encapsulated sources which would only pose an external radiation hazard, not a contamination hazard, if the package was ruptured.

Normal form (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 appendix B to 49 CFR 172.101 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 pounds 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.

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, 172.203, and 172.204.

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 subpart B of 49 CFR 172 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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

l) Explain the relationship between IAEA regulations and DOT regulations.

The IAEA periodically revises its regulations 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 packages.

Reference: http://hazmat.dot.gov/regs/notices/misc/69fr-25656.htm

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
A package that contains no material and previously contained radioactive materials.

Excepted Quantity
When the following conditions are met for an excepted quantity, the shipper is relieved from having to fill out any hazardous paperwork, use UN packaging, do any labeling, or meet any other requirements.

49 CFR 173.4 states that for something to be an "excepted quantity," the quantity per inside package must be less than 30 mL for liquids, or 30 g for solids (or 1 g for class/division 6.1 poisons in packaging group 1 only). This allowance cannot be used for any explosives in class 1 (dynamite), gas materials in class 2 (propane, carbon dioxide), or flammable solids in classes 4.2 or 4.3 (activated carbon, zinc powder). For other classes, as long as the inside package is less than stated above, a shipper is allowed to package them in multiples until the gross outside package reaches 29 kg, or 64 lb. There are some drop tests to a sample package which the shipper can perform, and these are outlined in the regulation. There are also some materials which are excluded from using this rule; see the complete rule for further details.

Reference:
http://www.labsafety.com/refinfo/printpage.htm?page=/refinfo/ezfacts/ezf156.htm

Fissile
A fissile material is one that is capable of sustaining a chain reaction of nuclear fission.

Fissile Excepted
Fissile excepted material is exempt from criticality safety packaging requirements. These materials must still be shipped in accordance with both shipping and receiving facility fissionable material limits and restrictions. The most common exception is no more than 15 g fissile material in a package. If material is transported in bulk, the 15 g limitation applies to the conveyance. Additional fissile material exceptions are given in 49 CFR 173.453.

Reference: http://www.hanford.gov/chgcp/SafetyExternalWeb/v18s02p01.pdf

Highway Route Controlled Quantity
If the amount is greater than 3,000 times the A1 or 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.

Special form (A1) radionuclides are usually encapsulated sources which would only pose an external radiation hazard, not a contamination hazard, if the package was ruptured.

Normal form (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.

Reference: http://www.nrc.gov/reading-rm/basic-ref/teachers/11.pdf

Industrial Packaging
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.

Reference:
http://www.teppinfo.com/TrainingProgramSchedule/DraftModules/Mod06_SG.pdf

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.

Reference: 49 CFR 171.8, Definitions and Abbreviations

Low Specific Activity (LSA)
Low specific activity is radioactive material with limited specific activity that satisfies the descriptions and limits set forth in the three LSA categories. Shielding materials surrounding the LSA material may not be considered in determining the estimated average specific activity of the package contents.

- Low Specific Activity, Category I
  - Ores containing only naturally occurring radionuclides (e.g., uranium, thorium) and uranium or thorium concentrates of such ores.
  - Solid unirradiated natural uranium or depleted uranium or natural thorium or their solid or liquid compounds or mixtures.
  - Radioactive material, other than fissile material, for which the A2 value is unlimited.
  - Mill tailings, contaminated earth, concrete, rubble, other debris, and activated material in which the radioactive material is essentially uniformly distributed, and the average specific activity does not exceed 106 A2/g. Note: A2 value is the maximum activity of radioactive material, other than special form, LSA, and surface contaminated object (SCO) material, permitted in a type A package.
- Low Specific Activity, Category II
  - Water with tritium concentration up to 0.8 TBq/L (20.0 Ci/L).
  - Material in which the radioactive material is distributed throughout, and the average specific activity does not exceed 10^{-4} A2/g for solids and gases, and 10^{-5} A2/g for liquids. Note: A2 value is the maximum activity of radioactive material, other than special form, LSA, and surface contaminated object material, permitted in a type A package.
- Low Specific Activity, Category III
  - Solids (e.g., consolidated wastes, activated materials) in which: (1) 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.); (2) 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 A2; (3) the average specific activity of the solid does not exceed 2 x 10^{-3} A2/g. Note: A2 value is the maximum activity of radioactive material, other than special form, LSA, and SCO material, permitted in a type A package.

