National Nuclear Security Administration

Environmental Restoration

Qualification Standard

Reference Guide

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ACRONYMS	
AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ANSI	American National Standards Institute
ARAR	applicable, relevant and appropriate requirements
ASTM	American Society for Testing and Materials
BACT	best available control technology
BOD	biochemical on demand
Btu	British thermal unit
Bq	Becquerel
C	realized risk
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CE	categorical exclusion
CEQ	Council on Environmental Quality
CGS	centimeter-gram-second system of international measurement
cm	centimeter
CWA	Clean Water Act
CX	categorical exclusion
DOE	U.S. Department of Energy
EA	environmental assessment
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
EIS	environmental impact statement
EML	Environmental Measurements Laboratory
EMS	environmental management system
ESA	Endangered Species Act
ESA	expedited site assessment
ETV	Environmental Technology Verification
EV	earned value
EVMS	Earned Value Management System
FAQS	Functional Area Qualification Standard
FEOSH	Federal Employee Occupational Safety and Health
FFCA	Federal Facilities Compliance Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	finding of no significant impact
FS	feasibility study
GIS	geographic information system
HAP	hazardous air pollutant
HEPA	high-efficiency particulate air (filter)
HMTA	Hazardous Materials Transportation Act
HRS	hazard ranking system
HSWA	Hazardous and Solid Waste Amendments

ACRONYMS	
IAG	interagency agreement
IRIS	Integrated Risk Information System
ISMS	Integrated Safety Management System
KE	kinetic energy
km	kilometer
kPa	kilopascal
KSA	knowledge, skill, and ability
LDR	land disposal restrictions
LOAEL	lowest observed adverse effect level
m	mass
m	meter
MACT	maximum achievable control technology
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MKS	Meter-kilogram-second system of international measurement
MRD	mean relative difference
mrem	millirem
MS4	municipal separate storm sewer system
MSGP	multi-sector general permit
MSHA	Mine Safety and Health Act
mSv	millisievert
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGPP	National Groundwater Pollution Program
NNSA	National Nuclear Security Administration
NOAEL	no observed adverse effect level
NOI	notice of intent
NPDES	National Pollutant Discharge Elimination System
NPL	national priorities list
NRC	Nuclear Regulatory Commission
NSPS	new source performance standards
OAQ	Outdoor Air Quality
OMB	Office of Management and Budget
ONRW	outstanding national resource water
OPA	Oil Pollution Act
OSC	on-scene coordinator
OSH	occupational safety and health
OSHA	Occupational Safety and Healthy Act
OSHA	Occupational Safety and Health Administration
P	probability of occurrence
PA	preliminary assessment
PCB	polychlorinated biphenyl

ACRONYMS	
pCi	picocurie
PE	potential energy
pH	hydrogen ion concentration
PM	particulate matter
$PM_{2.5}$	particulate matter ≤ 2.5 micrometers in diameter
PM_{10}	particulate matter ≤ 10 micrometers in diameter
pOH	hydroxyl ion concentration
POTW	publicly owned treatment work
PPA	Pollution Prevention Act
PPE	personal protective equipment
ppb	parts per billion
ppm	parts per million
PSD	prevention of significant deterioration
psi	pounds per square inch
psia	absolute pressure
psig	gauge pressure
QA	quality assurance
QAP	Quality Assessment Program
RA	remedial action
RAGS	Risk Assessment Guide for Superfund
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RF	risk factor
RfD	reference dose
RGO	remedial goal option
RHA	Rivers and Harbors Act
RI	remedial investigation
ROD	record of decision
RPD	relative percent difference
RQ	reportable quantity
RRT	regional response team
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SI	international units of measurement
SL	screening levels
SNM	special nuclear material
SPCC	spill prevention, control and countermeasures
STP	site treatment plan
SWDA	Solid Waste Disposal Act
TSCA	Toxic Substances Control Act
TSDF	treatment, storage, and disposal facility
TRI	toxic release inventory

ACRONYMS	
UIC	underground injection control
USDW	underground source of drinking water
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WBS	work breakdown structure

PURPOSE

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

SCOPE

This reference guide addresses the competency statements in the November 2002 edition of DOE-STD-1157-2002, *Environmental Restoration Functional Area Qualification Standard*. The qualification standard contains 42 competency statements.

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

PREFACE

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

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

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

Every effort has been made to provide the most current information and references available as of November 2009. However, the candidate is advised to verify the applicability of the information provided. It is recognized that some personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the Technical Qualification Program.

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

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

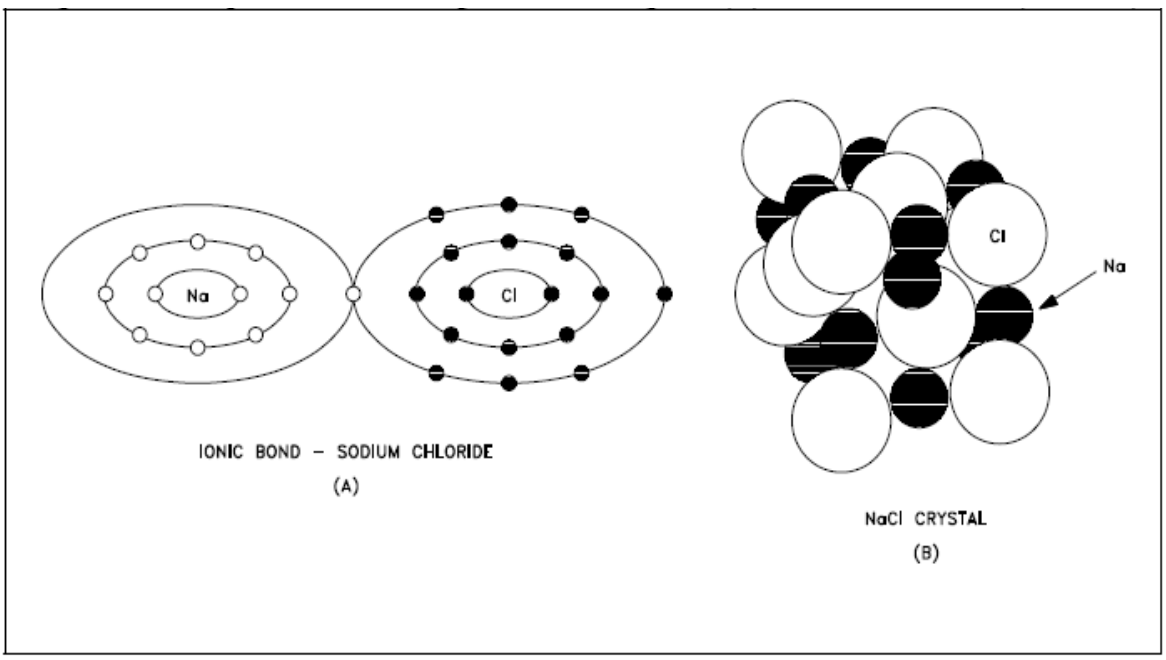
1. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of chemistry fundamentals.

a. Discuss the following types of chemical bonds:
- **Ionic**
- **Covalent**
- **Metallic**

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

Ionic

An ionic bond is formed when one or more electrons is wholly transferred from one element to another, and the elements are held together by the force of attraction due to the opposing charges. An example of ionic bonding is shown in figure 1(A) for sodium chloride (table salt).



Source: DOE-HDBK-1015/1-93

Figure 1. Ionic bond, sodium chloride

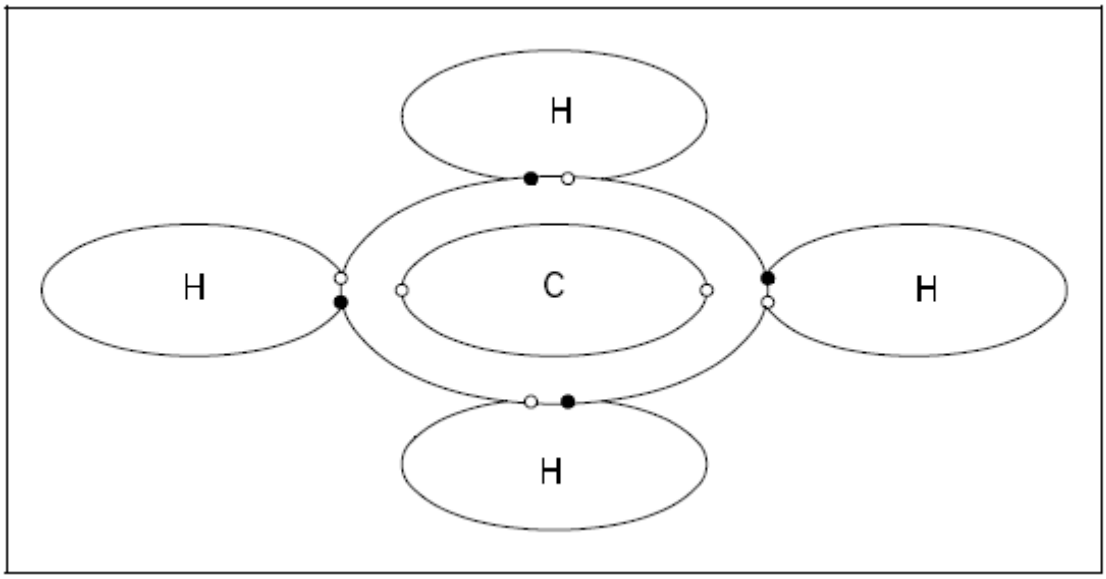
The sodium atom loses the one electron in its outer shell to the chlorine atom, which uses the electron to fill its outer shell. When this occurs, the sodium atom is left with a +1 charge and the chlorine atom a -1 charge. The ionic bond is formed as a result of the attraction of the two oppositely-charged particles. No single negatively-charged ion has a greater tendency to bond to a particular positively-charged ion than to any other ion.

Because of this, the positive and negative ions arrange themselves in three dimensions, as shown in figure 1(B), to balance the charges among several ions. In sodium chloride, for

example, each chloride ion is surrounded by as many sodium ions as can easily crowd around it, namely six. Similarly, each sodium ion is surrounded by six chloride ions. Therefore, each chloride ion is bonded to the six nearest sodium ions and bonded to a lesser extent to the more distant sodium ions. Accordingly, the ionic bond is a force holding many atoms or ions together rather than a bond between two individual atoms or ions.

Covalent

A covalent bond is formed when one or more electrons from an atom pair off with one or more electrons from another atom and form overlapping electron shells in which both atoms share the paired electrons. Unlike an ionic bond, a covalent bond holds together specific atoms. Covalent bonding can be single covalent, double covalent, or triple covalent depending on the number of pairs of electrons shared. Figure 2 shows the bonding that occurs in the methane molecule, which consists of four single covalent bonds between one carbon atom and four hydrogen atoms.



Source: DOE-HDBK-1015/1-93

Figure 2. Covalent bond, methane CH_4

Metallic

Another chemical bonding mechanism is the metallic bond. In the metallic bond, an atom achieves a more stable configuration by sharing the electrons in its outer shell with many other atoms. Metallic bonds prevail in elements in which the valence electrons are not tightly bound with the nucleus, namely metals, thus the name metallic bonding. In this type of bond, each atom in a metal crystal contributes all the electrons in its valence shell to all other atoms in the crystal.

b. Discuss how elements combine to form chemical compounds.

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

Two atoms of different elements held together by a bond form a compound. The molecule is the primary particle of a chemical compound. Some examples of this type of molecule include hydrogen chloride, water, methane, and ammonia. The Law of Definite Proportions states that no matter how a given chemical compound is prepared, it always contains the same elements in the same proportions by mass.

c. Define and discuss the following terms:

- **Mixture**
- **Solvent**
- **Solubility**
- **Solute**
- **Solution**
- **Equilibrium**
- **Density**
- **Molarity**
- **Parts per million (ppm)**
- **Acid**
- **Base**
- **pOH**
- **Salt**
- **pH**

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

Mixture

Mixtures consist of two or more substances intermingled with no constant percentage composition. Each component retains its original properties. When a teaspoon of sugar is added to a glass of water, it will slowly dissolve into the water and disappear from view. As a result, the molecules of sugar are evenly distributed throughout the water and become mixed with the water molecules. Because the sugar and water mixture is uniform throughout, it is said to be homogeneous.

Solvent

All solutions consist of a solvent and one or more solutes. The solvent is the material that dissolves the other substance(s). It is the dissolving medium. In the water-sugar solution, the water is the solvent. The substances that dissolve in the solution are called solutes. In the water-sugar solution, sugar is the solute.

Solubility

Solubility is defined as the maximum amount of a substance that can dissolve in a given amount of solvent at a specific temperature. At this point, the solution is said to be saturated. A solution is saturated when equilibrium is established between the solute and the solvent at a particular temperature.

Solute

The substances that dissolve in the solution are called solutes. In the water-sugar solution, sugar is the solute.

Solution

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

Equilibrium

A solution is saturated when equilibrium is established between the solute and the solvent at a particular temperature. Equilibrium is the point at which the rates of the forward and reverse reactions are exactly equal for a chemical reaction if the conditions of reaction are constant.

Density

Density is the measure of the mass per unit volume of a material (density = mass/volume). Density is a characteristic of a substance; mass and volume are not. Mass and volume vary with size but density will remain constant. Temperature will affect the density of a substance and the temperature at which density for that substance was determined is usually reported along with the density value.

Molarity

A useful way to express exact concentrations of solutions is molarity. Molarity is defined as moles of solute per liter of solution. Molarity is symbolized by the capital letter M. It can be expressed mathematically as follows:

$$\text{molarity (M)} = \frac{n}{V}$$

Where n is the number of moles of solute and V is the number of liters of solution. Notice that the moles of solute are divided by the liters of solution not solvent. One liter of one molar solution will consist of one mole of solute plus enough solvent to make a final volume of one liter.

Parts per million

Another term used to describe the specific concentration of a solution is parts per million or ppm. The term ppm is defined as the concentration of a solution in units of one part of solute to one million parts solvent. One ppm equals one milligram of solute per liter of solution. This term is usually used for very dilute solutions.

Acid

Acids are substances that dissociate in water to produce hydrogen. Examples of common acids include sulfuric acid, vinegar, aspirin, and lemon juice. Acid solutions taste sour, react with many metals to form hydrogen gas, turn litmus paper red, conduct electricity, and react with bases to form a salt and water.

Base

Bases are substances that produce hydroxide ions in water solutions. An example of a common base is sodium hydroxide. Other common bases are lye, household ammonia, and most soaps. Basic solutions taste bitter and feel slippery to the touch, turn litmus paper blue, conduct electricity, and neutralize acids.

pOH

The pOH of a solution is defined as the negative logarithm of the hydroxyl concentration, represented as $[OH^-]$ in moles/liter.

$$pOH = -\log[OH^-]$$

$$[OH^-] = 10^{-pOH}$$

Salt

When an acid reacts with a base, two products are formed; water and a salt. A salt is an ionic compound composed of positive ions and negative ions. The ionic bond is what keeps salts in their molecular form.

pH

Many compounds dissolve in water and alter the hydrogen ion concentration. Compounds that produce hydrogen ions directly when dissolved in water are called acids, and those that produce hydroxyl ions directly when dissolved in water are called bases. To treat these aspects of chemistry more precisely, a quantitative system of expressing acidity or basicity (alkalinity) is needed. This need could be met by using the value of $[H^+]$, where $[H^+]$ is expressed in moles/liter, as a measure of acidity. pH is defined as the negative logarithm of the hydrogen concentration, represented as $[H^+]$ in moles/liter.

$$pH = -\log[H^+]$$

$$[H^+] = 10^{-pH}$$

2. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of chemistry fundamentals in the areas of corrosion and water treatment.

a. Explain the process of general corrosion of iron and steel when exposed to water.

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

Corrosion is the deterioration of a material due to interaction with its environment. Electrolysis is the decomposition by electric current (in the context of corrosion the use of electrical current to bring about chemical change). An electrolyte is an electricity-conducting fluid; that is, it has positive and negative ions that can move and constitute an electrical current. Pure water has a limited number of dissociated H^+ and OH^- ions and is a relatively poor conductor of electricity. Addition of acids, bases, or salts that dissociate into ions increases the current-carrying capability of the water (electrolyte). General corrosion is the process whereby the surface of a metal undergoes a slow, relatively uniform; removal of

material. The two conditions typically required for a metal to undergo general corrosion are: 1) metal and water in the same environment, and 2) a chemical reaction between the metal and water that forms an oxide.

b. Discuss the two conditions that can cause galvanic corrosion.

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

Galvanic corrosion is the corrosion that results when two dissimilar metals with different potentials are placed in electrical contact in an electrolyte. A difference in electrical potential exists between the different metals and serves as the driving force for electrical current flow through the electrolyte. This current results in corrosion of one of the metals. A method called cathodic protection is often used to retard or eliminate galvanic corrosion. One of several ways of accomplishing this is to attach a third metal to the metals to be protected. This metal must have an oxidation potential even greater than that of the metal to be protected. The most active metal then tends to corrode in place of the protected metal. The metal that corrodes to protect another metal is called a sacrificial anode. Zinc is a common sacrificial anode and is often used in cooling water systems that contain seawater.

c. Discuss the following types of specialized corrosion:
- **Pitting corrosion**
- **Stress corrosion cracking**
- **Crevice corrosion**

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

Pitting Corrosion

Pitting corrosion occurs where the anodic site becomes fixed in a small area and the formation of holes (deep attack) in an otherwise unaffected area takes place. Pitting corrosion requires two conditions to occur, low flow and areas of both high and low oxygen concentration.

Stress Corrosion Cracking

Stress corrosion cracking is a type of intergranular attack corrosion that occurs at the grain boundaries under tensile stress. Stress corrosion cracking occurs in susceptible alloys (many stainless steels) when the alloy is exposed to a particular, specific environment (presence of hydroxides, chlorides, and oxygen) if the alloy is in a stressed condition.

Crevice Corrosion

Crevice corrosion is a type of pitting corrosion that occurs specifically within the low flow region of a crevice.

d. Explain the following water treatment processes.
- **Ion exchange**
- **pH adjustment**
- **Clarification**
- **Solids handling**
- **Disinfection techniques**

Ion Exchange

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

Ion exchange is a process used extensively in nuclear facilities to control the purity and pH of water by removing undesirable ions and replacing them with acceptable ones. Specifically, it is the exchange of ions between a solid substance (called a resin) and an aqueous solution (reactor coolant or makeup water). Depending on the identity of the ions that a resin releases to the water, the process may result in purification of water or in control of the concentration of a particular ion in a solution. An ion exchange is the reversible exchange of ions between a liquid and a solid. This process is generally used to remove undesirable ions from a liquid and substitute acceptable ions from the solid (resin). The devices in which ion exchange occurs are commonly called demineralizers. This name is derived from the term demineralize, which means the process whereby impurities present in the incoming fluid (water) are removed by exchanging impure ions with H^+ and OH^- ions, resulting in the formation of pure water. H^+ and OH^- are present on the sites of resin beads contained in the demineralizer tank or column.

pH Adjustment

The following is taken from City of Maui, Lead and Copper, Soda Ash.

Soda ash is the common name for sodium carbonate. It is a sodium salt and is alkaline. It is commonly used in water treatment for pH adjustments and for corrosion and scale control. Soda ash works by producing an increase in the final sodium content, pH and alkalinity. The combination of higher pH and alkalinity can dramatically reduce lead solubility relative to lower pH and lower alkalinity water.

Clarification

The following is taken from the U.S. Environmental Protection Agency, Terms of Environment: Glossary, Abbreviations, and Acronyms.

Clarification is a clearing action that occurs during wastewater treatment when solids settle out. This is often aided by centrifugal action and chemically induced coagulation in wastewater.

Solids Handling

The following is taken from eProcess Technologies, Solid Liquid Separation.

Solids handling and disposal can be broken down into five main steps: separate, collect, clean, dewater, and haulage.

1. Separate - The solids must first be removed from the well or process fluid stream.
2. Collect - To facilitate a simple system design, all collected or removed solids must be gathered into one central location.
3. Clean - In many cases the sand or solids may require cleaning for oil or chemical removal, prior to further handling.
4. Dewater - The total volume of sand slurry to be disposed can be greatly reduced by a dewatering step.

5. Haulage - Haulage includes removal, hauling, and disposal of the solids. The design of the haulage system will be dependent upon the location (land based or offshore) and disposal requirements (i.e. disposal well, overboard, landfill, road surfacing, etc.).

Disinfection Techniques

The following is taken from the Pacific Northwest National Laboratory, Disinfection Technologies for Potable Water and Wastewater Treatment: Alternatives to Chlorine Gas.

There are a variety of techniques to disinfect fluids and surfaces. Three common techniques are disinfection ozone, ultraviolet radiation, and chlorination.

Ozone

Ozone technology has been used for potable water treatment for nearly a century. Ozone disinfects by oxidizing the cell walls of microorganisms, which then disintegrate, destroying the microorganism. Ozone disinfects much faster than chlorine, killing E. coli, for example, approximately 3000 times faster than chlorine.

Ultraviolet Radiation

Ultraviolet light is used primarily for wastewater treatment. In an ultraviolet light system, water flows past ultraviolet lamps to expose microbes to energy at a germicidal wavelength of 253.7 nanometers. This exposure modifies the cells of contaminants (bacteria, viruses, molds, algae, etc.) so that they can no longer reproduce, and thus present no threat to human health.

Chlorination

Chlorine gas technology has been the primary method of disinfecting water in this country for nearly a century. Chlorine gas is used in about 87 percent of US municipal water treatment facilities that disinfect. While some treatment facilities have retired chlorine gas technology, the vast majority have not, given the familiarity, perceived economic benefits and general disinfection performance of this method.

With this disinfection method, chlorine is absorbed and distributed throughout the water being treated and the target organisms are killed. Chemically, this process is termed hydrolyzation, with the organisms killed by the resulting hypochlorous acid.

3. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of solving problems involving probability and simple statistics.

a. State the definition of the following statistical terms:

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

Mean

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

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

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

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

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

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

Example:

Determine the mean of the following numbers: 5, 7, 1, 3, 4

Solution:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i \;=\; \frac{1}{5}\sum_{i=1}^{5} x_i$$

where
$\bar{x}$ = the mean
n = the number of values (data) = 5
$x_1 = 5$, $x_2 = 7$, $x_3 = 1$, $x_4 = 3$, $x_5 = 4$

substituting $\bar{x}$ = (5 + 7 + 1 + 3 + 4) / 5 = 20 / 5 = 4

4 is the mean.

Variance

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

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

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

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

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

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

Example:

Calculate the mean and mean variance of the following set of data: 40, 38, 28, 28, 40, 38, 34, 28, 40, 38, 34, 30, 40, 36.

Solution:

The mean is [40(4) + 38(3) + 36 + 34(2) + 30 + 28(3)] / 14 = 492 / 14 = 35.1

The mean variance = $\frac{1}{14}$(|40 – 35.1| + |38 – 35.1| + |28 – 35.1| + …|36 – 35.1|)

$$= \frac{1}{14}(57.8) = 4.12$$

Standard Deviation of the Mean

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

The following is taken from Graphpad Software, Key Concepts: SEM.

The standard error of the mean quantifies the precision of the mean. It is a measure of how far the sample mean is likely to be from the true population mean. It is expressed in the same units as the data. The standard error of the mean is always smaller than the standard deviation. With large samples, the standard error of the mean is much smaller than the standard deviation. The standard error of the mean is calculated by dividing the standard deviation by the square root of the number of samples.

$$\text{standard error of the mean} = \frac{\sigma}{\sqrt{n}}$$

where σ is the standard deviation of the data, and n is the number of data values.

The following definitions are taken from DOE-HDBK-1122-2009, module 2.03.

Median

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

The center value in a data set arranged in ascending order.

Examples:

The median for the data set 2, 4, 7, 9, 3 is 4.
2, 3, 4, 7, and 9 is the ascending order of the data set 2, 4, 7, 9, 3. The middle number in the ordered data set is 4.

Find the median of a data set with even number of items in it, e.g. 33, 30, 42, 22, 18, and 31. Arranging the above data set in ascending order yields 18, 22, 30, 31, 33, and 42. The middle numbers from the above data set are 30 and 31. The mean of those two numbers is 30.5. So, 30.5 is the median (middle value) of the data set 33, 30, 42, 22, 18, and 31.

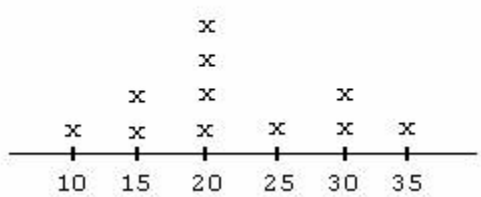
Mode

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

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

Example:

10, 20, 15, 20, 25, 30, 35, 20, 20, 30, 15



In the given line plot, the most number of crosses (4) is shown against 20. So 20 is the mode of the given line plot.

Standard Deviation

The following is taken from DOE-HDBK-1122-2009, module 2.03.

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

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

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

b. Explain the structure and function of distributions.

The following is taken from DOE-HDBK-1122-2009, module 2.03.

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

Table 1. Probability of success

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

Source: DOE-HDBK-1122-2009, module 2.03

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

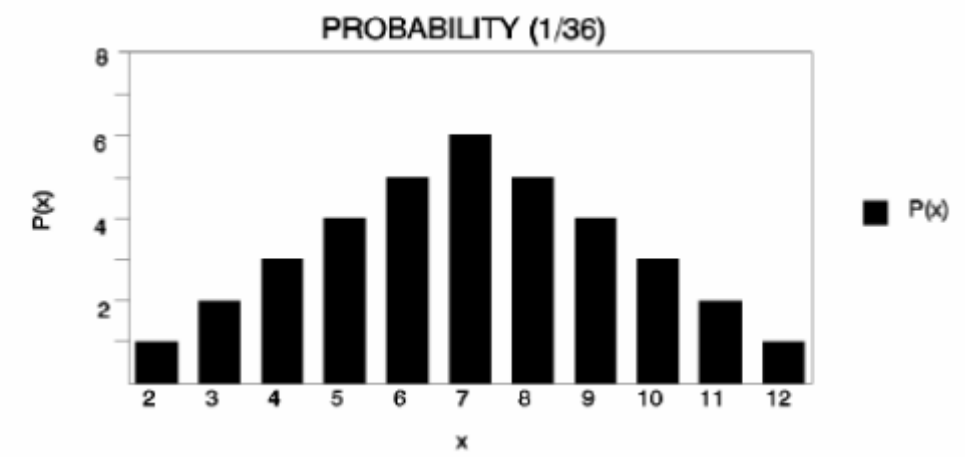
Table 2. Possibilities in rolling dice

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

Source: DOE-HDBK-1122-2009, module 2.03

If success is defined as throwing a number between 2 and 12, the outcome is academic. All trials will be successful, and the probability of throwing any individual number between the range of 2 and 12 inclusive would add up to 1. If success is defined as throwing a particular

number, the probability of success can be defined in terms of the number of possible outcomes that would give that number in comparison to the total number of possible outcomes. If the dice is rolled a large number of times a graph of the results would produce a curve such as the one shown in figure 3.



Source: DOE-HDBK-1122-2009, module 2.03

Figure 3. Probability of a binary process

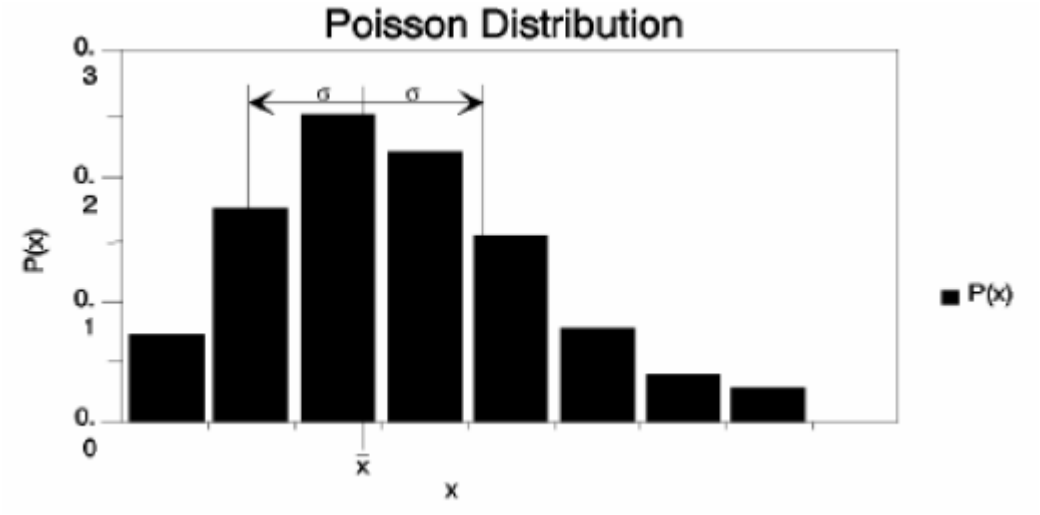
The area under the curve can be mathematically determined and would correspond to the probability of success of a particular outcome. For example, to determine the probability of throwing a particular number between 2 and 12 we would calculate the area under the curve between 2 and 12. The results of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

Binomial Distribution

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

Poisson Distribution

A simplified version of binomial distribution is the Poisson (pronounced “pwusówn”) distribution, which is valid when the probability of success, P(x), is small. A graph of a Poisson distribution function would show the predicted number of successes at the lower end of the curve, with successes over the entire range if sufficient trials were attempted. Thus, the curve would appear as seen in figure 4.



Source: DOE-HDBK-1122-2009, module 2.03

Figure 4. Predicted success for Poisson

Gaussian Distribution

Also called the normal distribution, the Gaussian (pronounced "Gowziun") distribution is a further simplification that is applicable if the average number of successes is relatively large, but the probability of success is still low. A graph of a Gaussian distribution function is shown in figure 5.

Source: DOE-HDBK-1122-2009, module 2.03

Figure 5. Predicted success for Gaussian

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

note that the mean, or average number of successes, is at the highest point, or at the center of the curve.

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 KSAs. The Qualifying Official will evaluate their completion.

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

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

Arithmetic Mean is the most commonly used measure of central tendency, commonly called the average. Mathematically, it is the sum of all the values of a set divided by the number of values in the set. Variability is a general term for the dispersion of values in a data set. Variance is a measure of the variability of samples within a subset or the entire population.

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

The following is taken from DOE Memorandum, *Environmental Protection Agency Notice of Proposed Rulemaking: Waste Management Systems; Testing and Monitoring Activities; Methods Invention Rule.*

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

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

Table 3. Conclusions and consequences for a test of hypotheses

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

Source: DOE Memorandum, *Environmental Protection Agency Notice of Proposed Rulemaking: Waste Management Systems; Testing and Monitoring Activities; Methods Invention Rule*

4. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of the basic principles and concepts of hydrology, geology, and soil science.

a. List the different soil textures (compositions) and soil structures.

The following is taken from U.S. Department of Agriculture, The Twelve Orders of Soil Taxonomy.

There are 12 soil classifications.

Alfisols

Alfisols are in semiarid to moist areas. These soils result from weathering process that leach clay minerals and other constituents out of the surface layer and into the subsoil, where they can hold and supply moisture and nutrients to plants. They are formed primarily under forest or mixed vegetative cover and are productive for most crops. Alfisols make up about 10 percent of the worlds ice-free land surface.

Andisols

Andisols form from weathering processes that generate minerals with little orderly crystalline structure. These minerals can result in high water and nutrient holding capacity and tend to be highly productive soils. They are common in cool areas with moderate to high precipitation, especially those areas associated with volcanic materials. Andisols make up about 1 percent of the world's ice-free land surface.

Aridisols

Aridisols are soils that are common in the desserts of the world. The lack of moisture greatly restricts the intensity of weathering processes and limits most soil development processes to the upper part of the soils. Aridisols make up about 12 percent of the world's ice-free land surface.

Entisols

Entisols are soils that show little or no evidence of horizontal layer development. They occur in areas where erosion or deposition rates are faster than the rate of soil development such as

dunes, steep slopes, and flood plains. Entisols make up about 16 percent of the world's ice-free land surface.

Gelisols

Gelisols are soils that have permafrost near the soil surface and/or have evidence of frost churning or ice segregation. Gelisols are common in the higher latitudes or at high elevations. Gelisols make up about 9 percent of the world's ice-free land surface.

Histosols

Histosols have a high content of organic matter and no permafrost. Most are saturated year round, but few are freely drained. Histosols are commonly called bogs, moors, peats, or mucks. Histosols make up about 1 percent of the world's ice-free land surface.

Inceptisols

Inceptisols are soils of semiarid to humid environments that generally exhibit only moderate degrees of soil weathering and development. Inceptisols have a wide range of characteristics and occur in a wide variety of climates. Inceptisols make up about 17 percent of the world's ice-free land surface.

Mollisols

Mollisols are soils that have a dark colored surface horizon relatively high in content of organic matter. The soils are base rich throughout and therefore quite fertile. Mollisols characteristically form under grass in climates that have a moderate to pronounced seasonal moisture deficit. Mollisols make up about 7 percent of the world's ice-free land surface.

Oxisols

Oxisols are highly weathered soils of tropical and subtropical regions. They are dominated by low activity minerals such as quart, kaolinite, and iron oxides. Oxisols characteristically occur on land surfaces that have been stable for a long time. Oxisols make up about 8 percent of the world's ice-free land surface.

Spodosols

Spodosols are formed from weathering processes that strip organic matter from the surface layer and deposit them in the subsoil. Spodosols commonly occur in areas of coarse-textured deposits under coniferous forests of humid regions and tend to be acid and infertile. Spodosols make up about 4 percent of the world's ice-free land surface.

Ultisols

Ultisols are soils in humid areas. They are formed from fairly intense weathering and leaching processes that result in a clay-enriched subsoil dominated by minerals such as quartz, kaolinite, and iron oxides. Ultisols are typically acid soils in which most nutrients are concentrated in the upper few inches. Ultisols make up about 8 percent of the world's ice-free land surface.

Vertisols

Vertisols have a high content of expanding clay minerals. They undergo pronounced changes in volume with changes in moisture. They tend to be fairly high in natural fertility. Vertisols make up about 2 percent of the world's ice-free land surface.

The following is taken from the U.S. Department of Agriculture, National Resources Conservation Service, *Soil Survey Manual*, chapter Three, Examination and Description of Soils.

Soil structure refers to units composed of primary particles. The cohesion within these units is greater than the adhesion among units. In soils that have structure, the shape, size, and grade (distinctness) of the units are described. Several basic shapes of structural units are recognized in soils: platy, prismatic, columnar, blocky, and granular. Five size classes are employed: very fine, fine, medium, coarse, and very coarse. Grade describes the distinctness of units. Criteria are the ease of separation into discrete units and the proportion of units that hold together when the soil is handled. Three classes are used: weak, moderate, and strong.

b. Define humus and explain its role in chemical reactions in the soil.

The following is taken from U.S. Department of Agriculture, *Soil Biology Primer*, chapter 1.

Humus is defined as complex organic compounds that remain after many organisms have used and transformed the original material. Humus is not readily decomposed because it is either physically protected inside of aggregates or chemically too complex to be used by most organisms. Humus is important in binding tiny soil aggregates, and improves water and nutrient holding capacity.

The following is taken from U.S. Department of Agriculture, New Jersey NRCS, Soil Chemical Properties.

Some plant nutrients and metals exist as positively charged ions, or "cations", in the soil environment. Among the more common cations found in soils are hydrogen, aluminum, calcium, magnesium, and potassium. Most heavy metals also exist as cations in the soil environment. Clay and organic matter particles (humus) are predominantly negatively charged (anions), and have the ability to hold cations from being "leached" or washed away.

c. Define erosion (water and wind).

The following is taken from the U.S. Department of Agriculture, National Resources Conservation Service, *Soil Survey Manual*, chapter 3, Examination and Description of Soils.

Erosion is the detachment and movement of soil material. The process may be natural or accelerated by human activity. Water erosion results from the removal of soil material by flowing water. A part of the process is the detachment of soil material by the impact of raindrops. The soil material is suspended in runoff water and carried away. Wind erosion in regions of low rainfall can be widespread, especially during periods of drought. Unlike water erosion, wind erosion is generally not related to slope gradient. The hazard of wind erosion is increased by removing or reducing the vegetation. When winds are strong, coarser particles

are rolled or swept along on or near the soil surface, kicking finer particles into the air. The particles are deposited in places sheltered from the wind. When wind erosion is severe, the sand particles may drift back and forth locally with changes in wind direction while the silt and clay are carried away.

d. Describe the following processes and explain how water and soil interact in each:

- **Infiltration and percolation**
- **Groundwater recharge**
- **Runoff**
- **Evapotranspiration**
- **Unsaturated flow**

The following is taken from the U.S Geological Survey, The Water Cycle.

The water cycle describes the existence and movement of water on, in, and above the Earth. Earth's water is always in movement and is always changing states, from liquid to vapor to ice and back again.

Infiltration and Percolation / Groundwater Recharge

Infiltration is the downward movement or percolation of water from the land surface into soil or porous rock. Some water that infiltrates will remain in the shallow soil layer, where it will gradually move vertically and horizontally through the soil and subsurface material. Eventually it might enter a stream by seepage into the stream bank. Some of the water may infiltrate deeper, recharging groundwater aquifers.

Runoff

Surface runoff is precipitation runoff that travels over the soil surface to the nearest stream channel. Runoff flowing over bare soil deposits sediment into rivers, which is not good for water quality.

Evapotranspiration

Evapotranspiration is the process by which water vapor is discharged to the atmosphere as a result of evaporation from the soil and transpiration by plants. Transpiration is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere. Transpiration is essentially evaporation of water from plant leaves.

Unsaturated Flow

As precipitation infiltrates into the subsurface soil, it generally forms an unsaturated zone and a saturated zone. In the unsaturated zone, the voids—that is, the spaces between grains of gravel, sand, silt, clay, and cracks within rocks—contain both air and water. Although a considerable amount of water can be present in the unsaturated zone, this water cannot be pumped by wells because it is held too tightly by capillary forces.

e. Describe how soil characteristics, slope factors, and land cover conditions impact the detachment and transport processes of pollution.

The following is taken from the Encyclopedia of Water Science, *Erosion Research: History* and *Erosion Processes*.

Each type of soil has its own inherent susceptibility to the forces of erosion in large part because of chemical composition and organic matter content. Large-grained materials are easily detached by raindrop splash or flowing water; however, they are not easily transported. On the other hand, fine soils such as clays and mixtures of clays and silts that bond together tightly are not easily detached, but once free they are transported with little difficulty.

Soil erosion implies detachment, transport and deposition of soil by energy from water, wind, or gravity. Soil erosion is a natural process and is responsible for formation of fertile soils. Activities that accelerate the soil erosion process include deforestation, biomass burning, conversion of natural to agricultural ecosystems, and plowing especially up and down the slope without protective ground cover of crop residue or a cover crop. In contrast to the natural process, the accelerated soil erosion is an extremely destructive process leading to severe adverse effects on-site, and pollution of natural waters and sedimentation of waterways and reservoirs off-site.

Mulch and vegetative covers play an important role in hindering the erosion process. Without protective ground cover, raindrops may splash soil particles up to one meter. However, when mulch lies directly on the ground and completely covers the soil surface, the force from falling raindrops is absorbed and thus eliminates or reduces splash erosion. Canopy cover will also reduce drop erosion to a great extent. Close growing crops such as corn and soybeans catch raindrops and keep them from hitting soil directly.

f. Discuss contaminant loading and the contaminant delivery ratio.

[Note: The term *pollutant* is utilized in place of the term *contaminant* in the reference material.]

The following is taken from U.S Environmental Protection Agency, *Handbook for Developing Watershed Plans to Restore and Protect Our Waters.*

The term pollutant load refers to the amount of pollutants entering a water body. Loads are usually expressed in terms of a weight and a time frame, such as pounds per day.

The following is taken from an Ohio State University Extension Fact Sheet, *Nonpoint Source Pollution: Water Primer*.

The delivery ratio is the amount of a pollutant generated at its source compared to the amount of the pollutant actually reaching a water resource. This term is frequently expressed as a percentage. Point and nonpoint source pollutants may have different delivery ratios. A large percentage of many point source pollutants may actually reach a water resource in nearly the same amount as when they were generated and released into the environment. Suppose that a commercial operation generated a waste product as part of a manufacturing process, did not treat the waste, and subsequently discharged the waste directly to a stream. The delivery ratio

for this point source case would be near 100 percent. Some nonpoint source pollutants also may have large delivery ratios. As an example, pollution from parking lots where the runoff flows from paved surfaces directly to a storm sewer or stream may have a large delivery ratio. The delivery ratio for pollutants generated from agricultural land use is variable, but usually ranges between 1 and 40 percent. For example, much soil may be detached and eroded on an agricultural field during a rainfall event. However, only a small percentage of the sediment may actually enter a stream depending on field slope, soil type, tillage direction, proximity of field to stream, proper use of sediment control methods or best management practices, or other factors that might help reduce runoff velocity and amount, and enhance sediment deposition within the field.

g. Discuss the use of soil survey maps.

The following is taken from the U.S. Department of Agriculture, National Resources Conservation Service, How to Use a Soil Survey.

A soil survey is a detailed report on the soils of an area. The soil survey has maps with soil boundaries and photos, descriptions, and tables of soil properties and features. Soil surveys are used by farmers, real estate agents, land use planners, engineers and others who desire information about the soil resource.

The tables section of the soil survey report provides detailed information on soil properties and their suitability and limitations as well as management and production potential of the various soils. It also provides detailed information on engineering index properties, physical and chemical properties, soil and water features, use for crops and pasture, and use for recreation.

h. Discuss the cation and anion exchange capacity of soils.

The following is taken from University of Hawaii at Manoa, Soil Nutrient Management for Maui County, Soil Mineralogy.

Less weathered soils that contain minerals such as montmorillonite are said to have a cation exchange capacity under acidic, neutral, and alkaline conditions. Cation exchange capacity is the soil's ability to attract, retain, and supply nutrients, such as calcium, potassium, ammonium, and magnesium. These nutrients are positively charged atoms, known as cations. The surfaces of less-weathered clay minerals (such as montmorrillonite) generally have a negative charge. Much like a magnet, negatively charged soil surfaces attract positively charged cations. However, under acidic conditions the soil will also have a tendency to attract aluminum and hydrogen cations. The presence of aluminum and hydrogen contributes to soil acidity. In contrast, under alkaline conditions, the soil attracts sodium that contributes to soil alkalinity.

Although the majority of the world's soils have cation exchange capacity, the highly weathered soils of the tropics are an exception. In addition to having the cation exchange capacity, many tropical soils also have an anion exchange capacity, depending upon the pH of the soil. Under neutral and alkaline conditions, the soil has cation exchange capacity, like the less weathered soils. However, under acidic conditions these soils generate anion

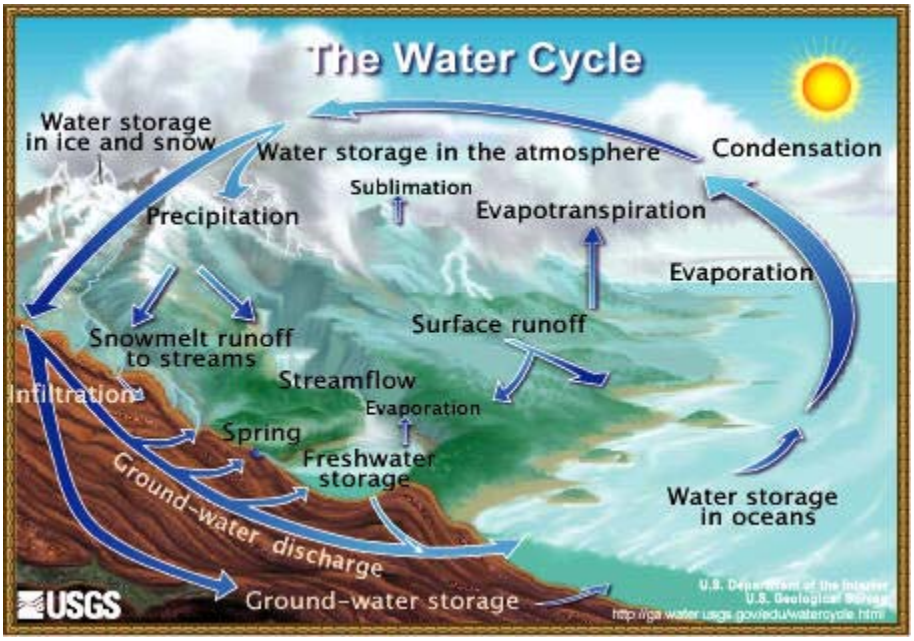
exchange capacity. This means that the soil becomes positively charged and attracts, retains, and supplies negatively charged anions, such as sulfate, phosphate, nitrate, and chloride. For soils with anion exchange capacity, proper management of pH is crucial in order to provide sufficient amounts of the nutrient cations (calcium, magnesium, ammonium, and potassium).