Reference: http://www.sandia.gov/tp/SAFE_RAM/GLOSSARY/L/LSA.HTM

Normal Form
Radioactive materials may be considered as normal form or special form. pecial form materials are those defined in accordance with DOT regulations (49 CFR 173.403). pecial form materials must be a single, solid piece or be contained in a sealed capsule with one dimension greater than 5 millimeters and must pass tests to demonstrate its resistance to breach or destruction. ll other radioactive materials are considered normal form.

Reference: http://www.usace.army.mil/publications/eng-manuals/em1110-35-1/c-11.pdf

Radioactive Instruments and Articles
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.

Reference: 49 CFR 173.403, Definitions

Special Form
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 5 mm (0.2 in.); and
- It satisfies the test requirements of 49 CFR 173.469. 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. Any other special form encapsulation must meet the requirements of this paragraph.

Reference: 49 CFR 173.403, Definitions

Surface Contaminated Object
Surface contaminated object is a solid object which is not itself radioactive but which has radioactive material distributed on its surface.

Reference: 49 CFR 173.403, Definitions

Transportation Index
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 millisieverts (mSv) per hour at 1 m (3.3 ft) from the external surface of the package by 100 (equivalent to the maximum radiation level in millirem per hour at 1 m [3.3 ft]).

Reference: 49 CFR 173.403, Definitions

Type A Package
Type A package is a packaging that, together with its radioactive contents limited to A1 or A2 as appropriate, meets the requirements of 49 CFR 173.410 and 173.412 and is designed to retain the integrity of containment and shielding required by 40 CFR 173 under normal conditions of transport as demonstrated by the tests set forth in 49 CFR 173.465 or 173.466, as appropriate. A type A package does not require competent authority approval.

Reference: 49 CFR 173.403, Definitions

Type B Package
Type B package is a packaging designed to transport greater than an A1 or A2 quantity of radioactive material that, together with its radioactive contents, is designed to retain the integrity of containment and shielding required when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR 71.

Reference: 49 CFR 173.403, Definitions

b) Describe when the following labels are applicable:
- **Empty label**
- **Radioactive white I**
- **Radioactive yellow II**
- **Radioactive yellow III**

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.

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	

Reference: http://orise.orau.gov/reacts/guide/hazard.htm

c) Describe the general design requirements for type A and type B packages.

Type A Packages
In addition to meeting the general design requirements prescribed in 49 CFR 173.410, 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 10 cm (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 must include 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, 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 psi).
- 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 or using any of the methods authorized by 49 CFR 173.461(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 or evaluated against these tests by any of the methods authorized by 49 CFR 173.461(a); 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 40 TBq (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(a).

Reference: 49 CFR 173.412, Additional Design Requirements for Type A Packages

Type B Packages
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 1 m (40 in.) 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 must be met.

Reference: http://www.nrc.gov/reading-rm/doc-collections/cfr/part071/part071-0051.html

d) Describe the general design requirements for industrial packages 1, 2, and 3.

Each industrial packaging must comply with the requirements of 49 CFR 173.411 which 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(c) and (d) or evaluated against these tests by any of the methods authorized by 49 CFR 173.461(a), 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 265 kPa (37.1 pounds per square inch gage [psig]); 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 in the International Organization for Standardization (ISO) document ISO 1496-1. 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 United Nations 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.

Reference: 49 CFR 173.411, Industrial Packagings

e) Determine the radiation level limitations as defined by DOT.

Except as provided in paragraph (b) 49 CFR 173.441, 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 in paragraph (a) of 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:

- 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); and
- 0.02 mSv/h (2mrem/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.

Conveyance limits on the sum of package transport indices are as follows:

- Except for shipments by cargo aircraft only 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. The conditions of paragraphs (b)(2), (b)(3), (b)(4) and (c) of 49 CFR 173.441must be met.
- 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 paragraph (a) of 49 CFR 173.441 may not be transported by aircraft.

Reference: 49 CFR 173.441, Radiation Level Limitations and Exclusive Use Provisions

f) Determine the thermal limitations as defined by DOT.

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.

Reference: 49 CFR 173.442, Thermal Limitations

g) Determine the contamination control requirements as defined by DOT.

The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for transport must be kept as low as reasonable achievable. The level of non-fixed radioactive contamination may not exceed the limits set forth in table 9, 49 CFR 173.443 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 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 9 in 49 CFR 173.443 is as follows:

Non-fixed External Radioactive Contamination Limits for Packages

Contaminant	Maximum Permissible Limits		
	Bq/cm^2	**m-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

Except as provided in paragraph (d) of 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 paragraph (a) of 49 CFR 173.443. The levels at the beginning of transport may not exceed the levels prescribed in paragraph (a) of 49 CFR 173.443.

Except as provided in paragraph (d) of 49 CFR 173.443, each transport vehicle used for transporting class 7 (radioactive) materials as an exclusive use shipment that utilizes the provisions of paragraph (b) 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 0.005 mSv per hour (0.5 mrem per hour) or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of 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 0.1 mSv per hour (10 mrem per hour) at the surface or 0.02 mSv per hour (2 mrem per hour) 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 in.) 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.

Reference: 49 CFR 173.443, Contamination Control

h) Determine the quality control requirements that must be made prior to the shipment of radioactive materials.

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.

Reference: 49 CFR 173.475, Quality Control Requirements Prior to Each Shipment of Class 7 (Radioactive) Materials

i) Describe the routing requirements for class 7 radioactive material, highway route controlled quantities, unclassified high-level radioactive waste shipments, and spent nuclear fuel.

Except as provided in paragraph (b) of 49 CFR 397.101 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(l), 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(l) and (y), 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 (or a designated agent) who operates a motor vehicle which contains a package of highway route controlled quantity of class 7 (radioactive) materials, as defined in 49 CFR 173.403(l), shall prepare a written route plan and supply a copy before departure to the motor vehicle driver and a copy to the shipper (before departure for exclusive use shipments, as defined in 49 CFR 173.403(i), or within 15 working days following departure for all other shipments). 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 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.

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 (see 49 CFR 173.401[l]), 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 (MC-PSDECH), 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; and
- a copy of the shipping paper or the description of the class 7 (radioactive) material in the shipment required by 49 CFR 172.202 and 172.203.

Reference: 49 CFR 397.101, Requirements for Motor Carriers and Drivers.

j) Describe what shipments are subject to the physical security requirements of DOE O 473.1, Physical Protection of Safeguards and Security Interests (draft).

DOE O 473.1 was never approved and is no longer included in the draft standards. As a result, no information is available for this competency. The qualifying official may substitute an appropriate competency or exempt the candidate from this competency.

k) Describe the procedures for international shipment of nuclear materials in which DOE operations offices or their contractors participate. (Transportation Operations Manual).

The transport of nuclear material is probably the operation most vulnerable to an attempted act of unauthorized removal of nuclear material or sabotage. Therefore, taking into account the State's design basis threat, the physical protection provided should be in depth and particular attention should be given to the recovery of missing nuclear material. Emergency procedures should be prepared to counter effectively the State's design basis threat.

Achievement of the objectives of physical protection should be assisted by:

- Minimizing the total time during which the nuclear material remains in transport;
- Minimizing the number and duration of nuclear material transfers, i.e. transfer from one conveyance to another, transfer to and from temporary storage and temporary storage while awaiting the arrival of a vehicle, etc.;
- Protecting nuclear material during transport and in temporary storage in a manner consistent with the category of that material;
- Avoiding the use of regular movement schedules;
- Requiring predetermination of the trustworthiness of all individuals involved during transport of nuclear material; and
- Limiting advance knowledge of transport information to the minimum number of persons necessary.

Appropriate measures, consistent with national requirements, should be taken to protect the confidentiality of information relating to transport operations, including detailed information on the schedule and route, and particular consideration should be given to those operations involving Category I and II nuclear material. This requires great restraint in the use of any special markings on vehicles, and also in the use of open channels for transmission of messages concerning shipments of nuclear material. When a message is required by safeguards or radiological safety regulations, measures such as coding and appropriate routing to the extent practicable should be taken; care should be exercised in the handling of such information. These considerations should apply also to any subsequent communications.