Cation exchange capacity and anion exchange capacity values are important measurements that provide us with important information regarding the soil's ability to retain and supply certain nutrients to the plant. In addition to nutrient retention, cation exchange capacity and anion exchange capacity helps us predict the leaching potential of certain nutrients in areas with high rainfall. When the soil has a very high cation exchange capacity, negatively charged nutrients such as nitrate are not retained by the soil. Instead, nitrate leaches through the soil profile in areas with high amounts of precipitation. Likewise, soils with high anion exchange capacity experience leaching of positively charged nutrients, such as calcium and potassium.

i. Describe the hydrologic cycle.

The following is taken from the U.S Geological Survey, The Water Cycle.

Earth's water is always in movement, and the water cycle, also known as the hydrologic cycle, describes the continuous movement of water on, above, and below the surface of the Earth. Since the water cycle is truly a "cycle," there is no beginning or end. Water can change states among liquid, vapor, and ice at various places in the water cycle. See figure 6.



Source: U.S Geological Survey, The Water Cycle

Figure 6. The Water Cycle

j. Define the following hydrologic terms and describe the relationships between them:

- **Precipitation**
- **Stream flow**
- **Evaporation**
- **Transpiration**
- **Subsurface water**
- **Sedimentation**

The following definitions are taken from the U.S Geological Survey, The Water Cycle.

Precipitation

Precipitation is the discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. It is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth. Most precipitation falls as rain.

Stream Flow

Streamflow is the movement of water in a natural channel, such as a river. Streamflow is always changing, from day to day and even minute to minute. The main influence on streamflow is precipitation runoff.

Evaporation

Evaporation is the process by which water changes from a liquid to a gas or vapor. Evaporation is the primary pathway that water moves from the liquid state back into the water cycle as atmospheric water vapor. Studies have shown that the oceans, seas, lakes, and rivers provide nearly 90 percent of the moisture in our atmosphere via evaporation, with the remaining 10 percent being contributed by plant transpiration.

Transpiration

Transpiration is the process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapor and is released to the atmosphere. Transpiration is essentially evaporation of water from plant leaves. It is estimated that about 10 percent of the moisture found in the atmosphere is released by plants through transpiration.

Subsurface Water

Large amounts of water are stored in the ground. The water is still moving, possibly very slowly, and it is a part of the water cycle. Most of the water in the ground comes from precipitation that infiltrates downward from the land surface. The upper layer of the soil is the unsaturated zone, where water is present in varying amounts that change over time, but does not saturate the soil. Below this layer is the saturated zone, where all of the pores, cracks, and spaces between rock particles are saturated with water. The term groundwater is used to describe this area. Another term for groundwater is “aquifer,” although this term is usually used to describe water-bearing formations capable of yielding enough water to supply peoples’ uses. Aquifers are a huge storehouse of Earth’s water, and people all over the world depend on groundwater in their daily lives.

Sedimentation

The following is taken from the U.S. Geological Survey, Water Science for Schools, Earth's water: Rivers and Sediment.

When it rains, soil and debris from the surrounding land are eroded and washed into streams. From there, sediment particles from as small as clay to as large as boulders flow along with the water. On the plus side, sediment deposited on the banks and flood plains of a river is often mineral-rich and makes excellent farmland. On the negative side, when rivers flood, they leave behind many tons of mud. Sediments can also harm dams and reservoirs. When a river is dammed and a reservoir is created, the sediments that used to flow along with the relatively fast-moving river water are, instead, deposited in the reservoir. This happens because the river water flowing through the reservoir moves too slowly to keep sediment suspended -- the sediment settles to the bottom of the reservoir. Reservoirs slowly fill up with sediment and mud, eventually making them unusable for their intended purposes.

k. Define the following groundwater terms and describe the relationships between them:

- **Capillary water**
- **Zone of saturation**
- **Specific yield**
- **Hydraulic conductivity**
- **Transmissivity**
- **Vadose zone**

The following definitions are taken from U.S. Geological Survey, Oregon Water Science Center, Glossary of Hydrologic Terms.

Capillary Water

Capillary water is water held in the soil above the phreatic surface (water table) by capillary forces.

Zone of Saturation

The zone of saturation is the part of a groundwater system in which all of the spaces between soil and rock material are filled with water. Water found within the zone of saturation is called groundwater. The water table is the top of the zone of saturation.

Specific Yield

Specific yield is the ratio of the volume of water that the porous medium, after being saturated, will yield by gravity to the volume of the porous medium.

Hydraulic Conductivity

A proportionality constant relating hydraulic gradient to specific discharge which for an isotropic medium and homogeneous fluid, equals the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Also defined as the rate of flow of water through a porous medium that contains more than one fluid, such as water and air in the unsaturated zone, and that should be specified in terms of both the fluid type and content and the existing pressure.

Transmissivity

The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Vadose Zone

The Vadose Zone is the zone between the land surface and the deepest water table that includes the capillary fringe. Water in this zone is generally under less than atmospheric pressure, and some of the voids may contain air or other gases at atmospheric pressure. Beneath flooded areas or in perched water bodies, the water pressure locally may be greater than atmospheric.

l. Define the following surface water terms:
- **Mass curve**
- **Frequency analysis**

The following is taken from American Meteorological Society, Glossary of Meteorology.

Mass Curve

Mass curve is a plotting of the cumulative values of a variable as a function of time. This is applied especially to mass curves of rainfall in storm studies, to departures of various weather elements from normal, and to streamflow data for reservoir studies.

Frequency Analysis

The following is taken from the U.S. Geological Survey, Office of Surface Water, Estimating Magnitude and Frequency of Floods Using the PeakFQ Program.

Flood-frequency analysis provides information about the magnitude and frequency of selected flood discharges. Flood-frequency information is important for defining flood-hazard areas; for managing floodplains; and for designing bridges, culverts, dams, levees, and other structures.

m. Discuss the composition and identification of the following types of rocks and cite examples of each.
- **Igneous**
- **Sedimentary**
- **Metamorphic**

The following definitions are taken from U.S. Geological Survey, Geology in the Parks, Rocks and Minerals, Rocks 101.

Igneous

Igneous rocks form when molten rock (magma) originating from deep within the Earth solidifies. The chemical composition of the magma and its cooling rate determine the final igneous rock type.

Sedimentary

Sedimentary rocks are formed from pre-existing rocks or pieces of once-living organisms. They form from deposits that accumulate on the Earth's surface.

Metamorphic

Metamorphic rocks are rocks that have been substantially changed from their original igneous, sedimentary, or earlier metamorphic form. Metamorphic rocks form when rocks are subjected to high heat, high pressure, hot, mineral-rich fluids or, more commonly, some combination of these factors.

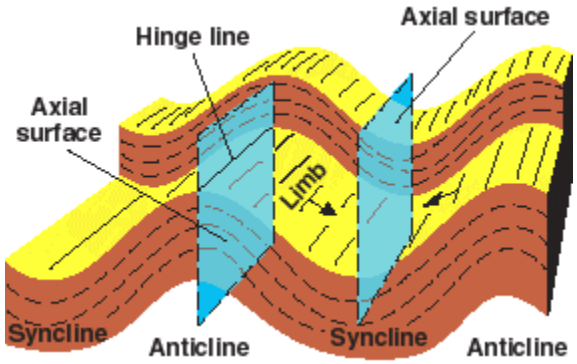
n. Describe the geometry and properties of the following rock mass features:

- **Folds**
- **Faults**
- **Structural discontinuities**
- **Residual stress**
- **Sheet Joints**
- **Shear strength of discontinuities**

The following definitions are taken from Schlumberger, Oilfield Glossary.

Folds

A fold is a wave-like geologic structure that forms when rocks deform by bending instead of breaking under compressional stress. Anticlines are arch-shaped folds in which rock layers are upwardly convex. The oldest rock layers form the core of the fold, and outward from the core progressively younger rocks occur. A syncline is the opposite type of fold, having downwardly convex layers with young rocks in the core. Folds typically occur in anticline-syncline pairs as shown in figure 7.



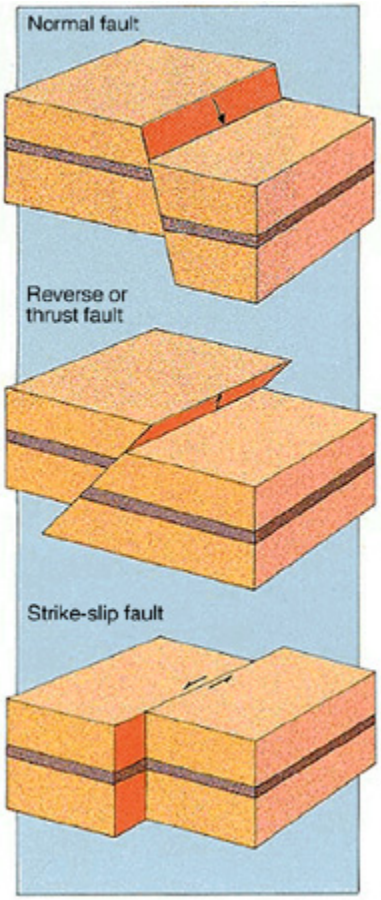
Source: Schlumberger, Oilfield Glossary

Figure 7. Diagram of parts of synclines and anticlines

Faults

A fault is a break or planar surface in brittle rock across which there is observable displacement. Depending on the relative direction of displacement between the rocks, or fault blocks, on either side of the fault, its movement is described as normal, reverse or strike-slip.

According to terminology derived from the mining industry, the fault block above the fault surface is called the hanging wall, while the fault block below the fault is the footwall. See figure 8.



Source: Schlumberger, Oilfield Glossary

Figure 8. Schematic diagrams of normal reverse, and strike-slip faults

Structural Discontinuities

A structural discontinuity is a subsurface boundary or interface at which a physical quantity, such as the velocity of transmission of seismic waves, changes abruptly.

The following is taken from Washington State Earthquake Hazards, What are Earthquakes?

Residual Stress

An earthquake is the shaking of the ground caused by an abrupt shift of rock along a fracture in the Earth, called a fault. Within seconds, an earthquake releases stress that has slowly accumulated within the rock, sometimes over hundreds of years. Any residual stress is often released by later minor readjustments along the fault causing smaller earthquakes called aftershocks.

Sheet Joints

The following is taken from U.S. Geological Survey, Bedrock Geology of Yosemite.

The type of jointing that has most influenced the form of Yosemite's monuments is the broad shell-like unloading joints, or sheeting, also commonly referred to as exfoliation. Granitic rocks crystallized at great depths within the Earth while under extreme pressure from miles of overlying rock. As the still-buried rocks were uplifted into mountains and the overlying rock eroded, the release, or unloading, of the previously confining pressure caused the rock to expand outward. In jointed rocks such expansion is taken up by adjustments along the numerous partings, but in a massive rock monolith the stresses accumulate until they exceed the tensile strength of the rock and the outer and more rapidly expanding layer bursts loose. In the course of time the process is repeated, and the monolith becomes covered with several layers of shells. The outermost layer, being exposed to the weather, gradually disintegrates, and the pieces fall off. Because the expansion that forms sheet jointing takes place perpendicular to the Earth's surface, the shape of sheets generally reflects the topography, although their formation also subtly modifies the topography. If the ground surface is level, the sheets will be horizontal. If the granite underlies a hill, the sheets will curve accordingly, convex upward; beneath a valley, concave upward. Sheeting also tends to parallel the walls of canyons. If a canyon wall slopes toward the river, the sheets do also. If the walls are vertical, the sheets are also vertical.

Shear Strength of Discontinuities

The following is taken from the U.S. Bureau of Reclamation, *Engineering Geology Field Manual*, volume 1, chapter 5, Terminology and Descriptions for Discontinuities.

Structural breaks or discontinuities generally control the mechanical behavior of rock masses. In most rock masses the discontinuities form planes of weakness or surfaces of separation, including foliation and bedding joints, joints, fractures, and zones of crushing or shearing. These discontinuities usually control the strength, deformation, and permeability of rock masses. Dimensional characteristics such as roughness and waviness and characteristics, such as weathering and hardness of the surfaces, are important in evaluating the shear strength of fractures.

o. Discuss the use of geological and geotechnical maps.

The following is taken from the U.S. Geological Survey, National Cooperative Geologic Mapping Program, About Geologic Maps and Mapping, Introduction to Geologic Mapping.

Geologic mapping is a highly interpretive, scientific process that can produce a range of map products for many different uses, including assessing groundwater quality and contamination risks; predicting earthquake, volcano, and landslide hazards; characterizing energy and mineral resources and their extraction costs; waste repository siting; land management and land-use planning; and general education.

The value of geologic map information in public and private decision-making (such as for the siting of landfills and highways) has repeatedly been described anecdotally, and has been demonstrated in benefit-cost analyses to reduce uncertainty and, by extension, potential costs.

The geologic mapper strives to understand the composition and structure of geologic materials at the earth's surface and at depth, and to depict observations and interpretations on maps using symbols and colors. Within the past 10 to 20 years, geographic information system (GIS) technology has begun to change some aspects of geologic mapping by providing software tools that permit the geometry and characteristics of rock bodies and other geologic features (such as faults) to be electronically stored, displayed, queried, and analyzed in conjunction with a seemingly infinite variety of other data types. For example, GIS can be used to spatially compare possible pollutant sources (such as oil wells) with nearby streams and geologic units that serve as groundwater supplies. In addition, GIS can be used to compare the position of a proposed road with the surrounding geology to identify areas of high excavation costs or unstable slopes. These comparisons have always been possible, but GIS greatly facilitates the analysis and, as a result, offers geologists the opportunity to provide information in map form that is easily interpreted and used by the non-geologist.

The public has come to expect near-instantaneous delivery of relevant, understandable information via the Internet, which in turn has begun to affect the methods used in geologic mapping, as well as the nature of the product. Geologists are rapidly incorporating GIS and information technology techniques into the production and dissemination of geologic maps.

p. Describe the geologic considerations, criteria, and procedures used to assess natural hazards and potential environmental problems related to the following topographic features and conditions:

- **Areas of high or low relief**
- **Potentially unstable slopes**
- **Flood plain**
- **Karst terrain**
- **Proximity to fault zones**
- **Volcanic terrain**
- **Glaciated terrain**

Area of High or Low Relief

The following is taken from U.S. Geological Survey, Shaded Relief, Topographic Slope, and Land Use Planning in the Los Altos Hills Area, California -- An Example of the Use of Elevation Data.

The steepness of the ground surface can be represented on a map in several ways. The most familiar and widely used is the conventional topographic map, on which points of equal elevation above sea level are joined by contour lines.

Slope is an important characteristic of the land surface in land-use planning in hilly terrain largely because people generally live, work, and play on flat surfaces. If such surfaces do not exist, they must be created as needed during the development process – the steeper the initial slope, the greater the required alteration of the natural terrain. The flattened surfaces are commonly covered by impermeable paving and rooftops. This causes more rapid runoff of rainwater and erosive effects that, though more complex than the geometric effects of grading, also generally increase sharply with the slope of the terrain. These slope-sensitive alterations from development generally have important effects of two kinds for land use planning: 1) immediate changes in the appearance of the terrain owing to the changed

contours and vegetation, and the introduction of buildings, roads, and other structures, and 2) the associated changes in performance of the terrain in the natural systems, such as runoff, erosion, sedimentation, flooding, and slope stability.

Potentially Unstable Slopes

The following is taken from U.S. Geological Survey, Landslide Hazard Program, Landslides 101.

The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors. Erosion by rivers, glaciers, or ocean waves can create oversteepened slopes. Rock and soil slopes are weakened through saturation by snowmelt or heavy rains. Earthquakes create stresses that make weak slopes fail. Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows. Excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or from man-made structures may stress weak slopes to failure. Slope material that becomes saturated with water may develop a debris flow or mud flow.

Flood Plain

The following is taken from U.S. Geological Survey, The 100 Year Flood.

A flood plain is relatively flat lowland that borders a river, usually dry but subject to flooding. Flood plain soils actually are former flood deposits.

The following is taken from Suffolk County Risk Assessment, Natural Groundwater Contamination.

Groundwater can be contaminated in many ways and through a variety of compounds, both of natural origin and man-made. Runoff, or water flowing over the land surface, may pick up pollutants from wildlife and soils. This is often the case after flooding.

Karst Terrain

The following is taken from U.S. Geological Survey, Ground Water and Surface Water A Single Resource--USGS Circular 1139, Box L, *Field Studies of Karst Terrain*.

Karst terrain is characteristic of regions that are underlain by limestone and dolomite bedrock. In many karst areas, the carbonate bedrock is present at land surface, but in other areas it may be covered by other deposits and is referred to as “mantled” karst. The Edwards Aquifer in south-central Texas is an example of karst terrain where the limestones and dolomites are exposed at land surface. In this outcrop area, numerous solution cavities along vertical joints and sinkholes provide an efficient link between the land surface and the water table. Precipitation on the outcrop area tends to infiltrate rapidly into the ground, recharging groundwater. In addition, a considerable amount of recharge to the aquifer is provided by losing streams that cross the outcrop area.

Proximity to Fault Zones

The following is taken from U.S. Geological Survey, Earthquake Hazards Program, Strength and Permeability of Core Samples Taken From Drillholes Crossing the Nojima Fault of the 1995 Kobe Earthquake.

There is a strong correlation between permeability (the ease with which fluids flow through the rock) and proximity to the fault zone shear axes, with low permeability in the narrow shear zone, higher permeability on either side, and again low permeability still farther away in the unfractured country rock. The width of the high permeability zone (approximately 20 to 40 m) is in good agreement with overall fault zone width inferred from trapped wave analysis and other evidence. In addition, shear strength of the core material gradually increases with distance from the shear axis. These permeability and strength observations are consistent with a fault zone model in which a highly localized core or shear zone of low permeability, clay-rich material is surrounded by a damage zone of fractured rock. In this case, the damage zone will act as a high-permeability conduit for vertical and horizontal fluid flow in the plane of the fault. The clay core region, however, will impede fluid flow across the fault.

Volcanic Terrain

The following is taken from U.S. Geological Survey, General Interest Publications, *Volcanoes*.

Volcanoes are mountains but they are very different from other mountains. They are not formed by folding and crumpling but by uplift and erosion. Instead, volcanoes are built by the accumulation of their own eruptive products--lava, bombs (crusted over ash flows) and tephra (airborne ash and dust). A volcano is most commonly a conical hill or mountain built around a vent that connects with reservoirs of molten rock below the surface of the Earth.

Volcanic materials ultimately break down to form some of the most fertile soils on Earth, cultivation of which fostered and sustained civilizations. People use volcanic products as construction materials, as abrasive and cleaning agents, and as raw materials for many chemical and industrial uses.

Glaciated Terrain

The following is taken from U.S. Geological Survey, Glossary of Selected Glacier and Related Terminology.

A glacier is a body of ice showing evidence of movement as reported by the presence of ice flowline, crevasses, and recent geologic evidence. As glaciers melt, their remaining load of rocks is distributed in several ways. Rocks may be dropped in place by the melting ice; they may be rolled to the ice margins, or they may be deposited by meltwater streams. Collectively, these deposits are called glacial drift. Till refers to the debris deposited directly by the glacier. Rock debris rolls off the glacier edges and builds piles of loose unconsolidated rocks called glacier moraine. Lateral moraines form along the side of a glacier and curl into a terminal moraine at the glacier's downvalley end. Drift and moraines are valuable to geologists because they outline the boundaries of past glaciations. Formed by glacier erosion, a U-shaped valley results when a glacier widens and over-steepens a V-shaped stream valley.

q. Discuss weathering and its significance in geotechnical engineering.

The following is taken from U.S. Geological Survey, Geology 1, Rock Cycle Lab.

When rocks are exposed at the earth's surface (by volcanism, uplift of mountains, etc.) they are placed in an environment that is inherently different than the environment in which they

formed or in which they were derived. Consequently, rocks exposed at the earth's surface begin to break down under a process called weathering. Weathering can be classified in two broad categories. Mechanical weathering is the physical breakdown of rocks (i.e. breaking of big rocks into little rocks). This may happen through rock fall, landslides, wedging and cracking by tree roots, water freezing and expanding, etc. Chemical weathering is the chemical breakdown of minerals (the primary constituents of rocks) to form minerals that are more stable on the earth's surface. For example, metallic iron, when exposed to air and water, will change to rust, a substance of quite a different chemistry (a combination of oxygen, iron and water). As weather breaks rocks down, they are eventually removed from their place of origin by erosion.

r. Describe and discuss tests that assess weatherability.

The following is taken from Washington State Department of Transportation, *Geotechnical Design Manual*, chapter 4.

An important facet of soil and rock classification is the determination of what constitutes rock, as opposed to extremely weathered, partially cemented, or altered material that approaches soil in its character and engineering characteristics. Extremely soft or decomposed rock that is friable (easily crumbled) and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil. In general, the strength of the rock tends to decrease as the degree of weathering increases. Determination of relative rock strength can be estimated by simple field tests, which can be refined, if required, through laboratory testing.

Relative rock strength ranges from extremely weak rock that can be indented by a thumbnail to very strong rock that requires several blows with a hammer to break off an intact sample.

The following is taken from Metarock Laboratories, Rock Mechanics Testing.

Over the years, a triaxial compressive strength system has been developed, verified and applied to realistic material models and computational procedures for characterizing the behavior of soils, rocks, and concrete. Triaxial tests are done to measure the rock strength as a function of confining pressure. The testing procedure is to maintain both confining pressure and internal axial load for two hours. After maintaining a base line, the sample is loaded axially by increasing the axial stress with constant strain rates at 0.006 mil/sec. At the onset of failure, the confining pressure is maintained, and the axial loading continues until failure occurs. Axial, radial, external load, internal load, and confining pressure data is collected.

s. Describe and discuss the process for logging rock cores.

The following is taken from Washington State Department of Transportation, *Geotechnical Design Manual,* chapter 4.

The protocol for field logging the test hole is to first describe the intact properties of the rockmass followed by the description of the in-situ properties. Intact properties include rock name, rock color, grain size, weathered state, and relative rock strength. In-situ properties include discontinuity spacing, discontinuity condition, core recovery, rock quality designation, and fracture frequency. Core recovery is defined as the ratio of core recovered to

the run length expressed as a percentage. The rock quality designation provides a subjective estimate of rock mass quality based on a modified core recovery percentage from a double or triple tube diamond core barrel. The rock quality designation is defined as the percentage of rock core recovered in intact pieces of 4 inches or more in length in the length of a core run, generally 6 feet in length.

t. Discuss how contaminant movement relates to soil density.

The following is taken from the Oregon State University Extension Service, How Soil Properties Affect Groundwater Vulnerability to Pesticide Contamination.

Soils whose properties allow rapid transmission of a contaminant to groundwater are called sensitive soils.

Soil sensitivity depends on four soil properties: permeability, water table conditions, organic matter content, and clay content.

Permeability and water table conditions together control the leaching potential. Soils with high leaching potentials are more sensitive than soils with low leaching potentials. Organic matter and clay content together control the sorption potential. Soils with low sorption potentials are more sensitive to groundwater contamination than soils with high sorption potentials. Interactions between leaching potential and sorption potential govern the overall sensitivity of the soil. A soil that has a high leaching potential and a low sorption potential is the most sensitive. A soil that has a low leaching potential and a high sorption potential is the least sensitive.

Leaching refers to the removal of soluble materials by water passing through soil. Naturally occurring salts, chemical fertilizers, and pesticides are subject to leaching. Whether leaching occurs depends on the amount of water passing through the soil and the rate of water movement.

Leaching potential refers to the risk that soluble contaminants will be transmitted through the soil to the groundwater reservoir. Leaching potential depends on soil permeability, water table conditions, and hydraulic loading.

Permeability refers to the rate that water moves through soil. Permeability is controlled by the size and continuity of the soil pores.

Soil texture refers to the proportions of sand, silt, and clay in a soil. A loam is a balanced mixture of sand, silt, and clay. Unbalanced mixtures dominated by increasing amounts of sand are called sandy loam, loamy sand, and just plain sand. If clay dominates, the texture is called clay loam, or, with more clay, just plain clay. Silty soils that contain little or no sand are called, in order of increasing clay content, silt loams, silty clay loams, or silty clays.

Coarse-textured sandy and gravelly soils have the largest pores and the most rapid permeabilities. Fine-textured clayey soils have very tiny pores and very slow permeability rates. Medium-textured loams, silt loams, and clay loams have intermediate rates of soil permeability.

Organic matter helps create and stabilize aggregates of the grains of sand, silt, and clay. These aggregates, or units of soil structure, have relatively large spaces between them, permitting more rapid water movement.

Roots and burrowing insects and animals create large voids, or macropores, that can transmit water very rapidly under saturated conditions.

Dense, compact, or cemented soil layers have very slow rates of permeability.

The combined effects of leaching potential and sorption potential determine a soil's sensitivity with respect to groundwater vulnerability. The most sensitive soil is an irrigated sandy soil with very low organic matter content. The least sensitive soil is a well-drained clayey soil with high organic matter content.

Fine-textured soils, silty clays, and clays generally have low sensitivities because they have slow or very slow permeabilities and high sorption potentials.

Medium-textured soils, silt loams, silty clay loams, loams, and clay loams generally have low to moderate sensitivities, even in humid areas, because they have relatively slow permeabilites and relatively high sorption potentials.

Coarse-textured soils, sands, loamy sands, and sandy loams generally have moderate to high sensitivities because they are more permeable and tend to have lower sorption potentials.

5. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of reading and plotting graphs and interpreting graphical data.

Items a through f are performance-based KSAs. The Qualifying Official will evaluate their completion. The following information provides the necessary basic information to have a familiarity-level of knowledge for reading and plotting graphs and interpreting graphical data.

a. Solve for the unknown given a linear equation with multiple units, such as Environmental Protection Agency (EPA) risk equations.

The following is taken from U.S. Environmental Protection Agency, Mid-Atlantic Risk Assessment, Risk Based Concentration Table, User's Guide.

EPA risk equations are used to determine whether levels of contamination found at a site may warrant further investigation or site cleanup, or whether no further investigation or action may be required. As an example, the equation for determining the concentration or screening level (SL) for incidental ingestion of soil that contains carcinogens by an indoor worker is:

$$\text{SL} = \frac{TR \times AT \times BW}{EF \times ED \times CSF \times IR}$$

where
SL = screening level with units of milligrams of contaminant per kilogram of sample,

TR = target risk, a unit-less term that corresponds to a fixed level of risk (one in a million, or 1×10^{-6} for cancer) ,
AT = averaging time with units of days corresponding to the total time of exposure to a worker during lifetime,
BW = body weight in kilograms,
EF = exposure frequency with units of days per year,
ED = exposure duration with units of years,
CSF = chronic oral slope factor with units of $\left(\frac{mg}{kg\text{–}day}\right)^{-1}$, representing a toxicity value for a specific contaminant,
IR = ingestion rate with units of milligrams per day.

b. Given a graph, interpret meaning of slope and intercept, such as slope factor for a carcinogenic chemical.

The following is taken from DOE-HDBK-1014/1-92.

Many physical relationships in science and engineering may be expressed by plotting a straight line. The slope (*m*), or steepness, of a straight line tells us the amount one parameter changes for a certain amount of change in another parameter.

For a straight line, slope is equal to rise over run, or

$$\text{slope} = \frac{rise}{run} = \frac{change\ in\ y}{change\ in\ x} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

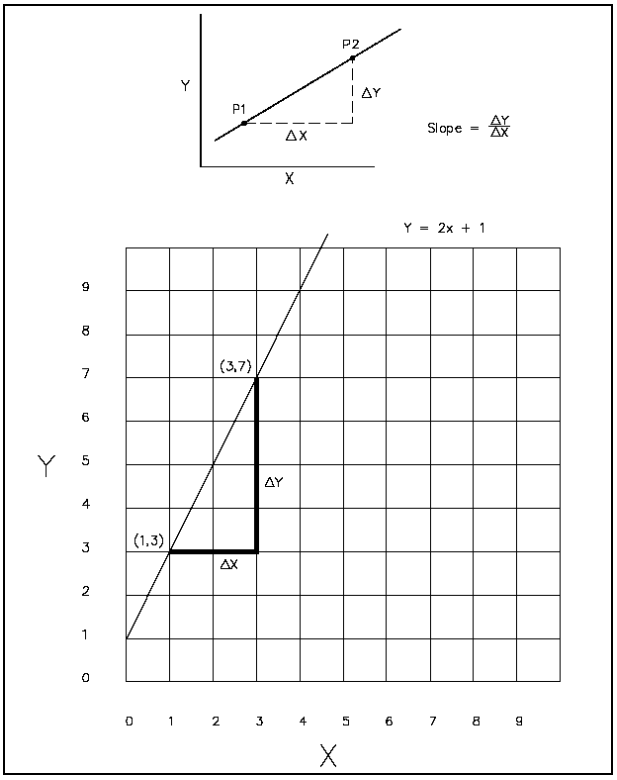
Consider the curve shown in figure 9. Points *P*1 and *P*2 are any two different points on the line, and a right triangle is drawn whose legs are parallel to the coordinate axes. The length of the leg parallel to the x-axis is the difference between the x-coordinates of the two points and is called "Δx," read "delta *x*," or "the change in *x*." The leg parallel to the y-axis has length Δy, which is the difference between the y-coordinates. For example, consider the line containing points (1,3) and (3,7) in the second part of the figure. The difference between the x-coordinates is Δx = 3-1 = 2. The difference between the y-coordinates is Δy = 7-3 = 4. The ratio of the differences, $\Delta y/\Delta x$, is the slope, which in the preceding example is 4/2 or 2. It is important to notice that if other points had been chosen on the same line, the ratio $\Delta y/\Delta x$ would be the same, since the triangles are clearly similar. If the points (2,5) and (4,9) had been chosen, then $\Delta y/\Delta x$ = (9-5)/(4-2) = 2, which is the same number as before. Therefore, the ratio $\Delta y/\Delta x$ depends on the inclination of the line, *m* = rise [vertical (y-axis) change] ÷ run [horizontal (x-axis) change].

c. Interpret data on a simple graph, such as time/concentration.

d. Given a table of data, plot the data points on a Cartesian coordinate graph.

e. Given a table of data, plot the data points on a logarithmic coordinate graph.

f. Given a graph, determine the slope of a line.



Source: DOE-HDBK-1014-1/92

Figure 9. Slope

6. Environmental restoration personnel shall demonstrate a working-level knowledge of the units of measurement and conversion between English and SI systems.

The information for the KSAs in this competency is taken from DOE-HDBK-1010-92.

a. Define the three fundamental dimensions: length, mass, and time.

Length

Length is the distance between two points. The concept of length is needed to locate the position of a point in space and thereby describe the size of a physical object or system. When measuring a length of pipe, the ends of the pipe are the two points and the distance between the two points is the length.

Mass

Mass is the amount of material present in an object. This measurement describes "how much" material makes up an object. Often, mass and weight are confused as being the same because the units used to describe them are similar. Weight (a derived unit, not a fundamental unit) is a measurement that describes the force of gravity on the "mass" of an object.

Time

Time is the duration between two instants. The measurement of time is described in units of seconds, minutes, or hours.

b. List standard units of the fundamental dimensions for each of the following systems.
- **International system of units (SI)**
- **English system**

International System of Units

The SI system is made up of two related systems, the meter-kilogram-second (MKS) system and the centimeter-gram-second (CGS) system. The MKS system is used primarily for calculations in the field of physics while both the MKS and CGS systems are used in the field of chemistry. The units for each of these systems are shown in tables 4 and 5 below.

Table 4. MKS units of measurement

Length	Mass	Time
millimeter	milligram	*second
*meter	gram	minute
kilometer	*kilogram	hour
		day
		month
		year

*Standard unit of measure

Source: DOE-HDBK-1010-92

Table 5. CGS units of measurement

Length	Mass	Time
*centimeter	milligram	*second
meter	*gram	minute
kilometer	kilogram	hour
		day
		month
		year

*Standard unit of measure

Source: DOE-HDBK-1010-92

English System

The English system is presently used in the field of engineering and throughout the United States. The foot-pound-second system is the usual unit system used in the U.S. when dealing with physics. These units are shown in table 6.

Table 6. English units of measurement

Length	Mass	Time
inch	ounce	*second
*foot	*pound	minute
yard	ton	hour
mile		day
		month
		year

*Standard unit of measure

Source: DOE-HDBK-1010-92

c. Differentiate between fundamental and derived measurements.

Most physical quantities have units that are combinations of the three fundamental dimensions of length, mass, and time. When these dimensions or measurements are combined, they produce what are referred to as derived units. This means that they have been "derived" from one or more fundamental measurements. These combinations of fundamental measurements can be the combination of the same or different units. Examples of derived measurements include: area (units of square inches or square meters), velocity (units of kilometers per hour or feet per sec), and density (units of kilograms per cubic meter or pounds mass per cubic foot).

7. Environmental restoration personnel should demonstrate a familiarity-level knowledge of the basic terms and concepts of environmental biology.

a. Define the following terms:

- **Ecosystem**
- **Habitat**
- **Species**
- **Pathways analysis**
- **Bioaccumulation**
- **Bioconcentration**
- **Biotoxicity**
- **Biodiversity**

The following definitions are taken from the U.S. Environmental Protection Agency, Terms of Environment Glossary.

Ecosystem

An ecosystem is the interacting system of a biological community and its non-living environmental surroundings. The structure of the ecosystem consists of attributes related to

the physical state of the ecosystem such as species population density, species richness or evenness, and standing crop biomass.

Habitat

A habitat is the place where a population (e.g. human, animal, plant, microorganism) lives and its surroundings, both living and non-living.

Species

A species is a reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name.

Pathways Analysis

Pathways analysis describes the physical course a chemical or pollutant takes from its source to the exposed organism

Bioaccumulation

Bioaccumulants are substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted.

Bioconcentration

Bioconcentration is the accumulation of a chemical in tissues of a fish or other organism to levels greater than in the surrounding medium.

Biotoxicity

Toxicity is the degree that a substance or mixture of substances can harm humans or animals. Acute toxicity involves harmful effects in an organism through a single or short-term exposure. Chronic toxicity is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism. Subchronic toxicity is the ability of the substance to cause effects for more than one year but less than the lifetime of the exposed organism.

Biodiversity

Biodiversity refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

b. Discuss how synergism makes it difficult to establish a cause and effect relationship between pollutants and disease.

The following is taken from the U.S. Environmental Protection Agency, Thesaurus of Terms Used in Microbial Risk Assessment.

Synergism is an interaction of two or more chemicals that results in an effect greater than the sum of their separate effects. A synergistic effect refers to a biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves. For example, a laboratory study of the effect of a single chemical on an organism may underestimate the effects that will occur in the natural environment, where the organism may be simultaneously exposed to a multitude of other chemicals that may interact with the original chemical.

8. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of the basic principles and concepts of meteorology.

a. Discuss the properties of high pressure and low pressure systems and their impact on air pollution.

The following is taken from the Environmental Protection Agency, Reading Material: Weather and Air Quality.

Weather systems typically are defined as being either a high or low pressure system. High pressure systems are air masses with unique properties, such as warm or cool, or moist or dry. The winds of a high pressure system rotate in a clockwise direction.

Low pressure systems are pockets of air masses located between high pressure systems. These systems flow in a counterclockwise direction between two clockwise rotating high pressure systems. Since several weather systems occur at the same time, air masses are constantly colliding. When this occurs, weather fronts form that often lead to some form of precipitation.

Daily weather conditions directly affect the quality of the air. Shifting air masses and wind can move air pollutants from one location to another. Conversely, stagnant air can result in increased concentrations of harmful pollutants. All forms of precipitation wash pollutants from the air and onto the ground. Although this cleanses the air, it may create land and surface water pollution.

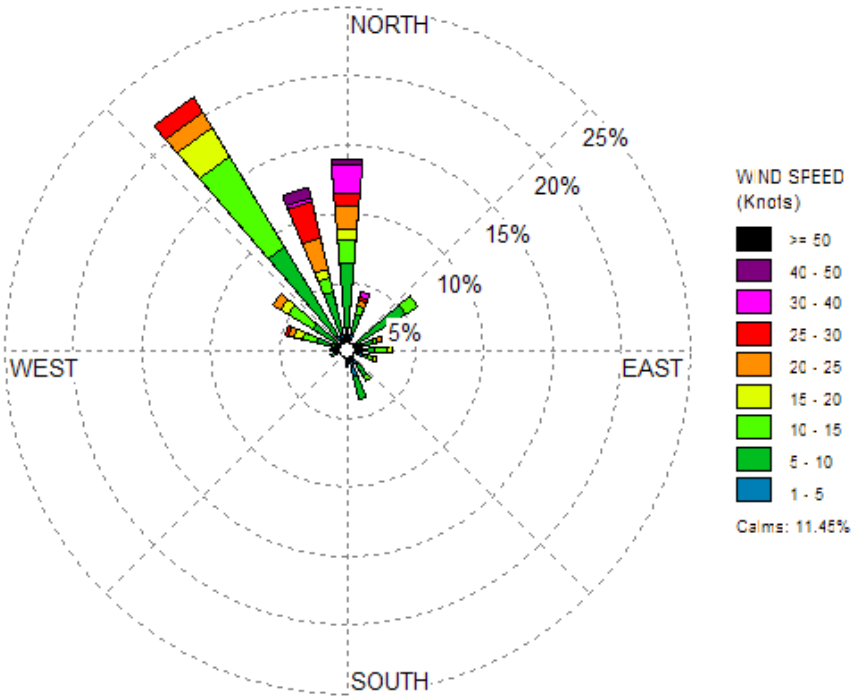
b. Discuss the following horizontal dispersion terms:
- **Wind rose**
- **Pollution rose/plume meander**

Wind Rose

The following is taken from the U.S. Department of Agriculture, Natural Resources Conservation Service, Wind Rose Data.

A wind rose gives a very succinct but information laden view of how wind speed and direction are typically distributed at a particular location. Presented in a circular format, the wind rose in figure 10 shows the frequency of winds blowing from particular directions. The length of each spoke around the circle is related to the frequency of time that the wind blows from a particular direction. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequencies at the outer circles. The wind

rose also shows that each spoke is broken down into discrete frequency categories that show the percentage of time that winds blow from a particular direction and at certain speed ranges.



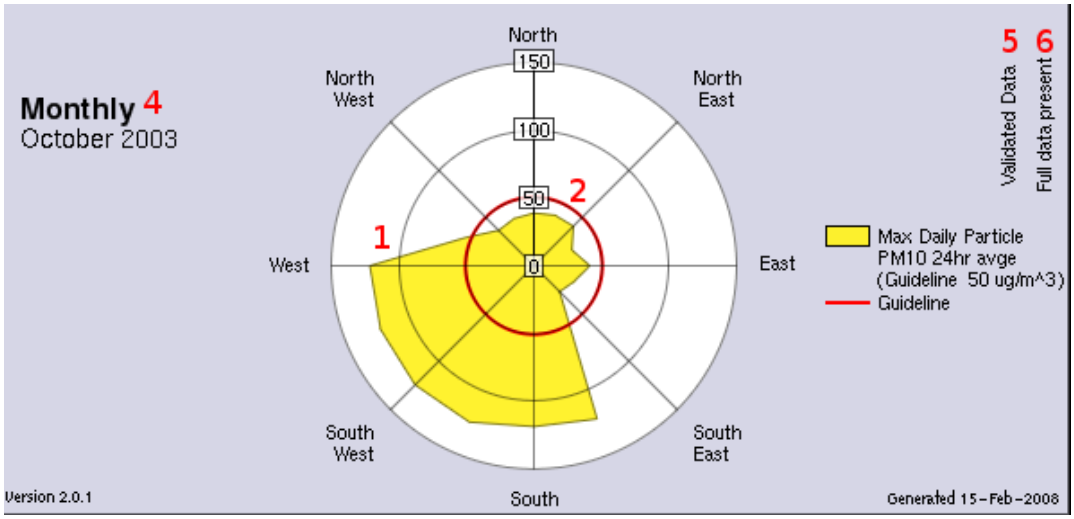
Source: National Weather Forecast Office, Albuquerque, NM

Figure 10. A wind rose

Pollution Rose/Plume Meander

The following is taken from Queensland Government, A Pollution Rose.

A pollution rose has the same general concept as a wind rose; however the pollutant concentration data is not broken up into smaller portions after being categorized into a direction. This graph in figure 11 is formed by simply taking the maximum recorded value at each direction and plotting the given area.



Source: Queensland Government, A Pollution Rose

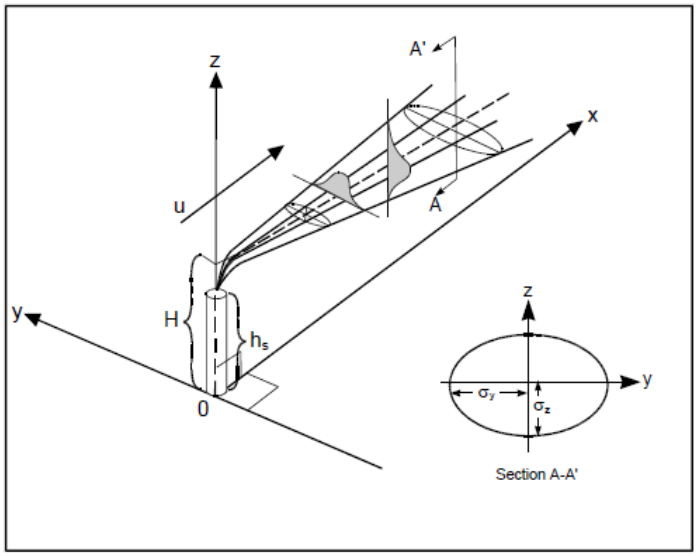
Figure 11. A pollution rose

c. Describe the role of lapse rate in determining dispersion coefficients.

- **Dry adiabatic lapse rate**
- **Prevailing lapse rate**
- **Neutral lapse rate**
- **Subadiabatic lapse rate**
- **Weak lapse rate**
- **Inversion**
- **Superadiabatic lapse rate**

The following is taken from U.S. Environmental Protection Agency, SI 409, Basic Air Pollution Meteorology Test, Lesson 6.

A Gaussian distribution determines the size of the smoke or pollution plume downwind from the smokestack or pollution source. A schematic representation of the Gaussian Plume is shown in figure 12. The plume size is dependent on the stability of the atmosphere and the dispersion of the plume in the horizontal and vertical directions. These horizontal and vertical dispersion coefficients (σ_y and σ_z respectively) are merely the standard deviation from normal on the Gaussian distribution curve in the y and z directions. These dispersion coefficients, σ_y and σ_z, are functions of wind speed, cloud cover, and surface heating by the sun.



Source: U.S. Environmental Protection Agency, SI 409

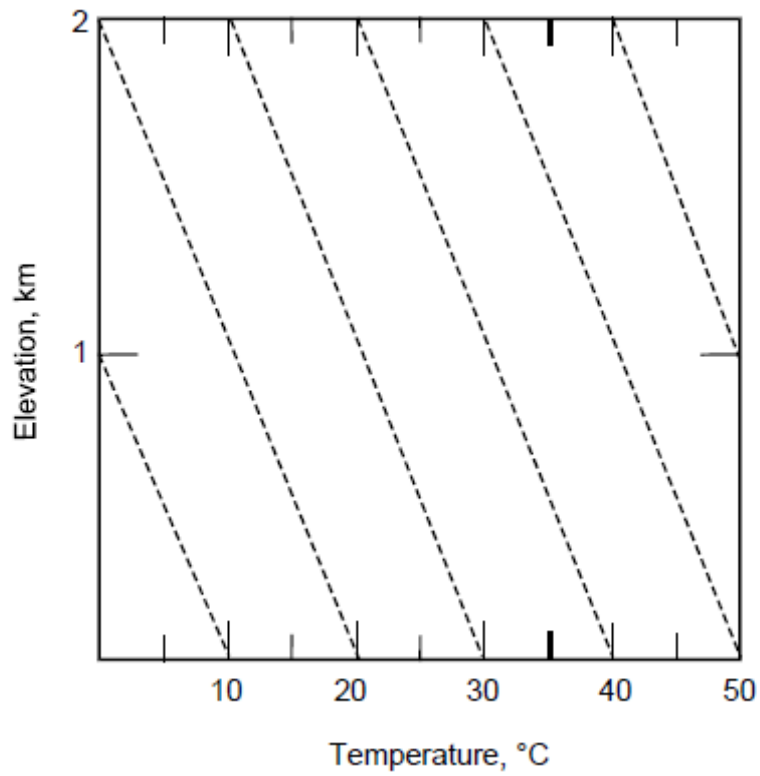
Figure 12. Schematic representation of a Gaussian plume

The following is taken from U.S. Environmental Protection Agency, SI 409, Basic Air Pollution Meteorology Test, Lesson 4.

The lapse rate is defined as the rate that air temperature changes with height. The actual lapse rate in the atmosphere is approximately -6ºC to -7ºC per kilometer (km) (in the troposphere) but it varies widely depending on location and time of day. We define a temperature decrease with height as a negative lapse rate and a temperature increase with height as a positive lapse rate.

A dry adiabatic lapse rate is a fixed rate, entirely independent of ambient air temperature. A parcel of dry air moving upward in the atmosphere, then, will always cool at the rate of 9.8ºC per km, regardless of its initial temperature or the temperature of the surrounding air. A dry adiabatic lapse rate, sometimes called a neutral lapse rate, is central to the definition of atmospheric stability.

A simple adiabatic diagram demonstrates the relationship between elevation and temperature. A dry adiabatic lapse rate is indicated by a broken line, as shown in figure 13, beginning at various temperatures along the horizontal axis. The slope of the line remains constant, regardless of its initial temperature on the diagram.

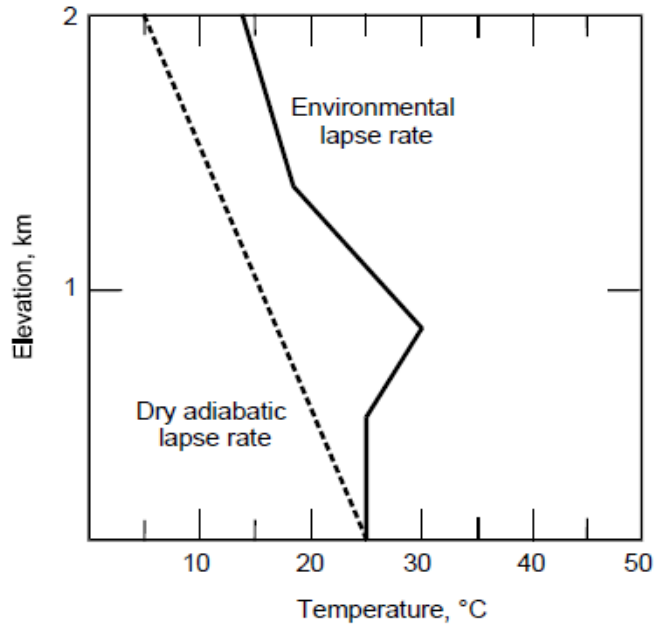


Source: U.S. Environmental Protection Agency, SI 409

Figure 13. Dry adiabatic lapse rate

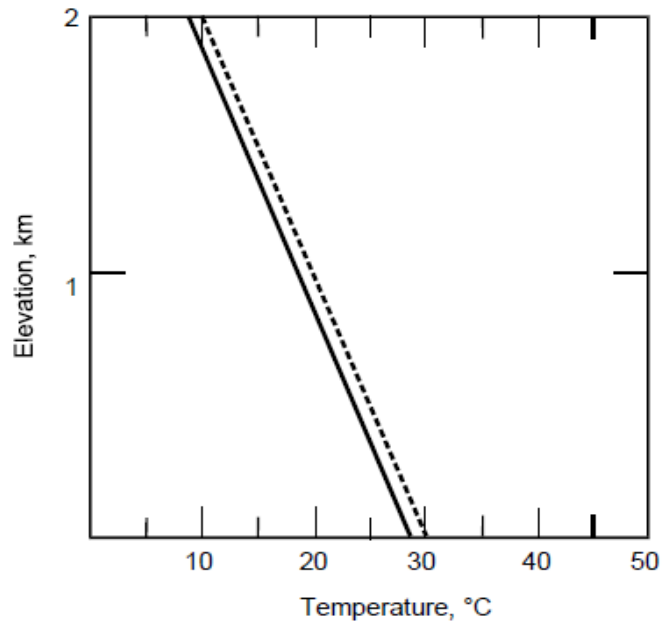
The actual temperature profile of the ambient air shows the environmental lapse rate. Sometimes called the prevailing or atmospheric lapse rate, it is the result of complex interactions of meteorological factors, and is usually considered to be a decrease in temperature with height. It is particularly important to vertical motion since surrounding air temperature determines the extent that a parcel of air rises or falls. As figure 14 shows, the temperature profile can vary considerably with altitude, sometimes changing at a rate greater than the dry adiabatic lapse rate and some times changing less. The condition when temperature actually increases with altitude is referred to as a temperature inversion.

When the environmental lapse rate is the same as the dry adiabatic lapse rate, the atmosphere is in a state of neutral stability or neutral lapse rate as shown in figure 15. Vertical air movement is neither encouraged nor hindered. The neutral condition is important as the dividing line between stable and unstable conditions.



Source: U.S. Environmental Protection Agency, SI 409

Figure 14. Prevailing lapse rate

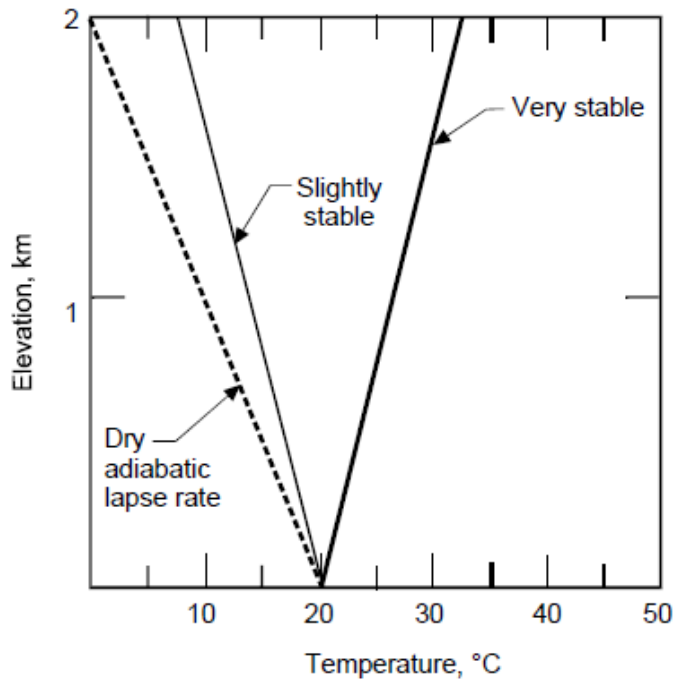


Source: U.S. Environmental Protection Agency, SI 409

Figure 15. Neutral lapse rate

When the environmental lapse rate is less than the adiabatic lapse rate (cools at less than 9.8 ºC per km), the air is stable and resists vertical motion. This is a subadiabatic lapse rate (figure 16). Air that is lifted vertically will remain cooler, and therefore more dense than the surrounding air. Once the lifting force is removed, the air that has been lifted will return to its

original position. A subadiabatic lapse rate is sometimes referred to as a weak adiabatic lapse rate.

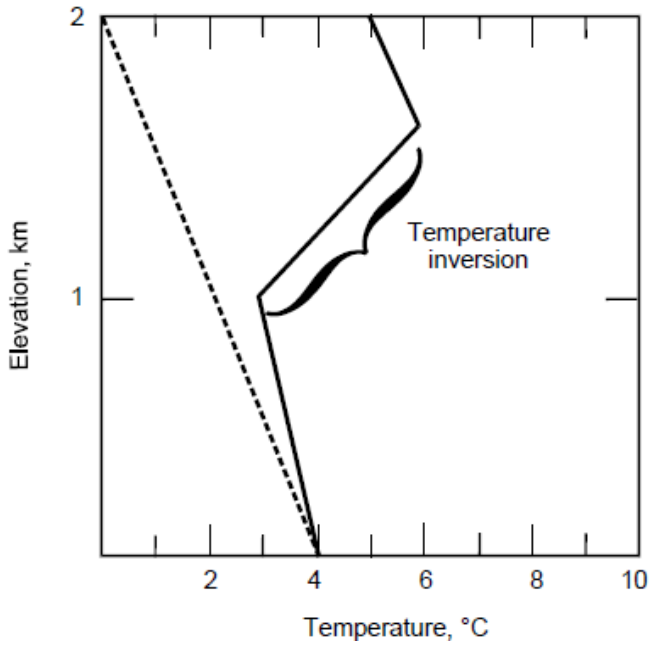


Source: U.S. Environmental Protection Agency, SI 409

Figure 16. Subadiabatic or weak lapse rate

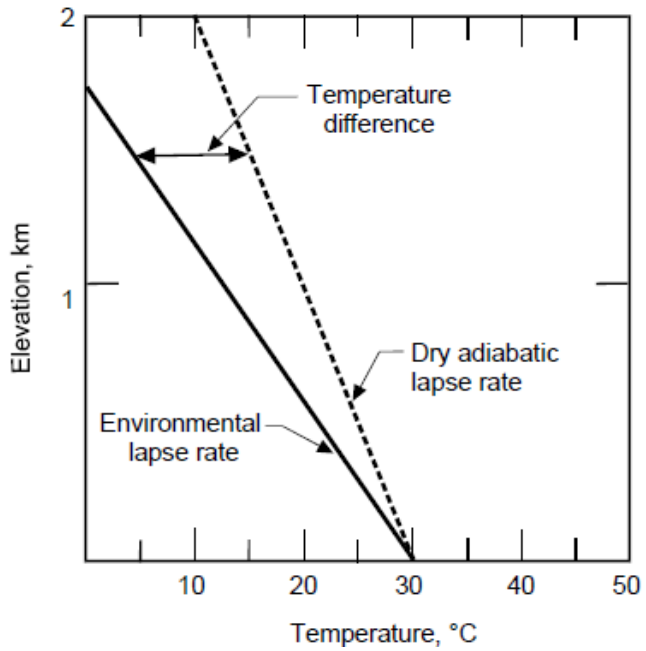
An inversion occurs when air temperature increases with altitude. This situation occurs frequently but is generally confined to a relatively shallow layer. An example of the lapse rate for an inversion is depicted in figure 17. High concentrations of air pollutants are often associated with inversions since they inhibit smoke plume dispersion.

A superadiabatic lapse rate occurs when the surrounding atmosphere has a lapse rate greater than the dry adiabatic lapse rate (cooling at more than 9.8 ºC per km). As figure 18 shows, the temperature difference between the actual environmental lapse rate and the dry adiabatic lapse rate actually increases with height.



Source: U.S. Environmental Protection Agency, SI 409

Figure 17. Lapse rate showing a temperature inversion



Source: U.S. Environmental Protection Agency, SI 409

Figure 18. A superadiabatic environmental lapse rate

d. Describe the classes of atmosphere stability, including inversions.

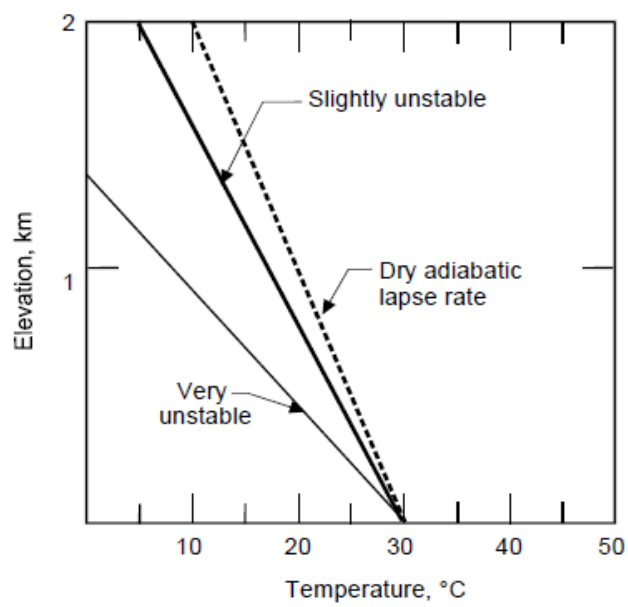
The following is taken from U.S. Environmental Protection Agency, SI 409, Basic Air Pollution Meteorology Test, Lesson 4.

The degree of stability of the atmosphere is determined by the temperature difference between an air parcel and the air surrounding it. This difference can cause the parcel to move vertically (i.e., it may rise or fall). This movement is characterized by four basic conditions that describe the general stability of the atmosphere: unstable, neutral, stable, and inversion.

In stable conditions, this vertical movement is discouraged, whereas in unstable conditions the air parcel tends to move upward or downward and to continue that movement. When conditions neither encourage nor discourage air movement beyond the rate of adiabatic heating or cooling, they are considered neutral. When conditions are extremely stable, cooler air near the surface is trapped by a layer of warmer air above it. This condition, called an inversion, allows virtually no vertical air motion. These conditions are directly related to pollutant concentrations in the ambient air.

Unstable Conditions

Remember that an air parcel that begins to rise will cool at the dry adiabatic lapse rate until it reaches its condensation temperature or dew point at which point it will cool at a lower rate. As the air rises, cooler air moves underneath. It, in turn, may be heated by the earth's surface and begin to rise. Under such conditions, vertical motion in both directions is enhanced, and considerable vertical mixing occurs. The degree of instability depends on the degree of difference between the environmental and dry adiabatic lapse rates as illustrated in figure 19.



Source: U.S. Environmental Protection Agency, SI 409

Figure 19. Unstable conditions

Neutral Conditions

When the environmental lapse rate is the same as the dry adiabatic lapse rate, the atmosphere is in a state of neutral stability (figure 15). Vertical air movement is neither encouraged nor hindered. The neutral condition is important as the dividing line between stable and unstable conditions. Neutral stability occurs on windy days or when there is cloud cover such that strong heating or cooling of the earth's surface is not occurring.

Stable Conditions

When the environmental lapse rate is less than the adiabatic lapse rate (cools at less than 9.8 ºC per km), the air is stable and resists vertical motion. This is a subadiabatic lapse rate (figure 16). Air that is lifted vertically will remain cooler, and therefore denser than the surrounding air. Once the lifting force is removed, the air that has been lifted will return to its original position. Stable conditions occur at night when there is little or no wind.

Inversions

An inversion occurs when air temperature increases with altitude. This situation occurs frequently but is generally confined to a relatively shallow layer. Plumes emitted into air layers that are experiencing an inversion (inverted layer) do not disperse very much as they are transported with the wind. Plumes that are emitted above or below an inverted layer do not penetrate that layer; rather these plumes are trapped either above or below that inverted layer. An example of the lapse rate for an inversion is depicted in figure 17. High concentrations of air pollutants are often associated with inversions since they inhibit smoke plume dispersion.

e. Describe the kind of information given by a wind rose and pollution rose.

See item b of competency 8.

9. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of basic thermodynamics concepts and theories.

a. Define the following terms:
- **Specific volume**
- **Density**
- **Specific gravity**
- **Mass**
- **Weight**

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

Specific Volume

The specific volume of a substance is the total volume of that substance divided by the total mass of that substance (volume per unit mass). It has units of cubic feet per pound-mass (ft^3/lbm).

Density

The density of a substance is the total mass of that substance divided by the total volume occupied by that substance (mass per unit volume). It has units of pound-mass per cubic feet (lbm/ft^3). The density of a substance is the reciprocal of its specific volume.

Specific Gravity

Specific gravity is a measure of the relative density of a substance as compared to the density of water at a standard temperature. Physicists use 39.2°F (4°C) as the standard, but engineers ordinarily use 60°F. In the International System of Units, the density of water is 1.00 g/centimeter $(cm)^3$ at the standard temperature. Therefore, the specific gravity (which is

dimensionless) for a liquid has the same numerical value as its density in units of g/cm^3. Since the density of a fluid varies with temperature, specific gravities must be determined and specified at particular temperatures.

Mass

The mass of a body is the measure of the amount of material present in that body.

Weight

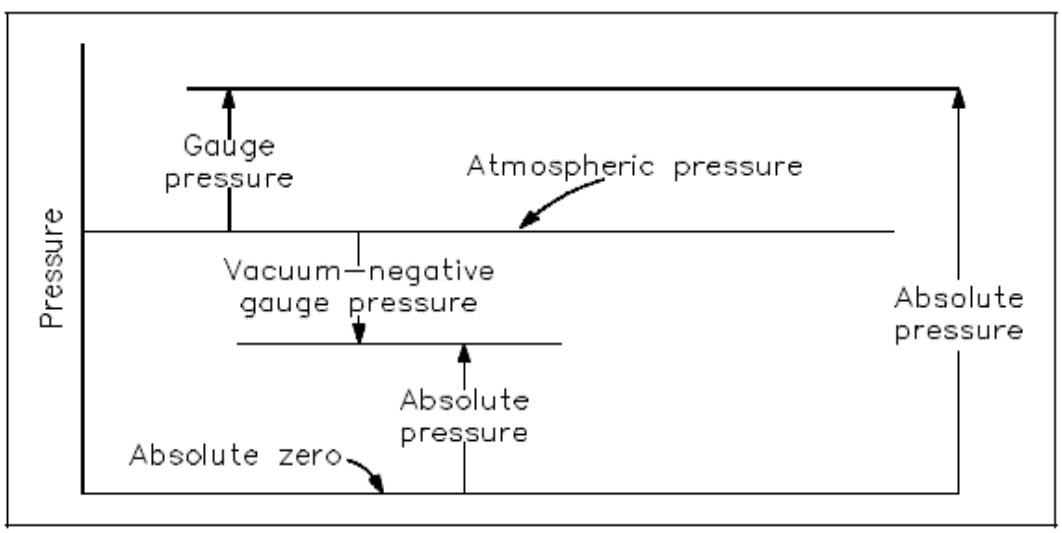
The weight of a body is the force exerted by that body when its mass is accelerated in a gravitational field.

b. Describe the relationship between absolute pressure, gauge pressure, and vacuum.

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

When pressure is measured relative to a perfect vacuum, it is called absolute pressure (psia), and when measured relative to atmospheric pressure (14.7 pounds per square inch [psi]), it is called gauge pressure (psig). The latter pressure scale was developed because almost all pressure gauges register zero when open to the atmosphere. Therefore, pressure gauges measure the difference between the pressure of the fluid to which they are connected and that of the surrounding air.

If the pressure is below that of the atmosphere, it is designated as a vacuum. A perfect vacuum would correspond to absolute zero pressure. All values of absolute pressure are positive, because a negative value would indicate tension, which is considered impossible in any fluid. Gauge pressures are positive if they are above atmospheric pressure and negative if they are below atmospheric pressure. Figure 20 shows the relationships between absolute, gauge, vacuum, and atmospheric pressures.



Source: DOE-HDBK-1012/1-92

Figure 20. Pressure relationships

c. Define the following and describe their relationship:

- **Energy**
- **Potential energy**
- **Kinetic energy**
- **Work**
- **Heat**

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

Energy

Energy is defined as the capacity of a system to perform work or produce heat.

Potential Energy

Potential energy (PE) is defined as the energy of position. Using English system units, it is defined by the following equation:

$$PE = mgz/g_c$$

where
PE = potential energy (ft-lbf)
m = mass (lbm)
z = height above some reference level (ft)
g = acceleration due to gravity (ft/sec^2)
g_c = gravitational constant = 32.17 ft-lbm/lbf-sec^2

In most practical engineering calculations, the acceleration due to gravity (g) is numerically equal to the gravitational constant (g_c); thus, the potential energy (PE) in foot-pounds-force is numerically equal to the product of the mass (m) in pounds-mass times the height (z) in feet above some reference level.

Kinetic Energy

Kinetic energy (KE) is the energy of motion. Using English system units, it is defined by the following equation:

$$KE\ mv^2/2g_c$$

where
KE = kinetic energy (ft-lbf)
m = mass (lbm)
v = velocity (ft/sec)
g_c = gravitational constant = 32.17 ft-lbm/lbf-sec^2

Work

Work is a form of energy, but it is energy in transit. Work is not a property of a system. Work is a process done by or on a system, but a system contains no work.

This distinction between the forms of energy that are properties of a system and the forms of energy that are transferred to and from a system is important to the understanding of energy transfer systems.

Work is defined for mechanical systems as the action of a force on an object through a distance. It equals the product of the force (F) times the displacement (d).

In dealing with work in relation to energy transfer systems, it is important to distinguish between work done by the system on its surroundings and work done on the system by its surroundings. Work is done by the system when it is used to turn a turbine and thereby generate electricity in a turbine-generator. Work is done on the system when a pump is used to move the working fluid from one location to another. A positive value for work indicates that work is done by the system on its surroundings; a negative value indicates that work is done on the system by its surroundings.

Heat

Heat, like work, is energy in transit. The transfer of energy as heat, however, occurs at the molecular level as a result of a temperature difference. The symbol (Q) is used to denote heat. In engineering applications, the unit of heat is the British thermal unit (Btu). Specifically, this is called the 60 degree Btu because it is measured by a one degree temperature change from 59.5°F to 60.5°F.

As with work, the amount of heat transferred depends upon the path and not simply on the initial and final conditions of the system. Also, as with work, it is important to distinguish between heat added to a system from its surroundings and heat removed from a system to its surroundings. A positive value for heat indicates that heat is added to the system by its surroundings. This is in contrast to work that is positive when energy is transferred from the system and negative when transferred to the system. The symbol (q) is sometimes used to indicate the heat added to or removed from a system per unit mass. It equals the total heat (Q) added or removed divided by the mass (m).

d. Describe the following types of thermodynamic systems:

- **Isolated system**
- **Open system**
- **Closed system**

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

Isolated System

An isolated system is one that is not influenced in any way by the surroundings. This means that no energy in the form of heat or work may cross the boundary of the system. In addition, no mass may cross the boundary of the system.

Open System

An open system is one that may have a transfer of both mass and energy with its surroundings.

Closed System

A closed system has no transfer of mass with its surroundings, but may have a transfer of energy (either heat or work) with its surroundings.

e. Using the ideal gas law, discuss the relationship between pressure, temperature, and volume.

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

The ideal gas constant is designated by (R), and the ideal gas equation is

$$Pv = RT$$

where
P = pressure
v = volume
T = temperature, and the pressure and temperature are absolute values.

The individual gas constant (R) may be obtained by dividing the universal gas constant (Ro) by the molecular weight of the gas. The units of (R) must always be consistent with the units of pressure, temperature, and volume used in the gas equation. No real gases follow the ideal gas law or equation completely. At temperatures near a gas' boiling point, increases in pressure will cause condensation to take place and cause drastic decreases in volume. At very high pressures, the intermolecular forces of a gas are significant. However, most gases are in approximate agreement at pressures and temperatures above their boiling point.

The ideal gas law is used by engineers working with gases because it is simple to use and approximates real gas behavior. Most physical conditions of gases used by man fit the above description. Perhaps the most common use of gas behavior studied by engineers is that of the compression process using ideal gas approximations. Such a compression process may occur at constant temperature (pV = constant), constant volume, or under adiabatic conditions (no heat transfer). Whatever the process, the amount of work that results from it depends upon the process.

f. Describe the effects of pressure and temperature changes on confined fluids.

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

The predominant effect of an increase in pressure in a compressible fluid, such as a gas, is an increase in the density of the fluid. An increase in the pressure of an incompressible fluid will not have a significant effect on the density. For example, increasing the pressure of 100°F water from 15 psia to 15,000 psia will only increase the density by approximately 6 percent. Therefore, in engineering calculations, it is assumed that the density of incompressible fluids remains constant.

An increase in temperature will tend to decrease the density of any fluid. If the fluid is confined in a container of fixed volume, the effect of a temperature change will depend on whether the fluid is compressible.

If the fluid is a gas, it will respond to a temperature change in a manner predicted by the ideal gas laws. A 5 percent increase in absolute temperature will result in a 5 percent increase in the absolute pressure.

If the fluid is an incompressible liquid in a closed container, an increase in the temperature will have a tremendously greater and potentially catastrophic effect. As the fluid temperature increases, it tries to expand, but expansion is prevented by the walls of the container. Because the fluid is incompressible, this results in a tremendous increase in pressure for a relatively minor temperature change. The change in specific volume for a given change in temperature is not the same at various beginning temperatures. Resultant pressure changes will vary. A useful rule for water is that pressure in a water-solid system will increase about 100 psi for every 1°F increase in temperature.

g. Describe how the density of a fluid varies with temperature.

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

An increase in temperature will tend to decrease the density of any fluid.

h. Define the term "buoyancy."

The following is taken from DOE-HDBK-1012/3-92.

Buoyancy is defined as the tendency of a body to float or rise when submerged in a fluid. We all have had numerous opportunities of observing the buoyant effects of a liquid. When we go swimming, our bodies are held up almost entirely by the water. Wood, ice, and cork float on water. When we lift a rock from a stream bed, it suddenly seems heavier on emerging from the water. Boats rely on this buoyant force to stay afloat. When a body is placed in a fluid, it is buoyed up by a force equal to the weight of the water that it displaces.

i. Describe the relationship between the pressure in a fluid column and the density and depth of the fluid.

The following is taken from DOE-HDBK-1012/3-92.

Anyone who dives under the surface of the water notices that the pressure on his eardrums at a depth of even a few feet is noticeably greater than atmospheric pressure. Careful measurements show that the pressure of a liquid is directly proportional to the depth, and for a given depth the liquid exerts the same pressure in all directions. Liquids are generally considered to be incompressible. For instance, a pressure of 16,400 psig will cause a given volume of water to decrease by only 5 percent from its volume at atmospheric pressure.

j. Define the property of viscosity.

The following is taken from DOE-HDBK-1012/3-92.

Viscosity is a fluid property that measures the resistance of the fluid to deforming due to a shear force. Viscosity is the internal friction of a fluid that makes it resist flowing past a solid

surface or other layers of the fluid. Viscosity can also be considered to be a measure of the resistance of a fluid to flowing. Thick oil has a high viscosity; water has a low viscosity.

k. Define the term head, head loss, and frictional loss, with respect to its use in fluid flow.

The following definitions are taken from DOE-HDBK-1012/3-92.

Head

The term head is used by engineers in reference to pressure. It is a reference to the height, typically in feet, of a column of water that a given pressure will support. The elevation head represents the potential energy of a fluid due to its elevation above a reference level.

Head Loss

Head loss is a measure of the reduction in the total head (sum of elevation head, velocity head and pressure head) of the fluid as it moves through a fluid system. Head loss is unavoidable in real fluids. It is present because of: the friction between the fluid and the walls of the pipe; the friction between adjacent fluid particles as they move relative to one another; and the turbulence caused whenever the flow is redirected or affected in any way by such components as piping entrances and exits, pumps, valves, flow reducers, and fittings.

Frictional Loss

Frictional loss is that part of the total head loss that occurs as the fluid flows through straight pipes. The head loss for fluid flow is directly proportional to the length of pipe, the square of the fluid velocity, and a term accounting for fluid friction called the friction factor. The head loss is inversely proportional to the diameter of the pipe.

10. Environmental restoration personnel shall demonstrate a working-level knowledge of engineering drawings.

a. Given an engineering drawing, read and interpret the information contained in the title block, the notes and legend, the revision block, and the grid.

b. Identify the symbols used on engineering P&IDs for:
- **Types of valves and actuators**
- **Basic types of instrumentation**
- **Types of instrument signal controllers and modifiers**
- **Types of system components (pumps, etc.)**
- **Types of lines**

c. Identify the symbols used on engineering P&IDs to denote the location of instruments, indicators, and controllers.

d. Identify how valve conditions are depicted.

e. Determine system flowpath(s) for a given valve lineup.

Items a through e are performance-based KSAs. The Qualifying Official will evaluate their completion.

11. Environmental restoration personnel shall demonstrate a working-level knowledge of the principles and concepts of environmental restoration.

a. Discuss the currently available investigation, characterization, and data management technologies for environmental restoration.

Investigation

The following is taken from U.S. Environmental Protection Agency, Waste and Cleanup Assessment, Remedial Investigation/Feasibility Studies.

After a federal facility site is listed on the national priorities list (NPL), a remedial investigation/feasibility study (RI/FS) is performed at the site. The RI serves as the mechanism for collecting data to:

- characterize site conditions;
- determine the nature of the waste;
- assess risk to human health and the environment; and
- conduct treatability testing to evaluate the potential performance and cost of the treatment technologies that are being considered.

The FS is the mechanism for the development, screening, and detailed evaluation of alternative remedial actions (RAs).

The RI and FS are conducted concurrently: data collected in the RI influence the development of remedial alternatives in the FS, which in turn affect the data needs and scope of treatability studies and additional field investigations. This phased approach encourages the continual scoping of the site characterization effort, which minimizes the collection of unnecessary data and maximizes data quality.

Characterization

The following is taken from U.S. Environmental Protection Agency, Environmental Technology Verification Program, Advanced Monitoring Systems Center.

EPA's Advanced Monitoring Systems Center is operated in cooperation with Battelle Memorial Institute. This center verifies the performance of commercial-ready technologies that monitor contaminants and natural species in air, water, and soil. The center tests both field-portable and stationary monitors, as well as innovative technologies that can be used to describe the environment (site characterization). This center has verified technologies in a range of categories, including mercury emission monitors, ambient fine particulate monitors, test kits for arsenic and cyanide, and multi-parameter water quality probes.

The Advanced Monitoring Systems Center has verified technologies in the categories listed below.

Air

- Ambient ammonia sensors
- Ambient fine particulate monitors
- Ammonia continuous emission monitors
- Chemiluminescent ozone analyzers

- Dioxin emission monitoring systems
- Field portable ion chromatographs
- Hydrogen sulfide monitors
- Leak detection and repair technologies
- Mercury emission monitors
- Multi-metal continuous emission monitors
- Nitrogen oxide portable analyzers
- On-board emissions monitors
- Optical open-path monitors
- Personal cascade impactor samplers
- Portable multi-gas emissions analyzers

Water

- Arsenic test kits
- Beach monitoring
- Ballast water exchange screening tools
- Enzymatic test kits
- Estrogen enzyme-linked immunosorbent assay kits
- Immunoassay test kits for atrazine
- Immunoassay test kits for biotoxins
- Mobile mass spectrometers
- Multi-parameter water monitors for distribution systems
- Multi-parameter water quality probes
- Multi-parameter water sensor technologies
- Nutrient monitoring technologies for industrial applications
- Passive groundwater samplers
- Portable cyanide analyzers
- Portable water analyzers/test kits (nitrate/nitrite)
- Rapid polymerase chain reaction technologies
- Rapid toxicity testing systems
- Turbidimeters

Soils, Surfaces, and Site Characterization

- Decision support software
- Detecting toxicity in soil
- Field explosives detection technologies
- Field polychlorinated biphenyl (PCB) detection technologies
- Field-portable gas chromatographs/mass spectrometers for measurement of volatile organics in soil, water, and soil gas
- Field-portable X-ray fluorescence analyzers for measurement of metals in soil
- Groundwater sampling devices
- Laser-induced fluorescence sensors for in situ detection of petroleum hydrocarbons
- Lead-in-dust detection technologies
- Radio frequency identification devices
- Sediment sampling technologies
- Soil/soil gas sampling technologies

- Wellhead monitoring technologies for measurement of chlorinated volatile organic compounds (VOCs) in water

Data Management

The following is taken from U.S. Environmental Protection Agency, Environmental Technology Verification Program Quality Management Plan.

EPA's Environmental Technology Verification (ETV) Program Quality Management Plan contains the specifications and guidelines that apply to test-specific environmental activities involving the generation, collection, analysis, evaluation, and reporting of test data.

During planning of the technology verification test, the process, environmental, laboratory, response, and quality assurance (QA) data to be collected are identified. Also identified are testing organizations, test personnel, skill levels, methods, procedures, and equipment unique to each verification test.

An audit of data quality is an examination of a set of data after it is collected and 100 percent verified by project personnel, consisting of tracing at least 10 percent of the data from original recording through transferring, calculating, summarizing and reporting. "Ten percent of the data" means a random selection of 10 percent of the data from all of the measured parameters. Assessing whether the data quality indicator goals specified in the test/QA plan were met requires a detailed review of the recording, transferring, calculating, summarizing, and reporting of the data.

Data are verified by the data collector. The goal of data verification is to ensure and document that the data are what they purport to be (i.e., the reported results reflect what actually was done). When deficiencies in the data are identified, then those deficiencies should be documented for the data user's review and, where possible, resolved by corrective action. Data verification applies to activities in the field as well as in the laboratory. Data verification procedures are specified in the center/project quality management plan. Validated data are reported in ETV verification reports and ETV verification statements along with any limitations on the data and recommendations for limitations on data usability. All validated data arising from testing under the ETV program are disclosed in verification reports, even if the technology did not perform to the expectations of the technology provider.

b. Discuss the various currently available remediation technologies and their applications.

The following is taken from Federal Remediation Technologies Roundtable, The Remediation Technologies Screening Matrix, section 3, Treatment Perspectives.

Three primary strategies used separately or in conjunction to remediate most sites are:

- destruction or alteration of contaminants;
- extraction or separation of contaminants from environmental media; and
- immobilization of contaminants.

Treatment technologies capable of contaminant destruction by altering their chemical structure are thermal, biological, and chemical treatment methods. These destruction technologies can be applied in situ or ex situ to contaminated media.

Treatment technologies commonly used for extraction and separation of contaminants from environmental media include soil treatment by thermal desorption, soil washing, solvent extraction, and soil vapor extraction and groundwater treatment by either phase separation, carbon adsorption, air stripping, ion exchange, or some combination of these technologies. Selection and integration of technologies should use the most effective contaminant transport mechanisms to arrive at the most effective treatment scheme. For example, more air than water can be moved through soil. Therefore, for a volatile contaminant in soil that is relatively insoluble in water, soil vapor extraction would be a more efficient separation technology than soil flushing or washing.

Immobilization technologies include stabilization, solidification, and containment technologies, such as placement in a secure landfill or construction of slurry walls. No immobilization technology is permanently effective, so some type of maintenance is desired. Stabilization technologies are often proposed for remediating sites contaminated by metals or other inorganic species.

The following is taken from U.S. Environmental Protection Agency, Technology Innovation Program, Contaminated Site, Clean-Up Information, Technologies, *Databases.*

EPA maintains a searchable database of treatment technology applications for soil, groundwater, and other media at Superfund sites. The information in this database was gathered from Superfund decision documents and project managers at Superfund remedial and removal sites. It contains information about source control technologies (addressing soil, sludge, sediment, and other solid-matrix wastes), innovative (in situ) groundwater treatment technologies, and subsurface barrier groundwater containment technologies (vertical engineered barriers). The database is searchable by site name, site identification number, state, technology type, contaminant, and media.

The following is taken from U.S. Environmental Protection Agency, Technology Innovation Program, Contaminated Site, Clean-Up Information, Technologies, Remediation.

The Citizen's Guide series is a set of 21 fact sheets that describe, in general terms, cleanup methods used at Superfund and other sites. Each fact sheet is two pages long and answers five questions about the cleanup method: 1) What is it? 2) How does it work? 3) Is it safe? 4) How long will it take? and 5) Why use it? The following guides are available:

- Activated Carbon Treatment
- Air Stripping
- Bioremediation
- Capping
- Chemical Dehalogenation
- Chemical Oxidation
- Soil Excavation
- Fracturing
- In Situ Flushing

- In Situ Thermal Treatment Methods
- Incineration
- Monitored Natural Attenuation
- Permeable Reactive Barriers
- Phytoremediation
- Pump and Treat
- Soil Vapor Extraction and Air Sparging
- Soil Washing
- Solidification/Stabilization
- Solvent Extraction
- Thermal Desorption
- Vitrification

For example, solvent extraction (also known as chemical extraction) is a cleanup method that uses solvents to extract or remove harmful chemicals from polluted materials. Chemicals like PCBs, oil, and grease do not dissolve in water. Instead, they tend to stick or sorb to soil, sediment, and sludge, making it hard to clean them up. Solvents are chemicals that can dissolve sorbed chemicals and remove them from polluted materials.

Before using solvent extraction, the soil must be dug from the polluted area to be treated. The soil is sifted to remove large objects like rocks and debris. The sifted soil is then placed in a machine called an extractor where it is mixed with a solvent. The type of solvent will depend on the harmful chemicals present and the material being treated.

The cleaned soil is tested to make sure that the harmful chemicals have been removed. If harmful chemicals remain, the soil is placed back in the extractor to repeat the process. Clean soil (or sediment) can be placed back on the site.

Once the solvent dissolves the sorbed chemicals, the solvent is drained into a separator. This is where the chemicals are separated from the solvent. The used solvent often can be recycled and reused to clean up more soil. Otherwise, the solvents must be destroyed or disposed of in a landfill.

If any solvent remains in the soil following treatment, the soil is heated to remove it. The heat evaporates the solvent, changing it from a liquid to a gas. The gas is then removed from the clean soil. As the gas cools, it changes back to a liquid solvent, which can be recycled and reused. Solvent extraction can clean up to 125 tons of soil at a site per day.

12. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of evaluating technologies.

a. Discuss the Department's policies and procedures for screening technologies.

The following is taken from DOE O 413.3A.

The DOE Acquisition Management System establishes principles and processes to translate user needs and technological opportunities into reliable and sustainable facilities, systems, and assets that provide a required mission capability. The system is organized by project

phases and critical decisions, which represent a logical maturing of broadly stated mission needs into well-defined requirements resulting in operationally effective, suitable, and affordable facilities, systems, and other products.

The project phases are: initiation phase, definition phase, execution phase, and transition/closeout phase.

Initiation Phase

During this phase, preconceptual planning activities focus on the program's strategic goals and objectives. User needs are analyzed for consistency with the department's strategic plan, congressional direction, administration initiatives, and political and legal issues. One outcome of the analysis could be a determination that a user need exists that cannot be met through other than material means. This outcome leads to the development and approval of a Mission Need Statement. The information developed during this phase also provides the basis for the Project Engineering and Design budget request when preliminary design activities are planned.

Definition Phase

Upon approval of mission need, the project enters the definition phase where alternative concepts, based on user requirements, risks, costs, and other constraints, are analyzed to arrive at a recommended alternative. This is accomplished using systems engineering and other techniques and tools such as alternatives analysis and value management/value engineering. This ensures the recommended alternative provides the essential functions and capability at optimum life cycle cost, consistent with required performance, scope, schedule, cost, security, and Environment, Safety and Health considerations. During this phase, the required Value Management assessment is completed, and more detailed planning is accomplished that further defines required capabilities. The products produced by this planning provide the detail necessary to develop a range of estimates for the project cost and schedule.

Execution Phase

Following the Definition Phase, preliminary design activities mark the beginning of the Execution Phase. Systems Engineering continues to balance requirements, cost, schedule, and other factors to optimize the design, cost, and capabilities that satisfy the mission need. Engineering and design continue until the project has a sufficiently mature design that can be implemented successfully within a firm performance baseline.

Transition/Closeout Phase

When the project nears completion and has progressed into formal transition and commissioning, which generally includes final testing, inspection, and documentation, the project is prepared for operation, long-term care, or closeout. The nature of the transition and its timing depends on the type of project and the requirements that were identified subsequent to the mission need.

b. Describe the process for performing an analysis of alternative environmental compliance options.

The following is taken from DOE O 413.3A.

The DOE Acquisition Management System requires primary and alternative analysis to evaluate multiple areas including environmental compliance, life cycle cost, safety, security, and health considerations. During the definition phase, documentation is developed establishing proposed inventories of hazardous materials, and facility hazards are identified and analyzed. The alternative analysis process uses a systems methodology that integrates requirements analysis, risk identification and analysis, acquisition strategies, and concept exploration to evolve cost-effective, preferred solutions to meet a mission need.

13. Environmental restoration 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.

a. Describe and explain the application of problem analysis techniques, including the following:
- **Root Cause Analysis**
- **Causal Factor Analysis**
- **Change Analysis**
- **Barrier Analysis**

The following definitions are taken from DOE-NE-STD-1004-92.

Root Cause Analysis

The cause is a condition or an event that results in an effect. The root cause is the cause that, if corrected, would prevent recurrence of a specific or similar occurrence. Root cause analysis identifies the problem, determines the significance of the problem, identifies the causes (conditions or actions) immediately preceding and surrounding the problem, and identifies the reasons why the causes in the preceding step existed, working back to the root cause.

Causal Factor Analysis

Causal factor analysis identifies the time sequence of a series of tasks and/or actions and the surrounding conditions leading to an occurrence.

Change Analysis

Change analysis is used when the problem is obscure. It is a systematic process that is generally used for a single occurrence and focuses on elements that have changed.

Barrier Analysis

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.

The following is taken from DOE G 231.1-2, attachment 4.

Causal Factor Identification Methodologies

Events and Causal Factor Analysis - Events and causal factor analysis identifies the time sequence of a series of tasks and/or actions and the surrounding conditions leading to an event. The results are displayed in an events and causal factor chart that gives a picture of the relationships of the event and causal factors.

Change Analysis - Change analysis is used when the event is obscure. It is a systematic process that is generally used for a single occurrence and focuses on elements that have changed to identify causal factors.

Barrier Analysis - Barrier analysis is a systematic process that can be used to identify causal factors related to physical, administrative, and procedural barriers or controls that should have prevented the event.

Management Oversight and Risk Tree Analysis - Management oversight and risk tree analysis is used to identify causal factors related to inadequacies in barriers/controls, specific barrier and support functions, and management functions.

Kepner-Tregoe Problem Solving and Decision Making - Kepner-Tregoe provides a systematic framework for gathering, organizing, and evaluating information to determine causal factors during the investigation process.

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**

The following definitions are taken from DOE-NE-STD-1004-92.

Events and Causal Factors Charting

Events and Causal Factor Analysis is used for multi-faceted problems or long, complex causal factor chains. The resulting 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 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 the chart describe a causal factor chain.

Root Cause Coding

Cause codes are letters and/or numbers that represent specific cause descriptions related to categories such as equipment/material problems, procedural problems, personnel error, or training deficiencies.

Recommendation Generation

After root cause analysis is completed, effective corrective actions can be determined, recommended, and implemented to reduce the probability that a problem will recur, thereby improving reliability and safety.

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

The following is taken from DOE O 225.1A.

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

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

The heads of DOE field elements are responsible for promptly reporting and categorizing all accidents to determine whether a Type A or Type B investigation is required. Not properly categorizing an accident investigation can result in wasted resources (over-categorization) or the failure to prevent similar or more serious accidents because of unresolved or unidentified causes (under-categorization). Table 7 contains the criteria for determining whether an accident investigation should be categorized as Type A or Type B.

Providing examples of Type A and Type B accidents is a performance-based KSA. The Qualifying Official will evaluate its completion.

Table 7. Investigation categorization summary

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

Table 7. Investigation Categorization Summary (continued)

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

Source: DOE G 225.1A-1

d. Explain the necessity for and differences between the immediate, short term, and long term actions taken as the result of a problem identification or occurrence.

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

[Note: Corrective actions are no longer classified as short term and long term.]

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

Corrective actions fall into four categories:

- Immediate corrective actions that are taken by the organization managing the site where the accident occurred to prevent a second or related accident.
- Corrective actions required to satisfy judgments of need identified by the board in the final report. These corrective actions are developed by the heads of field elements

and/or contractors responsible for the activities resulting in the accident and are designed to prevent recurrence and correct system problems.
- Corrective actions determined by the appointing official to be appropriate for DOE-wide application. The appointing official recommends these corrective actions when the report is distributed.
- DOE Headquarters corrective actions that result from discussions with senior management. These actions usually address DOE policy.

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

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

f. Participate in a contractor problem analysis and critique the results.

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

14. Environmental restoration personnel shall demonstrate a working-level knowledge of Department of Energy (DOE) Order 5400.1, General Environmental Protection Program.

a. State the purpose of DOE Order 5400.1, General Environmental Protection Program.

[Note: DOE Order 5400.1 was cancelled by DOE O 450.1, which was subsequently superseded by DOE O 450.1A, *Environmental Protection Program.*]

The following is taken from DOE O 450.1A.

The purpose of this order is to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, and by which DOE cost effectively meets or exceeds compliance with applicable environmental, public health, and resource protection requirements.

b. Define the following terms:
- **Effluent**
- **Environmental monitoring**
- **Environmental protection standard**
- **Effluent monitoring**
- **Environmental surveillance**
- **Environmental occurrence**
- **Waste minimization**

The following definitions are taken from DOE Order 5400.1.