An evaluation of the potential for sabotage and associated radiological consequences of a package design with respect to its mode of transport may be required by the State's competent authority. This should be done in close consultation with safety specialists.

Before an international shipment is made the shipper should ensure that the arrangements are in accordance with the physical protection regulations of the receiving State and of other States which are transited.

Requirements for Category I Nuclear Material

Advance Notification to Receiver

The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), the estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

The receiver should confirm his readiness to accept delivery immediately (and hand-over, if applicable) at the expected time, prior to commencement of the shipment.

Advance Authorization

Advance authorization by the competent authority is required. This implies the performance of a security survey in advance. The consent to a transport operation can include specific limitations and conditions related to the particular circumstances and to whatever emergency plans have been prepared.

Selection of Mode of Transport and Routing

In choosing the route, consideration should be given to the security of passage, in particular, arranging the route in such a way as to avoid areas of natural disasters or civil disorders and taking into consideration the capabilities of the response forces. The mode of transport for any given consignment should be such as to keep to a minimum the number of cargo transfers and the length of time the cargo remains in transport. The co-operation of the carrier concerning the implementation of physical protection measures should be ensured in advance.

Competent authorities should approve the route, including alternate routing as appropriate, stopping places, destination hand-over arrangements, identification of persons authorized to take delivery, accident procedures and reporting procedures, both routine and emergency.

Provision of Locks and Seals

Unless there are overriding safety considerations, the packages containing nuclear material should be carried in closed, locked vehicles, compartments, or freight containers. However, carriage of packages weighing more than 2000 kg that are locked or sealed should be allowed in open vehicles. Subject to safety considerations, the package should be tied down or attached to the vehicle or freight container. Checks should be made before dispatch to confirm the integrity of the locks and seals on the package, vehicle, compartment or freight container.

Search of Load Vehicle

There should be a detailed search of the load vehicle prior to loading and shipment, to ensure that sabotage devices have not been implanted or that sabotage has not been initiated.

Written Instructions

Personnel with physical protection responsibilities should be given written instructions detailing their responsibilities during the transport which have been approved by the competent authority.

Measures After Shipment

The receiver should check the integrity of the packages, locks, and seals and accept the shipment immediately upon arrival. The receiver should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at its destination. In addition, the guard should be instructed to report by two-way voice communications to the transport control center his/her arrival at the destination and each overnight stopping place and place of hand-over of the shipment.

Communication

Physical protection measures should include provision of a continuous two-way voice communication system between the vehicle, its escort, and the transport control center. Redundant and diverse communication systems should be utilized, where available.

For shipments by road, rail or sea, there should be a transport control center for the purpose of keeping track of the current position and security status of the shipment of nuclear material, alerting response forces in case of an attack and maintaining continuous two-way communication with the shipment and the response forces. The transport control center should be hardened so that its function can continue in the presence of the design basis threat. While the shipment is in progress, the transport control center should be staffed by qualified shipper or State designees, whose trustworthiness has been predetermined.

Guards

Guards, who are appropriately equipped and trained, should accompany each shipment to protect the nuclear material against unauthorized removal or sabotage. Continuous, effective surveillance of the packages or locked cargo hold, or compartment holding the packages is to be maintained by the guard at all times, especially when the transport is not in motion. States are encouraged to use armed guards to the extent that laws and regulations permit. When guards are not armed, compensating measures should be applied.

Emergency Action

Arrangements should be made to provide an adequately sized, equipped, and trained response force to deal with emergencies. The objective should be the arrival of the response force in time to prevent the unauthorized removal of nuclear material or sabotage.

Arrangements for International Transport

In contracts or agreements between shippers and receivers involving international transport of nuclear material, the point at which responsibility for physical protection is transferred from the shipper to the receiver should be clearly stated.

When the contract or agreement involving international transport provides for delivery to a destination in the receiving State in the vehicle of the shipping State, this contract or

agreement should provide that information be supplied in time to enable the receiver to make adequate physical protection arrangements.

Requirements for Category I Nuclear Material Related to the Mode of Transport

In addition to the requirements mentioned above, there should be further detailed requirements for Category I material related to the mode of transport as set out below.