Effluent

An effluent is any treated or untreated air emission or liquid discharge at a DOE site or from a DOE facility.

Environmental Monitoring

Environmental monitoring is the collection and analysis of samples or direct measurements of environmental media. Environmental monitoring consists of two major activities: effluent monitoring and environmental surveillance.

Environmental Protection Standard

Environmental protection standard is a specified set of rules or conditions concerned with: delineation of procedures; definition of terms; specification of performance, design, or operations; or measurements that define the quantity of emissions, discharges, or releases to the environment and the quality of the environment.

Effluent Monitoring

Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for the purpose of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, providing a means to control effluents at or near the point of discharge, and demonstrating compliance with applicable standards and permit requirements.

Environmental Surveillance

Environmental surveillance is the collection and analysis of samples, or direct measurements, of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs for the purpose of determining compliance with applicable standards and permit requirements, assessing radiation exposures of members of the public, and assessing the effects, if any, on the local environment.

Environmental Occurrence

Environmental occurrence is any sudden or sustained deviation from a regulated or planned performance at a DOE operation that has environmental protection and compliance significance.

Waste Minimization

A waste minimization program contains goals for minimizing the volume and toxicity of all wastes that are generated, with annual reductions if programmatic requirements allow. Changes in waste quantity, volume, and toxicity that are achieved shall be compared with quantities generated in the previous year. The proposed methods of treatment, storage, and disposal that accomplish waste minimization that are technically and economically practicable shall be reported as appropriate. Waste minimization plans required by specific legislation, such as the Resource Conservation and Recovery Act (RCRA), shall be included as a part of this program plan. The plan shall be reviewed annually and updated every three years.

c. Discuss the Department's policy pertaining to the environmentally safe and sound operation of its facilities.

The following is taken from DOE P 450.7.

It is DOE policy that the safety of our workers, respect for the environment, and protection of the public health and safety are paramount in all that we do. We must expect and demand from ourselves as both Federal employees and contractors the highest levels of performance. The DOE's ultimate goal is zero accidents, work-related injuries and illnesses, regulatory enforcement actions, and reportable environmental releases. This goal is to be pursued through a systematic and concerted process of continuous performance improvements using performance measurement. As DOE and its contractors strive to achieve our ultimate goal, DOE will continue to have zero tolerance for accidents that result in life-threatening injuries or major environmental contamination. Furthermore, it is DOE policy that environment, safety, and health goals be established that drive performance excellence, thereby reducing or precluding other work related injuries and illnesses, and adverse impacts to the public and environment. It is anticipated that these goals will be established, and changed over time as necessary to improve performance. In achieving these goals, we will use appropriate performance measures, will accurately report incidents, and will assess site and corporate performance.

d. Discuss the Department's policy pertaining to the minimization of waste.

The following is taken from DOE O 450.1A.

DOE's objective is to reduce environmental hazards, protect environmental resources, minimize life-cycle cost and liability of DOE programs, and maximize operational sustainability by eliminating or minimizing the generation of wastes and other pollutants, through source reduction including segregation, substitution, and reuse, that would otherwise require storage, treatment, disposal, and long-term monitoring and surveillance (i.e., future environmental legacies).

DOE intends to accomplish this objective by doing the following:

- Establish operational assessments, such as pollution prevention opportunity assessments, of waste generating activities, as objectives and measurable targets in site environmental management systems (EMSs).
- Based on operational assessments, establish objectives and measurable targets in site EMSs for the prevention, reduction, reuse, and recycling of waste streams generated at sites.
- Identify through the annual DOE budgetary process the funding and resources needed to implement this sustainable environmental stewardship goal and site-specific objectives and targets that are not alternatively funded through Energy Savings Performance Contracts.
- Participate in voluntary environmental partnership programs (e.g., National Waste Minimization Program, Waste Wise, National Environmental Performance Track, etc.) where there is a programmatic benefit from doing so (community outreach, technology transfer, regulatory incentives, etc.).

e. Discuss the requirements for notification and reports. Include the following at a minimum:
- **Office of Management and Budget Circular A-106**

[Note: The Office of Management and Budget Circular A-106 is no longer active.]

The following is taken from DOE M 231.1-2.

An occurrence is one or more (i.e., recurring) events or conditions that adversely affect, or may adversely affect DOE (including NNSA) or contractor personnel, the public, property, the environment, or the DOE mission.

Reportable environmental occurrences include:
- Any release (onsite or offsite) of a hazardous substance, material, waste, or radionuclide from a DOE facility, that is above permitted levels and exceeds the reportable quantities specified in 40 CFR 302, "Designation, Reportable Quantities, and Notification" or 40 CFR 355, "Emergency Planning and Notification."
- Any discharge that exceeds 100 gallons of oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil. For operations involving oil field crude or condensate, any discharge of 100 barrels or more is reportable under this criterion.
- Any release (onsite or offsite) of a hazardous substance, material, waste, or radionuclide from a DOE facility that is above permitted levels and exceeds 50 percent of the reportable quantities specified in 40 CFR 302 or 40 CFR 355.
- Any release (onsite or offsite) of a hazardous substance, material, waste, or radionuclide from a DOE facility that must be reported to outside agencies in a format other than routine periodic reports.
- Any occurrence causing significant impact to any ecological resource for which DOE is a trustee (e.g., destruction of a critical habitat, damage to an historic/archeological site, damage to wetlands).

The Facility Manager must notify the DOE Facility Representative and the DOE Headquarters Operations Center as required, of reportable occurrences as soon as practical (i.e., promptly), but no later than 2 hours after categorization. The Facility Manager must e-mail the prompt notification of the reportable occurrence to the DOE Headquarters Operations Center, and follow up with a phone call to the DOE Headquarters Operations Center to ensure receipt of the e-mail.

The Facility Manager must prepare the written Notification Report (including all required fields and all other fields for which information is known) as discussed in DOE G 231.1-1, *Occurrence Reporting and Performance Analysis Guide,* and distribute it per section 5.6.e. Direct entry into the computerized Occurrence Reporting and Processing System satisfies this requirement.

Environmental Protection Program Reporting

Heads of Headquarters Elements and Heads of Field Elements, for matters under their purview, must make the following annual reports to the Chief Health, Safety, and Security Officer:

- Information on site progress in implementing EMSs.
- Information on site progress in reducing or eliminating the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances. Site reporting must be accomplished utilizing the Web-based Pollution Prevention Performance Tracking and Reporting System.
- Information on site procurement of recycled-content materials and environmentally preferable products and services. Site reporting must be accomplished utilizing the Web-based Pollution Prevention Performance Tracking and Reporting System.
- Information on pollution prevention award nominations from sites, and nominations selected as best in class by heads of Primary DOE Organizations.

Annual Site Environmental Report

The following is taken from DOE M 231.1-1A.

Heads of Field Elements will prepare an integrated Annual Site Environmental Report for each calendar year. This report must present summary environmental data in order to:

- Characterize site environmental management performance. It includes data on effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive material at DOE sites.
- Summarize environmental occurrences and responses reported during the calendar year.
- Confirm compliance with environmental standards and requirements.
- Highlight significant programs and efforts. It includes environmental performance indicators and/or performance measures programs. The breadth and detail of this reporting should reflect the size and extent of programs at a particular site.

The Annual Site Environmental Report for the calendar year will be completed and made available to the public by October 1 of the following year and will be submitted to the Chief Health, Safety and Security Officer at that time.

National Environmental Policy Act Reporting

The following is taken from DOE M 231.1-1A.

Heads of Headquarters and Field Elements with responsibility for National Environmental Policy Act Reporting matters will:

- Submit an annual report to the Office of National Environmental Protection Act (NEPA) Policy and Compliance on progress in implementing, and the effectiveness of, any commitment for environmental impact mitigation that is essential to render the impacts of a proposed action not significant or that is made in a record of decision (ROD). The report may be submitted on the mitigation action plan anniversary or as part of a combined report.
- Submit an annual NEPA planning summary to the General Counsel by January 31 of each year and make it available to the public. The current version of DOE O 451.1B, *National Environmental Policy Act Compliance Program*, describes the contents of the annual NEPA planning summary.

Reports on Radioactive/Effluent/On-Site Discharge/Unplanned Releases

Any release of radioactive material that meets the criteria outlined in DOE M 231.1-2 is classified as a reportable occurrence.

The following is taken from 40 CFR 355.40.

The requirements of 40 CFR 355.40 apply to any facility at which a hazardous chemical is produced, used or stored, and at which there is release of a reportable quantity (RQ) of any extremely hazardous substance or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substance. The owner or operator of a facility subject to this section shall immediately notify the community emergency coordinator for the local emergency planning committee of any area likely to be affected by the release and the state emergency response commission of any state likely to be affected by the release. If there is no local emergency planning committee, notification shall be provided under this section to relevant local emergency response personnel.

f. Discuss the requirements for an Environmental Monitoring Plan.

The following is taken from DOE O 450.1A

Implementation and Long Range Planning

Each DOE site must develop and implement an EMS. This EMS must be integrated into the site's Integrated Safety Management System (ISMS) developed pursuant to DOE P 450.4, *Safety Management System Policy*, and DOE M 450.4-1, *Integrated Safety Management System Manual*. The EMS must encompass the environmental aspects of site operations and activities, including environmental aspects of energy and transportation functions, and it must promote the long-term stewardship of a site's natural and cultural resources throughout its design and construction, operation, closure, and post-closure life cycle. The EMS must address the following:

- Sustainable practices for enhancing environmental, energy, and transportation management performance.
- Protection of public health and the environment including, but not limited to:
  - Conformity with state implementation plans to attain and maintain national ambient air quality standards (NAAQS).
  - Implementation of a watershed approach for surface water protection.
  - Implementation of a site-wide approach for groundwater protection.
  - Protection of other natural resources, including biota.
  - Assessment of the hazard of engineered nanomaterials and implementation of appropriate environment, safety and health controls in accordance with DOE P 456.1, *Secretarial Policy Statement on Nanoscale Safety.*
- Protection of site resources from wildland fires consistent with site wildland and operation fire management plans that consider the Federal Wildland Fire Management Policy recommendations.
- Identification and protection of cultural resources.
- The conduct of environmental and effluent monitoring, as appropriate, to characterize pre-operational conditions and to detect, characterize, and respond to releases from site operations and activities; assess impacts; estimate dispersal patterns in the

environment; characterize the pathways of exposure to members of the public; characterize the exposures and doses to individuals and the population; and evaluate the potential impacts to the biota in the vicinity of the release.

- Assurance that analytical work for environmental and effluent monitoring supports data quality objectives, using a documented approach for collecting, assessing, and reporting environmental data.
- The conduct of appropriate operational assessments, such as pollution prevention opportunity assessments, of site operations and activities to identify opportunities to implement sustainable practices as part of achieving DOE's Sustainable Environmental Stewardship goals found in Attachment 2 of DOE O 450.1A.

Special Program Planning Requirements

Each head of field organization shall prepare a separate plan of sufficient scope and detail to reflect program significance, as appropriate, for each of the following activities.

The following is taken from DOE G 450.1-3.

Cultural Resource Management Plan

Preservation and protection of America's cultural heritage are important functions and responsibilities of the Federal government for properties under its control or jurisdiction. DOE recognizes its stewardship responsibilities for managing the cultural resources on DOE-owned and other lands that are impacted by DOE programs. Concern for this public trust has prompted the development of a DOE-wide cultural resource management program for all DOE facilities and programs.

Cultural resources include, but are not limited to, the following broad range of items and locations:

- archeological materials (artifacts), ethnographic resources, and prehistoric and historic sites currently located on the ground surface or buried beneath it;
- standing structures that are more than 50 years old or, if younger, are important because they represent a major historical theme or era;
- cultural and natural places, select natural resources, and sacred objects important to Native Americans;
- American folk life traditions and arts; and
- places significant to the facility's history.

The following is taken from DOE G 450.1-4.

Wildland Fire Management Program

DOE field elements are responsible for developing, implementing, and overseeing protection programs for individuals and assets under their cognizance. This includes protecting assets from internal structural fire damage and from the conflagration potential associated with the external wildland fire. A Wildland Fire Management Program comprises the full range of activities and functions necessary to plan, prepare, and respond to potential fires and rehabilitate undeveloped lands following a fire.

The following is taken from DOE G 450.1-5.

Integrating Pollution Prevention into EMSs

This document provides discretionary guidance for implementing the requirements of DOE O 450.1, which requires implementation of sound stewardship practices that are protective of the air, water, land, and other natural resources impacted by DOE operations. This objective is to be accomplished by implementing EMSs as part of existing ISMSs. As part of that integration, DOE O 450.1 requires DOE elements, and contractors to reduce or eliminate waste, pollutants, and Class I ozone-depleting substances at DOE facilities through source reduction, reuse, segregation, and recycling and by procuring recycled-content materials and environmentally preferable products and services.

The following is taken from DOE G 450.1-6.

Ground Water Surveillance Monitoring Program

The purpose of this guidance is to assist DOE sites in establishing and maintaining surveillance monitoring programs to detect future impacts on groundwater resources from site operations, to track existing groundwater contamination, and to assess the potential for exposing the general public to site releases.

Surveillance monitoring is performed to detect at the earliest possible time any impact on groundwater from an operating facility or practice at a DOE site. A surveillance monitoring network should include observation points located and sampled based on prioritized areas of the site where the groundwater may be particularly vulnerable to contamination. At many DOE sites, observation points are appropriately located in the unsaturated zone since the occurrence of groundwater that may be vulnerable to contamination from DOE activities is well below the surface (i.e., hundreds of feet below ground surface). Early detection of a release to the subsurface may necessitate vadose zone monitoring to detect releases before the groundwater is affected.

A carefully prepared contingency plan is a critical element in a site-wide groundwater surveillance monitoring network. Fundamentally, the contingency plan identifies ranges of action levels and corresponding responses to be taken if contaminants are detected in the surveillance monitoring network. The contingency plan also should provide guidance on lines of authority and responsibility for invoking contingencies and for reporting and evaluating results.

The following is taken from DOE G 450.1-9.

Ground Water Protection Programs

Implementing a groundwater protection program will facilitate planning, implementation, and management review of site-wide protection activities. The site-wide groundwater protection program should enable cost-effective protection of groundwater and allow for a flexible approach that is tailored to each DOE site's unique features. A successful groundwater protection program ensures that:

- possible sources of current and future groundwater contamination are identified, and the potential for future contamination is evaluated;

- all applicable Federal, state, and DOE requirements are met;
- appropriate groundwater protection goals are established for all affected or potentially affected groundwater consistent with the water quality and current or likely future use;
- strategies for predicting and preventing future contamination and for controlling existing contamination are developed;
- the history of groundwater protection program activities is documented for future site management;
- the quality of ambient groundwater and vadose zone conditions at the site are documented;
- environmental monitoring with surveillance program elements for the groundwater and the vadose zone, including ambient subsurface conditions, is described; and
- the way the monitoring program provides the information needed to predict and respond to potential contamination associated with significant site aspects and to achieve groundwater protection goals is described.

The following is taken from DOE G DOE/EH-0173T, chapter 4.

Meteorological Monitoring Program

Each DOE and NNSA site should establish a meteorological monitoring program that is appropriate to the activities at the site, and that gives due consideration to the topographical characteristics of the site, the distance to each of the critical receptors (i.e., worker, co-located worker, maximally effected offsite individual), and planned future uses of the site. The scope of the program should be based on an evaluation of the regulatory requirements, and a determination of meteorological data needed to support facility operations, environmental impact assessments, environment surveillance activities, safety analyses, environmental restoration activities, and the consequence assessment element of emergency preparedness and response.

The site's meteorological program should be documented in a meteorological monitoring section of the Environmental Monitoring Plan and in the Annual Site Environmental Report. Sites should have onsite measurements of basic meteorological data. These include, but are not limited to wind direction, wind speed, and an indicator of atmospheric stability (e.g., temperature lapse rate). This information is needed to:

- calculate and evaluate atmospheric transport and dispersion in the vicinity of facilities;
- perform the required dose calculations for routine gaseous releases, as specified in 40 CFR 61 subpart H, "National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities"; and
- develop radiological and chemical consequence assessments per DOE O 151.1C, *Comprehensive Emergency Management System.*

Specific meteorological information requirements for each facility should be based on the magnitude of potential radiological and chemical source terms, the location, nature, and state of potential releases from the facility, possible pathways to the atmosphere, local topography, distances from release points to critical receptors, and the proximity of other DOE facilities, and other non-DOE facilities that handle radioactive and/or other toxic materials.

15. Environmental restoration personnel shall demonstrate a working-level knowledge of monitoring techniques related to environmental restoration.

a. Describe the types of equipment used to monitor a site for the following:
- **Ambient air quality**
- **Emissions**
- **Groundwater contamination**
- **Meteorological factors**
- **River and stream contamination**
- **Soil and sediment contamination**
- **Wildlife contamination**

Ambient Air Quality/Emissions

The following is taken from Encyclopedia of the Atmospheric Environment, Measuring Air Quality.

There are many ways to measure air pollution, with both simple chemical and physical methods and with more sophisticated electronic techniques. There are four main methods of measuring air pollution.

Passive sampling methods provide reliable, cost-effective air quality analysis, which gives a good indication of average pollution concentrations over a period of weeks or months. Passive samplers are so-called because the device does not involve any pumping. Instead the flow of air is controlled by a physical process, such as diffusion. Diffusion tubes are simple passive samplers, which provide very useful information regarding ambient air quality. They are available for a number of pollutants, but are most commonly and reliably used for nitrogen dioxide and benzene. The tubes, which are 71mm long with an internal diameter of 11mm, contain two stainless steel gauzes placed at one end of a short cylinder. The steel gauzes contain a coating of triethanolamine, which converts the nitrogen dioxide to nitrite. The accumulating nitrates are trapped within the steel gauze, ready for laboratory analysis. The tube is open to the atmosphere at the other end, which is exposed downwards to prevent rain or dust from entering the tube. To ensure that all the nitrogen dioxide originates from the test site, the tubes are sealed before and after exposure. The tubes are manually distributed and collected, and are analyzed in a laboratory.

Active sampling methods use physical or chemical methods to collect polluted air, and analysis is carried out later in the laboratory. Typically, a known volume of air is pumped through a collector (such as a filter, or a chemical solution) for a known period of time. The collector is later removed for analysis. Samples can be collected daily, providing measurements for short time periods, but at a lower cost than automatic monitoring methods.

Automatic methods produce high-resolution measurements of hourly pollutant concentrations or better, at a single point. Pollutants analyzed include ozone, nitrogen oxides, sulfur dioxide, carbon monoxide, and particulates. The samples are analyzed using a variety of methods including spectroscopy and gas. The sample, once analyzed is downloaded in real-time, providing very accurate information.

Remote optical / long path-analyzers use spectroscopic techniques and make real-time measurements of the concentrations of a range of pollutants including nitrogen dioxide and sulfur dioxide.

The amount of pollution in the air, however sampled, is usually measured by its concentration in air. The concentration of a pollutant in air may be defined in terms of the proportion of the total volume that it accounts for. Concentrations of pollutant gases in the atmosphere are usually measured in ppm by volume, parts per billion by volume (ppb) or parts per trillion by volume. Pollutant concentrations are also measured by the weight of pollutant within a standard volume of air, for example micrograms per cubic meter or milligrams per cubic meter.

The following is taken from Livestock and Poultry Environmental Stewardship Curriculum, Measuring Outdoor Air Quality (OAQ) Components.

Some measuring techniques or instruments give a single instantaneous reading at a specific place and point in time. Another measurement using the same method some time later will probably give a different value. A series of instantaneous readings can be used to indicate how a gas concentration fluctuates. Some people combine individual readings and report average concentrations.

Other measuring techniques sample air for several minutes or more and give an average concentration over the sampling period. When comparing results, it is important to recognize that instantaneous readings will vary more and have higher and lower individual readings than average readings over a sampling period.

Technique precision or detection limit is an important measurement characteristic. Some devices or methods can measure concentrations to within ±1 ppm of the true concentration. Others may only be able to measure concentrations to within ±20 ppm of the true concentration. Devices with greater precision can be used to detect small differences in concentrations that less precise devices cannot detect. However, devices with greater precision usually cost more.

Patches are single-use pieces of cardboard or plastic coated with a chemical that changes color when exposed to the gas being measured. Both the amount of time exposed and the amount of color change are important. Patches give an integrated or average value but are not very precise. They can be hung in a space, worn by workers, or combined with small fans for different applications.

Different types of indicator tubes are available to measure a wide range of gases. Indicator tubes are glass tubes with both ends sealed. To take a reading with an indicator tube, the tips on both ends of the tube are broken off, and the tube is attached to a hand-held pump. The pump pulls a known amount of air through the tube. The media in the tube reacts and changes color with select gases in the air sample. A scale on the tube is used to measure the amount of media that reacted with the gas and indicates the concentration. Tubes come with limited scales; precision is around 10 percent of the full-scale reading on the tube. Indicator tubes give nearly instantaneous readings.

Portable electronic devices or single-point monitors can be used to monitor ambient air concentrations of individual compounds hydrogen sulfide over extended periods of time. A special cassette tape reacts, causing a color change, with the chemical being monitored. The color change is measured and used to indicate the gas concentration in the ambient air. These monitors can be used to measure ambient hydrogen sulfide concentrations over a variety of ranges, depending on the "key" being used. The key with the lowest detection levels can measure concentrations between 2 and 90 ppb over 15-minute periods. Units with different electronics and cassettes can be used to monitor other gases.

Many different electronic sensors are available for measuring gas concentrations. Their method of action and precision vary. Some units have multiple gas sensors; some units are used in the safety field to monitor gas concentrations and sound alarms if safe concentrations are exceeded in confined spaces.

A gas chromatograph/mass spectrometer, generally considered a research laboratory device, can be used to both identify and measure gas concentrations. Very small air samples are injected into a carrier (nitrogen or helium) gas stream passing through a spectrometer column. The column adsorbs and desorbs the chemicals in the air at different rates to separate them. After separation, the carrier gas stream with the separated chemicals passes through a detector. The detector output signal identifies the chemical and the amount in the sample. Portable units for field research are available.

Groundwater Contamination

The following is taken from DOE G 450.1-6.

Groundwater monitoring wells, vadose zone monitoring techniques, piezometers, springs, seeps, and other observation points where measurements are taken constitute the site-wide groundwater monitoring network. Each observation point should be a component of one or more unique facility-specific or area-specific monitoring networks. A series of groundwater and vadose zone monitoring wells and methods that have been placed up and down gradient from, and below, an operating facility (e.g., a reactor, an accelerator, a low-level radioactive waste disposal unit) is an example of a facility-specific network.

An area-specific monitoring network is a unique set of groundwater observation points designed to monitor existing subsurface conditions (i.e., hydrological parameters and contaminant concentration levels) to determine if significant deviations from expected conditions are observed that may warrant further investigation. An example of an area-specific network is a series of wells designed to monitor a contaminant plume where active remediation has ceased and monitored natural attenuation is being implemented.

The following is taken from U.S. Geological Survey, *National Field Manual for the Collection of Water Quality Data*, chapter A2, Selection of Equipment for Water Sampling.

The type of sampler or sampling system selected depends on the type of well, depth to water from land surface, physical characteristics of the well, groundwater chemistry, and the analytes targeted for study. Groundwater most commonly is collected using either pumps designed specifically for water sampling from monitoring wells, pumps installed in supply wells, or a bailer or other point or thief-type sampler. Sampling equipment must not be a

source of contamination or otherwise affect analyte concentration. Of specific importance for groundwater sampling is a potential change in groundwater chemistry due to atmospheric exposure.

Pumps transport water from depth to land surface either by suction lift or positive pressure. The pumping mechanism for most suction-lift pumps (peristaltic, jet, and some nonsubmersible centrifugal pumps) is at land surface. Positive-pressure pumps (helical rotor, gear, bladder, piston, inertial submersible, and centrifugal pumps) are grouped together as submersible pumps because they are placed below static water level.

Use of a bailer or other thief sampler that is lowered and raised repeatedly in the well to collect a sample disturbs the water column and is not recommended for this reason. The disturbance can result in stirring up or mobilizing particulates, including colloidal matter or mineral precipitates that are artifacts of well construction and are not part of the ambient groundwater flow. This, in turn, can result in substantially greater than ambient concentrations of trace elements and hydrophobic organic compounds.

Water samples must be processed as quickly as possible after collection. The equipment most commonly used for sample processing includes sample splitters, filtration units or assemblies, solid-phase extraction systems, and chambers in which samples are processed and treated with chemical preservatives.

The collection of surface water generally results in a single composite sample. A groundwater sample generally is not composited; instead the sample is pumped directly into separate bottles for designated analyses. Once a sample has been composited, the sample is often subdivided or split into subsamples for analysis using a sample splitter.

Processing and preservation chambers reduce the possibility of random atmospheric contamination during sample splitting, filtration, and preservation. These chambers are required for samples for trace-element determinations. The processing chamber can serve also as a collection chamber for pumped samples.

Filtration separates particulate substances (solid-phase and biological materials) from the solute or aqueous phase of a water sample. Water samples are filtered for analysis of inorganic constituents, organic compounds, and biological materials to help determine the environmental fate and quantify the transport of these target analytes.

The following is taken from U.S. Environmental Protection Agency, Examples of Alternatives to Conventional Ground-Water Monitoring Wells at Small, Dry or Remote Landfills.

In addition to the use of monitoring wells, other methods and equipment are often used in studies of groundwater contamination. These methods include other sampling techniques as well as geophysical methods. Surface geophysical surveys and downhole geophysical logging are used to define geological characteristics and assist in delineating zones of groundwater flow and contaminant transport. These techniques can assist in defining the extent of contamination and to help determine whether a “plume” of contamination exists. Some methods are:

- Pressure-vacuum lysimeters may be used to obtain samples of in situ soil moisture in the unsaturated zone. They consist of a porous ceramic cup capable of holding a vacuum, a small-diameter sample chamber made of polyvinyl chloride pipe, and two sampling tubes leading to the surface.
- The cone penetrometer is a cone-shaped instrument attached to a drill rod that is pushed onto soils to measure resistance to penetration. Two types of cones are available, mechanical and electronic. The electronic cone penetrometer uses a cone-tipped cylindrical probe (piezocone) which contains instruments capable of measuring pore water pressures, which can indicate the presence of moisture bearing zones. The cone penetrometer provides high resolution stratigraphic and hydrogeologic data which are used to characterize the extent of contaminant plumes, thus optimizing the number and location of wells required for effective site assessment and monitoring.
- The hydropunch is a device that collects one-time groundwater samples in unconsolidated material. It consists of a probe with a sample chamber that can be driven to the desired depth by either conventional drill rods or cone penetrometer rods. The outer sleeve of the probe is pulled back exposing a well screen. Groundwater enters the screen under hydrostatic pressure and fills the sample chamber. Hydropunching is a method that has gained rapid acceptance as a preliminary reconnaissance method. The results presented in the literature generally agree that the quality of the hydropunch sample data is comparable to data obtained from monitoring wells, which provides a level of confidence suitable for detailed plume delineation programs.
- The geoprobe is a small diameter percussion driven probing tool that can be used for the recovery of soil vapor, soil core and groundwater samples. Mechanized, vehicle mounted soil probe systems apply both static force and hydraulically powered percussion hammers for tool placement. The geoprobe is driven to the depth desired below the water table; then the detachable drive point is removed from the end of the rod, allowing groundwater to enter the rod at the base of the hole. Polyethylene tubing (with a bottom check valve) is then lowered inside the rods to the base of the hole. The check valve allows groundwater to enter the tubing and prevents it from escaping. When enough water is collected, the tubing is extracted from inside the rods, and the water in the tubing is decanted into a glass vial.
- Ground penetrating radar can be used to detect pollution plumes when contaminants change the conductivity of groundwater. A transmitting and a receiving antenna are dragged along the ground surface. The small transmitting antenna radiates short pulses of high-frequency radio waves (ranging form 10 to 1,000 megahertz) into the ground and the receiving antenna records variations in the reflected return signal.
- Transient Electromagnetics/Time Domain Electromagnetics instruments use a large transmitter loop on the ground and a receiving coil to measure the decaying magnetic field generated by a descending eddy current that is generated when the transmitter loop current is suddenly turned off. These measurements can be interpreted in terms of the subsurface conductivity as a function of depth. These instruments can be used to detect pollution plumes when contaminants change the conductivity of groundwater.
- Frequency Domain Electromatic Induction uses a transmitter coil to generate an electromagnetic field that induces eddy currents in the earth below the instrument.

Secondary electromagnetic fields created by the eddy currents are measured by a receiver coil that produces an output voltage that can be related to subsurface conductivity. These instruments can be used to detect pollution plumes when contaminants change the conductivity of groundwater.

- In Seismic Refraction, an artificial seismic source (hammer, controlled explosive charge) creates direct compressional waves that are refracted by traveling along the contact between geologic boundaries before signals from the wave reach the surface again. The refracted waves are sensed by receiving geophones, which are attached to a seismograph. The seismograph records the time of arrival of all waves, using the moment the seismic source is set off as time zero. Travel time is plotted against source-to-geophone distance to produce a time/distance plot. Line segments, slope and break points in the time/domain plot are used to identify the number of layers and depth of each layer. These instruments can be used to detect pollution plumes when contaminants change the conductivity of groundwater.
- Neutron Probe (Nuclear Borehole Logging). The probe contains a source of neutrons and detectors that are arranged so that the output is primarily a function of the hydrogen content of the borehole environment. It is the most commonly used nuclear method for measurement of soil moisture.

Meteorological Factors

The following is taken from the Illinois State Climatologist Office, Weather Instruments for Measuring the Climate of Illinois.

Electronic Maximum-Minimum Temperature Sensor - an electronic temperature sensor that has largely replaced liquid-in-glass thermometers. It is housed in a white case to reflect sunlight and has vents all around so that the air flows freely over the temperature sensor inside. The idea is to measure the temperature in the shade, away from any direct effect of the sun.

Anemometer - used to measure wind speed and direction. The wind speed is measured by the propeller. The stronger the wind, the faster the propeller turns. The tail points the instrument into the wind so that we can measure wind direction. The instrument is mounted on a 10-meter (33-foot) tower to minimize the effects of nearby trees and buildings.

Barometer - used to measure the air pressure. In general, rising air pressure indicates fair weather while falling pressure indicates foul weather. Like many instruments, this one has been largely replaced by electronic sensors.

Standard 8-inch Raingage - used for measuring precipitation, simply insert the measuring stick and record the amount. Dump the water out of the can and you are ready for the next storm. Measures precipitation to the nearest 100th of an inch (0.01 inches). Still the primary raingage of the National Weather Service because of its simplicity and reliability (no moving parts and needs no electricity).

River and Stream Contamination

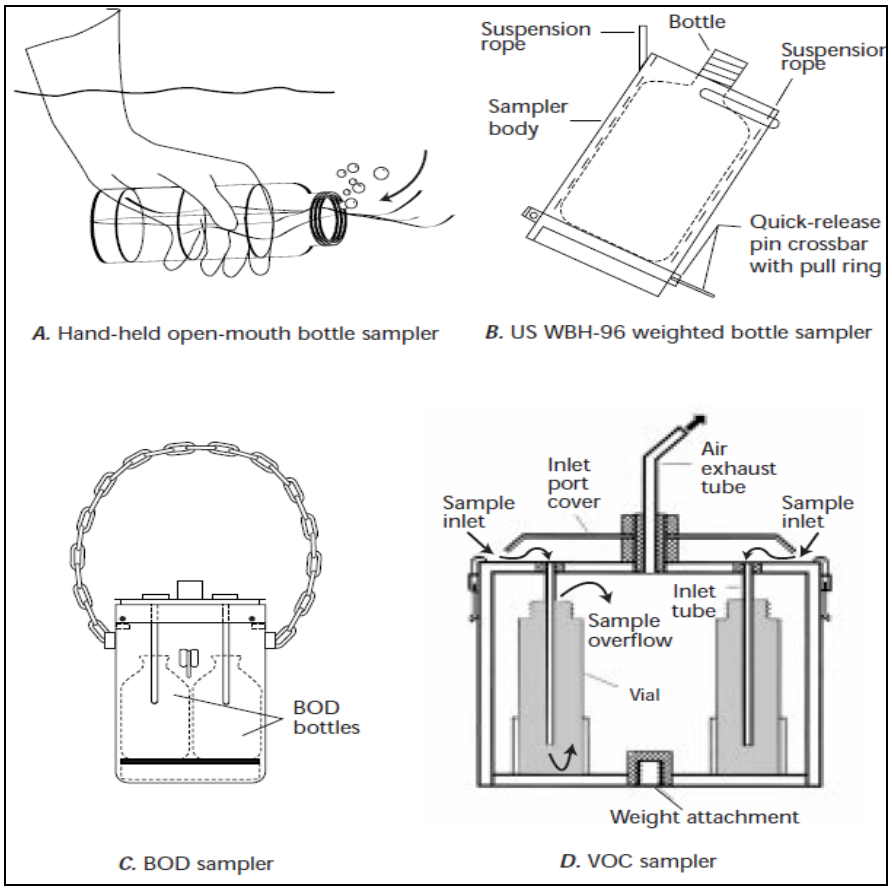
The following is taken from U.S. Geological Survey, *National Field Manual for the Collection of Water Quality Data*, chapter A2, Selection of Equipment for Water Sampling.

Study objectives, flow conditions, and sampling structures (such as a bridge, cableway, or boat) must be considered when determining which sample-collection equipment to use. The equipment selected depends on whether the stream can be waded (preferred) or not. Two primary types of surface-water samplers are used by the U.S. Geological Survey: isokinetic depth-integrating samplers and nonisokinetic samplers.

An isokinetic depth-integrating sampler is designed to accumulate a representative water sample continuously and isokinetically (that is, stream water approaching and entering the sampler intake does not change in velocity) from a vertical section of a stream while transiting the vertical at a uniform rate. Isokinetic depth-integrating samplers are categorized into two groups, based on the method of suspension: hand-held samplers and cable-and-reel samplers.

Hand held samplers are used to collect water samples where flowing water can be waded or where a bridge is accessible and low enough to sample from. Both inorganic and organic samples can be collected as long as the construction material of the sampler components does not affect ambient concentrations of target analytes. Isokinetic depth-integrated samples for bacteria analysis also can be collected with these samplers. Cable-and-reel samplers are used to collect water samples where flowing water cannot be waded.

Nonisokinetic samplers, consist of open mouth samplers and thief samplers. Open-mouth samplers used for the collection of water samples include the hand-held bottle, the weighted-bottle sampler, the biochemical on demand (BOD) sampler, and the VOC sampler. Figure 21 illustrates these sampler types.



Source: U.S. Geological Survey, *National Field Manual for the Collection of Water Quality Data*, chapter A2, Selection of Equipment for Water Sampling

Figure 21. Examples of nonisokinetic open mouth samplers

The hand-held bottle sampler is the simplest type of open mouth sampler. A bottle is dipped to collect a sample where depth and velocity are less than the minimum requirements for depth-integrated samplers.

The weighted-bottle sampler is available in stainless steel or polyvinyl chloride. The weighted bottle sampler can be used to collect samples where flow velocities are less than the minimum requirement for isokinetic depth-integrating samplers and where the water body is too deep to wade. An open bottle is inserted into a weighted holder that is attached to a handline for lowering. Sampling depth is restricted by the capacity of the bottle and the rate of filling.

The BOD sampler and the VOC sampler, are open-mouth samplers designed to collect nonaerated samples. The BOD sampler accommodates 300-mL glass BOD bottles specifically designed to collect samples for dissolved-oxygen determination. The VOC sampler is specifically designed to collect nonaerated samples in 40-mL glass septum vials for determination of volatile organic compounds.

Thief samplers are used to collect instantaneous discrete (point) samples. Thief samplers have been used primarily to collect samples from lakes, reservoirs, and some areas of estuaries. Smaller versions, designed to collect groundwater samples, also have been used in still and flowing surface water.

Automatic pumping samplers with fixed-depth intakes are sometimes used to collect samples at remote sites; from ephemeral, small streams; or from urban storm drains where stage rises quickly. These samplers can be programmed to collect samples at preset time intervals or at selected stages, thus reducing the personnel requirements for time-intensive sampling. Whenever automatic samplers or pumps are used, the sample is considered to be a point or grab sample.

Soil and Sediment Contamination

The following is taken from U.S. Department of Agriculture, National Soil Survey Center, *Field Book for Describing and Sampling Soils.*

The objective of the task determines the methodology and the location of the soil material collected for analysis. Characterization Samples include sufficient physical and chemical soil analyses, from virtually all layers, to fully characterize a soil profile. The specific analyses required vary with the type of material; e.g., a Mollisol requires some different analyses than does an Andisol. Nonetheless, a wide compliment of data (i.e., pH, particle size analysis, cation exchange capacity, base saturation, organic carbon content, etc.) are determined for all major soil layers.

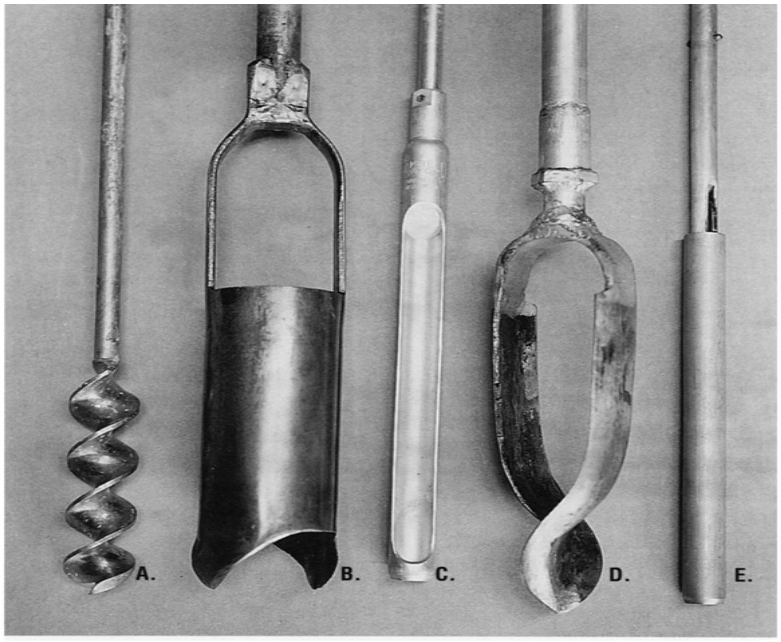
The following is taken from U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey Manual.*

A soil scientist examines the soil often in the course of mapping. Examination of both horizontal and vertical variations is essential. The most commonly used tools are spades and soil augers. Backhoes, spades, and shovels are used to expose larger soil sections for examinations, sampling, and photography. Augers are used in most areas for routine mapping. In some areas, however, a spade is used to examine the soil. In soils free of rock fragments, probes provide samples that are quick and relatively easy to obtain. Where a probe or auger is regularly used for examining the soil, some profiles need to be exposed in a pit and examined as a check. Power equipment is often used to save time and effort. Various small instruments can also be used to examine the soil.

The screw, or worm, soil auger is essentially like a wood auger and ranges from about 2 1/2 to 4 cm in diameter. The worm part is about 15 cm in length, and the distance between flanges is about the same as the diameter.

Several kinds of barrel augers are used. Barrel augers are known as post-hole augers, bucket augers, orchard augers, core augers, and various other names. They have a cylinder, or barrel, to hold the soil, which is forced into the barrel by cutting lips at the lower end. Barrel augers disturb the soil less than screw augers. Soil structure, porosity, consistence, and color can be observed better. Barrel augers work well in loose or sandy soils and in compact soils.

Probes consist of a small-bore tube that has a tempered sharp cutting edge slightly smaller in bore but larger in outside diameter than the barrel. Approximately one-third of the tube is cut away above the cutting edges so that the soil can be observed and removed. Probes are about 2.5 cm in diameter and about 20 to 40 cm in length. The tube is attached to a shaft with a "T" handle at the opposite end. Shaft length can be varied by adding or removing sections. Probes can be used to examine the soil to a depth of 2 meters. Various probes and augers are shown in figure 22.



Soil augers and tubes: *A*, screw or worm auger; *B*, barrel auger; *C*, sampling tube; *D*, "Dutch""mud" auger; *E*, peat sampler.

Source: U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey Manual*

Figure 22. Soil augers and tubes

Power equipment is used for rapid excavation or for extracting cores and samples rapidly and from depths that are difficult to reach with hand tools. The use of power equipment results in large savings in time and permits deeper and larger excavations with better exposure of the various horizons than can be attained with hand tools. A backhoe is used to expose vertical sections of soil. The width of the bucket, or shovel, ranges from 30 cm on the smaller models to more than 75 cm on the larger ones. Power augers are commonly mounted on a small truck and are powered by the engine of the truck. Some have independent power plants and can be mounted on a trailer. Power-operated probes are used in moist soils that have few stones. They are usually mounted on a truck and are forced into the soil by hydraulic drivers that are powered by the engine of the truck and act against the weight of the truck and its load. The tubes are usually 2.5 to 10 cm in diameter.

The following is taken from U.S. Environmental Protection Agency, Soil-Gas Measurement.

The term "soil-gas" refers to the atmosphere present in soil pore spaces. Volatile compounds introduced into the subsurface can be present in the gas phase or more commonly, can undergo a transition from a liquid or sorbed phase (pure product, dissolved, or adsorbed to soil) to become part of the soil atmosphere. Soil-gas measurement has become an accepted environmental site screening tool. The technique is rapid, low cost, and provides a high yield of information when carefully applied. Because it is an indirect measure of underlying contamination and because of the potential for false negative results, the technique should be used only for site screening and not for confirmation.

Soil-gas surveys can be used to:

- identify contaminants and relative concentrations
- identify sources; indicate extent of contamination
- monitor the progress of cleanups
- guide placement of subsequent confirmatory samples (soil borings, monitoring wells)
- monitor at fixed vapor wells (long-term monitoring)
- detect leaks through use of tracer compounds

Typical primary sources include surface spills, leaking underground storage tanks (USTs), pipes, trenches, dry wells, or landfills. Contaminants from such sources frequently reach the water table, causing the groundwater to become a source of contamination to downgradient sites. The nature of the source will influence the vertical and horizontal dispersion of gas-phase contaminant vapors.

Contaminants detectable in soil gases include many common chlorinated solvents and the lighter fractions of petroleum products, substances that are widespread environmental contaminants. Of the 25 most commonly encountered contaminants at Superfund sites, 15 are amenable to detection by soil-gas sampling. Inorganic contaminants that can be detected by soil-gas sampling include radon, mercury, and hydrogen sulfide.

Soil-gas samples can be collected by active or passive methods. For active sampling, a probe is driven into the ground, withdrawn several inches, and soil gases are pumped from the subsurface into a sample or through a sorbent medium. For passive sampling, a sampler containing a sorbent with an affinity for the target analytes is placed in the ground for a period of time, and contaminants are collected by virtue of diffusion and adsorption processes.

Passive sorbers have been shown to collect and identify a greater number of VOCs in soils than the active soil gas collection methods collected at the same site. Passive vapor sorbers are also capable of collecting some of the low molecular weight polyaromatic hydrocarbons present at the site. After exposure, the passive sampler is transported to a laboratory for analysis.

The most commonly used technique for analyzing soil-gas samples is gas chromatography in combination with a detector appropriate to the target analytes. Analyses can be done on-site or off-site. Soil-gas samples can also be screened in the field using organic vapor detectors,

which provide results expressed as total hydrocarbon concentration relative to a calibration standard.

Wildlife Contamination

The following is taken from U.S. Environmental Protection Agency, ECO Update, Field Studies for Ecological Risk Assessment.

[Note: ECO is an abbreviation for ecology. ECO Update is a bulletin series on ecological risk assessment of Superfund sites.]

Ecological risk assessments of Superfund sites evaluate the actual or potential effects of site contaminants on plants and animals and assess the need for remediation, including considering remedial alternatives and evaluating ecological effects of remediation. Rather than studying individual organisms, field studies generally focus on populations or communities. Populations are groups of organisms belonging to the same species and inhabiting a contiguous area. Communities consist of populations of different species living together.

Although a large number of species can inhabit a site, an ecological risk assessment of a site concerns itself only with those that are actually or potentially adversely affected by site contamination or that can serve as surrogates for such species. Such organisms are among a site's ecological components. Ecological components are populations, communities, habitats, or ecosystems actually or potentially affected by site contamination.

At a site where contaminated surface water is a medium of concern, field studies can focus on periphyton, plankton, benthic macroinvertebrates, or fish. Benthic macroinvertebrates are invertebrate animals that live in or near the bottom of a body of water. Freshwater benthic macroinvertebrates include insects, worms, freshwater clams, snails, and crustaceans. The benthic macroinvertebrate communities of marine and estuarine environments include worms, clams, mussels, scallops, oysters, snails, crustaceans, sea anemones, sponges, starfish, sea urchins, sand dollars, and sea cucumbers.

When water becomes contaminated, some of the contaminants migrate to the sediment and accumulate there. Field studies of benthic macroinvertebrates can indicate the degree that sediment contamination can adversely affect biota. In addition, the composition and diversity of benthic macroinvertebrate communities can indicate the overall well-being of the aquatic ecosystem.

Semi-aquatic and terrestrial animals—including insects, other invertebrates, and vertebrates—can all provide useful information about ecological effects associated with a semi-aquatic or terrestrial site. Field studies focusing on vertebrates such as amphibians, reptiles, and mammals can contribute to a site's ecological assessment. Depending on their diet, these vertebrates may ingest contaminants as a result of consuming contaminated plants, other terrestrial animals, or fish. Burrowing animals, such as field mice, can show greater ecological effects from contaminated soil than animals that have less intimate contact with the soil. Where investigators at sites decide to study terrestrial vertebrates, they generally choose small species, which are likely to range over a smaller area than larger species. As a

result, the smaller species tend to spend more of their time on the site, making it easier to estimate exposure.

Field studies of birds present certain difficulties at a site. These organisms can range far off-site, making it difficult for a field study to establish whether an adverse ecological effect results from exposure to site-associated contaminants.

Methods of collecting samples for further study vary with the kind of organism being studied. A field worker can catch a fish in a net, capture a mouse in a trap, or sieve organisms from a soil or sediment sample. Depending on the species and objectives, once the investigator has collected the organisms, he or she may make direct observations and then release them. Alternatively, the investigator may retain the organisms for further study, such as analyzing tissues for their contaminant content or examining them microscopically for indications of contaminant-related abnormalities.

b. Describe the requirements of the following documents as they relate to environmental monitoring:
- **CERCLA**
- **RCRA**
- **NEPA**

CERCLA

The following is taken from U.S. Environmental Protection Agency, Superfund, CERCLA Overview.

The CERCLA, commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA:
- established prohibitions and requirements concerning closed and abandoned hazardous waste sites;
- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions:
- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on the EPA NPL.

CERCLA also enabled the revision of the National Contingency Plan. The National Contingency Plan provided the guidelines and procedures needed to respond to releases and

threatened releases of hazardous substances, pollutants, or contaminants. The National Contingency Plan also established the NPL.

RCRA

The following is taken from U.S. Environmental Protection Agency, Cleanup Enforcement, RCRA Cleanup.

The RCRA regulates hazardous and non-hazardous wastes. RCRA subtitle C establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal. Facilities that generate, treat, store, or dispose of hazardous waste are regulated under subtitle C.

RCRA Subtitle C has two general paths to protecting human health and the environment:

- preventing environmental problems by ensuring that wastes are well managed from "cradle to grave," reducing the amount of waste generated, conserving energy and natural resources, and
- cleaning up environmental problems caused by the mismanagement of wastes.

The RCRA corrective action program, part of Subtitle C, addresses when action is needed to clean up contamination at a facility. RCRA corrective action usually takes place at facilities that treat, store, or dispose of hazardous waste. Corrective action may be prompted through the enforcement mechanisms found in RCRA, through a RCRA permit, or through voluntary agreements. Corrective action can take place while a facility continues operating.

NEPA

The following is taken from U.S. Environmental Protection Agency, National Environmental Policy Act (NEPA), Basic Information.

The NEPA requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

To meet NEPA requirements federal agencies prepare a detailed statement known as an environmental impact statement (EIS). EPA reviews and comments on EISs prepared by other federal agencies, maintains a national filing system for all EISs, and assures that its own actions comply with NEPA.

c. Describe the various quality assurance and quality control programs used to enhance data quality. Include in your discussion programs both internal and external to the Department.

The following is taken from DOE O 414.1C.

The objective of the DOE QA Program is to ensure that DOE and NNSA products and services meet or exceed customers' expectations. One of the management criteria to achieve this objective is to monitor how the QA Program addresses DOE work processes.

Work processes must be performed consistent with technical standards, administrative controls, and hazard controls adopted to meet regulatory or contract requirements using approved instructions and procedures. Items utilized in the work process must be identified and controlled to ensure their proper use. These items must also be properly maintained to prevent their damage, loss, or deterioration. Additionally, work process equipment must be properly calibrated and maintained when used for process monitoring or data collection.

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

A graded approach that doesn't compromise public, employee, or facility safety or adversely impact the environment and complies with requirements, rules, and regulations must be used to implement the DOE QA Program. The graded application of facility/activity requirements is dependent on the hazards and/or level of risk associated with the activity or structures, systems, and components under consideration. The scope, depth, and rigor of the quality management system's application of requirements should be determined by the use of a grading process before performing the activity. The purpose of grading is to select the controls and verifications to be applied to various items and activities consistent with their importance to safety, cost, schedule, and success of the program.

The following is taken from U.S. Environmental Protection Agency, Guidance for Quality Assurance Project Plans, EPA QA/G-5.

A QA project plan describes the activities of an environmental data operations project involved with the acquisition of environmental information whether generated from direct measurements activities, collected from other sources, or compiled from computerized databases and information systems. Performance and acceptance criteria are often expressed in terms of data quality indicators. The principal indicators of data quality are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. Measurement quality objectives are the acceptance thresholds or goals for this project's data, usually based on the individual data quality indicators for each matrix and analyte group or analyte.

d. Given a sampling parameter/equipment, describe the standard sampling methods and protocols.

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

16. Environmental restoration personnel shall demonstrate a working-level knowledge of the purpose and uses of environmental sampling and monitoring equipment.

a. Explain the reason for measuring emissions, meteorological factors, and ambient air quality under various operation conditions (e.g., routine and emergency).

The following is taken from U.S. Environmental Protection Agency, Clean Air Markets, Emission Monitoring.

EPA's emissions monitoring requirements ensure that the emissions data collected is of a known, consistent, and high quality, and that the mass emissions data from source to source are collected in an equitable manner. This is essential to support the Clean Air Markets

Division's mission of promoting market-based trading programs as a means for solving air quality problems.

Wind direction, temperature, air pressure, precipitation, and other meteorological conditions affect data collected on ambient air quality and emissions and help to establish pollutant dispersion patterns and determine the relative risk posed to populations in emergency conditions.

b. Describe the purpose and limitations of the following air quality measurement instruments.
- **High volume particulate sampler**
- **Liquid bubbler (e.g., for sulfur dioxide)**
- **Infrared spectrometer**

High Volume Particulate Sampler

The following is taken from American Standard Test Method, ASTM D4096-91(2009), Standard Test Method for Determination of Total Suspended Particulate Matter in the Atmosphere (High-Volume Sampler Method).

The high volume particulate sampler is commonly used for the collection of the airborne particulate component of the atmosphere. Some physical and chemical parameters of the collected particulate matter are dependent upon the physical characteristics of the collection system and the choice of filter media. A variety of options available for the high volume particulate sampler give it broad versatility and allow the user to develop information about the size and quantity of airborne particulate material and, using subsequent chemical analytical techniques, information about the chemical properties of the particulate matter.

This test method measures the atmosphere presented to the sampler with good precision, but the actual dust levels in the atmosphere can vary widely from one location to another. This means that sampler location may be of paramount importance, and may impose far greater variability of results than any lack of precision in the method of measurement. In particular, localized dust sources may exert a major influence over a very limited area immediately adjacent to such sources. Examples include unpaved streets, vehicle traffic on roadways with a surface film of dust, building demolition and construction activity, or nearby industrial plants with dust emissions. In some cases, dust levels measured close to such sources may be several times the community wide levels exclusive of such localized effects

Liquid Bubblers

The following is taken from U.S. Centers for Disease Control, National Institute for Occupational Safety and Health, The Industrial Environment - its Evaluation and Control.

This method involves the passage of a known volume of air through an absorbing medium to remove the desired contaminants from the sampled atmosphere. The contaminant that is removed from the air stream becomes concentrated in the collecting liquid or medium. The collecting liquid or medium is then analyzed to determine the concentration of the contaminant in question. Selected sampling reagents that do not react chemically with contaminants in the air stream can reduce the collection efficiencies of the sampling procedure.

Infrared Spectrometer

The following is taken from U.S. Department of Labor, Occupational Safety and Health Administration, *OSHA Technical Manual*.

Infrared analyzers are useful for measuring a broad range of inorganic and organic chemicals in air. Depending upon the chemical, the sensitivity of infrared analyzers can be sufficient for industrial hygiene purposes. Because most chemicals absorb infrared light, an infrared analyzer may not be selective unless the chemical of interest can be measured at a wavelength that is unique for that chemical in the air sample, or the industrial hygienist is able to determine that other interfering chemicals are not present in the work environment. Some of the routine applications for infrared analyzers include measuring carbon dioxide in indoor air quality assessments; anesthetic gases, including, nitrous oxide, halothane, enflurane, penthrane, and isoflurane; ethylene oxide; and fumigants, including ethylene dibromide, chloropicrin, and methyl bromide.

For measuring the amount of a chemical in air, a wavelength is selected for which the chemical of interest absorbs the light. The amount of light absorbed by the air sample at this wavelength would be proportional to the amount of the chemical in the sample if there is no other chemical present in the air that absorbs at that same wavelength.

c. Describe the purpose and types of material collected by the following sampling media.
- **High efficiency glass fiber filter**
- **Activated charcoal cartridge**
- **Silica gel**

High Efficiency Glass Fiber Filter

The following is taken from Cardinal Health, Glass Fiber Filters.

Glass fiber filters are made of 100 percent borosilicate glass fibers. Glass fiber filters have a clear advantage over other filtration media due to their efficient retention, fast flow rates and high loading capacity. Binder-free glass fiber filter grades are chemically, physically and biologically inert and are ideal for use with biological materials and highly corrosive chemicals**.** These filters can also be easily sterilized and have a longer shelf life than other filtration media.

The following is taken from U.S. Environmental Protection Agency, Indoor Air Quality, Frequent Questions, What is a HEPA filter?

A high-efficiency particulate air (HEPA) filter is a special form of high efficiency glass fiber filter. This type of air filter is designed to remove at least 99.97 percent of dust, pollen, mold, bacteria, and any airborne particles including radioactive particles with a size of 0.3 microns. The diameter specification of 0.3 microns responds to the worst case; the most penetrating particle size. Particles that are larger are trapped with even higher efficiency.

Activated Charcoal Cartridge / Silica Gel

The following is taken from Traveler's Insurance, Travelers Laboratory Services, Air Sampling Field Instructions.

Active sampling consists of the collection of a known volume of air and depositing of the contaminant being investigated upon the appropriate collection medium. Solid sorbent tubes are typically used for collecting either gas or vapor. A variety of different sorbent tubes are available. The media within each tube is specific for a contaminant or class of contaminants. The most common types of tubes used in workplace air sampling contain charcoal or silica gel. Chemical contaminant molecules become trapped within the media and are either adsorbed (in the case of charcoal) or absorbed (in the case of silica gel). The contaminant molecules are then "desorbed" or washed from the media in the laboratory and the amount of contaminant in the sample is measured.

d. Describe the purpose for measuring each of the following parameters during field surveys of water quality.

- **Temperature**
- **Dissolved oxygen**
- **Conductivity**
- **pH**

The following is taken from United Nations Environment Programme, GEMS/Water Programme, Water Quality for Ecosystem and Human Health.

Temperature

Temperature affects the speed of chemical reactions, the rate that algae and aquatic plants photosynthesize, the metabolic rate of other organisms, as well as how pollutants, parasites, and other pathogens interact with aquatic residents. Temperature is important in aquatic systems because it can cause mortality and it can influence the solubility of dissolved oxygen and other materials in the water column

The following is taken from United Nations Educational, Scientific and Cultural Organization, Technical Report No. 9, *Water Quality Assessment in and around Keoladeo National Park, Bharatpur, Rajasthan.*

Several parameters are important for functioning of a healthy aquatic ecosystem. These could be grouped as physical, chemical and biological. Physical parameters analyzed and monitored are pH, electrical conductance, and dissolved oxygen.

Dissolved Oxygen

Like terrestrial animals, fish and other aquatic organisms need oxygen to live. Oxygen can be present in the water, but at too low a concentration to sustain aquatic life. Dissolved oxygen is a critical water quality parameter indicating the health of an aquatic system. Dissolved oxygen is the measurement of oxygen dissolved in water and available for fish and other aquatic life.

Oxygen is produced during photosynthesis of plants and consumed during respiration and decomposition. Because it requires light, photosynthesis occurs only during daylight hours. Respiration and decomposition, on the other hand, occur 24 hours a day. This difference alone can account for large daily variations in dissolved oxygen concentrations. Dissolved oxygen concentrations steadily decline during the night and are the lowest just before dawn, when photosynthesis resumes. Dissolved oxygen should always be measured at the same

time of day. Other sources of oxygen include the air and inflowing water sources. More oxygen dissolves into water when wind stirs the water. Rivers and streams deliver oxygen, especially if they are turbulent. Turbulence mixes water and air (aeration).

Another physical process that affects dissolved oxygen concentrations is the relationship between water temperature and gas saturation. Cold water can hold more gas (dissolved oxygen) than warmer water. Warmer water becomes "saturated" more easily with oxygen. Seasonal changes also affect dissolved oxygen concentrations. Warmer temperatures during summer speed up the rates of photosynthesis and decomposition. When plants die at the end of the growing season their decomposition results in heavy oxygen consumption.

Conductivity

Electrical conductivity is a measure of the capacity of water to conduct an electric current. A higher value of conductivity means that the water is a better electrical conductor. The amount of dissolved salts in water will affect the conductivity of electricity. The more dissolved mineral salts, the higher the conductivity. This is because of the presence of dissolved ions from the mineral salts. Conductivity is also increased by higher temperatures. Although the conductivity of water will not tell us which mineral salts are present, this measure gives us an index of their level. High levels of mineral salts in fresh waters can affect animal and plant survival and reproduction.

Electrical conductivity increases when more of any salt including the most common one, sodium chloride, is dissolved in water. For this reason, conductivity is often used as an indirect measure of the salt concentration in waterbodies. In general, waters with more salts are the more productive ones - except, of course, where there are limiting nutrients or limiting environmental factors involved. Natural factors can also cause higher conductivity values in the open water. For example, drought conditions can increase the salt concentrations in a waterbody in two ways: (1) drought can cause inflowing waters to have higher salt concentrations, and (2) heat and low humidity can increase the rate of evaporation in open water, leaving the waterbody with a higher concentration of salt. Because animal and human wastes contain salts, the measurement of conductivity can be used for the detection of contamination.

pH

The pH test measures the hydrogen ion concentration of water. It provides a gauge of the relative acid/base nature of a water sample. The pH of water determines the solubility and biological availability of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. Metals tend to be more toxic at lower pH, because they are more soluble. pH values between 7.0 and 8.0 are optimal for supporting a diverse aquatic ecosystem. A pH range between 6.5 and 8.5 is generally suitable. When pollution results in higher productivity, for example, from increased temperature or excess nutrients, pH levels increase. Although these small changes in pH are not likely to have a direct impact on aquatic life, they greatly influence the availability and solubility of all chemical forms and may aggravate nutrient problems.

e. Discuss the factors that can affect readings and the preservation methods for the field measurements listed above.

Factors that can affect the readings of field measurements are listed with the content above.

The following is taken from U.S. Geological Survey, *National Field Manual for the Collection of Water Quality Data*, chapter 5, Sample Preservation.

Sample preservation is the measure or measures taken to prevent reduction or loss of target analytes. Analyte loss can occur between sample collection and laboratory analysis because of physical, chemical, and biological processes that result in chemical precipitation, adsorption, oxidation, reduction, ion exchange, degassing, or degradation. Preservation stabilizes analyte concentrations for a limited period of time. Some samples have a very short holding time. Some samples must be preserved by filtration, chilling, chemical treatment or combinations of these methods. The preservation required for a given sample is described by the analyzing laboratory.

Immediately following sample collection and processing, samples that require chilling must be packed in ice or placed in a refrigerator and maintained at 4°C or less, without freezing, until analyzed.

Chemicals used for sample preservation depend on the target analyte. The most frequently used chemical preservatives by the U.S. Geological Survey are provided in individual ampoules and contain one of the following: ultrapure nitric acid, hydrochloric acid, sulfuric acid, sodium hydroxide, or phosphoricacid/copper sulfate. It should be noted that a chemical preservative for one sample may be a source of contamination for another.

f. Describe how trace toxic organics in water are assayed by gas chromatography.

The following is taken from State of California, Office of the Attorney General, Bureau of Forensic Services, An Introduction to Gas Chromatography / Mass Spectrometry.

The Gas Chromatography/Mass Spectrometry instrument represents a device that separates chemical mixtures (the gas chromatography component) and a very sensitive detector (the mass spectrometry component) with a data collector (the computer component).

Once the sample solution is introduced into the gas chromatography inlet it is vaporized immediately because of the high temperature (250ºC) and swept onto the column by the carrier gas (usually helium).

The sample flows through the column experiencing the normal separation processes. As the various sample components emerge from the column opening, they flow into the capillary column interface. This device is the connection between the gas chromatography column and the mass spectrometer. Some interfaces are separators and concentrate the sample via removal of the helium carrier.

The sample then enters the ionization chamber. Two potential methods exist for ion production. The most frequently used method is electron impact. The occasionally used alternative is chemical ionization. For electron impact ionization a collimated beam of

electrons impact the sample molecules causing the loss of an electron from the molecule. A molecule with one electron missing is represented by M+ and is called the molecular ion (or parent ion). When the resulting peak from this ion is seen in a mass spectrum, it gives the molecular weight of the compound. Chemical ionization begins with ionization of methane (or other gas), creating a radical that in turn will impact the sample molecule to produce M.H+ molecular ions. Some of the molecular ions fragment into smaller daughter ions and neutral fragments. Both positive and negative ions are formed, but only positively charged species will be detected.

Less fragmentation occurs with chemical ionization than with electron impact, hence chemical ionization yields less information about the detailed structure of a molecule, but does yield the molecular ion; sometimes the molecular ion can not be detected by the electron impact method, hence the two methods complement one another. Once ionized, a small positive potential is used to repel the positive ions out of the ionization chamber.

The next component is a mass analyzer (filter), which separates the positively charged particles according to their mass. Several types of separating techniques exist; quadrupole filters, ion traps, magnetic deflection, time-of-flight, radio frequency, cyclotron resonance and focusing to name a few. The most common are quadrupoles and ion traps.

After the ions are separated according to their masses, they enter a detector and then on to an amplifier to boost the signal.

The detector sends information to the computer. It records all the data produced, converts the electrical impulses into visual displays and hard copy displays. The computer also drives the mass spectrometer.

Identification of a compound based on its mass spectrum relies on the fact that every compound has a unique fragmentation pattern. A library of known mass spectra which may be several thousand compounds in size is stored on the computer and may be searched using computer algorithms to assist the analyst in identifying the unknown.

g. Describe how heavy metals in water are measured using atomic absorption spectrophotometry.

The following is taken from U.S. Environmental Protection Agency, Air Pollution Control Orientation Course, Principles of Sampling and Analysis – Particulates.

Atomic absorption spectrometry has been the most used method for the determination of single elements in analytical samples. Atomic Absorption Spectrometry is a sensitive means for the quantitative determination of more than 60 metals or metalloid elements. This technique operates by measuring energy changes in the atomic state of the analyte. An analyte is a substance whose chemical composition is to be determined by chemical analysis.

The following is taken from U.S. Environmental Protection Agency, Wastes - Hazardous Wastes –Test Methods, 7000 Series Methods, Method 7000B, Flame Atomic Absorption Spectrophotometry.

In direct-aspiration atomic absorption spectrophotometry, a sample is aspirated and atomized in a flame. A light beam from a hollow cathode lamp or an electrodeless discharge lamp is directed through the flame into a monochromator, and onto a detector that measures the amount of absorbed light. Absorption depends upon the presence of free unexcited ground-state atoms in the flame. Because the wavelength of the light beam is characteristic of only the metal being determined, the light energy absorbed by the flame is a measure of the concentration of that metal in the sample. This principle is the basis of atomic absorption spectrophotometry.

h. Describe how volatile organics are measured.

The following is taken from U.S. Environmental Protection Agency, Air Pollution Control Orientation Course, Principles of Sampling and Analysis – Gaseous Pollutants.

Gaseous pollutant monitoring can be accomplished using various measurement principles, some of which have been covered earlier in this guide. Table 8 summarizes methods for measuring and analyzing air pollutants. The term $PM_{2.5}$ refers to particles less than 2.5 micrometers in diameter, also called "fine" particles. PM_{10} particles, between 2.5 and 10 micrometers in diameter are referred to as "coarse" particles.

Table 8. Methods of measuring and analyzing air pollutants

Method	Variable Measured	Principle
Gravimetric	PM_{10}, $PM_{2.5}$	Particles are trapped or collected on filters, and the filters are weighed to determine the volume of the pollutant.
Atomic absorption spectrometry	more than 60 metals or metalloid elements (e.g. lead, mercury, zinc)	This technique operates by measuring energy changes in the atomic state of the analyte. Emitted radiation is a function of atoms present in the sample.
Spectrophotometry	sulfer diozide, ozone	Measure the amount of light that a sample absorbs. The amount of light absorbed indicates the amount of analyte present in the sample.
Chemiluminescence	nitrogen dioxide, ozone	Based upon the emission spectrum of an excited species that is formed in the course of a chemical reaction.
Gas chromatography - flame ionization detector	VOC	Responds in proportion to number of carbon atoms in gas sample.
Gas chromatography-mass spectrometry	VOC	Mass spectrometers use the difference in mass-to-charge ratio of ionized atoms or molecules to separate them from each other.
Fourier Transform Infrared Spectroscopy	carbon monoxide, VOC, methane	Sample absorbs infrared radiation and difference in absorption is measured.

Source: U.S. Environmental Protection Agency, Air Pollution Control Orientation Course, Principles of Sampling and Analysis – Gaseous Pollutants

17. Demonstrate working-level knowledge of the Occupational Safety and Health Act (OSHA) requirements (and Mine Safety and Health Act (MSHA) requirements where facility applicable) 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**
- **30 CFR 57, Safety and Health Standards — Underground Metal and Nonmetal Mines**
- **30 CFR 58, Health Standards for Metal and Nonmetal Mines**
- **Other applicable portions of MSHA regulations found at 30 CFR Subchapters A-K (Parts 1-199)**

a. Discuss the application and impact of OSHA and/or MSHA on Department projects.

The following is taken from DOE, Office of Health, Safety, and Security, Federal Employee Occupational Safety and Health (FEOSH) Program Overview.

Congress established Public Law 91-596, "The Occupational Safety and Health Act of 1970" (OSH Act) to ensure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources. Section 19 of the OSH Act contains broad responsibilities and requirements for Federal agency safety and health programs to ensure safe and healthful working conditions for Federal employees.

Executive Order 12196, *Occupational Safety and Health Programs for Federal Employees*, contains, among other items, additional responsibilities for the heads of Federal agencies and a requirement for the Secretary of Labor to issue basic program elements for Federal agency safety and health programs in conformance with the OSH Act.

The basic program elements mandated by the President in Executive Order 12196 are issued in the Department of Labor's implementing regulations in 29 CFR 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters." This OSHA standard establishes and communicates the requirements under which agencies, including the DOE, must develop and implement their FEOSH program

DOE O 440.1B, *Worker Protection Program for DOE (including the National Nuclear Security Administration) Federal Employees*, contains the required components to be utilized by DOE Elements in the development, implementation, and management of site-specific DOE Federal employee worker protection programs consistent with the requirements for FEOSH programs in 29 CFR 1960.

All FEOSH program management components (i.e., organization, training, inspections, self-assessments, hazard abatement, accident investigations, etc.) should be built around the DOE ISMS.

b. Identify the requirements in the OSHA and/or MSHA that form the basis of authority for project management personnel in the oversight and management of a project.

See item a of competency 17.

c. Discuss the project manager responsibilities set forth in DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees.

[Note: DOE O 440.1A was superseded by DOE O 440.1B. The following information is from the most current version.]

The construction project manager responsibilities are to:

- determine the necessity for requiring dedicated construction contractor safety and health personnel at project workplaces;
- ensure that construction project acquisition documents provide information or references to existing documentation that describes known hazards to which project workers may be exposed;
- ensure that a prework safety meeting is conducted with the construction contractor to review project safety and health requirements;
- ensure that the project safety and health plan is approved prior to any onsite project work, and that required hazard analyses are completed and approved prior to start of work on affected construction operations;
- ensure that project safety and health plans and hazard analyses are revised, as necessary, to address identified deficiencies in project safety and health performance or changes in project operations, contractors, or personnel;
- through personal on-site involvement and/or formal delegation to support staff and/or the construction manager, perform frequent and regular documented on-site reviews of construction contractor safety and health program effectiveness; and
- ensure documentation of all formal contract actions taken to enforce construction contractor compliance with project safety and health requirements.

d. Discuss the construction contractor's responsibilities under DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees:

- **Establishing a safety program**
- **Worksite presence during work activities**
- **Compliance by subcontractors**

[Note: DOE O 440.1A was superseded by DOE O 440.1B. The following information is from the most current version.]

The bulleted items in this KSA are discussed in item c of this competency. In addition to the information listed in item c of competency 14, DOE is required to establish the following safety programs:

Fire Protection

Establish and implement a comprehensive fire protection program with the objective of providing an acceptable level of safety from fire and related hazards for DOE and NNSA personnel and for the public. This includes appropriate facility and site-wide protection, fire

alarm notification and egress features, and access to a fully staffed, trained, and equipped fire department that is capable of responding in a timely and effective manner to site occurrences.

Firearms Safety

Establish firearms safety policies and procedures for security operations and training to ensure proper accident prevention controls are in place. Written procedures must address firearms safety, engineering and administrative controls, as well as personal protective equipment (PPE) requirements.

Explosives Safety

Ensure that applicable explosives operations comply with DOE M 440.1-1A, *DOE Explosives Safety Manual*. Facility management must determine the applicability of the requirements to research and development laboratory type operations consistent with the DOE level of protection criteria in the manual.

Industrial Hygiene

Implement a comprehensive and effective industrial hygiene program to reduce the risk of work-related disease or illness.

Biological Safety

Implement and manage a program that confirms handling, transfer, use, and receipt of etiologic agents are conducted by professionally and technically qualified individuals in a manner consistent with the potential hazard.

Confirm that each DOE contractor performing work with etiologic agents establishes an Institutional Biosafety Committee or equivalent, which will be responsible for recommending approval and reviewing proposals and programs for compliance with the Centers for Disease Control, Department of Agriculture, National Institutes of Health, World Health Organization, and other international, Federal, state, and local regulations or guidelines for work with etiologic agents.

Pressure Safety

DOE Elements must implement a comprehensive pressure vessel and pressure system safety program.

Motor Vehicle Safety

Implement a Motor Vehicle Safety Program to protect the safety and health of all drivers and passengers in Government-owned or -leased motor vehicles and powered industrial equipment (i.e., fork, trucks, tractors, platform lift trucks, and other similar specialized equipment powered by an electric motor or an internal combustion engine).

Electrical Safety

DOE Elements must implement a comprehensive electrical safety program appropriate for the activities at the facility. The program must meet all applicable electrical safety codes and standards.

Construction project managers, through personal on-site involvement and/or formal delegation to support staff and/or the construction manager, are required to perform frequent and regular documented on-site reviews of construction contractor safety and health program effectiveness. Additionally, project managers are to ensure documentation exists for all formal contract actions taken to enforce construction contractor compliance with project safety and health requirements.

e. Discuss the requirements for the performance of a hazard analysis and a hazard abatement/prevention program. Include in the discussion each of the following elements:
- **Responsibility for implementation**
- **Purpose and content of the hazard analysis**
- **Worker awareness of the hazards and hazard abatement/prevention program**

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

Responsibility for Implementation

DOE elements are required to identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness. There are several components of this requirement.

Purpose and Content of the Hazard Analysis - Analysis and Review

DOE O 440.1B requires the analysis or review of:
- designs for new facilities, and for modifications to existing facilities and equipment;
- operations and procedures; and
- equipment, product, and service needs.

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; and
- safety review.

Exposure Assessment

DOE O 440.1B 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; and
- 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 PPE); and
- 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*.

Worker Awareness of the Hazards and Hazard Abatement/Prevention Program - Workplaces and Activities

DOE O 440.1B 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 PPE prior to and during use. Additionally, workplace conditions, housekeeping, utilization of assigned PPE, 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 440.1B 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 Occupational Safety and Health Administration (OSHA) Form 300, *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; and
- a formalized approach to analyze identified trends, to determine root causes, and to develop appropriate control measures.

Hazard Prevention/Abatement and Control

DOE O 440.1B requires DOE elements to implement a hazard prevention/abatement process to ensure that all identified hazards are managed through final abatement or control.

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.

Hazards that are identified in the design phase of new facilities and facility modifications or during the development or modification of procedures should be eliminated or controlled through design or procedure changes.

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.

In the event an imminent danger situation is discovered, immediate action must be taken either to correct the imminent danger condition or practice or to remove all employees from exposure to the imminent danger until the condition or practice has been abated. An effective hazard abatement program is essential to ensure that workers are protected from exposure to current and future workplace hazards.

The relative level of risk should be assessed for each identified hazard to ensure that hazard abatement efforts and resources are focused first on addressing the most serious workplace hazards. Hazard abatement management requires a mechanism to track all planned abatement activities through to completion. Therefore, all hazards identified during worker protection evaluations should be recorded regardless of whether the evaluation was conducted by DOE, contractors, or external agencies such as OSHA. To ensure that the responsible Operations Office is kept informed of the status of abatement activities, any DOE office under the purview of an Operations Office should advise that Operations Office quarterly on the status of hazard abatement activities requiring 30 or more days to complete.

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

The following is taken from DOE O 440.1B.

All DOE elements and contractors are required to develop and implement a worker safety and health training and information program to ensure that all federal workers exposed or potentially exposed to hazards are provided with the training and information on that hazard in order to perform their duties in a safe and healthful manner.

All DOE elements and contractors are to provide the following:

- training and information for new federal workers, before or at the time of initial assignment to a job involving exposure to a hazard;
- periodic training as often as necessary to ensure that workers are adequately trained and informed; and
- additional training when safety and health information or a change in workplace conditions indicates that a new or increased hazard exists.

DOE must provide training and information to federal workers who have worker safety and health program responsibilities that is necessary for them to carry out those responsibilities.

g. Discuss the project manager's responsibility for on-site safety and health inspections.

See item c of competency 17.

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

See item e of competency 17.

18. Environmental restoration personnel shall demonstrate a working-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**
- **MSHA approved self-rescue devices (at applicable sites)**

Respirators

The following is taken from U.S. Department of Transportation, Federal Highway Administration, Bridge Lead Removal and General Site Safety, FHWA-RD-98-179, *Personal Protective Equipment.*

The type of respirator worn by workers depends on the level of exposure. A medical evaluation will be necessary to determine if an individual can wear a particular respirator. Medical conditions, such as heart disease, emphysema, asthma, or other lung disorders, may make it difficult for an individual to wear a particular type of respirator. There are two major categories of respirators: air purifying respirators and supplied air respirators.

Air purifying respirators purify the air a worker breathes by removing or filtering the contaminant from the air before it enters the wearer's lungs. The filter removes the contaminant from the air before the air enters the inside of the respirator through the inhalation valve and supplies clean or purified air to the wearer. When the wearer exhales, air from the lungs is released through a separate valve called the exhalation valve.

Air purifying respirators are commonly called negative pressure respirators. These masks depend on the wearer's lungs to pull air through the filter or cartridge. When a worker inhales, suction is created that draws air outside the respirator into the mask. This suction is referred to as a negative pressure and means that the air pressure inside the mask becomes negative (lower) compared with the air pressure outside the mask when the wearer inhales. In contrast, when a worker exhales or blows out air, a positive (greater) pressure is created inside the mask compared with the outside air pressure.

Facial features can prevent a good respirator seal from occurring with the wearer's face. Facial hair, such as beards, stubble, and sideburns that lie between the sealing surface of the respirator and the face will result in leaks of contaminated air into the mask. Likewise, deformities on the face, such as scars, acne, and lack of teeth, can cause leaks. Because of the potential for leaks through an improper seal, beards and other facial hair that lies along the sealing surface are not permitted for workers who wear respirators, and special care must be given to proper fitting of respirators for workers with facial deformities. Air purifying respirators can only be used in atmospheres with sufficient oxygen and where air contaminants do not exceed the concentration range specified for the respirator.

All air purifying respirators, whether half-face, full-face, or powered have the following limitations:

- Cartridge life problem. The cartridge has only so much capacity, and when that capacity is reached, the cartridge is no longer any good. If the cartridge is used for organic vapors or gases and the capacity is reached, the contaminants will pass through the filtering material directly into the worker's lung. This is called "breakthrough." Some chemicals have poor warning properties so the worker will not smell the chemical when breakthrough occurs. This will cause serious problems. As a result, this type of respirator cannot be used with substances that have poor warning properties. If the contaminant is a solid, and a HEPA or other particulate filter is used, at some point the worker will have a hard time breathing through the filter as it becomes clogged. It will need to be changed at that point.
- Oxygen limitations. Air purifying respirators can only be used when there is sufficient oxygen in the air. The minimum concentration must be no less than 19.5 percent.
- Toxic concentrations (immediately dangerous to life or health). Under these concentrations it is much too dangerous to trust this type of respirator. It doesn't provide enough margin of safety.

Supplied air respirators do not depend on filters. Instead, they provide an independent supply of uncontaminated air. This type supplies air to the face-piece through a length of hose called an air line. The air line is connected to either a compressed-air cylinder or else to a compressor that is equipped with equipment to purify the air. The air supply can be used to pressurize the mask to achieve a high protection factor.

Limitations of supplied air respirators:

- The air line impairs worker movement. The air line cannot exceed 300 feet (91.4M) in length according to regulations. Workers also must retrace their steps coming off of the job.

- The air line is vulnerable to damage. Rough or sharp surfaces can puncture the line. The rubber hose may deteriorate from exposure to chemicals or to sunlight. Falling objects, vehicles, and heavy equipment also can damage the air line.
- The system air compressor must be located away from potential chemical or contamination hazards.
- All filters and alarms must be working properly and the system must be maintained according to the manufacturers' recommendations.
- The maximum inlet pressure cannot exceed 125 psi (862kPa) or fall below 80 psi (522kPa).

Protective Clothing

The following is taken from U.S. Centers for Disease Control, *Managing Hazardous Materials Incidents Volume II, Hospital Emergency Departments*.

Protective clothing is designed to prevent direct contact of a chemical contaminant with the skin or body of the user. However, there is not one single material that will afford protection against all substances. Thus, multilayered garments are often employed, which may reduce dexterity and agility. Protective clothing is designed to afford the wearer a known degree of protection from a known type, a known concentration, and a known length of exposure to a hazardous material, but only if it is properly fitted and worn correctly. Improperly worn equipment can expose and endanger the wearer. One factor to keep in mind during the selection process is that most protective clothing is designed to be impermeable to moisture, thus limiting the transfer of heat from the body through natural evaporation. This is a particularly important factor in hot environments or for strenuous tasks since such garments can increase the likelihood of heat injury.

The effectiveness of protective clothing can be reduced by three actions: degradation, permeation, and penetration. Chemical degradation occurs when the characteristics of the material in use are altered through contact with chemical substances. Examples of degradation include cracking and brittleness, and other changes in the structural characteristics of the garment. Degradation can also result in an increased permeation rate through the garment, that is, the molecular absorption by or passage through the protective material of a chemical substance.

Permeation is the process in which chemical compounds cross the protective barrier of protective clothing because of passive diffusion. The rate at which a compound permeates protective clothing is dependent on factors such as the chemical properties of the compound, the nature of the protective barrier in the protective clothing, and the concentration of the chemical on the surface of the protective clothing. Most manufacturers of protective clothing provide charts on the breakthrough time, or the time it takes for the chemical to permeate the material of a protective suit, for a wide range of chemical compounds.

Penetration occurs when there is an opening or a puncture in the protective material. These openings can include unsealed seams, button holes, and zippers. Often such openings are the result of faulty manufacture or problems with the inherent design of the suit. Protective clothing is available in a wide assortment of forms, ranging from fully-encapsulating body suits to gloves, hard hats, earplugs, and boot covers. Protective clothing comes in a variety of materials, offering a range of protection against a number of chemicals.

MSHA Approved Self-Rescue Devices

The following is taken from U.S. Department of Labor, MSHA's Occupational Illness and Injury Prevention Program Health Topic, Filter Self-Rescue Devices.

The filter self-rescue device is a small filter-type respirator designed to provide respiratory protection only against carbon monoxide gas for a limited period of time. The device is approved for protection against carbon monoxide, such as may result from underground fires, in concentrations up to 1 percent by volume (10,000 ppm) for a period of up to one hour. As such, the device is to be used for escape only. It is required that a self-rescue device be provided and available for each worker underground. The filter self-rescue device is not a self-contained nor oxygen-supplying respirator, and must be used only in oxygen-containing atmospheres. Neither does the device provide protection against toxic gases other than carbon monoxide. Thus it must be emphasized that, in an underground mining emergency, the self-rescue device must be used for escape only.

The filter self-rescue device must be carried on the worker, attached to the mobile equipment the worker is operating, or located within 25 feet of the worker, so that it will be readily available in case of an emergency. When the device is worn in the presence of carbon monoxide, heat is generated within the device, which may become uncomfortable or even painful to the wearer. In such a case, the device must still be kept in place; otherwise, the worker would subject himself/herself to high risk of carbon monoxide poisoning and possibly collapse and death. As indicated above, the self-rescue device is meant for escape only, and is a single-use unit to be discarded after use or after the seal is broken.

There are two filter self-rescue devices approved for use in metal/nonmetal mines. The MSA W65 manufactured by Mine Safety Appliances Company, and the Drager 810 and 910 manufactured by Dragerwerk.

The operator has the responsibility of training workers in the use of filter self-rescue devices, and also of setting up and carrying out a maintenance program for the devices. The maintenance program should include both visual inspection and weighing. Weight gain indicates leakage and absorption of moisture. Each device should be weighed upon receipt from the vendor and at regular intervals thereafter. The device is weighed by first cleaning it (scraping off debris and wiping with a damp cloth) and then placing it on the balance. The current weight is compared with the manufacture's weight stamped on the case. A weight record should be kept for each device. In addition to regular weighing, the miner should know how to inspect the device and report defects such as a damaged case, a broken seal, or any sign that leakage has occurred. Defective devices should be removed from service immediately.

Workers must be conscious of the filter self-rescue device available for use, and that it is provided for escape only. Proper use, care, and maintenance are necessary for the device to be reliable.

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

See item a of competency 18.

c. Given a work procedure and atmospheric conditions, identify the appropriate type of respiratory protection for the activity.

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

d. Describe the four levels of protection for workers at hazardous waste sites or for those workers conducting emergency response activities as defined by the EPA.

The following is taken from U.S. Centers for Disease Control, *Managing Hazardous Materials Incidents Volume II, Hospital Emergency Departments*.

The EPA has assigned four levels of protection to assist in determining which combinations of respiratory protection and protective clothing should be employed:

- Level A protection should be worn when the highest level of respiratory, skin, eye, and mucous membrane protection is needed. It consists of a fully-encapsulating chemical-resistant suit and self-contained breathing apparatus.
- Level B protection should be selected when the highest level of respiratory protection is needed but a lesser level of skin and eye protection is sufficient. It differs from Level A only in that it provides splash protection by use of chemical-resistant clothing (overalls, long sleeves, jacket, and self-contained breathing apparatus).
- Level C protection should be selected when the type of airborne substances is known, concentration is measured, criteria for using air-purifying respirators are met, and skin and eye exposures are unlikely. This involves a full-facepiece, air-purifying, canister-equipped respirator and chemical-resistant clothing. It provides the same level of skin protection as Level B, but a lower level of respiratory protection.
- Level D is primarily a work uniform. It should not be worn on any site where respiratory or skin hazards exist. It provides no respiratory protection and minimal skin protection.

19. Environmental restoration personnel shall demonstrate a familiarity-level knowledge of the safety-related requirements for hazardous substances.

The information for the KSAs in this competency is taken from DOE-HDBK-1015/2-93.

a. Discuss the hazards associated with the use of corrosives (acids and alkalies).

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

The alkalies (bases), whether in solid form or concentrated liquid solution, are more destructive to tissue than most acids. Alkali dusts, mists, and sprays may cause irritation of the eyes and respiratory tract and lesions of the nasal septum. Strong alkalies combine with

tissue, causing severe burns, frequently deep ulceration, and ultimate scarring. Severe burns result not only from contact with solid alkalies, but also from solutions of these compounds. Potassium and sodium hydroxide are the most active materials in this group. Even dilute solutions of the stronger alkalies tend to soften the epidermis (skin) and emulsify or dissolve the skin fats. Exposure to atmospheres contaminated with alkalies may result in damage to the upper respiratory tract and to lung tissue, depending upon the severity of the exposure. The effects of inhalation may vary from mild irritation of the nasal mucous membranes to severe inflammation of the lungs. Ingestion causes severe damage to mucous membranes or deeper tissues with which contact is made. Perforation of these tissues may follow, or there may be severe and extensive scar formation. Death may result if penetration into vital areas occurs.

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

Precautions when using corrosives:

- An adequate supply of washdown water must be available.
- Proper ventilation in corrosive work area must be provided.
- Proper drainage must be provided such that exposure is limited.
- Face shields and safety glasses that protect the eyes from splashes and extensive vapor should be worn.
- Proper personnel safety equipment should be worn when appropriate (chemical gloves, respirators, coveralls, etc.)

Precautions when storing corrosives:

- The building, or area within the building selected, should be of fire resistant construction.
- The floors should be composed of chemical-resistant brick or treated concrete, be washable, and be provided with adequate drainage.
- A well-lit and ventilated area in which there are adequate outlets for water should be provided.
- A relatively cool and dry environment should be maintained, preventing extremes of temperature and humidity.
- Electrical fixtures should be protected against corrosive mists, and wiring should be enclosed and covered with corrosive-resistant material.

c. Discuss the general safety precautions regarding toxic compounds.

The general safety precautions regarding toxic compounds:

- proper ventilation
- appropriate hygienic practices
- housekeeping
- protective clothing
- training

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; and
- control measures used.

Toxic compounds may enter the body through the following processes:

- inhalation;
- ingestion; and
- absorption.

e. Discuss the general safety precautions regarding the use, handling, and storage of compressed gases, including hydrogen, oxygen, and nitrogen.

Compressed and liquified 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 asphyxiants 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 liquified 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 liquified 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 liquified 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 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 125 ºF, and they should never be heated with a torch or other open flame. Initial protection against the possibility of vessel rupture is provided by the demanding requirements and recommendations that compressed gas containers fulfill in their construction, testing, and retesting.

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

Most cryogenic liquids are colorless, odorless, and tasteless when vaporized to a gas. As liquids, most have no color (except liquid oxygen which is light blue). However, whenever the cold liquid and vapor are exposed to the atmosphere a warning appears. As the boil-off gases condense moisture in the air, a fog forms that extends over an area larger than the vaporizing gas. Many cryogenic liquids are inert gases, and may inert an enclosed space. Inert gases will not support life.

Both the liquid and its boil-off vapor can rapidly freeze human tissue and can cause many common materials such as carbon steel, plastic, and rubber to become brittle or fracture under stress. Liquids in containers and piping at temperatures at or below the boiling point of liquefied air (-318°F) can cause the surrounding air to condense to a liquid.

Extremely cold liquified gases (helium, hydrogen, and neon) can even solidify air or other gases to which they are directly exposed. In some cases, plugs of ice or foreign material will develop in cryogenic container vents and openings and cause the vessel to rupture. If a plug forms, contact the supplier immediately. Do not attempt to remove the plug; move the vessel to a remote location.