Shipment by Road

Designated load vehicle(s) should be used exclusively for each consignment and should preferably be specially designed to resist attack and equipped with a vehicle disabling device. Each load vehicle should carry a guard for that vehicle.

Each load vehicle should be accompanied by at least one vehicle manned by one or more guards.

If the transport cannot be completed in one day, prior arrangements should be made for overnight stay at a stopping place approved by the competent authority. During such overnight stays the load vehicle should be immobilized or parked in a locked and guarded building or compound.

There should be two-way communication between the load vehicle and the escort vehicle in addition to communication between these vehicles and the transport control center.

Shipment by Rail

Shipment should be in a freight train in an exclusive use wagon. Accompanying guards should travel in the carriage nearest to the shipment.

Shipment by Sea

Shipment should be carried out by a dedicated transport ship. The shipment should be placed in a secure compartment or container which is locked and sealed.

Shipment by Air

Shipment should be by aircraft designated for cargo only and for which the nuclear material is its sole cargo.

Requirements for Category II Nuclear Material

Advance Notification to Receiver

The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

Selection of Mode of Transport and Routing

In choosing the route, consideration should be given to the security of passage, in particular, arranging the route in such a way as to avoid areas of natural disasters or civil disorders, and

taking into consideration the capabilities of the response force. The transport method for any given consignment should be such as to keep to a minimum the number of cargo transfers and the length of time the cargo remains in transport. The co-operation of the carrier concerning the implementation of physical protection measures should be ensured in advance.

Competent authorities should approve the route, including alternate routing as appropriate, stopping places, destination hand-over arrangements, identification of persons authorized to take delivery, accident procedures, and reporting procedures, both routine and emergency.

Provision of Locks and Seals

Unless there are overriding safety considerations, the packages containing nuclear material should be carried enclosed, locked vehicles, compartments or freight containers. However, carriage of packages weighing more than 2000 kg that are locked or sealed shall be allowed in open vehicles. Subject to safety considerations, the package should be tied down or attached to the vehicle or freight container. Checks should be made before dispatch to confirm the integrity of the locks and seals on the package, vehicle, compartment or freight container.

Search of Load Vehicle

There should be a detailed search of the load vehicle prior to loading and shipment to ensure that sabotage devices have not been implanted or that sabotage has not been initiated.

Written Instructions

Personnel with physical protection responsibilities should be given written instructions detailing their responsibilities during transport which have been approved by the competent authority.

Measures After Shipment

The receiver should check the integrity of the packages, locks and seals and accept the shipment immediately upon arrival. The receiver should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at its destination.

Communication

Physical protection measures should include provision of frequent communication between the vehicle and the shipper, receiver, and/or shipper/receiver/State designee.

Arrangements for International Transport

In contracts or agreements between shippers and receivers involving international transport of nuclear material, the point at which responsibility for physical protection is transferred from the shipper to the receiver should be clearly stated.

When the contract or agreement involving international transport provides for delivery to a destination in the receiving State in a vehicle of the shipping State, this contract or agreement should provide that information be supplied in time to enable the receiver to make adequate physical protection arrangements.

Requirements for Category III Nuclear Material

Advance Notification to Receiver

The shipper should give the receiver advance notification of the planned shipment specifying the mode of transport (road/rail/sea/air), the estimated time of arrival of the shipment and the exact point of hand-over if this is to be done at some intermediate point before the ultimate destination.

Provision of Locks and Seals

Where practicable, locks and seals should be applied to vehicles or freight containers.

Search of Load Vehicle

There should be a detailed search of the load vehicle prior to loading and shipment, to ensure that sabotage devices have not been implanted or that sabotage has not been initiated.

Measures After Shipment

The receiver should notify the shipper of the arrival of the shipment immediately or of non-arrival within a reasonable interval after the estimated time of arrival at the destination.

Reference:
http://www.iaea.org/worldatom/Programmes/Protection/inf225rev4/rev4_transport.html

l) Describe the certification process for type B and fissile material packaging.

The safety analysis report for packaging (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 prepared in the format described in NRC Regulatory Guide 7.9. 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.

Reference: Overview of the DOE Packaging Certification Process
http://www.osti.gov/energycitations/servlets/purl/212431-27Olj0/webviewable/212431.pdf

m) Determine empty package requirements.