All cryogenic liquids produce large volumes of gas when they vaporize. For example, 1 volume of saturated liquid nitrogen at 1 atmosphere vaporizes to 696.5 volumes of nitrogen gas at room temperature at 1 atmosphere. When vaporized in a sealed container, cryogenic liquids produce enormous pressures. If 1 volume of liquid helium at 1 atmosphere is warmed to room temperature and vaporized in a totally enclosed container, it has the potential to generate a pressure of more than 14,500 psig. Because of this high pressure, cryogenic

containers are usually protected with two pressure-relief devices, a pressure-relief valve and a frangible (easily broken) disk.

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:

- 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 un-insulated pipes or vessels that contain cryogenic fluids. The extremely cold metal will cause the flesh to stick fast to the surface and tear when withdrawn. Touching even nonmetallic materials at low temperatures is dangerous.

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

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

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

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

h. Describe the general safety precautions regarding the use, 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 five 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.

20. Environmental restoration personnel shall demonstrate a working level-knowledge of hazardous waste operations and their impact on worker safety and health.

a. Describe the industrial process associated with hazardous waste operations as they pertain to environmental restoration.

The following is taken from DOE-HDBK-1139/1-2006.

For hazardous waste sites, the mechanism for identifying work site chemical hazards and controls may be found in the site-specific Health and Safety Plan. Pollution prevention and waste minimization should be considered during planning, acquisition, use, consumption, excessing, recycling, and waste disposal. Pollution prevention is the most responsible and preferred approach to minimizing DOE's impact on the environment and minimizing potential health effects on workers using toxic or hazardous substances or handling wastes, reducing compliance vulnerabilities, and saving money otherwise spent on waste management.

The following is taken from DOE, Office of Environmental Management – Grand Junction, Moab Project Health and Safety Plan.

The plan defines safety and health policies and procedures for performing on-site work at the former Atlas Moab Uranium Mill site, Moab, Utah (Moab site), the Crescent Junction Disposal site, Crescent Junction, Utah, and vicinity properties and applies to all personnel, including subcontractors. It identifies the responsible personnel and their functions in the implementation of the Health and Safety Plan. The Health and Safety Plan also addresses the hazards associated with and the site-specific employee protection requirements for these activities at the Moab project.

The Moab Health and Safety Plan delineates topics such as training requirements, hazard identification, specific methods of hazard control, personnel and environmental monitoring, and emergency response.

b. Explain the personnel hazards associated with the following:
- **Polychlorinated biphenyls (PCB) removal**
- **Asbestos disposal**
- **Biological hazards**
- **Solvents**

- **Paint removal**
- **Waste oil**

PCB Removal

The following is taken from U.S. Environmental Protection Agency, Polychlorinated biphenyls (PCBs), Health Effects of PCBs.

PCBs have been demonstrated to cause a variety of adverse health effects. PCBs have been shown to cause cancer in animals. PCBs have also been shown to cause a number of serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, endocrine system and other health effects. Studies in humans provide supportive evidence for potential carcinogenic and non-carcinogenic effects of PCBs. The different health effects of PCBs may be interrelated, as alterations in one system may have significant implications for the other systems of the body.

Asbestos Disposal

The following is taken from State of Washington, Department of Ecology, Asbestos in Demolition Debris Summary.

Asbestos waste or debris must be promptly disposed of at an approved disposal site. Disposal of asbestos must follow EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP), 40 CFR 61, subpart M, "National Emissions Standard for Asbestos." See EPA's asbestos waste management guidance for general information about disposal. The rule requires:

- methods to contain asbestos waste (wet, double-bagged).
- procedures for hauling waste. Asbestos must not leak from the containers used to haul it.
- disposal of asbestos containing material in an authorized landfill. Landfilling is the environmentally preferred method of asbestos disposal because asbestos fibers are immobilized by soil. Asbestos cannot be safely incinerated or chemically treated for disposal.
- formal record keeping of asbestos waste disposal.

Biological Hazards

The following is taken from Canadian Centre for Occupational Health and Safety, Biological Hazards.

Sources of biological hazards include bacteria, viruses, insects, plants, birds, animals, and humans. These sources can cause a variety of health effects ranging from skin irritation and allergies to infections (e.g., tuberculosis, AIDS), cancer and so on.

Solvents and Paint Removal

The following is taken from University of Illinois at Chicago, Online Health and Safety in the Arts Library, Paint Removers.

Liquid paint and varnish removers are among the most toxic products used in homes and workshops. The active ingredients in most common paint removers are organic solvents that may damage the skin, eyes, respiratory tract, nervous system, and internal organs. Special

precautions must be taken in their use, especially if there are children present who might come in contact with either the material or its vapors. Paint stripper formulations in paste form are less hazardous than the liquid forms because they only contain around 50 percent solvents rather than the 100 percent found in the liquid forms.

All solvents can irritate the sensitive membranes of the nose and throat to varying degrees. Solvent concentrations that can irritate nose and throat membranes also may be capable of damaging sensitive lung tissue. These inhaled substances commonly enter the blood stream where they can attack other internal organs and the nervous system.

All solvents can cause skin disease (dermatitis) by dissolving the skin's natural protective barrier of oils. If the skin experiences enough direct contact with a solvent, it can turn dry and white and become cracked and fissured. In case of skin or eye contact, wash immediately to avoid burns and other serious damage.

Dermal contact with paint remover solvents, besides causing deterioration of the skin, can result in absorption through the skin. Damage to the skin may lead to greater penetration of the solvents, resulting in internal organ injury. Chronic exposure may damage the liver and kidneys, which are responsible for detoxification and elimination of toxic chemicals from the body. Certain solvents can cause heart damage. Benzene, which was an ingredient in paint removers up until 1978, can damage bone marrow, causing aplastic anemia and leukemia.

The most commonly experienced symptom of acute solvent exposure is narcosis or intoxication resulting from the solvent causing depression of the central nervous system. Drinking or inhaling grain or ethyl alcohol produces similar results. Central nervous system depression can produce varied symptoms including irritability, fatigue, headaches, dizziness, sleepiness, loss of coordination and reflexes, nausea, and a staggering gait. Although these acute effects are reversible if exposure to the solvent is discontinued, narcosis symptoms are an indication of overexposure to a solvent. Chronic exposure may cause permanent brain damage, including behavioral changes, loss of memory, decreased intellectual abilities, confusion, seizures, etc.

The fire-causing potential of solvents can be classified as extremely flammable, flammable, combustible, or non-flammable. Extremely flammable means that even in cold weather (below 20ºF) the presence of a flame, spark, or even static electricity can cause the solvent vapors to ignite. Flammable solvents can cause a flash fire in the range of room temperature (below 100ºF), while combustible solvents must be heated above room temperature to ignite into flame. Paint removers are a mixture of different solvents whose combined fire-causing potential is usually stated on product labels.

Waste Oil

The following is taken from Indiana Department of Environmental Management, *Indiana's Collision Repair and Automotive Refinishing Shops Compliance Manual, Section 4.27.*

One gallon of oil can contaminate up to one million gallons of water. The effect of oil on organisms can include genetic damage, structural deformities, reduced egg volume, and reproductive failure.

Oil contains low levels of carcinogenic compounds, such as benzene and toluene. In addition to these compounds, oil also contains relatively high levels of polycyclic aromatic hydrocarbons, which may be absorbed through the skin of employees who are exposed to oil. Polycyclic aromatic hydrocarbons are directly linked to a number of types of cancer, including skin tumors. Shop personnel should avoid prolonged or frequently repeated skin contact with oil by wearing impervious protective gloves and by washing hands and other exposed areas thoroughly after contact. Because oil is a combustible liquid, it must be properly handled, and oil soaked clothing must be changed to avoid a fire safety hazard.

21. Environmental restoration personnel shall demonstrate a working-level knowledge of the principles, concepts, and requirements of environmental risk assessment.

a. Define risk assessment, risk management, and risk communication.

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Basic Information.

Risk Assessment

EPA uses risk assessment to characterize the nature and magnitude of health risks to humans (e.g., residents, workers, recreational visitors) and ecological receptors (e.g., birds, fish, wildlife) from chemical contaminants and other stressors that may be present in the environment. Risk managers use this information to help them decide how to protect humans and the environment from stressors or contaminants. At EPA, environmental risk assessments typically fall into one of two areas: human health or ecological.

Risk assessment is, to the highest extent possible, a scientific process. In general terms, risk depends on the following factors:

- How much of a chemical is present in an environmental medium (e.g., soil, water, air),
- How much contact (exposure) a person or ecological receptor has with the contaminated environmental medium, and
- The the inherent toxicity of the chemical.

Risk Management

Risk Management is the process which evaluates how to protect public health. Examples of risk management actions include deciding how much of a substance a company may discharge into a river; deciding which substances may be stored at a hazardous waste disposal facility; deciding to what extent a hazardous waste site must be cleaned up; setting permit levels for discharge, storage, or transport; establishing NAAQS; and determining allowable levels of contamination in drinking water. Risk assessment provides information on potential health or ecological risks, and risk management is the action taken based on consideration of that and other information.

Risk Communication

The following is taken from U.S. Environmental Protection Agency, Science Policy Council Handbook, *Risk Characterization*.

Risk communication emphasizes the process of exchanging information and opinion with the public, including individuals, groups, and other institutions, about levels of health or environmental risks. Risk communication is used for such things as information and education, behavior change and protective action, disaster warnings and emergency information, joint problem solving and conflict resolution. While the final risk assessment documentation can be used to communicate with the public, the risk communication process is probably better served by separate documentation designed for particular audiences.

b. Describe the four steps of a risk assessment.

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Human Health Risk Assessment.

Ecological risk assessments are very similar but are broader in scope than human health risk assessments. An ecological risk assessment is the process for evaluating how likely it is that the environment may be impacted as a result of exposure to one or more environmental stressors such as chemicals, land change, disease, invasive species and climate change. Ecological risk assessment includes three phases: problem formulation, analysis, and risk characterization.

A human health risk assessment is the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future. Human health risk assessment includes four basic steps: hazard identification, dose-response assessment, exposure assessment, and risk characterization.

EPA begins the process of a human health risk assessment with planning and research. During this preliminary phase, the following questions are asked:

- Who/What/Where is at risk?
- What is the environmental hazard of concern?
- Where do these environmental hazards come from?
- How does exposure occur?
- What does the body do with the environmental hazard and how is this impacted by factors such as age, race, sex, genetics, etc.?
- What are the health effects?
- How long does it take for an environmental hazard to cause a toxic effect? Does it matter when in a lifetime exposure occurs?

Hazard Identification

Hazard identification is the process of determining whether exposure to a stressor can cause an increase in the incidence of specific adverse health effects (e.g., cancer, birth defects) and whether the adverse health effect is likely to occur in humans. In the case of chemical stressors, the process examines the available scientific data for a given chemical (or group of chemicals) and develops a weight of evidence to characterize the link between the negative effects and the chemical agent.

Exposure to a stressor may generate many different adverse effects in a human: diseases, formation of tumors, reproductive defects, death, or other effects.

Dose-Response Assessment

A dose-response relationship describes how the likelihood and severity of adverse health effects (the responses) are related to the amount and condition of exposure to an agent (the dose provided). Typically, as the dose increases, the measured response also increases. At low doses there may be no response. At some level of dose the responses begin to occur in a small fraction of the study population or at a low probability rate. Both the dose at which response begin to appear and the rate at which it increases given increasing dose can be variable between different pollutants, individuals, exposure routes, etc.

Dose-response assessment is a two-step process. The first step is an assessment of all data that are available or can be gathered through experiments, in order to document the dose-response relationship(s) over the range of observed doses. The second step consists of extrapolation to estimate the risk (probably of adverse effect) beyond the lower range of available observed data in order to make inferences about the critical region where the dose level begins to cause the adverse effect in the human population.

Exposure Assessment

Exposure assessment is the process of measuring or estimating the magnitude, frequency, and duration of human exposure to an agent in the environment, or estimating future exposures for an agent that has not yet been released. Exposure assessment considers both the exposure pathway (the course an agent takes from its source to the person(s) being contacted) as well as the exposure route (means of entry of the agent into the body).

The applied dose is the amount of agent at the absorption barrier that is available for absorption. The potential dose is the amount of agent that is ingested, inhaled, or applied to the skin. The applied dose may be less than the potential dose if the agent is only partly bioavailable. The internal dose or absorbed dose is the amount of an agent that has been absorbed and is available for interaction with biologically significant receptors within the human body. Finally, the delivered dose is the amount of agent available for interaction with any specific organ or cell.

Risk Characterization

A risk characterization conveys the risk assessor's judgment as to the nature and presence or absence of risks, along with information about how the risk was assessed, where assumptions and uncertainties still exist, and where policy choices will need to be made. In practice, each component of the risk assessment (e.g. hazard assessment, dose-response assessment, exposure assessment) has an individual risk characterization written to carry forward the key findings, assumptions, limitations, and uncertainties. The set of these individual risk characterizations provide the information basis to write an integrative risk characterization analysis. The overall risk characterization informs the risk manager and others about the rationale behind EPA's approach to conducting the risk assessment - why EPA did what it did to assess the risk.

c. Describe how risk assessment helps in site decision-making.

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Ecological Risk Assessment.

Ecological and human health risk assessments are used to support many types of actions, including the regulation of hazardous waste sites, industrial chemicals, and pesticides; or the management of watersheds or other ecosystems affected by multiple chemical, physical, or biological stressors.

Ecological risk assessments can be used to predict the likelihood of future effects or evaluate the likelihood that effects are caused by past exposure to stressors. Information from ecological risk assessments are then used by risk managers for follow-up such as communicating to interested parties and the general public, limiting activities related to the ecological stressor, limiting use of a given chemical, or developing a monitoring plan to determine if risks have been reduced or whether an ecosystem is recovering.

d. Define the term "baseline risk assessment."

The following is taken from DOE, CERCLA Information Brief, Use of Institutional Controls in a CERCLA Baseline Risk Assessment.

The CERCLA, as amended, requires that the DOE conduct an RI and FS for facilities listed on the NPL, and that DOE's CERCLA response must be consistent with the guidelines established by the EPA. EPA promulgated guidelines for hazardous substance response in the National Oil and Hazardous Substances Pollution Contingency Plan, and specified that lead agencies must assess the "baseline risk" posed by the contaminants under investigation in the RI/FS.

During the Site Characterization phase of an RI/FS, a baseline risk assessment is used to evaluate the potential threat to human health and the environment in the absence of any RA. That is, the baseline risk assessment describes the risk conditions under the "no action alternative." The baseline risk assessment is extremely important because it provides the basis for determining whether RA is necessary. It also determines the extent of cleanup needed to reduce potential risk levels to within EPA's acceptable range.

e. Describe the process for performing a toxicity assessment.

The following is taken from U.S. Environmental Protection Agency, Region 8 - Mountains and Plains, Toxicity Assessment.

The basic objective of a toxicity assessment is to identify what adverse health effects a chemical causes and how the appearance of these adverse effects depends on exposure level (dose). The toxic effects of a chemical frequently depend on the route of exposure (oral, inhalation, dermal) and the duration of exposure (subchronic, chronic, or lifetime). Thus, a full description of the toxic effects of a chemical includes a listing of what adverse health effects the chemical may cause and how the occurrence of these effects depends upon dose, route, and duration of exposure.

The toxicity assessment process is usually divided into two parts: the first characterizes and quantifies the non-cancer effects of the chemical, while the second addresses the cancer effects of the chemical. This two-part approach is employed because there are typically major differences in the time-course of action and the shape of the dose-response curve for cancer and non-cancer effects.

Non-Cancer Effects

Essentially all chemicals can cause non-cancer adverse health effects if given at a high enough dose. However, when the dose is sufficiently low, typically no adverse effect is observed. Thus, in characterizing the non-cancer effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be safe, while doses above the threshold are likely to cause an effect.

The threshold dose is typically estimated from toxicological data (derived from studies of humans and/or animals) by determining the highest dose that does not produce an observable adverse effect and the lowest dose which does produce an effect. These are referred to as the "no observed adverse-effect level" (NOAEL) and the "lowest observed adverse effect level" (LOAEL), respectively. The threshold is presumed to lie in the interval between the NOAEL and the LOAEL.

However, in order to be conservative (protective), non-cancer risk evaluations are not based directly on the threshold exposure level, but on a value referred to as the reference dose (RfD). The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The RfD is derived from the NOAEL (or the LOAEL if a reliable NOAEL is not available) by dividing by an "uncertainty factor." If the data are from studies in humans and if the observations are considered to be very reliable, the uncertainty factor may be as small as 1.0. However, the uncertainty factor is normally at least 10 and can be much higher if data are limited. The purpose of dividing the NOAEL or the LOAEL by an uncertainty factor is to ensure that the RfD is not higher than the true threshold level for adverse effects. Thus, there is always a "margin of safety" built into an RfD, and doses equal to or less than the RfD are nearly certain to be without any risk of adverse effect. Doses higher than the RfD may carry some risk, but because of the margin of safety, a dose above the RfD does not mean that an effect will necessarily occur.

Cancer Effects

For cancer effects, the toxicity assessment process has two components. The first is a qualitative evaluation of the weight of evidence that the chemical does or does not cause cancer in humans. For chemicals that are believed to be capable of causing cancer in humans, the second part of the toxicity assessment is to describe the carcinogenic potency of the chemical. This is done by quantifying how the number of cancers observed in exposed animals or humans increases as the dose increases. Typically, it is assumed that the dose-response curve for cancer has no threshold (i.e., there is no dose other than zero that does not increase the risk of cancer), arising from the origin and increasing linearly until high doses are reached. Thus, the most convenient descriptor of cancer potency is the slope of the dose-response curve at low doses (where the slope is still linear). This is referred to as the Slope Factor, which has dimensions of risk of cancer per unit dose.

Estimating the cancer Slope Factor is often complicated by the fact that observable increases in cancer incidence usually occur only at relatively high doses, frequently in the part of the

dose-response curve that is no longer linear. Thus, it is necessary to use mathematical models to extrapolate from the observed high dose data to the desired (but unmeasurable) slope at low dose. In order to account for the uncertainty in this extrapolation process, EPA typically chooses to employ the upper 95th confidence limit of the slope as the Slope Factor. That is, there is a 95 percent probability that the true cancer potency is lower than the value chosen for the Slope Factor. This approach ensures that there is a margin of safety in cancer as well as non-cancer risk estimates.

Toxicity Values

Toxicity values for use in Superfund human health risk assessments are available from several sources. The preferred source of toxicity data is EPA's Integrated Risk Information System (IRIS). Values in this database have been derived by expert toxicologists at EPA and most values have undergone thorough review and validation both within and outside EPA. If a toxicity value is available in IRIS, that value should be used in preference to any other value. If toxicity values for a contaminant of potential concern are not available in IRIS, the next source to consult is EPA's Provisional Peer Reviewed Toxicity Values. This source includes toxicity values that have been developed by the Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center.

Additional EPA and non-EPA sources of toxicity information include:

- The California EPA's Toxicity Criteria Database which contains toxicity values that are peer-reviewed and address both cancer and non-cancer effects.
- The Agency for Toxic Substances and Disease Registry's Minimal Risk Levels for Hazardous Substances which are peer-reviewed estimates of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.
- Toxicity values in EPA's Health Effects Assessment Summary Tables (EPA-540-R-97-036, July 1997). These values on chemical contaminants are not currently available on an EPA internet site. They may be obtained by contacting a Superfund risk assessor.

f. Describe the process for performing an exposure assessment.

The following is taken from U.S. Environmental Protection Agency, Exposure Assessment Tools and Models, What Is OPPT's Approach to Exposure Assessment?

Exposure assessments may use measured data or model estimates. Representative measured data of known quality are preferred over model estimates and are needed to validate and improve models. *The EPA Guidelines for Exposure Assessment* includes guidance on collecting and using monitoring data for exposure assessments. EPA's Office of Pollution, Prevention, and Toxics uses a tiered approach to exposure assessment. The steps in the tiered approach are as follows:

- Step 1. Gather basic data and information for a complete and transparent exposure assessment.
- Step 2. Develop a screening level exposure assessment.
- Step 3. If needed, develop an advanced exposure assessment.

These steps are explained in the following paragraphs.

Gather Basic Data and Information for a Complete and Transparent Exposure Assessment

Manufacturing/Processing/Use

The first step in assessing exposure for a chemical is to identify all of the manufacturing, processing and use activities for the chemical. This would include identifying all industrial, commercial and consumer uses.

Gather Measured Data.

Monitoring or measured data may be available in a variety of resources, such as company records or databases, national databases, studies published in the open literature, references and other resources (e.g., for physical/chemical properties, fate, exposure factors, etc.) When obtaining measured or monitoring data, it is important to obtain all of the needed supporting information. Information on data quality objectives, the sampling plan, use of QA samples, measurement of background levels, establishment and use of QA and quality control measures, and selection and validation of analytical methods are important considerations when evaluating monitoring data or determining a strategy to collect additional monitoring data.

Estimates of Environmental Releases

Environmental release estimates are critical inputs for models that calculate indirect human exposures via the environment such as through ambient air or drinking water. They are also critical to modeling exposures to nonhuman aquatic and terrestrial species. Release estimates may be site-specific or they may be generic for a particular industrial process or industrial use. Releases from consumer and commercial products should also be estimated if applicable.

Potentially Exposed Human Populations

All potentially exposed populations should be identified. The exposed populations should be associated with the activity, task or source of environmental releases that leads to the exposure. Highly exposed or highly susceptible populations should be addressed whenever possible. Include all routes of exposure.

Chemical Properties and Fate

Reliable, measured values are preferred, and should be used when available. Measured values or estimates of water solubility and vapor pressure are important in evaluating whether a chemical will dissolve in water or exist as a vapor at ambient temperature, and are used to estimate worker and consumer exposures. Measured data or estimates of biodegradation, sorption, and volatilization potential are used to predict removal in wastewater treatment. Information on decay rates in the atmosphere, surface water, soil, and groundwater are important in evaluating how long it takes a chemical to break down in the environment, and are used to estimate exposures to the general population and the environment.

Mitigation of Exposures

Process and engineering controls which are used to control exposures should be identified. PPE that will mitigate occupational exposures should be noted and quantitative estimates of exposure with and without the use of PPE should be provided.

Documentation of Basic Data and Information

Document all measured data, environmental release scenarios, exposure scenarios, assumptions and estimation techniques.

Screening Level Exposure Assessment

Screening level exposure assessments should be used to quickly prioritize exposures for further work. It will generate a quantitative conservative estimate of exposure. The screening approach generally involves using readily available measured data, existing release and exposure estimates and other exposure related information.

Advanced Exposure Assessment

An advanced assessment will develop more accurate estimates of exposure and will generally focus on the higher priority exposures identified in screening activities. It should quantify central tendency (e.g. median, arithmetic mean) and high end (i.e. greater than 90th percentile) exposures. A representative, well designed monitoring study of known quality is the ideal. Information on data quality objectives, the sampling plan, use of QA samples, measurement of background levels, establishment and use of QA and quality control measures, and selection and validation of analytical methods are important considerations when evaluating monitoring data or determining a strategy to collect additional monitoring data.

g. Describe the process used to characterize risk.

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Human Health Risk Assessment.

A good risk characterization will restate the scope of the assessment, express results clearly, articulate major assumptions and uncertainties, identify reasonable alternative interpretations, and separate scientific conclusions from policy judgments. EPA's Risk Characterization Policy calls for conducting risk characterizations in a manner that is consistent with the following principles:

- Transparency - The characterization should fully and explicitly disclose the risk assessment methods, default assumptions, logic, rationale, extrapolations, uncertainties, and overall strength of each step in the assessment.
- Clarity - The products from the risk assessment should be readily understood by readers inside and outside of the risk assessment process. Documents should be concise, free of jargon, and should use understandable tables, graphs, and equations as needed.
- Consistent - The risk assessment should be conducted and presented in a manner which is consistent with EPA policy, and consistent with other risk characterizations of similar scope prepared across programs within the EPA.

- Reasonable - The risk assessment should be based on sound judgment, with methods and assumptions consistent with the current state-of-the-science and conveyed in a manner that is complete, balanced, and informative.

For more information about Risk Characterization refer to *EPA's Risk Characterization Handbook.*

h. Define the term "dose" and explain how it differs from "risk" as used in CERCLA.

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

Dose is the actual quantity of a chemical administered to an organism or to which it is exposed.

Risk is a measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

22. Environmental restoration personnel shall demonstrate a familiarity-level of knowledge of the purpose and requirements of DOE Order 5400.5, Radiation Protection of the Public and Environment.

The information for the KSAs in this competency is taken from DOE Order 5400.5.

a. State the Department's policy and discuss the objectives regarding the protection of the public and the environment from radiation as contained in DOE Order 5400.5.

This DOE Order is directly applicable to DOE and its facilities, as it is written and administered by DOE. The purpose of this Order is to establish standards and requirements for operations of DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

Policy

It is the policy of DOE to implement legally applicable radiation protection standards and to consider and adopt, as appropriate, recommendations by authoritative organizations, e.g., the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection. It is also the policy of DOE to adopt and implement standards generally consistent with those of the Nuclear Regulatory Commission (NRC) for DOE facilities and activities not subject to licensing authority.

Objectives

It is DOE's objective to operate its facilities and conduct its activities so that radiation exposures to members of the public are maintained within the limits established in this Order and to control radioactive contamination through the management of real and personal property. It is also a DOE objective that potential exposures to members of the public be as far below the limits as is reasonably achievable and that DOE facilities have the capabilities,

consistent with the types of operations conducted, to monitor routine and non-routine releases and to assess doses to members of the public.

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

b. List and discuss the factors that must be considered pertaining to the release of materials and equipment having residual radioactive material as outlined in Chapter IV of the order, Residual Radioactive Material Cleanup.

Release of Real Property

Release of real property (land and structures) shall be in accordance with the guidelines and requirements for residual radioactive material presented in chapter IV of DOE Order 5400.5. These guidelines and requirements apply to DOE-owned facilities and to private properties that are being prepared by DOE for release. Real properties owned by DOE that are being sold to the public are subject to the requirements of section 120(h) of the CERCLA, as amended, concerning hazardous substances, and to any other applicable federal, state, and local requirements. The requirements of 40 CFR 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," are applicable to properties remediated by DOE under Title I of the Uranium Mill Tailings Radiation Control Act.

Release of Personal Property

Personal property, which potentially could be contaminated, may be released for unrestricted use if the results of a survey with appropriate instruments indicate that contamination to the property is less than the established contamination limits.

Release of Materials and Equipment

Surface Contamination Levels

Prior to being released, property shall be surveyed to determine whether removable and total surface contamination (including contamination present on and under any coating) are in compliance with the established acceptable levels and that the contamination has been subjected to the as low as reasonably achieavable (ALARA) process.

Potential for Contamination

Property shall be considered to be potentially contaminated if it has been used or stored in radiation areas that could contain unconfined radioactive material or that are exposed to beams of particles capable of causing activation (neutrons, protons, etc.).

Surveys

Surfaces of potentially contaminated property shall be surveyed using instruments and techniques appropriate for detecting the unacceptable limits.

Inaccessible Areas

Where potentially contaminated surfaces are not accessible for measurement (as in some pipes, drains, and ductwork), such property may be released after case-by-case evaluation

and when documentation based on the history of its use and available measurements demonstrate that the unsurveyable surfaces are likely to be within the established limits.

Records

The records of released property shall include a description or identification of the property, the date of the last radiation survey, the identity of the organization and the individual who performed the monitoring operation, the type and identification number of monitoring instruments, the results of the monitoring operation, and the identity of the recipient of the released material.

Volume Contamination

No guidance is currently available for release of material that has been contaminated in depth, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass). Such materials may be released if criteria and survey techniques are approved by EH-1 (now the Office of Health, Safety, and Security).

c. Identify and discuss the concepts of derived concentration guides and surface release criteria.

A derived concentration guide is the concentration of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (i.e., ingestion of water, submersion in air, or inhalation), would result in an effective dose equivalent of 100 millirem (mrem).

Prior to being released, property shall be surveyed to determine whether both removable and total surface contamination (including contamination present on and under any coating) are in compliance with the levels given DOE Order 5400.5 and that the contamination level is ALARA.

23. Environmental restoration personnel shall demonstrate a working-level knowledge of the purpose and requirements of DOE O 430.1A, Life Cycle Asset Management related to environmental restoration projects.

[Note: DOE O 430.1A was superseded by DOE O 430.1B, *Real Property Asset Management*. The following information is from the most current version.]

a. Describe the purpose, scope, and application of the requirements detailed in DOE O 430.1A, Life Cycle Asset Management.

The purpose of this Order is to establish a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. To accomplish the objective, this Order identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management. This Order implements DOE P 580.1, *Management Policy for Planning, Programming, Budgeting, Operation, Maintenance, and Disposal of Real Property*.

This Order applies to all DOE elements with responsibility for real property assets, including NNSA, except for the Office of the Deputy Administrator for Naval Reactors and Power Marketing Administrations (electric power transmission systems).

The management of real property assets must take a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. Acquisitions, sustainment, recapitalization, and disposal must be balanced to ensure real property assets are available, utilized, and in a suitable condition to accomplish DOE missions. This Order sets the requirements for the major real property asset management functional components of planning, real estate, acquisition, maintenance and recapitalization, disposition and long-term stewardship, value engineering, and performance goals and measures.

b. Discuss the four basic actions to be performed prior to completion of mission activities or prior to transfer or disposition to ensure that facility systems are placed in stable and known conditions and that hazards are identified and known.

[Note: The current order, DOE O 430.1B lists three basic actions.]

When real property assets are identified as no longer required for current program missions, a disposition baseline must be developed to assess and prepare the assets for disposition. Technical, programmatic, and regulatory information is to be used in developing the disposition baseline. The disposition baseline must include the following information and considerations:

- Identification and characterization of hazardous and radioactive materials, waste, and hazardous conditions of the real property asset
- Surveillance and maintenance requirements to ensure the real property asset, including its systems, and stored hazardous materials and waste remain in a stable and known condition and that adequate protection is provided to workers, the public, and the environment pending disposition
- Assessment and adjustment of the facility authorization basis, as necessary, to reflect conditions and activities pending disposition

c. Discuss the process and requirements for disposition of physical assets, including the specific requirements for contaminated facility disposition.

The disposition plan must integrate environmental, safety, and health requirements into disposition activities in accordance with DOE-STD-1120-2005, *Integration of Environment, Safety, and Health into Facility Disposition Activities*. The disposition plan should be tailored based on the disposition baseline and disposal method to be used (e.g., reuse, demolition, or decommissioning) and must consider DOE P 455.1, *Use of Risk-Based End States* and the guidance in the following DOE Guides:

- DOE G 430.1-2, *Implementation Guide for Surveillance and Maintenance during Facility Transition and Disposition*;
- DOE G 430.1-3, *Deactivation Implementation Guide*;
- DOE G 430.1-4, *Decommissioning Implementation Guide*; and
- DOE G 430.1-5, *Transition Implementation Guide*.

The disposition plan shall include the following:

- A method for identifying, evaluating, and selecting disposition alternatives and long-term stewardship requirements. Selection of the preferred disposition alternative needs to be documented and be in accordance with relevant regulatory standards. Stakeholder involvement is required in the development of long-term stewardship plans.
- The identification and completion of required activities related to historical preservation.
- A post-closure/post-disposition/ long-term stewardship records turnover or retention plan.
- Surveillance and maintenance plans for facilities and land parcels with residual contamination, hazards, or other conditions that are projected to require post-disposition long-term stewardship. These plans must identify appropriate management and funding requirements to ensure safety, health, and environmental regulatory compliance and meet relevant requirements of treaties, agreements, or other DOE commitments.
- A process to track status of long-term stewardship actions, including gap analysis of the long-term stewardship transition framework to identify actions remaining before end-point conditions are satisfied. This should include a method to periodically reassess monitoring requirements and make any necessary revisions.
- Development of specific end-point criteria for declaring disposition complete.
- Cost and schedule information for disposition activities and any follow on surveillance and maintenance and long-term stewardship requirements must be identified in the ten year site plan.

Where transfer of real property assets is required for disposition (e.g., turning a facility or site over to another organization for reuse or transferring it to another office within DOE to support the transition from one disposition phase to another or initiation of long-term stewardship), applicable DOE policies, assigned missions and responsibilities, appropriate industry standards, and the guidance provided in DOE G 430.1-5 must be adhered to. Real property asset transfers must include the following.

- Identification of the real property assets as candidates for transfer, formal notification of the potential receiving organizations, and issuance of other reports and notifications in accordance with the applicable requirements of this order.
- Development of a transfer acceptance process to ensure pre-transfer verification of the technical and regulatory information in the disposition baseline and agreement on a transfer date and the disposition/long-term stewardship scope, cost, and schedule. Normally, to match the DOE budget cycle, the date of transfer for a facility will be the 1st of October after the 2-year (or 3-year) anniversary of the date when the receiving organization was notified unless the parties reach an agreement that stipulates an alternative transfer date.
- Pre-transfer review for formal acceptance of the real property assets being transferred. Formal acceptance must be documented by an agreement signed by relevant program offices. DOE's Facility Information Management System will be updated to reflect the transfer of property accountability and custody.
- Conveyance of the appropriate funding and budget targets along with the real property assets being transferred.

Decommissioning must adhere to the relevant requirements for non-time-critical removal actions under CERCLA, using a tailored process negotiated with the EPA, with continued Defense Nuclear Facilities Safety Board oversight to the extent authorized by law.

A final report or equivalent document must be developed for each disposition and land parcel remediation/long-term stewardship project. The final report/document must describe, as a minimum, project activities, final facility status, and cost and performance information to demonstrate that specific end-point criteria have been met.

d. Using DOE O 430.1A, Life Cycle Asset Management, prepare an action plan which adequately outlines interviews and observations, and details documents to review during an evaluation of contractor compliance with the requirements of DOE O 430.1A, Life Cycle Asset Management.

e. Evaluate contractor compliance with the requirements of DOE O 430.1A, Life Cycle Asset Management. During this evaluation, demonstrate the ability to properly conduct interviews, observations, and document reviews.

f. Given data from an evaluation, analyze the results of the evaluation to determine contractor compliance or noncompliance of the requirements.

Items d through f are performance-based KSAs. The Qualifying Official will evaluate their completion.

24. Environmental restoration shall demonstrate a working-level knowledge of financial management necessary to integrate program resources and apply those resources to meet project commitments as described in DOE Guide 430.1-1, Life Cycle Asset Management.

[Note: The correct title for DOE G 430.1-1 is *Cost Estimating Guide*.]

a. Define the term "work breakdown structure" and discuss the process for developing one.

The following is taken from DOE G 430.1-1, chapter 5.

A work breakdown structure (WBS) is the result of project/program planning that establishes the physical work packages or elements and the activities within those packages that completely define a project. It organizes the physical work packages into levels that can be developed into a summary.

A WBS shows the relationship of all elements of a project. This provides a sound basis for cost and schedule control. During that period of a project's life from its inception to a completed project, a number of diverse financial activities must take place. These activities include cost estimating, budgeting, accounting, reporting, controlling and auditing. A WBS establishes a common frame of reference for relating job tasks to each other and relating project costs at the summary level of detail.

Since the WBS divides the package into work packages, it can also be used to interrelate the schedule and costs. The work packages or their activities can be used as the schedule's activities. This enables resource loading of a schedule, resource budgeting against time, and the development of a variety of cost budgets plotted against time.

A WBS is a numerical, graphic representation that completely defines a project by relating elements of work in that project to each other and to the end product. The WBS is comprised of discrete work packages, called elements, that describe a specific item of either hardware, service, or data. Descending levels of the WBS provide elements of greater and greater detail. The number of levels of a WBS depends on the size and complexity of the project. The DOE WBS Guide presents a structure that may be used as a guideline when developing the project/program WBS.

Examples of the first three levels of a WBS are as follows:

- Level 1 contains only the project end objective. The product at this level shall be identifiable directly to elements of the DOE Budget and Reporting Classification Structure.
- Level 2 contains the major product segments or subsections of the end objective. Major segments are often defined by location or by the purpose served.
- Level 3 contains definable components, subsystems or subsets, of the Level 2 major segments.

The initial WBS prepared for a project is the project summary WBS. Normally, the project summary WBS contains the top three levels only. Lower-level elements may be included when necessary to clearly communicate all project requirements.

The first prerequisite to the preparation of the project summary WBS is the clear understanding and statement of the project objective by the Project Secretarial Officer. This can include the delivery of a specific major end item, the erection of a building, or the remediation of a section of land. Once this overall project objective is established, it assists in determination of the supporting project sub-objectives. This process of identification and definition of sub-objectives assists the Project Secretarial Officer in structuring WBS levels and the contributing elements during WBS preparation.

Early in project planning, DOE project management should select the summary WBS(s) that will best describe the work of the project in the way it will be executed. WBS elements can be organized by physical area, process, or function. All elements of the WBS should be defined in an accompanying WBS dictionary. The summary WBS elements should be used as guides as the levels of the WBS are added or changed to reflect the changes and refinements of the scope as the design and project execution are being developed. As levels are added to the WBS, they should be checked across the project to ensure that they remain at the same level of detail. When developing a numbering system, the use of the computerized system should be considered since they may limit the number of digits in the WBS numeric identifier.

b. Define and compare the terms "cost estimate" and "budget."

The following is taken from DOE G 430.1-1, appendix A.

A cost estimate is a statement of costs estimated to be incurred in the conduct of an activity, such as a program, or the acquisition of a project or system. The estimate can be in the form of proposals by contractors or Government agencies, a response to a program opportunity notice, or a DOE estimate.

A budget is an annual proposal that outlines anticipated federal revenue and designates program expenditures for the upcoming fiscal year.

c. Describe the process for preparing cost estimates and budgets.

Cost Estimates

The following is taken from DOE G 430.1-1, chapter 15.

Several techniques are available to help the estimator estimate the cost of a project. Based on the project's scope, the purpose of the estimate, and the availability of estimating resources, the estimator can choose one or a combination of techniques when estimating an activity or a project.

Bottom-up Technique

Generally, a work statement and set of drawings or specifications are used to "take off" material quantities needed to perform each discrete task that is required to accomplish a given operation or produce an equipment component. From these quantities, direct labor, equipment, and overhead costs are derived and added. This technique is used as the level of detail increases as the project develops.

Specific Analogy Technique

Specific analogies depend upon the known cost of an item used in prior systems as the basis for the cost of a similar item in a new system. Adjustments are made to known costs to account for differences in relative complexities of performance, design, and operational characteristics.

Parametric Technique

Parametric estimating requires historical databases on similar systems or subsystems. Statistical analysis is performed on the data to find correlations between cost drivers and other system parameters, such as design or performance parameters. The analysis produces cost equations or cost-estimating relationships, which can be used individually or grouped into more complex models.

Cost Review and Update Technique

An estimate is constructed by examining previous estimates of the same project for internal logic, completeness of scope, assumptions, and estimating methodology and updating them with any changes.

Trend Analysis Technique

A contractor efficiency index is derived by comparing originally projected contract costs against actual costs on work performed to date. The index is used to adjust the cost estimate of work not yet completed.

Expert Opinion Technique

This technique may be used when other techniques or data are not available. Several specialists can be consulted reiteratively until a consensus cost estimate is established.

Budgets

The following is taken from DOE O 130.1.

DOE's annual budget formulation process consists of four distinct phases. Detailed reporting requirements for each phase are contained in DOE Budget Formulation Instructions.

The field budget process is the first phase of DOE's annual budget formulation process. It is the process through which Field Offices prepare and submit field budget data to Headquarters Elements for use in the corporate review budget process.

The corporate review budget process is the second phase of DOE's annual budget formulation process. It is the process whereby Headquarters organizations use, among other budget related information, field budget data and spring planning decisions to develop initial organizational budget requests that are jointly evaluated and considered in the DOE's internal budget review, resulting in corporate review budget allowances.

The Office of Management and Budget (OMB) budget review process is the third phase of DOE's annual budget formulation process. It is the principal mechanism for preparing DOE's annual budget submission to the OMB. DOE's OMB request is based on the Secretary's final budget allowances resulting from the corporate review budget process.

The congressional budget review process is the final phase of DOE's annual budget formulation process. It is based on final Presidential funding and policy determinations resulting from the OMB budget review process.

d. Describe and compare labor and non-labor costs.

The following is taken from DOE G 430.1-1, chapter 9.

Labor costs should include provisions for salaries, including medical benefits, vacation and holidays, and other employee compensation items. Labor overhead will consist of administrative costs for scheduling, payroll, etc., as well as costs for employee workspace maintenance.

Non-labor costs include taxes, rent, depreciation, interest, equipment and supply funding, and utilities.

e. Describe and compare direct and indirect costs.

The following is taken from DOE G 430.1-1, chapter 7.

Direct costs are costs that can be specifically identified with a particular project or activity, including salaries, travel, equipment, and supplies directly benefiting the project or activity.

Indirect costs are costs incurred by an organization for common or joint objectives and cannot be identified with a particular project or activity. Examples are insurance and taxes.

f. Discuss methods of reducing indirect costs.

The following is taken from DOE G 430.1-1, chapter 7.

Chapter 7 of DOE G 430.1-1 contains a table listing numerous categories of indirect costs. Examples include utilities, motor pool operations, medical and first aid, and consumables. Utility costs can be reduced by utilizing energy efficient practices and equipment. Motor pool operation costs can be reduced by eliminating excess and inefficient vehicles. Medical and first aid costs can be reduced by encouraging and supporting improvements in employee fitness. Consumable costs can be reduced by creating an accountability program for consumable items such as office supplies to reduce fraud, waste, and abuse.

g. Discuss the importance of determining the measure for work performed before work starts.

The following is taken from DOE G 430.1-1, chapter 14.

Project controls are systems used to plan, schedule, budget, and measure the performance of a project/program. The cost estimation package is one of the documents that is used to establish the baseline for project controls. The cost estimation package is developed primarily for establishing the project budget and for providing the appropriate documentation and justification for a funding request. Once the project is funded, this package is not filed away. It becomes the baseline or target against which the performance of the project/program can be controlled and compared. By comparing the baseline with the actual performance, deviations from the baseline can be identified and corrected before they cause an impact on the project/program.

The schedule in the cost estimation package represents the same time frame as the estimate. Therefore, any change in this schedule could affect the cost of the project/program. Thus, management can compare the baseline schedule to the actual schedule to identify scheduling problems or changes and any associated cost updates.

The WBS and the organization of the budget cost estimate included in the cost estimation package set the precedent for all estimates throughout the life of the project. The same organization will be used by project controls so any cost changes may be easily tracked against the baseline WBS element.

h. Describe methods for measuring work performed.

See item g of competency 24.

i. Discuss schedule and cost variance.

The following is taken from DOE G 413.3-10.

Variances identify cost, schedule, and estimate at completion deviations from the performance measurement baseline and should be reviewed to ensure that their causes, corrective action plans, and impacts to the project are clear, meaningful, and attempt to recover negative deviations from the plan and address reasons for significant positive deviations from the plan.

Possible cost variance causes include the following:

- rate changes (i.e., labor, overhead)
- vendor discounts or price increases
- quantity discounts
- material cost changes
- requirement changes

Possible schedule variance causes include:

- poor baseline schedule (Does it reflect reality?),
- subcontractor/vendor cannot deliver when needed,
- more/less effort than planned,
- insufficient resources (staffing),
- labor disputes/work stoppage,
- resource availability (Is it there when I need it?), and
- requirement changes.

j. Given actual project management documentation and data, identify budgeted cost of work scheduled, budgeted cost of work performed, and actual cost of work performed, and determine the schedule variance and cost variance.

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

k. Describe the types of EV and how they are measured.

The following is taken from DOE G 413.3-10.

The Earned Value Management System (EVMS) is an integrated set of policies, procedures, and practices to support program and project management as a decision enhancing tool and a critical component of risk management. An EVMS:

- effectively integrates a project's work scope, cost, and schedule into a single performance measurement baseline;
- reliably tracks:
  - planned value of work to be performed or the budgeted cost for work scheduled,
  - earned value of actual work performed or the budgeted cost for work performed, and

- actual cost of work performed;

- provides performance measures against the performance measurement baseline;
- provides means of identifying, reviewing, approving, and incorporating changes to the performance measurement baseline;
- provides trend analysis and evaluation of estimated cost at completion;
- provides a sound basis for problem identification, corrective actions, and management re-planning.

EVMS measures actual performance of work scope and the associated cost and schedule versus an agreed to baseline plan, while using disciplined means of baseline change control for documenting any changes to the agreed to baseline plan.

l. Explain what is meant by the term "baseline" as it relates to project management.

The following is taken from DOE G 430.1-1, appendix A.

A quantitative definition of cost, schedule, and technical performance that serves as a base or standard for measurement and control during the performance of an effort; the established plan against which the status of resources and the effort of the overall program, field program(s), project(s), task(s), or subtask(s) are measured, assessed, and controlled.

m. Describe the types of data required to forecast cost and schedule performance.

The following is taken from DOE G 430.1-1, chapter 19.

Cost estimating relationships or parametric equations are mathematical statements that indicate that the cost is proportional to a physical commodity. Parametric estimating requires that statistical analysis be performed on data points to correlate the cost drivers and other system parameters. The basis of the data points is collected from databases or is developed by building a model of a project or scenario.

When developing forecasts from historical data, it is important to consider the different sources available. Some examples of sources include published reports; adopted and draft regulations; local, commercial, and DOE databases; past and current estimates; and bid documents. The information extracted from these sources will provide the estimator an understanding of the steps that are necessary to perform the work for a project so the cost drivers can be identified.

Sometimes an analyst will be required to develop estimates pertaining to projects for which there is no historical data. In this situation, the analyst can develop a conceptual design of the project (a model) and can estimate the cost of the model. This estimate is a more comprehensive effort than ordinary estimates. The project must be designed and then estimated for three to five cases or sizes differing from one another with respect to the parameter expected to drive the cost or schedule.

n. Define the term "Life Cycle Cost Estimate."

The following is taken from DOE G 430.1-1, chapter 23.

Life-cycle costs are all the anticipated costs associated with a project or program alternative throughout its life. This includes costs from pre-operations through operations or to the end of the alternative.

o. Given sample data, calculate "Life Cycle Cost Estimate."

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

p. Discuss the importance of formal change control with regard to project management.

The following is taken from DOE, Management Model for Delivering High Performance and Leadership Class Computing Systems for Scientific Discovery.

Project changes can be classified into two broad categories. First are those changes that directly impact the performance baseline. Second are those that occur within the performance baseline, such as changes to project sub-element costs and milestones. Changes within the performance baseline are routinely accomplished during the development process as the design, engineering, execution or construction and risk management efforts continue. Establishing a formal change control process permits all changes to be managed to integrate the cost, schedule, and technical parameters that are affected by each change. Change control approval thresholds should be developed in a tiered manner, from the acquisition executive to the deputy administrator level down to the project director and the contractor, commensurate with the size and significance of the proposed change. Project changes shall be identified, controlled, and managed through a traceable, documented change control process that is defined in the project execution plan. Project changes caused by congressional action, such as a funding shortfall or the addition of new requirements, shall be called directed changes. Directed changes shall follow the change control process and shall be approved by the appropriate acquisition executive.

q. Discuss the use of strategic planning, and how such planning relates to ongoing operations and safety of operations.

The following is taken from DOE, Office of Strategic Planning, Budget and Program Evaluation, Guidelines for Strategic Planning.

Strategic planning is one of the integral steps in fulfilling the department's mission. The role of strategic planning is to ensure that, through effective preparation, DOE programs and support activities are best positioned to achieve the long-term goals and objectives of DOE. Strategic planning will assist the Secretary, Deputy Secretary, and Under Secretary in setting the long-term directions and policies for the department and in making decisions on near-term priorities and resource allocations. It will assist those who develop and implement programs by providing guidance for multiyear program plans and budgets.

The benefits of strategic planning include:

- building consensus around organizational goals, objectives, and priorities,
- providing the basis for resource allocations and operational planning,
- defining baselines for controlling outcomes, and
- helping to evaluate departmental performance.

A strategic plan will typically contain several objectives dealing with the program itself or with production or operations, as well as objectives dealing with people (employees), environmental concerns, waste management, health and safety, security, productivity and costs, quality, management excellence systems, community concerns. Determining which objectives are "musts" and which are "wants" and which of the "wants" are most important can be useful in narrowing the list to the key or essential strategic objectives

25. Environmental restoration shall demonstrate familiarity-level knowledge of project risk assessment.

a. Perform an assessment of project risks that identifies critical systems, subsystems, and other factors that require focused work and resolution.

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

b. Identify the types of risks that are addressed in a project risk assessment.

The following is taken from *Use of Probabilistic Cost and Schedule Analysis Results for Project Budgeting and Contingency Analysis at Los Alamos National Laboratory*.

Project/program risk analyses include the evaluation of technical, schedule, cost, and funding risks.

Technical risks are those events or issues associated with the research and development, design, construction, and operation of facilities and processes that could affect the actual level of performance versus that specified in the program functional and operational requirements.

Cost risk is the risk associated with the ability of the project/program to achieve the planned life-cycle costs. It includes design/construction and operating costs. The two major elements of cost risk are the accuracy and completeness of the cost estimates for the planned activities and the risk that program performance will not meet the planned objectives because of a failure to manage technical risks.

Schedule risk is the risk associated with the adequacy of the time allotted for research and development, regulatory approval, design, construction, startup, and operations activities. The two major elements of schedule risk are the reasonableness and completeness of the schedule estimates for the planned activities and the risk that program performance will not meet the planned schedule objectives because of a failure to manage technical risks.

In addition, program cost and schedule targets may not be met because the projected funding needed to complete the planned activities is not available when needed. Each of the four risk categories is related to the others.

c. Evaluate the assessed level of risk.

The following is taken from DOE Good Practice Guide GPG-F17-007, *Risk Analysis and Management*.

Risks are quantified (i.e., graded as low, medium, or high) based on the results of the risk analysis meeting and the definition of project scope, schedule, and cost. Each risk and its corresponding assumptions should be recorded on a risk identification and analysis form.

Any method chosen for grading risk should be qualitative as well as quantitative. Though formulas and modeling techniques are useful tools for organizing and assessing risks, they do not substitute for the professional judgment and experience of the project manager and other project team members.

A sound methodology for determining whether a risk is low, medium, or high is to combine information about its probability of occurrence and the consequence of the realized risk.

The probability of occurrence is considered for the duration of the project. However, if probability of occurrence is higher in some project phases than others, the probability of occurrence should be used in the current or next immediate project phase, and the probability of occurrence for the risk should be updated in a subsequent risk analysis. The probability is expressed as a decimal between 0 and 1, where 0 is no probability of occurrence and 1 is 100 percent probability of occurrence. Record the probability of occurrence on the risk identification and analysis form with any other assumptions or basis used for determining the probability.

The consequence of realized risk is best determined using a consequence table, which permits the team to define the cost and schedule thresholds at which the consequences of realized risk will result in one of the following outcomes:

- no consequence to cost and schedule;
- small reduction in desired cost and schedule results;
- some reduction in desired cost and schedule results;
- significant degradation in desired cost and schedule results; or
- project cost and schedule goals cannot be achieved.

The evaluation should quantify consequences in terms of dollars and schedule time units (days, weeks, months). The consequence of a realized risk should be recorded on the risk identification and analysis form with any other assumptions or bases used for determining the consequences.

One of the three following methodologies should be used to combine the probability of occurrence (P) and the consequence of the realized risk (C).

1. Determine the risk factor (RF). This approach yields the most conservative risk grading result; that is, it produces the highest number of risk factors that result in high risks. To use this method, the following formula is applied:

$$(RF) = (P + C) - (P \times C)$$

   where:
   High risk = RF greater than 0.7
   Medium risk = RF between 0.7 and 0.3
   Low risk = RF less than 0.3

2. Use a risk grading plotting chart. This is a less conservative methodology.

3. Use a purely subjective methodology. The team can evaluate the project, determine the risks, and assign a grade based purely on experience and judgment. This methodology may best be used for low dollar value and less complex projects.

Other methodologies can be employed to quantify risk. Whatever method is used, documentation of the chosen methodology is highly recommended. Documentation creates a record for future use in the event that a later review, revision, or update is performed by a new team.

d. Describe the basis for the risk assessment.

e. Identify the critical project elements that contribute to the risk.

f. Identify the consequences of the risk.

g. Develop activities and alternatives to minimize the risk.

h. Identify the stage(s) of the project in which the risk exists.

Items d through h are performance-based KSAs. The Qualifying Official will evaluate their completion.

26. Environmental restoration personnel shall demonstrate a working-level knowledge of configuration management principles to satisfy the project's technical and operational requirements.

a. Discuss the objectives of configuration management.

The following is taken from Naval Air Warfare Center, Training Systems Division, Acquisition Guide, *Configuration Management*.

Configuration management is a discipline applying technical and administrative direction and surveillance over the life cycle of items to:

- identify and document the functional and physical characteristics of configuration items,
- control changes to configuration items and their related documentation,

- record and report information needed to manage configuration items effectively, including the status of proposed changes and implementation status of approved changes, and
- audit configuration items to verify conformance to specifications, drawings, interface control documents, and other contract requirements.

b. Describe the following elements of configuration management:
- **Configuration identification**
- **Configuration control**
- **Configuration recording and reporting**
- **Waivers and deviations**

The following is taken from Naval Air Warfare Center, Training Systems Division, Acquisition Guide, *Configuration Management*.

Configuration Identification

The purpose of configuration identification is to define the functional and physical characteristics of a configuration item in sufficient detail so that it may be developed, tested, evaluated, produced, competitively procured, accepted, operated, maintained, and supported. Configuration identification is established by baselines plus approved changes.

Configuration Control

Configuration control ensures that proposed engineering changes to configuration items are fully coordinated and documented.

Configuration control is tailored during each life cycle phase of a configuration item as follows:
- Acquisition Phase. During this phase, configuration control will be applied to a new item's operational and functional requirements, and configuration control will be applied to all documents which establish the functional baseline documentation. This phase represents the acquisition of a new device, and as such, establishes the product baseline documentation.
- Operational Support Phase. During this phase, configuration control will be applied to any revisions to the established functional and product baseline documentation of an existing item. This phase represents the modification/update of existing devices.

Configuration Recording and Reporting

Configuration recording and reporting, often referred to as configuration status accounting, is the recording and reporting of information needed to manage configuration items effectively, including:
- a record of the approved configuration documentation and identification numbers;
- the status of proposed changes, deviations, and waivers to the configuration;
- the implementation status of approved changes;
- the configuration of all units of the configuration item in the operational inventory; and
- discrepancies from functional and physical configuration audits.

Waivers and Deviations

A waiver is a written request for authorization to accept a configuration item which, during manufacture or after having been submitted for inspection and acceptance, is found to depart from specified requirements, but is considered suitable for use as is or after rework by a government approved method. Each request for waiver will be designated as minor, major, or critical. Submittal of recurring waivers which are indicative of inherent design problems or overly restrictive performance requirements will not be submitted for Change Control Board approval. If such a condition exists, an engineering change proposal will be requested.

A deviation is a written authorization, prior to the manufacture of a configuration item, to depart from a particular performance or design requirement of a specification, drawing, or other document for a specified number of items or period of time. A request for deviation will be designated as minor, major, or critical. Recurring deviations which are indicative of inherent design problems or overrestrictive performance requirements will not be submitted for change control board approval. If such a condition exists, a trainer engineering change proposal will be requested.

c. Discuss the revision process for technical baselines over the life of a project, including an explanation of each of the following terms:
- **Functional requirements baseline**
- **Technical requirements baseline**

[Note: DOE currently utilizes an acquisition program/project management program derived from Department of Defense acquisition management principles. The terms "functional requirements baseline" and "technical requirements baseline" are not specifically utilized.]

The following is taken from DOE G 413.3-5.

Baselining is a central feature of the DOE project management system and reflects the adaptation of diverse management philosophies and practices borrowed from industry and other Federal agencies (notably Department of Defense).

The DOE project management system defines lifecycle in four major phases—initiation, definition, execution, and transition/closeout. In the initiation phase the project's need is identified and justified, high-level objectives and functional requirements to meet those objectives are outlined, rough order-of-magnitude cost estimate ranges and a few key milestones are established, and project team formation begins. In this phase preliminary key performance parameters are used to describe and communicate the mission need to project stakeholders.

During the definition phase, the project team begins to articulate and document a preliminary performance baseline and begins informal configuration management of key baseline parameters to start mapping baseline elements to supporting assumptions, plans, documentation, etc.

In the execution phase a preliminary project design is finalized, a finalized work scope is created and final cost and schedule baselines are established. Completion of full project

definition indicates that the project has been adequately defined to commit resources. Once these elements are complete, a final performance baseline is documented.

When the project nears completion and has progressed into formal transition and commissioning, which generally includes final testing, inspection, and documentation, the project is ready for operation, long-term care, or closeout. The performance baseline, and especially key performance parameters, serves as a basis for assessing, verifying, and documenting completion of the project.

The performance baseline development process involves formulating a technical baseline, a schedule baseline, and a cost baseline. Upon approval (during the execution phase), the performance baseline sets the final course for the project and is subject to formal change management procedures.

The following is taken from DOE O 413.3A.

Change control ensures that project changes are identified, evaluated, coordinated, controlled, reviewed, approved/disapproved, and documented in a manner that best serves the project. The change control process is defined in the Project Execution Plan. One key goal of change control is to ensure performance baseline thresholds are not exceeded. Changes can be classified into two broad categories: those that impact the Performance Baseline and those that do not. Approval authority for changes depends upon the impact of the change and can range from the contractor to the Secretarial Acquisition Executive, usually with the involvement and support of a Change Control Board. Significant changes could require Congressional notification.

27. Environmental restoration personnel shall demonstrate a working-level knowledge of the principles of streamlining and maximizing cost-effectiveness.

a. Define and discuss the following terms:
- **Early response action**
- **Problem statement**
- **Uncertainty**
- **Data needs**
- **Core team**
- **Expedited site characterization**

The following is taken from DOE Guide EH-413-0005, *Environmental Restoration Waste Management Guide.*

Identifying proper management strategies for environmental restoration wastes is primarily driven by an adequate understanding of three factors: (1) what media type (e.g., soil, debris, ground or surface water) needs to be managed; (2) what are the key characteristics of contaminants found in the media (including type of waste, constituents present, concentration levels, and extent of contamination); and (3) what is the selected response action (e.g., what steps will occur to implement the action).

The basis for the systematic approaches outlined in DOE's *Environmental Restoration Waste Management Guide* is the use of principles of environmental restoration that the DOE and EPA have developed and promoted. In particular, two of the principles, (1) the importance and value of the early identification of appropriate response actions and (2) uncertainty management, are critical to understanding and implementing effective environmental restoration waste management. Two other principles, (1) establishment of an effective core team and (2) early problem identification, are also relevant, but not as central to effective management of environmental restoration wastes.

Early Response Action

Early identification of likely response actions, and the implementation of those responses as soon as sufficient site information is available to do so, can significantly decrease the costs and accelerate the schedules of environmental restoration projects by eliminating unnecessary engineering studies. Because environmental restoration waste planning depends in large part on the response action selected, early identification of probable response actions allows the project manager to assess which regulatory requirements the waste will likely be subject, and begin planning compliant waste handling methods. By focusing early on the response strategy, project managers also improve their ability to collect missing data efficiently.

Problem Statement

The following is taken from U.S. Environmental Protection Agency, Expediting Cleanup through Problem Identification and Definition.

Clear and concise problem definition is essential to environmental restoration projects since it specifies the condition(s) requiring action, bounds the likely response(s) appropriate for consideration, and focuses data collection on reducing key uncertainties to support remedy selection and implementation. Unclear problem definition may result in overly extensive or ineffective investigations, thus extending project schedules and ultimately delaying cleanup. During the execution of a response action, inadequate problem definition can lead to difficulties addressing the problem, addressing the wrong problem (e.g., dealing with a "symptom" rather than the cause), or addressing a problem at significantly greater cost than was technically necessary.

Uncertainty

The following is taken from DOE Guide EH-413-0005, *Environmental Restoration Waste Management Guide.*

Uncertainty exists in nearly every aspect of an environmental restoration or facility disposition project. One major uncertainty is how wastes that will be generated during an environmental restoration project must be handled. Key elements of this uncertainty are often technical (e.g., what contaminants are present, what the depth of contamination is in soil), but also can be regulatory (e.g., will wastes have to meet RCRA disposal restrictions) or programmatic (e.g., what funding is available if a more stringent set of regulatory obligations are triggered because of unanticipated wastes that were found).

Data Needs

The following is taken from DOE Guide EH-413-0005, *Environmental Restoration Waste Management Guide.*

Environmental restoration investigations (i.e., RIs, RCRA facility investigations) seldom, if ever, result in a project manager learning all of the information needed to manage environmental restoration wastes. Effective sampling and analysis data gathered during these investigations, historical information regarding site operations, and information regarding the characteristics of contaminated groundwater, soil, and debris, will assist the remedial project manager in identifying the range of potential regulatory requirements that could apply to each type of environmental restoration waste.

Core Team

The following is taken from U.S. Environmental Protection Agency, Expediting Cleanup through a Core Team Approach.

The core team approach is a formalized, consensus-based process in which those individuals with decision-making authority, including DOE, EPA, and state remedial project managers, work together to reach agreement on key remediation decisions. Equally important, the core team works to ensure that all technical support staff and stakeholders are involved and communicating effectively throughout the decision-making process.

Expedited Site Characterization

The following is taken from U.S. Environmental Protection Agency, Underground Storage Tanks, Expedited Site Assessment.

The expedited site assessment (ESA) process is a framework for rapidly characterizing site conditions for corrective action decisions. This concept has been described with other names, including accelerated site characterization, rapid site characterization, and expedited site investigation. ESAs have been made possible by the recent development of improved, cost-effective methods for rapid sample collection and field analysis of soil gas, soil, and groundwater. Where appropriate (or necessary), conventional sampling and analytical methods can be used to augment the ESA process. An ESA is typically conducted in a single mobilization that can last several days and is distinguished by the following features:

- field-generated data and on-site interpretation
- flexible sampling and analysis
- field presence of senior staff empowered to redirect the investigation in response to new data

The ESA process contrasts with conventional site assessments in which a significant amount of data analysis and interpretation is completed off-site at a later date.

b. Discuss what should precede the development of a sampling and analysis plan.

The following is taken from U.S. Environmental Protection Agency, Expediting Cleanup through Problem Identification and Definition.

Clear and concise problem definition is essential to environmental restoration projects since it specifies the condition(s) requiring action, bounds the likely response(s) appropriate for consideration, and focuses data collection on reducing key uncertainties to support remedy selection and implementation. Uncertainties that prevent determination of whether a problem exists or prevent the evaluation and selection of an appropriate response action represent data needs which must be satisfied before the project can proceed. Therefore, the core team needs to specifically define the information required, and as this additional information is obtained, further evaluate site conditions to determine additional sampling and analysis requirements.Once a preferred response action is identified to address a site problem, a decision rule is an effective tool to formalize what constitutes sufficient information to trigger an agreed upon response by linking the problem definition, the response action to be taken, and the data required to support the decision.

c. Discuss the composition and role of a core team for ER projects.

The following is taken from U.S. Environmental Protection Agency, Expediting Cleanup through a Core Team Approach.

The core team approach is a formalized, consensus-based process in which those individuals with decision-making authority, including DOE, EPA, and state remedial project managers, work together to reach agreement on key remediation decisions. Equally important, the core team works to ensure that all technical support staff and stakeholders are involved and communicating effectively throughout the decision-making process.

The core team and their technical staff (site contractors and the federal and state technical support personnel) comprise the project team. Essential to the decision-making process, support personnel not only provide the information necessary for the core team to make technically defensible decisions (e.g., analysis of characterization data, technology evaluations), they also execute the work as directed by the core team.

Characteristics of a truly effective core team are:

- There is clear recognition of the core team's decision-making responsibility by all parties involved. As signators to Federal Facility Agreements and the cleanup decisions generated thereby, the core team constitutes the decision-making authority for a project.
- The core team clearly identifies which key decisions they will make and which decisions they intend to delegate to the technical support staff.
- The core team makes decisions based on consensus as each core team member has an "equal vote."
- There is no ambiguity in the core team's intent, minimizing the potential for misinterpretation by the technical staff.
- The core team representatives have sufficient decision-making authority so that agreements typically are not overturned by management.
- Core team members and their technical staff attend all meetings. Because core team decisions are based on consensus, there is little, if any, value in holding a meeting if one of the core team representatives is absent, since decisions cannot be finalized.
- All core-team decisions, and the rationale underlying these decisions, are documented immediately following each meeting.

d. Discuss uncertainty, as it is associated with characterization, and the ways in which it can be managed.

The following is taken from U.S. Environmental Protection Agency, Uncertainty Management: Expediting Cleanup through Contingency Planning.

Some degree of uncertainty in environmental restoration projects always exists. This inherent uncertainty may result from incomplete knowledge of the nature and extent of contamination, an inability to predict a technology's performance under site-specific conditions, or new or changing regulatory requirements. Although these inherent uncertainties present a significant challenge to effective project management, recognizing and planning for them helps to ensure that projects stay on schedule and within budget.

In order to effectively reduce and manage uncertainty prior to or during a response action, the project team must first determine which uncertainties are significant (i.e., can impact the implementation of the response action(s) under consideration). Once significant uncertainties are identified, the DOE, EPA and state project managers (i.e., the core team), must decide whether to reduce the uncertainty through data collection, or reach consensus on how best to "manage" the uncertainty through contingency planning. In short, this decision will require a balance between the cost of data collection (and decisional benefits gained) against the cost of planning for a potential deviation (i.e., uncertainty), and the cost / schedule impacts of modifying the design if the deviation occurs.

Outlined below are steps to follow once the core team decides to pursue managing an uncertainty through contingency planning.

Step One: Identify Expected Conditions and Potential Deviations

The core team should use their conceptual model developed for the site (or "problem") being addressed as a basis for identifying and evaluating expected conditions and potential deviations. An expected condition is any physical, chemical, technical, or regulatory condition that is expected to be encountered during implementation of the response action.

Step Two: Evaluate Deviations

Once potential deviations have been identified, the core team should determine what level of "pre-response" planning is appropriate by evaluating each deviation as to its possible impact on the implementation of the likely response(s), and its ability to negate achievement of response objectives.

Step Three: Develop Appropriate Contingency Plans

Once the core team determines the appropriate level of "pre-response" contingency plan for each specified deviation, development of contingency plans can begin. Based on the required level of detail, a contingency plan should include a strategy for what needs to be accomplished to effectively manage and respond to a deviation. Specifically, the core team should define the necessary design modifications and/or actions required in the field to manage the deviation.

Step Four: Develop Associated Monitoring Plan

A monitoring plan should be developed for each deviation in order to determine when the deviation has occurred and when to implement the corresponding contingency plan. Decision rules are an effective tool to specify monitoring requirements (how much and what type of data to collect) to detect specific deviations and link those monitoring requirements to specified contingency plans.

Decision rules define the criteria necessary for triggering action and therefore the core team must precisely define these criteria in order to clearly define the boundaries for taking action. Of particular importance in decision rule development is ensuring data quality and quantity are acceptable to the core team for making a decision of whether a deviation has occurred and the necessity of implementing a contingency plan. Similarly, the core team should determine an acceptable level of uncertainty associated with a decision to terminate the response (i.e., the error that is acceptable in analytical methods to verify remediation goals have been met in order to close the site). A table is useful in linking the expected condition to the evaluation of deviations and development of contingency plans.

e. Discuss the importance of a concise problem statement for ER projects.

The following is taken from U.S. Environmental Protection Agency, Expediting Cleanup through Problem Identification and Definition.

Clear and concise problem definition is essential to environmental restoration projects since it specifies the condition(s) requiring action, bounds the likely response(s) appropriate for consideration, and focuses data collection on reducing key uncertainties to support remedy selection and implementation. Unclear problem definition may result in overly extensive or ineffective investigations, thus extending project schedules and ultimately delaying cleanup. During the execution of a response action, inadequate problem definition can lead to difficulties addressing the problem, addressing the wrong problem (e.g., dealing with a "symptom" rather than the cause), or addressing a problem at significantly greater cost than was technically necessary.

It is the core team (DOE, EPA, and state project managers) which is responsible and accountable for identifying site problems and sufficiently defining them to ensure appropriate remedial measures are selected and implemented.

Specifically, the core team should, to the extent possible, define site problems in terms of:

- environmental media impacted (e.g., groundwater, soil);
- geographic features (e.g., creek bank);
- types of known or suspected wastes (e.g., radioactive sludge, volatile organic compounds);
- threshold exceeded (e.g., Federal maximum contaminant levels (MCLs), risk-based criteria); and
- where appropriate, the type of waste unit (e.g., tank, drum).

During problem identification and definition, the core team should focus on those uncertainties which prevent determination of whether a problem exists (e.g., the core team knows contamination is present but cannot determine if action is required since existing

information does not indicate that a threshold has been exceeded). As problems are determined to exist, the core team also should identify those uncertainties which prevent selection / implementation of an appropriate response action (e.g., insufficient information is available about the range and / or concentration of contaminants which will determine the effectiveness of likely response technologies).

During implementation of the response action, the problem statement (and associated decision rule) defines the conditions that require action and is, therefore, also critical in determining when response objectives have been met.

f. Define the following terms:

- **Risk-based concentration (RBC)**
- **Maximum contaminant level (MCL)**
- **Remedial goal option (RGO)**
- **Background**
- **Action level**
- **Data quality objectives**

RBC

[Note: EPA interchangeably refers to risk-based concentrations as "screening levels" and/or "preliminary remediation goals."]

The following is taken from U.S Environmental Protection Agency, Mid-Atlantic Risk Assessment, Frequently Asked Questions.

Screening levels (SLs) are for the Superfund/RCRA programs. They are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. SLs are considered by EPA to be protective for humans (including sensitive groups) over a lifetime; however, SLs are not always applicable to a particular site and do not address non-human health endpoints, such as ecological impacts. The SLs contained in the SL tables are generic; they are calculated without site-specific information. They may be re-calculated using site-specific data.

The SL's role in site "screening" is to help identify areas, contaminants, and conditions that require further federal attention at a particular site. Generally, at sites where contaminant concentrations fall below SLs, no further action or study is warranted under the Superfund program, so long as the exposure assumptions at a site match those taken into account by the SL calculations. Chemical concentrations above the SL would not automatically designate a site as "dirty" or trigger a response action; however, exceeding an SL suggests that further evaluation of the potential risks by site contaminants is appropriate. SLs are also useful tools for identifying initial cleanup goals at a site. In this role, SLs provide long-term targets to use during the analysis of different remedial alternatives. By developing SLs early in the decision-making process, design staff may be able to streamline the consideration of remedial alternatives.

MCL

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

The MCL is the maximum permissible level of a contaminant in water delivered to any user of a public system. MCLs are enforceable standards.

RGO

The following is taken from U.S. Environmental Protection Agency, Region 4: Superfund, Human Health Risk Assessment Bulletins-- Supplement to RAGS.

Throughout the process of remediating a hazardous waste site, a risk manager uses a progression of increasingly site-specific acceptable media levels, so called "cleanup levels," for the consideration of remedial alternatives. Prior to conducting a risk assessment, preliminary remediation goals are established for hazardous substances believed to be on site based on past disposal practices or recent sampling. EPA suggests that a range of RGOs be presented for the risk manager's use as the last component of the risk assessment. From the RGOs the risk manager chooses remediation levels for the chemicals of concern, and these numbers, derived from RGOs, are addressed in the FS and are included in the proposed plan and the ROD.

There are two methods to calculate RGOs. The first method consists of combining the intake levels of each chemical by a receptor from all appropriate routes (i.e. inhalation, ingestion and dermal) for a particular medium within a use scenario and rearranging the site-specific risk equations to solve for the concentration term.

The second method is a simplified method based on site specific exposure data. The ratio between the target risk and the calculated risk due to a specific chemical in a specific medium is used. This ratio provides the multiplier for the exposure point concentration, and this product is the RGO.

Background

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

Background level is the concentration of a substance in an environmental medium (air, water, or soil) that occurs naturally or is not the result of human activities. In exposure assessment, background level is the concentration of a substance in a defined control area, during a fixed period of time before, during, or after a data-gathering operation.

Action Level

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

In the Superfund program, an action level is the existence of a contaminant concentration in the environment high enough to warrant action or trigger a response under the Superfund Amendments and Reauthorization Act (SARA) and the National Oil and Hazardous Substances Contingency Plan. It can also relate to regulatory levels recommended by EPA for enforcement by the Food and Drug Administration and the U.S. Department of Agriculture when pesticide residues occur in food or feed commodities for reasons other than the direct application of the pesticide. As opposed to tolerances which are established for inadvertent residues resulting from previous legal use or accidental contamination.

Data Quality Objectives

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

Data quality objectives are qualitative and quantitative statements of the overall level of uncertainty that a decision-maker will accept in results or decisions based on environmental data. They provide the statistical framework for planning and managing environmental data operations consistent with users' needs.

28. Environmental restoration personnel shall demonstrate a working-level knowledge of the following DOE directives:

- **DOE P 450.1, General Environmental Protection Program**
- **DOE O 231.1A, Environmental Safety and Health Reporting**

a. Discuss the relationship between Comprehensive Environmental Response, Compensation, and Liability Act and DOE P 450.1, General Environmental Protection Program.

[Note: DOE P 450.1 was canceled by DOE P 450.7. Some of the content of DOE P 450.1 is contained in DOE O 450.1A, *Environmental Protection Program*, and its supporting DOE Guides. See item b of competency 15 for a discussion of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).]

The following is taken from DOE O 450.1A

Each DOE site must develop and implement an EMS. This EMS must be integrated into the site's ISMS developed pursuant to DOE P 450.4, *Safety Management System Policy*, and DOE M 450.4-1, *Integrated Safety Management System Manual*. The EMS must encompass the environmental aspects of site operations and activities, including environmental aspects of energy and transportation functions, and it must promote the long-term stewardship of a site's natural and cultural resources throughout its design and construction, operation, closure, and post-closure life cycle.

The following is taken from DOE G 450.1-1A.

Several sites within the DOE complex are designated as closure sites (i.e., sites that have ceased operations and have identified near term closure activities and schedules). Most of the sites are conducting cleanup and closure activities under the regulatory requirements of CERCLA or other legal agreements with the EPA and/or state environmental agencies.

A site conducting near term closure activities may have most of the elements of the ISMS/EMS available or completed. For example, identification of significant environmental aspects and impacts may have been identified in the RI/FS process under CERCLA. EISs conducted pursuant to the NEPA may also yield important information.

b. Identify and explain the guiding principles for environmental restoration personnel in performing their duties.

[Note: Guiding principles were listed in cancelled DOE P 450.1.]

The following is taken from DOE P 450.7.

It is DOE policy that the safety of our workers, respect for the environment, and protection of the public health and safety are paramount in all that we do. The DOE's ultimate environment, safety, and health goal is zero accidents, work-related injuries and illnesses, regulatory enforcement actions, and reportable environmental releases. This goal is to be pursued through a systematic and concerted process of continuous performance improvements using performance measurement. As DOE and its contractors strive to achieve our ultimate goal, DOE will continue to have "zero tolerance" for accidents that result in life-threatening injuries or major environmental contamination. Furthermore, it is DOE policy that environment, safety, and health goals be established that drive performance excellence, thereby reducing or precluding other work-related injuries and illnesses, and adverse impacts to the public and environment.

c. Discuss the purpose of the annual site environmental report as outlined in DOE O 231.1A, Environmental Safety and Health Reporting.

The following is taken from DOE M 231.1-1A.

Annual Site Environmental Report

Heads of Field Elements will prepare an integrated Annual Site Environmental Report for each calendar year. This report must present summary environmental data in order to:

- Characterize site environmental management performance. It includes data on effluent releases, environmental monitoring, and estimated radiological doses to the public from releases of radioactive material at DOE sites.
- Summarize environmental occurrences and responses reported during the calendar year.
- Confirm compliance with environmental standards and requirements.
- Highlight significant programs and efforts. It includes environmental performance indicators and/or performance measures programs. The breadth and detail of this reporting should reflect the size and extent of programs at a particular site.

The Annual Site Environmental Report for the calendar year will be completed and made available to the public by October 1 of the following year and will be submitted to the Chief Health, Safety and Security Officer at that time.

29. Environmental restoration personnel shall demonstrate a working-level knowledge of the purpose and processes required by the CERCLA as outlined in the National Contingency Plan.

a. Discuss the general purpose of CERCLA as it applies to risks to human health and the environment resulting from releases or threatened releases of hazardous substances into the environment.

The following is taken from U.S. Environmental Protection Agency, Superfund, CERCLA Overview.

CERCLA, commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA:

- established prohibitions and requirements concerning closed and abandoned hazardous waste sites;
- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on the EPA NPL.

CERCLA also enabled the revision of the National Contingency Plan. The National Contingency Plan provided the guidelines and procedures needed to respond to releases and threatened releases of hazardous substances, pollutants, or contaminants. The National Contingency Plan also established the NPL.

b. Identify what constitutes a hazardous substance under CERCLA.

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazardous Substances.

CERCLA hazardous substances are substances that are considered severely harmful to human health and the environment. Many are commonly used substances which are harmless in their normal uses, but are quite dangerous when released. They are defined in terms of those substances either specifically designated as hazardous under the CERCLA, commonly known as the Superfund law, or those substances identified under other laws. In all, the

Superfund law designates more than 800 substances as hazardous, and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release.

Superfund's definition of a hazardous substance includes the following:

- Any element, compound, mixture, solution, or substance designated as hazardous under section 102 of CERCLA.
- Any hazardous substance designated under section 311(b)(2)(a) of the Clean Water Act (CWA), or any toxic pollutant listed under section 307(a) of the CWA. There are over 400 substances designated as either hazardous or toxic under the CWA.
- Any hazardous waste having the characteristics identified or listed under section 3001 of the Resource Conservation and Recovery Act.
- Any hazardous air pollutant (HAP) listed under section 112 of the Clean Air Act (CAA), as amended. There are over 200 substances listed as HAPs under the CAA.
- Any imminently hazardous chemical substance or mixture which the EPA Administrator has "taken action" under section 7 of the Toxic Substances Control Act (TSCA).

Hazardous waste is defined under the RCRA as a solid waste (or combination of solid wastes) which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may: (1) cause or contribute to an increase in mortality or an increase in serious irreversible, or incapacitating illness; or (2) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. In addition, under RCRA, EPA establishes four characteristics that will determine whether a substance is considered hazardous, including ignitability, corrosiveness, reactivity, and toxicity. Any solid waste that exhibits one or more of these characteristics is classified as a hazardous waste under RCRA and, in turn, as a hazardous substance under Superfund.

The terms "hazardous substance" and "pollutant or contaminant" do not include petroleum or natural gas. EPA conducts emergency responses to incidents involving petroleum and non-petroleum oils separately from its responses to hazardous substance incidents. Throughout the Emergency Response Program, the term "hazardous substance" includes pollutants and contaminants.

In addition to the hazardous substances identified under the Superfund law, the Title III amendments to Superfund, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), identify several hundred hazardous substances for their extremely toxic properties. EPA designated them as "extremely hazardous substances" to help focus initial chemical emergency response planning efforts.

c. Explain the intent of the Hazardous Substance Response Trust Fund.

The following is taken from U.S. Environmental Protection Agency, Superfund, CERCLA Overview.

The CERCLA, commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous

substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites.

The following is taken from U.S. Environmental Protection Agency, Superfund, *SARA Overview*.

The SARA amended the CERCLA on October 17, 1986. SARA reflected EPA's experience in administering the complex Superfund program during its first six years and made several important changes and additions to the program including increasing the trust fund size to $8.5 billion.

d. Describe the National Oil and Hazardous Substance Response Trust Fund.

The legislation that created the National Oil and Hazardous Substance Response Trust Fund was repealed on February 25, 2005.

e. Describe when a hazardous substance release is subject to CERCLA reporting requirements.

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Reporting Requirements – Oil Spills and Hazardous Substance Releases.

For releases of hazardous substances, the federal government has established Superfund RQs. If a hazardous substance is released to the environment in an amount that equals or exceeds its RQ, the release must be reported to federal authorities, unless certain reporting exemptions for hazardous substance releases also apply. The federal government has designated several hundred substances as extremely hazardous substances based on their acute lethal toxicity. Under the law, releases of these extremely hazardous substances trigger reporting requirements to state and local authorities, as well as the federal authorities. The owner or operator of a facility that releases an extremely hazardous substance in an amount greater than its established RQ must follow requirements on how to report to the appropriate state and local authorities.

f. Describe the objectives of the national priorities list (NPL) and the hazard ranking system (HRS).

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

The NPL is EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term RA under Superfund. The list is based primarily on the score a site receives from the HRS. EPA is required to update the NPL at least once a year. A site must be on the NPL to receive money from the Trust Fund for RA.

The HRS is the principal screening tool used by EPA to evaluate risks to public health and the environment associated with abandoned or uncontrolled hazardous waste sites. The HRS calculates a score based on the potential of hazardous substances spreading from the site through the air, surface water, or groundwater, and on other factors such as density and

proximity of human population. This score is the primary factor in deciding if the site should be on the NPL and, if so, what ranking it should have compared to other sites on the list.

g. List the processes associated with the hazardous substance response process.

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Responding to an Incident.

When a release or spill occurs, the company responsible for the release, its response contractors, the local fire and police departments, and the local emergency response personnel provide the first line of defense. If needed, a variety of state agencies stand ready to support, assist, or take over response operations if an incident is beyond local capabilities. In cases where a local government or Indian tribe conducts temporary emergency measures in response to a hazardous substance release, but does not have emergency response funds budgeted, EPA operates the Local Governments Reimbursement program that will reimburse local governments or Indian tribes up to $25,000 per incident.

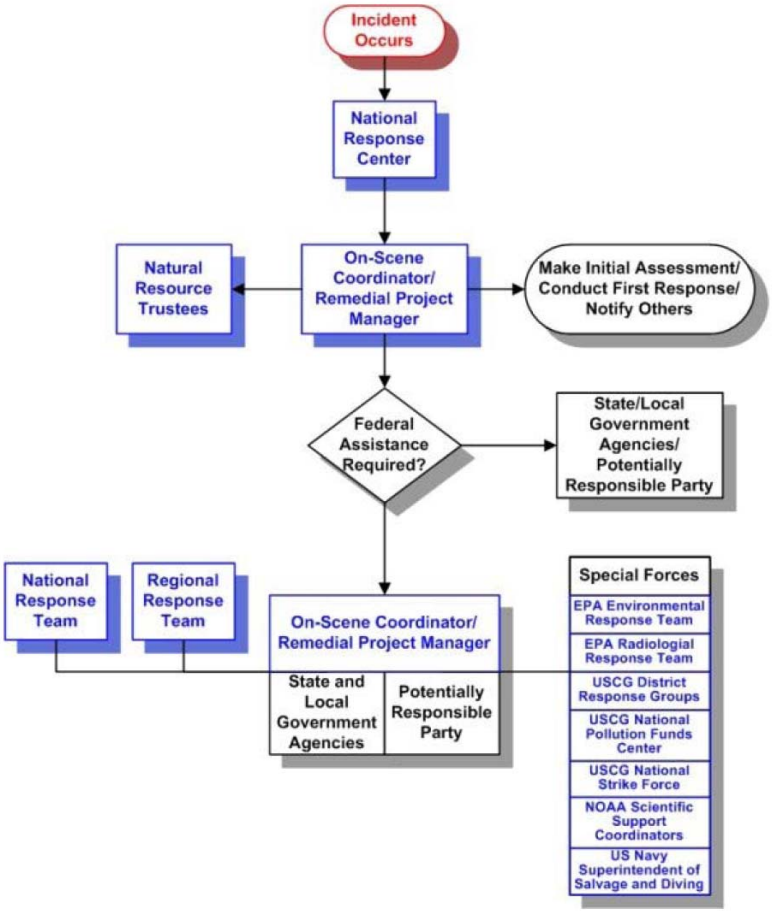
If the amount of a hazardous substance release or oil spill exceeds the established reporting trigger or RQ, the organization responsible for the release or spill is required by law to notify the federal government's National Response Center. Once a report is made, the National Response Center immediately notifies a pre-designated EPA or U.S. Coast Guard On-Scene Coordinator (OSC), based on the location of the spill. The procedure for determining the lead agency is clearly defined so there is no confusion about who is in charge during a response. The OSC determines the status of the local response and monitors the situation to determine whether, or how much, federal involvement is necessary. It is the OSC's job to ensure that the cleanup, whether accomplished by industry, local, state, or federal officials, is appropriate, timely, and minimizes human and environmental damage.

The OSC may determine that the local action is sufficient and that no additional federal action is required. If the incident is large or complex, the federal OSC may remain on the scene to monitor the response and advise on the deployment of personnel and equipment. However, the federal OSC will take command of the response in the following situations:

- if the party responsible for the chemical release or oil spill is unknown or not cooperative;
- if the OSC determines that the spill or release is beyond the capacity of the company, local, or state responders to manage; or
- for oil spills, if the incident is determined to present a substantial threat to public health or welfare due to the size or character of the spill.

The OSC may request additional support to respond to a release or spill, such as additional contractors, technical support from EPA's Environmental Response Team, or Scientific Support Coordinators from EPA or the National Oceanic and Atmospheric Administration. The OSC also may seek support from the Regional Response Team (RRT) to access special expertise or to provide additional logistical support. In addition, the National Response Team stands ready to provide backup policy and logistical support to the OSC and the RRT during an incident. The National Response System Flowchart shown in figure 23 provides a quick reference for how additional resources are brought into the response.

The federal government will remain involved at the oil spill site following response actions to undertake a number of activities, including assessing damages, supporting restoration efforts, recovering response costs from the parties responsible for the spill, and, if necessary, enforcing the liability and penalty provisions of the CWA, as amended by the Oil Pollution Act (OPA) of 1990.



Source: U.S. Environmental Protection Agency, Emergency Management, Responding to an Incident

Figure 23. National Response System flowchart

h. Discuss the Department's CERCLA policies and procedures.

The following is taken from DOE, Environmental Management, Background: Section 120 of CERCLA.

The SARA Amendments to CERCLA (1986) enacted a section devoted to the cleanup of federal facilities (section 120). Under section 120(a)(1), CERCLA specifies that Federal departments, agencies, and instrumentalities must comply with CERCLA in the same manner and to the same extent as non-governmental entities.

Section 120(c) of CERCLA requires the EPA to compile information about contaminated sites at Federal facilities and to enter the information into the Federal Agency Hazardous Waste Compliance Docket. The docket must also include information about Federal facilities where hazardous wastes are generated and managed under sections 3005 and 3010 of the RCRA, even if these facilities are not contaminated.

Once sites are listed on the compliance docket, timetables are prepared for addressing problems. Within 18 months, preliminary assessments (PAs) and site inspections are required. The facility is then scored under the HRS to place it on the NPL. If listed, the facility must begin an RI/FS within six months. During the RI/FS stage, consultation/negotiation with EPA must occur. Within 180 days after the completion of EPA's review, Federal agencies must enter into interagency agreements (IAGs) with the EPA for expeditious completion of RA at the facility. The contents of IAGs must include:

- a review of alternative RAs and selection of an RA;
- a schedule for the completion of the RA; and
- arrangements for long-term operation and maintenance of the facility.

30. Environmental restoration personnel shall demonstrate a working-level knowledge of the following document development, review, and assessment under CERCLA.

- **Remedial investigation feasibility study work plan**
- **Investigative work plan report**
- **Permits**
- **Records of decision**
- **Remedial design**
- **Remedial action work plan**
- **Consent order and settlement agreement**
- **Proposed plan**
- **Applicable, relevant and appropriate requirements (ARARs)**

a. Describe the process for developing the elements of the listed documents.

Remedial Investigation Feasibility Study Work Plan

The following is taken from U.S. Environmental Protection Agency, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.

The work plan documents the decision and evaluation made during the scoping process and presents anticipated future tasks. It also serves as a valuable tool for assigning responsibilities and setting the project's schedule and cost.

Five elements (Introduction, Site Background and Physical Setting, Initial Evaluation, Work Plan Rationale, and RI/FS Tasks) typically are included in a work plan.

1. Introduction - A general explanation of the reasons for the RI/FS and the expected results or goals of the RI/FS process are presented.
2. Site Background and Physical Setting – The current understanding of the physical setting of the site, the site history, and the existing information on the condition of the site are described.

3. Initial Evaluation - The conceptual site model developed during scoping is presented, describing the potential migration and exposure pathways and the preliminary assessment of human health and environmental impacts.
4. Work Plan Rationale - Data requirements for both the risk assessment and the alternatives evaluation identified during the formulation of the data quality objectives are documented, and the work plan approach is presented to illustrate how the activities will satisfy data needs.
5. RI/FS Tasks - The tasks to be performed during the RI/FS are presented. This description incorporates RI site characterization tasks identified in the QA project plan and the field sampling plan, the data evaluation methods identified during scoping, and the preliminary determination of tasks to be conducted after site characterization.