After receiving radioactive material, a wipe test must be taken on the exterior of the stock vial prior to breaking the seal. The result of the wipe test should be entered on the designated area of the radioactive material control sheet and the counter printout must be attached. The box and the contents being disposed must be surveyed with a meter, and the results must also be documented on the control sheet. This process ensures that a leaking or contaminated stock vial is discovered immediately, before concentrated radioactive contamination is spread or disposed of in the trash.

The empty package must also have all references to radioactive materials defaced prior to disposal.

Reference: http://www.georgetown.edu/gumc/ehs/news/shared/NEWS398.HTML

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.

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 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 (determine the emergency class) 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.

Reference: DOE O 151.1C, Comprehensive Emergency Management System

b) Describe the 49 CFR requirements for emergency information.

Emergency response information is 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 as required by 49 CFR 172.202 and 172.203(k), the ICAO technical instructions, the IMDG code, or the transportation of dangerous goods (TDG) regulations, as appropriate;
- 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; and
- Preliminary first aid measures.

The information required for a hazardous material must be

- printed legibly in English;
- available for use away from the package containing the hazardous material; and
- presented
  - on a shipping paper;
  - in a document, other than a shipping paper, that includes the basic description and technical name of the hazardous material as required by 49 CFR 172.202 and 172.203(k), the ICAO technical instructions, the IMDG code, or the TDG regulations, as appropriate, and the emergency response information required (e.g., a material safety data sheet); or
  - related to the information on a shipping paper, a written notification to pilot-in-command, or a dangerous cargo manifest, in a separate document (e.g., an emergency response guidance document), in a manner that cross-references the description of the hazardous material on the shipping paper with the emergency response information contained in the document.

Aboard aircraft, the ICAO Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods, and aboard vessels, the International Maritime Organizations Emergency Procedures for Ships Carrying Dangerous Goods, or equivalent documents, may be used to satisfy the requirements.

Emergency response information shall be maintained as follows:

- Carriers. Each carrier who transports a hazardous material shall maintain the information specified in 49 CFR 172.606 in the same manner as prescribed for shipping papers, except that the information must be maintained in the same manner aboard aircraft as the notification of pilot-in-command, and aboard vessels in the same manner as the dangerous cargo manifest. This information must be immediately accessible to train crew personnel, drivers of motor vehicles, flight crew members, and bridge personnel on vessels for use in the event of incidents involving hazardous materials.
- Facility Operators. Each operator of a facility where a hazardous material is received, stored, or handled during transportation, shall maintain the information whenever the hazardous material is present. This information must be in a location that is

immediately accessible to facility personnel in the event of an incident involving the hazardous material.

Reference: 49 CFR 172.602, Emergency Response Information

c) Emergency Response Guide

The Emergency Response Guidebook (ERG2004) was developed jointly by the United States Department of Transportation, 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 ERG is updated every 3 to 4 years to accommodate new products and technology. The next version is scheduled for 2008.

Reference: The Emergency Response Guidebook (ERG2004)

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 role of transportation and traffic management personnel is to ensure that safety requirements necessary for a practical safeguarding of applicable DOE facilities and personnel are being adequately implemented. Practical safe work procedures include training of skilled and unskilled personnel who work in construction. Safety measures shall protect personnel against both normal operations and emergency situations. In addition, only qualified persons who are capable of working safely in construction and are familiar with the proper use of special precautionary techniques, personal protective equipment, technical safety requirements, and operating procedures may perform work. Transportation and traffic management personnel perform DOE line management oversight of their assigned facilities to ensure that

- the contractor is operating facilities safely and efficiently (i.e., within the boundaries of those controls invoked in the facility authorization basis);
- the contractor's management system is effectively controlling conduct of operation as related to nuclear safety;
- effective lines of communication between DOE and its operating contractors are maintained during periods of normal operation, and following reportable events, in accordance with DOE Orders and requirements.

b) Describe the assessment requirements and limitations associated with the oversight of contractor transportation and traffic management personnel.

As assessment requirements and limitations associated with the interface of contractor employees vary from site to site, the local qualifying official will evaluate the completion of this competency.

c) Describe how planning, observations, interviews, and document research are used during an assessment.

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
Assessments can gain value from an exit interview. This interview is used primarily to present the assessment summary and provide the assessed organization an opportunity to verify the factual accuracy of assessment results. To facilitate this, assessors should be prepared to provide detailed supporting information for those results (ideally, a draft assessment report should be available at this time). This interview also offers an opportunity for the assessed organization to present its management position and any plans for addressing the results. Reasonable time should be allowed to discuss any concerns, but this interview should not be used to argue the assessment agenda or methodology.

Closure Process
In the closure process, contractors send a letter to the directives management group (DMG) requesting closure and stating that the corrective actions in the implementation plan have been completed. The DMG coordinates approval of the closure with the appropriate division of primary interest and the contracting officer's representative.

Tracking to Closure and Follow up
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, occurrence reporting and processing system, external oversight reports and regulatory violations, 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

The key thing to remember when verifying corrective action implementation is that verification is necessary. A solution to a problem may look good on paper but may not be readily implementable. The failure to adequately identify all root causes will most likely result in a recurrence of the deficiency. Therefore, an appropriate amount of follow-up is necessary to assure the effectiveness of the corrective action process and to reestablish confidence in the item/service assessed.

Contractor Corrective Action Implementation

Management responsible for the activities assessed is also responsible for the development of effective corrective action of the problem areas or deficiencies discovered during the assessment. At a minimum, the corrective action should address

- measures to correct each deficiency
- identification of all root causes for significant deficiencies
- determination of the existence of similar deficiencies
- corrective actions to preclude recurrence of like or similar deficiencies
- assignment of corrective action responsibility
- completion dates for each corrective action

For independent assessments, the proposed corrective action should be reviewed for concurrence by the assessment team leader. This will help ensure that the planned actions will be effective in resolving the problem areas and deficiencies reported by the assessment team.

e) Describe the actions to be taken if the contractor challenges the assessment findings and explain how such challenges can be avoided.

Disputes over the assessment findings, the corrective action plan, 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.

Reference: U.S. Environmental Protection Agency, EPA QA/G-3, Guidance on Assessing Quality Systems, March 2003

Acronyms

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
C	celsius
CAS	cost accounting standards
CBL	commercial bills granted
CFR	Code of Federal Regulations
DAC	derived air concentration
DMG	Directives Management Group
DOD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
DOT	Department of Transportation
EM	environmental management
EPA	Environmental Protection Agency
ERG	Emergency Response Guidebook
F	fahrenheit
FOB	free on board
GBL	government bill of lading
GOCO	government-owned, contractor-operated
GSA	General Services Administration
HMTA	Hazardous Materials Transportation Act
HQ	Headquarters
IAEA	International Atomic Energy Agency
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IDLH	immediately dangerous to life or health
IMDG	International Maritime Dangerous Goods
IP	industrial packaging
ISO	International Organization for Standardization
kg	kilogram
L	liter
LC	lethal concentration
LD	lethal dose
LSA	low specific activity
m^3	cubic meters
mg	milligrams
mL	milliliters
mm	millimeters
MORT	management oversight risk tree
MOU	memorandum of understanding
MSDS	material safety data sheet
NA	North America
NELA	nuclear explosive-like assemblies

NESHAP	National Emission Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NPL	National Priority Site List
NRC	Nuclear Regulatory Commission
NUREG	nuclear regulatory guide
ORM	other regulated material
ORPS	Occurrence Reporting and Processing System
OSH Act	Occupational Safety and Health Act
OSHA	Occupational Safety and Health Administration
P.L.	Public Law
PAAA	Price Anderson Amendments Act
PPE	personal protective equipment
psi	pounds per square inch
psia	pounds per square inch absolute
QF	quality factor
rad	roentgen absorbed dose
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RQ	reportable quantity
SARA	Superfund Amendments and Reauthorization Act
SARP	safety analysis report for packaging
SC	significance category
SCBA	self-contained breathing apparatus
SCO	surface contaminated object
SED	shippers export declarations
SNM	special nuclear material
TDG	transportation of dangerous goods
TI	transportation index
TRANSCOM	transportation tracking and communications system
TRR	technical review report
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
U.S.	United States
U.S.C.	United States Code
UCNI	unclassified controlled nuclear information
UN	United Nations

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