Investigative Work Plan Report

The following is taken from U.S. Environmental Protection Agency, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA.

The RI report consists of the following:

- introduction (site description and history, previous investigation information)
- study area investigation activities (surface features, contaminant source investigations, meteorological investigations, surface-water and sediment investigations, geological investigations, soil and vadose zone investigations, groundwater investigations, human population surveys, ecological investigations)
- physical characteristics of the study area (surface features, meteorology, surface-water hydrology, geology, soils, hydrogeology, demography and land use, ecology)
- nature and extent of contamination (sources, soils and vadose zone, groundwater, surface water and sediments, air)
- contaminant fate and transport (potential routes of migration, contaminant persistence, contaminant migration)
- baseline risk assessment (human health evaluation, environmental evaluation)
- summary and conclusions

Permits

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Water Act.

All DOE facilities that discharge wastewaters to either a surface water body or a publicly owned treatment work (POTW) must comply with the CWA. Facilities that directly discharge wastewaters must obtain a National Pollutant Discharge Elimination System (NPDES) permit. This permit specifies the discharge standards and monitoring and reporting requirements that the facility must achieve for each point source or outfall.

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System (NPDES), NPDES Permit Program Basics, Water Permitting 101.

All NPDES permits, at a minimum, consist of the following general sections:

- Cover Page - Typically contains the name and location of the permittee, a statement authorizing the discharge, and the specific locations for which a discharge is authorized.
- Effluent Limits - The primary mechanism for controlling discharges of pollutants to receiving waters. Permit writers spend a majority of their time deriving appropriate effluent limits based on applicable technology-based and water quality-based standards.
- Monitoring and Reporting Requirements - Used to characterize waste streams and receiving waters, evaluate wastewater treatment efficiency, and determine compliance with permit conditions.
- Special Conditions - Conditions developed to supplement effluent limit guidelines. Examples include: best management practices, additional monitoring activities, ambient stream surveys, and toxicity reduction evaluations.
- Standard Conditions - Preestablished conditions that apply to all NPDES permits and delineate the legal, administrative, and procedural requirements of the permit. Every permit contains these five basic sections, but the contents of sections will vary depending on whether the permit is issued to a municipal or industrial facility and whether the permit will be issued to an individual facility or to multiple dischargers (i.e., a general permit).

Records of Decision

The following is taken from U.S. Environmental Protection Agency, Superfund, Cleanup Process.

The ROD is a public document that explains which cleanup alternatives will be used to clean up a Superfund site. The ROD for sites listed on the NPL is created from information generated during the RI/FS.

A ROD contains site history, site description, site characteristics, community participation, enforcement activities, past and present activities, contaminated media, the contaminants present, scope and role of response action and the remedy selected for cleanup.

Remedial Design

The following is taken from U.S. Environmental Protection Agency, Superfund, Cleanup Process.

Remedial design (RD) is the phase in Superfund site cleanup where the technical specifications for cleanup remedies and technologies are designed. RA follows the RD phase and involves the actual construction or implementation phase of Superfund site cleanup. The RD/RA is based on the specifications described in the ROD.

Remedial Action Work Plan

The following is taken from DOE, Office of Health, Safety, and Security, CERCLA Remedial Action Site Closure Guidance, Pre-Remedial Activities.

Once the remedy is selected and the ROD is completed, DOE will begin the design of the full-scale remedy. Although EPA has not promulgated regulations that provide specific requirements for the plans developed during the RD phase of a CERCLA response, the following represent common elements to most RDs:

- review the objectives established for the RA;
- revise the Community Relations Plan;
- develop an RD Strategy Document;
- prepare a complete set of detailed construction drawings, document all engineering calculations, and prepare a complete set of process flow diagrams for the RA;
- develop a list of and specifications for all equipment and materials required to implement the RA;
- prepare operational guidance for the remedy;
- develop a cost estimate and proposed schedule;
- revise the QA Project Plan used during the RI/FS and Develop a Construction QA Plan; and
- revise the Health and Safety Plan used during the RI/FS.

Once the RD process is complete, DOE should provide these documents to EPA and the State for their review. These documents are usually identified in the Federal Facility Agreement (FFA) or Consent Agreement. EPA and the State will review and either approve or reject the documents. Only when EPA and the State have approved the documents should actual construction of the remedy begin.

Consent Order and Settlement Agreement

The following is taken from U.S. Environmental Protection Agency, Cleanup Enforcement, Types of Superfund Settlements.

EPA negotiates cleanup agreements with potentially responsible parties. These agreements are in the form of administrative orders on consent, administrative agreements, or judicial consent decrees. Negotiations are based on model settlement documents, which can be modified to fit site circumstances.

Administrative orders on consent are legal documents that formalize an agreement between EPA and one or more potentially responsible parties to address some or all of the parties' responsibility for a site. EPA uses Administrative orders on consent for removal activity (short-term cleanup), investigation, and remedy design work. EPA also uses administrative orders on consent for cost recovery when the payments are made as part of an agreement for work and for *de minimis* cash out payments. Administrative orders on consent do not require approval by the court.

Administrative agreements are legal documents that formalize an agreement between EPA and one or more potentially responsible parties to reimburse EPA for costs already incurred, or for costs to be incurred at a Superfund site. Administrative agreements do not require approval by the court. All types of payment agreements that do not include performance of work are generally written as administrative agreements.

Judicial consent decrees are legal agreements entered into by the United States (through EPA and the Department of Justice) and potentially responsible parties and lodged with a court.

Consent decrees are the only settlement type that EPA can use for the final cleanup phase (remedial action) at a Superfund site. EPA also uses consent decrees to recover cleanup costs in cost recovery and cash out settlements and on rare occasions to perform removal work or RI/FS. A consent decree is final when it is approved and entered by a U.S. district court.

EPA prefers that potentially responsible parties do the work of investigating, cleaning up, and maintaining the cleanup of Superfund sites. EPA negotiates an agreement (in the form of an administrative order on consent or consent decree) with the potentially responsible parties that outlines the work that is to be done. The term "work agreement" is used to cover a variety of agreements that involve the potentially responsible party doing the work (versus EPA doing the work). The most common agreements are for site investigation (RI/FS), short-term clean up (removal action), and long-term cleanup (RD/RA).

When EPA performs investigations or cleanup work, it can recover these costs from potentially responsible parties through a cost recovery agreement. When an agreement only addresses reimbursing EPA costs, it is referred to as a cost recovery agreement and takes the form of an administrative agreement. Administrative orders on consent for work may include a provision for the potentially responsible parties to reimburse EPA for past work costs and will include a provision for the potentially responsible party to pay EPA's future costs in overseeing the potentially responsible parties' work (considered "cost recovery" because such costs are billed to potentially responsible parties after they are incurred).

There are a few situations when it is more appropriate for potentially responsible parties not to be involved in performing work at a site. In such cases, EPA may negotiate a cash out agreement with the potentially responsible party, where the potentially responsible party pays an appropriate amount of estimated site costs in advance of the work being done. That money will be used to help pay for the clean up. Agreements to cash out *de minimis* potentially responsible parties are done as agreements orders on consent, and agreements to cash out peripheral and other ability to pay parties are done as administrative agreements. All types of cost recovery and cash out agreements may be done as consent decrees.

Proposed Plan

[Note: The proposed plan is now referred to as the record of decision (ROD) by EPA.]

ARARs

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

ARARs are any state or federal statute that pertains to protection of human life and the environment in addressing specific conditions or use of a particular cleanup technology at a Superfund site.

The following is taken from DOE, Office of Health, Safety, and Security, ARARs Frequently Asked Questions.

Section 121(d) of the CERCLA as amended by the SARA, requires attainment of federal and state ARARs.

Applicable requirements mean those cleanup standards, standards of control, or other substantive environmental protection requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting law that specifically address a hazardous substance, pollutant, contaminant, RA, location, or other circumstance found at a CERCLA site. Therefore, an applicable requirement is a requirement that a private party would have to comply with by law if the same action were being undertaken apart from CERCLA authority. All jurisdictional prerequisites of the requirement must be met in order for the requirement to be applicable.

If a requirement is not applicable, it still may be relevant and appropriate. Relevant and appropriate requirements mean those cleanup standards that address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. A requirement that is relevant and appropriate may not meet one or more jurisdictional prerequisites for applicability but still make sense at the site, given the circumstances of the site and the release. Once a requirement is relevant and appropriate, it must be complied with as if it were applicable.

EPA classified ARARs into three categories: (1) chemical-specific, (2) location-specific, and (3) action-specific, depending on whether the requirement is triggered by the presence or emission of a chemical, by a vulnerable or protected location, or by a particular action.

- Chemical-specific ARARs are typically health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, are expressed as numerical values that represent cleanup standards (i.e., the acceptable concentration of a chemical at the site). Examples of chemical-specific ARARs include non-zero maximum contaminant level goals (MCLGs) and MCLs established under the Safe Drinking Water Act (SDWA), and federal water quality criteria established under the CWA. As a general rule, if more than one chemical-specific ARAR exists for a particular contaminant, the most stringent should be applied.
- Location-specific ARARs are restrictions on the concentration of hazardous substances or the conduct of activities in environmentally sensitive areas. An example of a location-specific restriction on the concentration of hazardous substances is the RCRA land disposal restrictions (LDR) prohibiting hazardous waste placement into or onto the land (e.g., landfills and salt domes) until waste-specific treatment standards are met. Examples of restrictions on the conduct of activities in environmentally sensitive areas include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.
- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions or conditions taken with respect to specific hazardous substances. An example is the LDR requirement to recover mercury from high inorganic mercury nonwastewaters using roasting or retorting. Action-specific ARARs do not determine the remedial alternative; rather, they indicate how a selected alternative must be achieved. RCRA and the CWA provide the majority of action-specific ARARs.

b. Discuss the format that is to be used and the guidance available for developing each document.

See item a of competency 30.

c. Discuss the requirements set forth for each document and describe the process for reviewing these documents.

RI/FS Work Plan
See item a of competency 30.

Investigative Work Plan Report
See item a of competency 30.

Permits
See item a of competency 30.

RODs
See item a of competency 30.

Remedial Design
See item a of competency 30.

Remedial Action Work Plan
See item a of competency 30.

Consent Order and Settlement Agreement
See item a of competency 30.

Proposed Plan
See item a of competency 30.

ARARs
See item a of competency 30.

d. Conduct a review or assessment of at least three of the above listed documents.

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

31. Environmental restoration personnel shall demonstrate a working-level knowledge of the (CAA) and implementing regulations.

a. Discuss the application of the Clean Air Act to the DOE or its facilities.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Air Act.

The modern CAA was enacted in 1970 and has served as a model for other Federal environmental legislation. As amended in 1977 and 1990, the statute is sweeping in scope, affecting thousands of air pollution sources across many industries. The regulatory programs authorized by the CAA fall into several categories. First, all new and existing stationary sources of air pollution are subject to air quality regulation through state implementation

plans. Second, new sources are subject to more stringent emission control technology and permitting requirements. Third, the Act addresses specific pollution problems, including hazardous air pollution, visibility impairment, and acid rain.

The new 1990 law contains titles that:

- strengthen measures for attaining air quality standards (Title I),
- set forth provisions relating to mobile sources (Title II),
- expand the regulation of HAPs (Title III),
- require substantial reductions in power plant emissions for control of acid rain (Title IV),
- establish operating permits for all major sources of air pollution (Title V),
- establish provisions for stratospheric ozone protection (Title VI), and
- expand enforcement powers and penalties (Title VII).

The CAA Amendments have far-reaching effects not only on environmental activities at DOE facilities, but also on procurement, maintenance, and motor vehicle operation activities.

b. Identify the National Ambient Air Quality Standards (primary and secondary) and the National Emission Standards for Hazardous Air Pollutants (NESHAP).

The following is taken from U.S. Environmental Protection Agency, Air and Radiation, National Ambient Air Quality Standards (NAAQS).

The CAA requires EPA to set NAAQS (40 CFR 50, "National Primary and Secondary Ambient Air Quality Standards") for pollutants considered harmful to public health and the environment. The CAA established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set NAAQS for six principal pollutants, which are called "criteria" pollutants. These pollutants are carbon monoxide, lead, nitrogen dioxide, particulate matter ≤ 10 micrometers in diameter (PM_{10}), particulate matter ≤ 2.5 micrometers in diameter ($PM_{2.5}$), ozone, and sulfur dioxide.

The following is taken from Idaho Department of Environmental Quality, Air Toxics: Hazardous Air Pollutants and MACT Standards (Clean Air Act Section 112).

HAPs are pollutants that cause or may cause cancer or other serious health problems, such as reproductive effects or birth defects, or adverse environmental and ecological effects.

The CAA requires the EPA to regulate emissions of 187 HAPs from a published list of industrial sources called "source categories." EPA has identified source categories that must meet technology requirements to control HAP emissions and is required to develop regulations for all industries that emit one or more of the HAPs in significant quantities. These standards are called the NESHAP.

The NESHAP are air quality standards, issued under section 112 of the CAA (40 CFR 63), which regulate 187 HAPs from particular industrial sources. These industry-based NESHAPs are also called maximum achievable control technology (MACT) standards. MACT standards are designed to reduce HAP emissions to a maximum achievable degree, taking into consideration the cost of reductions and other factors.

The following is taken from U.S. Environmental Protection Agency, Green Book, Definitions.

A nonattainment area is any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.

An attainment area is any area that meets the national primary or secondary ambient air quality standard for the pollutant.

An unclassifiable is any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

c. Describe the requirements for permitting, monitoring, and reporting prescribed in the regulations that implement Title V of the Clean Air Act.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Air Act.

The New Source Performance Standards (NSPS) set minimum nationwide emission limitations for classes of facilities. The NSPS are set at levels that reflect the degree of control achievable through the application of the best system of continuous emission reduction that has been adequately demonstrated for that category of sources. The NSPS must take into consideration the cost of achieving such emissions reduction, any non-air quality health and environmental impacts, and energy requirements.

The facility classes of most interest to DOE are those applicable to fossil-fuel-fired steam generators for which construction was begun after August 17, 1971 (40 CFR 60, subpart D, "Standards of Performance for Fossil-Fuel-Fired Steam Generators for Which Construction Is Commenced After August 17, 1971"), and electric utility steam generating units for which construction was begun after September 18, 1978.

Title V of the CAA Amendments established a federal permitting program which is to be administered by the states. Title V declared that after the effective date of any approved or promulgated permit program, it will be unlawful to operate a major source, affected source, or any other source (including an area source) subject to regulation under the CAA unless the source complies with all air quality requirements and has an operating permit. Under previous federal law, construction permits were required only for new sources; existing sources were left largely unpermitted, unless the state elected to require an operating permit. The CAA Amendments eliminated the distinction between new and existing sources; all major sources are now required to have an operating permit.

The new permit program will be fee-based, and federal facilities are explicitly required to pay a fee or charge imposed by a state or local agency to defray the costs of its air pollution regulatory program. The statute sets minimum rates for such fees at $25 per ton of each regulated pollutant, up to 4,000 tons per year. The EPA Administrator may set other amounts to adequately reflect reasonable costs of the permit program.

The following sources must have a permit to operate:

- major HAP sources,
- major sources under NAAQS,
- all affected sources under Title IV (control of acid rain), and
- all sources subject to NSPS.

On July 21, 1992, EPA promulgated a rule (57 Federal Register 32250) that defined the minimum elements of a state operating permit program. This rule applies directly to the states, but ultimately to sources.

d. Describe the prevention of significant deterioration (PSD) regarding the requirements established by the Clean Air Act.

The following is taken from U.S. Environmental Protection Agency, New Source Review, Prevention of Significant Deterioration (PSD) Basic Information.

PSD applies to new major sources or major modifications at existing sources for pollutants where the area the source is located is in attainment or unclassifiable with the NAAQS. It requires the following:

- installation of the Best Available Control Technology (BACT),
- an air quality analysis,
- an additional impacts analysis, and
- public involvement.

BACT is an emissions limitation which is based on the maximum degree of control that can be achieved. It is a case-by-case decision that considers energy, environmental, and economic impact. BACT can be add-on control equipment or modification of the production processes or methods. This includes fuel cleaning or treatment and innovative fuel combustion techniques. BACT may be a design, equipment, work practice, or operational standard if imposition of an emissions standard is infeasible.

The main purpose of the air quality analysis is to demonstrate that new emissions emitted from a proposed major stationary source or major modification, in conjunction with other applicable emissions increases and decreases from existing sources, will not cause or contribute to a violation of any applicable NAAQS or PSD increment.

PSD increment is the amount of pollution an area is allowed to increase. PSD increments prevent the air quality in clean areas from deteriorating to the level set by the NAAQS. The NAAQS is a maximum allowable concentration “ceiling.” A PSD increment, on the other hand, is the maximum allowable increase in concentration that is allowed to occur above a baseline concentration for a pollutant. The baseline concentration is defined for each pollutant and, in general, is the ambient concentration existing at the time that the first

complete PSD permit application affecting the area is submitted. Significant deterioration is said to occur when the amount of new pollution would exceed the applicable PSD increment.

PSD does not prevent sources from increasing emissions. Instead, PSD is designed to:

- protect public health and welfare;
- preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value;
- insure that economic growth will occur in a manner consistent with the preservation of existing clean air resources; and
- assure that any decision to permit increased air pollution in any area to which this section applies is made only after careful evaluation of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process.

e. Discuss the modeling requirements for monitoring and close calculation air dispersion in the National Emissions Standards for Hazardous Air Pollutants, Standards for Radionuclides.

The following is taken from U.S. Environmental Protection Agency, Radiation Protection, Subpart H: Department of Energy Facilities.

Subpart H protects the public and the environment from the hazards of radionuclide emissions, other than radon, from DOE facilities. The regulation pertaining to subpart H is 40 CFR 61. It sets a limit on the emission of radionuclides that ensures no member of the public receives an effective dose equivalent of more than 10 mrem/year. Radon emissions are addressed in Subpart Q.

The DOE administers about 30 major and other smaller facilities. Owners/operators of each facility have specific responsibilities:

- continuously monitoring and tracking emissions;
- calculating the highest effective dose equivalent to a member of the public at an offsite point where there is a residence, school, business or office; and
- reporting this information annually to EPA, their EPA Regional office, or the state.

Calculations use data from all release points with a potential to contribute an effective dose equivalent of more than 0.1mrem/year.

All sampling must follow EPA-approved procedures. Computer models CAP-88 and AIRDOS-PC are approved for calculating effective dose equivalents, and EPA may approve other procedures with advanced notice. EPA's COMPLY model may be used under some conditions.

f. Identify the major sources and emission limitations per the Clean Air Act, Title I.

The following is taken from U.S. Environmental Protection Agency, Region 9: Air Programs, Air Permits, Definitions of Selected Permitting Terms.

Major source is a term used to determine the applicability of permitting regulations to specific sources. What constitutes a major source varies according to what type of permit is involved, the pollutant(s) being emitted, and the attainment designation of the area where the source is located. In general, a source is major if its emissions exceed certain thresholds that are defined in terms of tons per year. Under Title V of the CAA, any source that emits or has the potential to emit 100 tons per year or more of any criteria air pollutant is a major source and must obtain a Title V operating permit.

g. Discuss the New Source Performance Standards (40 CFR 60).

The following is taken from U.S. Environmental Protection Agency, Region 7: Air Program, New Source Performance Standards.

Section 111 of the CAA, Standards of Performance of New Stationary Sources, requires EPA to establish federal emission standards for source categories which cause or contribute significantly to air pollution. These standards are intended to promote use of the best air pollution control technologies, taking into account the cost of such technology and any other non-air quality, health, and environmental impact and energy requirements. These standards apply to sources which have been constructed or modified since the proposal of the standard. Since December 23, 1971, the Administrator has promulgated 88 such standards and associated test methods. These standards can be found in 40 CFR 60.

Generally, state and local air pollution control agencies are responsible for implementation, compliance assistance, and enforcement of the NSPS. EPA retains concurrent enforcement authority and is also available to provide technical assistance when a state or local agency seeks help. EPA also retains a few of the NSPS responsibilities, such as the ability to approve alternative monitoring methods, to maintain a minimum level of national consistency.

h. Discuss the potential liabilities of the Department of Energy and its contractors inherent in the enforcement of environmental regulations (i.e., compliance orders, enforcement actions, fines and penalties, and provisions for civil suits).

The following is taken from U.S. Environmental Protection Agency, Compliance and Enforcement at Federal Facilities, Federal Facilities Enforcement.

EPA has explicit authority to assess fines at federal facilities violating environmental statutes. EPA's federal facilities civil enforcement program helps protect public health and the environment by assuring that federal facilities comply with federal environmental laws.

EPA also enforces environmental cleanup requirements at federal facilities. Cleanup enforcement authority is derived from several statutes: the CERCLA (or Superfund), the RCRA, including the UST program, and the OPA, a part of the CWA. These statutes, as well as Presidential Executive Orders, require federal facilities to clean up environmental contamination at their facilities.

CERCLA requires federal agencies to investigate and clean up contamination at their facilities. Federal facilities that are significantly contaminated may be placed on the CERCLA NPL. For such facilities CERCLA requires that EPA and the federal facility enter into an IAG (IAG -- sometimes called Federal Facility Agreement) to govern the cleanup to

be done. States often are signatories to these IAGs, too. Once an IAG has been signed, EPA monitors the cleanup schedule and milestones and oversees its requirements to ensure proper implementation of each cleanup. EPA can assess stipulated penalties for non-compliance with the terms of the IAG including missed milestones.

i. Discuss the National Emissions Standards for Hazardous Air Pollutants air emission limits.

The following is taken from U.S. Environmental Protection Agency, Technology Transfer Network Air Toxics Website, Section 112(g) of the Clean Air Act.

Under the CAA Amendments of 1990, EPA is required to regulate large or major industrial facilities that emit one or more of 188 listed HAPs. Air toxics are those pollutants that are known or suspected of causing cancer or other serious health effects, such as developmental effects or birth defects. On July 16, 1992, EPA published a list of industrial source categories that emit one or more of these HAPs. EPA is required to develop standards for listed industrial categories of major sources (those that have the potential to emit 10 tons/year or more of a listed pollutant or 25 tons/year or more of a combination of pollutants) that will require the application of stringent controls, known as MACT.

j. Describe the Clean Air Act, Title V, Stratospheric Ozone Protection criteria.

[Note: The correct Title for Stratospheric Ozone Protection is Title VI.]

The following is taken from U.S. Environmental Protection Agency, Ozone Layer Depletion, Basic Information.

As part of the United States' commitment to implementing the Montreal Protocol, the U.S. Congress amended America's CAA adding provisions under Title VI for protection of the ozone layer. Most importantly, the amended Act required the gradual end to the production of chemicals that deplete the ozone layer. EPA has created several regulatory programs to address numerous issues, including:

- ending the production of ozone-depleting substances;
- ensuring that refrigerants and halon fire extinguishing agents are recycled properly;
- identifying safe and effective alternatives to ozone-depleting substances;
- banning the release of ozone-depleting refrigerants during the service, maintenance, and disposal of air conditioners and other refrigeration equipment; and
- requiring that manufacturers label products either containing or made with the most harmful ozone depleting substances.

k. Discuss the requirements for control technologies specified in the Clean Air Act and the purpose and function of various air pollutant abatement technologies.

The following is taken from U.S. Environmental Protection Agency, Clean Air Act.

The EPA will provide information on air pollution control techniques. This information shall include data relating to the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology. Such information shall include such data as are available on available technology and alternative

methods of prevention and control of air pollution. Such information shall also include data on alternative fuels, processes, and operating methods which will result in elimination or significant reduction of emissions. The EPA shall make information regarding emission control technology available to the states and to the general public through a central database.

l. Describe the four basic classes of air pollutant abatement/control technologies specified in the Clean Air Act.

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, Glossary, Abbreviations, and Acronyms.

The classes of air pollutant abatement/control technologies are:

Maximum Available Control Technology (MACT): The emission standard for sources of air pollution requiring the maximum reduction of hazardous emissions, taking cost and feasibility into account. Under the CAA Amendments of 1990, the MACT must not be less than the average emission level achieved by controls on the best performing 12 percent of existing sources, by category of industrial and utility sources.

Reasonably Available Control Technology: Control technology that is reasonably available and both technologically and economically feasible. Usually applied to existing sources in nonattainment areas; in most cases is less stringent than NSPS.

Best Available Control Technology (BACT): An emission limitation based on the maximum degree of emission reduction (considering energy, environmental, and economic impacts) achievable through application of production processes and available methods, systems, and techniques. BACT does not permit emissions in excess of those allowed under any applicable CAA provisions. Use of the BACT concept is allowable on a case by case basis for major new or modified emissions sources in attainment areas and applies to each regulated pollutant.

Lowest Achievable Emission Rate: Under the CAA, the rate of emissions that reflects (1) the most stringent emission limitation in the implementation plan of any state for such source unless the owner or operator demonstrates such limitations are not achievable; or (2) the most stringent emissions limitation achieved in practice, whichever is more stringent. A proposed new or modified source may not emit pollutants in excess of existing new source standards.

m. Describe, in general, the purpose and function of various pollution abatement equipment/technologies.

- **Cyclones**
- **Baghouse**
- **Electrostatic precipitator**
- **Thermal oxidizer**
- **Scrubber**
- **Adsorption**

The following is taken from U.S. Environmental Protection Agency, Technology Transfer Network, Clean Air Technology Center, General Information on CATC Products.

Cyclones

Cyclones use inertia to remove particles from the gas stream. The cyclone imparts centrifugal force on the gas stream, usually within a conical shaped chamber. Particles in the gas stream are forced toward the cyclone walls by the centrifugal force of the spinning gas but are opposed by the fluid drag force of the gas traveling through and out of the cyclone. For large particles, inertial momentum overcomes the fluid drag force so that the particles reach the cyclone walls and are collected. For small particles, the fluid drag force overwhelms the inertial momentum and causes these particles to leave the cyclone with the exiting gas. Gravity also causes the larger particles that reach the cyclone walls to travel down into a bottom hopper.

Baghouse

In a fabric filter, flue gas is passed through a tightly woven or felted fabric, causing particulate matter (PM) in the flue gas to be collected on the fabric by sieving and other mechanisms. Fabric filters may be in the form of sheets, cartridges, or bags, with a number of the individual fabric filter units housed together in a group. Bags are most common type of fabric filter. The dust cake that forms on the filter from the collected PM can significantly increase collection efficiency. Fabric filters are frequently referred to as baghouses because the fabric is usually configured in cylindrical bags. Bags may be 6 to 9 m (20 to 30 ft) long and 12.7 to 30.5 cm (5 to 12 inches) in diameter. Groups of bags are placed in isolable compartments to allow cleaning of the bags or replacement of some of the bags without shutting down the entire fabric filter.

Electrostatic Precipitator

An electrostatic precipitator is a particulate control device that uses electrical forces to move particles entrained within an exhaust stream onto collection surfaces. The entrained particles are given an electrical charge when they pass through a corona, a region where gaseous ions flow. Electrodes in the center of the flow lane are maintained at high voltage and generate the electrical field that forces the particles to the collector walls. In dry electrostatic precipitators, the collectors are agitated by various mechanical means to dislodge the particulate, which slides downward into a hopper where they are collected.

Thermal Oxidizer

Incineration, or thermal oxidation, is the process of oxidizing combustible materials by raising the temperature of the material above its auto-ignition point in the presence of oxygen and maintaining it at high temperature for sufficient time to complete combustion to carbon dioxide and water. Time, temperature, turbulence (for mixing), and the availability of oxygen all affect the rate and efficiency of the combustion process. These factors provide the basic design parameters for VOC oxidation systems.

Scrubber

Spray scrubbers consist of empty cylindrical or rectangular chambers in which the gas stream is contacted with liquid droplets generated by spray nozzles. A common form is a spray tower, in which the gas flows upward through a bank or successive banks of spray nozzles. Similar arrangements are sometimes used in spray chambers with horizontal gas flow. Water is the most common solvent used to remove inorganic contaminants. Pollutant removal may

be enhanced by manipulating the chemistry of the absorbing solution so that it reacts with the pollutant.

Wet scrubbers generate waste in the form of a slurry. This creates the need for both wastewater treatment and solid waste disposal. Initially, the slurry is treated to separate the solid waste from the water. The treated water can then be reused or discharged. Once the water is removed, the remaining waste will be in the form of a solid or sludge. If the solid waste is inert and nontoxic, it can generally be landfilled. Hazardous wastes will have more stringent procedures for disposal.

Adsorption

In air pollution control, adsorption is employed to remove VOCs from low to medium concentration gas streams when a stringent outlet concentration must be met and/or recovery of the VOC is desired. Adsorption itself is a phenomenon where gas molecules passing through a bed of solid particles are selectively held there by attractive forces which are weaker and less specific than those of chemical bonds. Most gases can be removed from the adsorbent by heating to a sufficiently high temperature, usually via steam or (increasingly) hot combustion gases, or by reducing the pressure to a sufficiently low value (vacuum desorption).

32. Environmental restoration personnel shall demonstrate a working-level knowledge of the following laws as related to the environmental medium of water:

- **Clean Water Act (CWA)**
- **Safe Drinking Water Act (SDWA)**
- **Resource Conservation and Recovery Act (RCRA) (groundwater provisions)**
- **National Groundwater Protection Policy (NGPP)**
- **Oil Pollution Act (OPA)**
- **Rivers and Harbors Act (RHA)**

a. Discuss the application of the listed laws to the Department of Energy and its facilities.

CWA

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Water Act.

The CWA, formerly known as the Federal Water Pollution Control Act, intended to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (section 101). To accomplish that objective, the act aimed to attain a level of water quality that "provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water" by 1983 and to eliminate the discharge of pollutants into navigable waters by 1985.

The CWA has five main elements: (1) a system of minimum national effluent standards for each industry, (2) water quality standards, (3) a discharge permit program that translates these standards into enforceable limits, (4) provisions for special problems such as toxic chemicals and oil spills, and (5) a revolving construction loan program for POTWs.

The CWA requires the EPA to establish effluent limitations for the amounts of specific pollutants that may be discharged by municipal sewage plants and industrial facilities. The two-step approach to setting the standards includes: (1) establishing a nationwide, base-level treatment through an assessment of what is technologically and economically achievable for a particular industry and (2) requiring more stringent levels of treatment for specific plants if necessary to achieve water quality objectives for the particular body of water into which that plant discharges. For example, EPA sets limits based on water quality to control pollution in waters designated by the states for drinking, swimming, or fishing.

The primary method by which the act imposes limitations on pollutant discharges is the nationwide permit program established under section 402 and referred to as the NPDES. Under the NPDES program any person responsible for the discharge of a pollutant or pollutants into any waters of the United States from any point source must apply for and obtain a permit.

The sections of the act most relevant to DOE deal with requirements for technology-based effluent limitations (section 301), water quality-based effluent limitations (section 302), individual control strategies for toxic pollutants [section 304(l)], NSPS (section 306), regulation of toxics and indirect discharges (section 307), federal facilities' pollution control (provisions for presidential exemption) (section 313), thermal discharges (section 316), permits under the NPDES (section 402), and permits for the discharge of dredged or fill materials into navigable waters (section 404).

All DOE facilities that discharge wastewaters to either a surface water body or a POTW must comply with the CWA. Facilities that directly discharge wastewaters must obtain an NPDES permit (section 402). This permit specifies the discharge standards and monitoring and reporting requirements that the facility must achieve for each point source or outfall.

For industrial facilities that existed before July 1, 1977, the "best conventional technology" must be applied to the discharge stream for conventional pollutants (section 301). For facilities built after July 1, 1977, so-called "new" facilities, the National Standards of Performance apply.

When either an existing or new facility discharges toxic pollutants, more stringent controls are required. The regulations for toxics are based on "best available technology economically achievable" (section 307). In all cases NPDES permits can be made even more stringent than the above standards if the specific water body in question requires lower discharges of pollutants to meet water quality standards (sections 302 and 303).

Facilities that discharge to a municipal or publicly-owned wastewater system do not have to obtain an NPDES permit, but they must follow the pretreatment regulations (section 307). These pretreatment regulations require that industrial dischargers remove or treat all pollutants that could pass through the municipal system untreated or could adversely affect the performance of the municipal system. Toxic pollutants are the primary concern of these regulations.

SDWA

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Safe Drinking Water Act.

In 1974 Congress enacted the SDWA to manage potential contamination threats to groundwater. The act instructed EPA to establish a national program to prevent underground injections of contaminated fluids that would endanger drinking water sources. Primary drinking water standards promulgated under the SDWA apply to drinking water "at the tap" as delivered by public water supply systems. As such, the standards apply directly to those DOE facilities that meet the definition of a public water supply system (e.g., the DOE Oak Ridge Reservation is a public water supply system because it provides water to the City of Oak Ridge).

Of equal significance to DOE is that the drinking water standards are used to determine groundwater protection regulations under a number of other statutes (e.g., RCRA). Therefore, many of the SDWA requirements apply to DOE activities, especially cleanup of contaminated sites and storage and disposal of materials containing radionuclides, inorganic chemicals, organic chemicals, and hazardous wastes.

Section 1447 of the SDWA states that each federal agency having jurisdiction over a federally owned or maintained public water system must comply with all federal, state, and local requirements; administrative authorities; and processes and sanctions regarding the provision of safe drinking water. Sections 1412, 1414, and 1445(a) of the SDWA authorize drinking water regulations and specific operating procedures for public water systems.

RCRA (Groundwater Provisions)

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Resource Conservation and Recovery Act.

In 1976 Congress enacted RCRA. RCRA established a system for managing non-hazardous and hazardous solid wastes in an environmentally sound manner. Specifically, it provides for the management of hazardous wastes from the point of origin to the point of final disposal. The Hazardous and Solid Waste Amendments (HSWA) of 1984 both expanded the scope and increased the requirements of RCRA. One of its initiatives states that facilities are required to satisfy minimum technology requirements (i.e., liners and leachate collection systems) for surface impoundments, waste piles, land treatment units, and landfills (40 CFR 264/265, subparts K-N) to prevent hazardous wastes and/or constituents from migrating into the groundwater and to allow releases to be detected when they occur [section 3004(o)].

Chapter I [implemented at 40 CFR 280, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)"] was added by HSWA. It established a program to regulate the three to five million USTs in the United States to prevent their leaking. Within the scope of Subtitle I, tanks containing radioactive materials and wastes (i.e., source, special, and by-product materials) subject to Atomic Energy Act (AEA) requirements are deferred from having to comply with UST regulations [40 CFR 280.10(c)(2)]. On the other hand, tanks containing mixtures of radioactive materials and hazardous wastes (i.e., "mixed" waste) are subject to RCRA subtitle C requirements due to the presence of the RCRA hazardous waste component.

NGPP

The following is taken from U.S. Environmental Protection Agency, *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action*.

The intent of the EPA NGPP of 1991 has now been incorporated into the EPA *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action*. This handbook contains the EPA's latest interpretation of policies on such topics as cleanup goals, the role of groundwater use, point of compliance, source control, and monitored natural attenuation. This handbook ties 15 different topics together with an overall Groundwater Protection and Cleanup Strategy that emphasizes a phased, results-based approach to cleaning up contaminated groundwater. Although the handbook focuses on RCRA Corrective Action, it is also useful for other groundwater protection and cleanup issues.

DOE's Ground Water Protection Program is discussed in item f of competency 14.

OPA

The following is taken from U.S. Environmental Protection Agency, Summary of the Oil Pollution Act.

The OPA of 1990 streamlined and strengthened EPA's ability to prevent and respond to catastrophic oil spills. A trust fund financed by a tax on oil is available to clean up spills when the responsible party is incapable or unwilling to do so. The OPA requires oil storage facilities and vessels to submit to the Federal government plans detailing how they will respond to large discharges. EPA has published regulations for above ground storage facilities; the U.S. Coast Guard has done so for oil tankers. The OPA also requires the development of Area Contingency Plans to prepare and plan for oil spill response on a regional scale. Facilities that store and use oil must submit plans to respond to a worst-case discharge of oil and to a substantial threat of such a discharge.

RHA

The following is taken from Pollution Issues, Rivers and Harbors Appropriations Act.

The modern form of the RHA was enacted in 1890, and amended by the Rivers and Harbors Appropriation Act of 1899, also known as the Refuse Act. It was amended again several times during the twentieth century. In general, the act prohibits the dumping of refuse into navigable waters or the creation of any navigational obstruction, and it regulates the construction of wharves, piers, jetties, bulkheads, and similar structures in ports, rivers, canals, or other areas used for navigation.

Although the CWA now predominates in the regulation of surface water pollution, the RHA remains valid law. It provides useful supplemental jurisdiction for addressing certain kinds of water pollution, and especially for dredge and fill activities. As with the CWA, discharges of refuse or fill material, or construction activities in waterways, require a permit. The permitting agency is the Army Corps of Engineers rather than the EPA, reflecting the essentially navigational concerns of this legislation.

b. Describe water quality criteria and stream use classification identified in the Clean Water Act.

[Note: Stream use classification is not a term used in the CWA. Designated uses or use classifications may be what was intended.]

Water quality criteria and designated uses are components of water quality standards that are mandated in the CWA. Section 303 of the CWA requires states to develop water quality standards. Water quality criteria, designated uses (stream use classifications), and antidegradation (a classifications related topic) are defined in the following sections of this KSA, and the interrelationship of these concepts are discussed under water quality standards. Although it is a separate component of the CWA, technology-based effluent standards play a similar role in permitting and are briefly described at the end of this KSA.

Water Quality Criteria

The following is taken from U.S. Environmental Protection Agency, Water Quality Criteria.

Section 304(a)(1) of the CWA requires the EPA to develop criteria for water quality that accurately reflects the latest scientific knowledge. These criteria are based solely on data and scientific judgments on pollutant concentrations and environmental or human health effects. Section 304(a) also provides guidance to states and tribes in adopting water quality standards. Criteria are developed for the protection of aquatic life as well as for human health. EPA's compilation of national recommended water quality criteria is presented as a summary table containing recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants.

Designated Uses (Stream Use Classifications)

The following is taken from U.S. Environmental Protection Agency, Water Quality Standards, What are Water Quality Standards? Designated Uses.

The water quality standards regulation requires that States and authorized Indian Tribes specify appropriate water uses to be achieved and protected. Appropriate uses are identified by taking into consideration the use and value of the water body for public water supply, for protection of fish, shellfish, and wildlife, and for recreational, agricultural, industrial, and navigational purposes. In designating uses for a water body, States and Tribes examine the suitability of a water body for the uses based on the physical, chemical, and biological characteristics of the water body, its geographical setting and scenic qualities, and economic considerations. Each water body does not necessarily require a unique set of uses. Instead, the characteristics necessary to support a use can be identified so that water bodies having those characteristics can be grouped together as supporting particular uses.

Where water quality standards specify designated uses less than those which are presently being attained, the State or Tribe is required to revise its standards to reflect the uses actually being attained.

A use attainability analysis must be conducted for any water body with designated uses that do not include the fishable/swimmable goal uses identified in the section 101(a)(2) of the Act. Such water bodies must be reexamined every three years to determine if new

information has become available that would warrant a revision of the standard. If new information indicates that fishable/swimmable uses can be attained, such uses must be designated.

Antidegradation Policy

The following is taken from U.S. Environmental Protection Agency, Water Quality Standards, What are Water Quality Standards? Antidegradation Policy.

Water quality standards include an antidegradation policy and implementation method. The water quality standards regulation requires States and Tribes to establish a three-tiered antidegradation program.

Tier 1 maintains and protects existing uses and water quality conditions necessary to support such uses. An existing use can be established by demonstrating that fishing, swimming, or other uses have actually occurred since November 28, 1975, or that the water quality is suitable to allow such uses to occur. Where an existing use is established, it must be protected even if it is not listed in the water quality standards as a designated use. Tier 1 requirements are applicable to all surface waters.

Tier 2 maintains and protects "high quality" waters -- water bodies where existing conditions are better than necessary to support CWA section 101(a)(2) "fishable/swimmable" uses. Water quality can be lowered in such waters. However, state and tribal tier 2 programs identify procedures that must be followed and questions that must be answered before a reduction in water quality can be allowed. In no case may water quality be lowered to a level which would interfere with existing or designated uses.

Tier 3 maintains and protects water quality in outstanding national resource waters (ONRWs). Except for certain temporary changes, water quality cannot be lowered in such waters. ONRWs generally include the highest quality waters of the United States. However, the ONRW classification also offers special protection for waters of exceptional ecological significance, i.e., those which are important, unique, or sensitive ecologically. Decisions regarding which water bodies qualify to be ONRWs are made by States and authorized Indian Tribes.

Antidegradation implementation procedures identify the steps and questions that must be addressed when regulated activities are proposed that may affect water quality. The specific steps to be followed depend upon which tier or tiers of antidegradation apply.

Water Quality Standards

The following is taken from U.S. Environmental Protection Agency, Water Quality Standards, What are Water Quality Standards?

Water quality standards are the foundation of the water quality-based control program mandated by the CWA. Water Quality Standards define the goals for a waterbody by designating its uses, setting criteria to protect those uses, and establishing provisions to protect water quality from pollutants. A water quality standard consists of four basic elements:

- designated uses of the water body (e.g., recreation, water supply, aquatic life, agriculture),
- water quality criteria to protect designated uses (numeric pollutant concentrations and narrative requirements),
- an antidegradation policy to maintain and protect existing uses and high quality waters, and
- general policies addressing implementation issues (e.g., low flows, variances, mixing zones).

Technology-Based Effluent Standards

The following is taken from U.S. Environmental Protection Agency, Effluent Limitation Guidelines, Treatment Technology.

EPA does not require the use or installation of particular technologies. Rather, the CWA, section 301, requires operators to meet certain performance standards that are based on the proper operation of pollution prevention and treatment technologies identified by EPA during an effluent guidelines and pretreatment standards rulemaking.

The EPA's National Risk Management Research Laboratory provides a review of the removal and/or destruction of chemicals in various types of media, including water, soil, debris, sludge and sediment. The treatability data summarizes the types of treatment used to treat specific compounds, the type of waste/wastewater treated, the size of the study/plant, and the treatment levels achieved. The data base currently contains over 1200 chemical compounds and almost 16,000 sets of treatability data.

The EPA's Vendor Information Database contains information on more than 1,200 pollution prevention equipment, products, or services. This website allows you to find listings using a free text method, or by selecting from the various equipment categories.

The goal of EPA's ETV Program is to further environmental protection by substantially accelerating the acceptance and use of improved, cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

The EPA's Environmental Technology Opportunities Portal links you to programs that help fund development of new environmental technologies and offers information on existing environmental technologies. EPA offers several programs to assist the public and private sectors in developing and commercializing new environmental technologies. This is done through financial, testing and verification support, and by promoting use and acceptance of a technology through collaborative, incentive, partnership and advocacy, and information programs.

c. Discuss the Clean Water Act permitting requirements including monitoring and reporting. Include in the discussion, National Pollutant Discharge Elimination System Program and the Rivers and Harbors Act Dredge/Fill material permits.

NPDES

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System (NPDES), NPDES Permit Program Basics, Water Permitting 101.

Under the NPDES Program, all facilities which discharge pollutants from any point source into waters of the United States are required to obtain an NPDES permit. A permit is typically a license for a facility to discharge a specified amount of a pollutant into a receiving water under certain conditions; however, permits may also authorize facilities to process, incinerate, landfill, or beneficially use sewage sludge. The two basic types of NPDES permits issued are individual and general permits.

An individual permit is a permit specifically tailored to an individual facility. Once a facility submits the appropriate application(s), the permitting authority develops a permit for that particular facility based on the information contained in the permit application (e.g., type of activity, nature of discharge, receiving water quality). The authority issues the permit to the facility for a specific time period (not to exceed five years) with a requirement that the facility reapply prior to the expiration date.

A general permit covers multiple facilities within a specific category. General permits may offer a cost-effective option for permitting agencies because of the large number of facilities that can be covered under a single permit. General permits, however, may only be issued to dischargers within a specific geographical area such as city, county, or state political boundaries; designated planning areas; sewer districts or sewer authorities; state highway systems; standard metropolitan statistical areas; or urbanized areas.

All NPDES permits, at a minimum, consist of the following general sections:

- Cover Page - Typically contains the name and location of the permittee, a statement authorizing the discharge, and the specific locations for which a discharge is authorized.
- Effluent Limits - The primary mechanism for controlling discharges of pollutants to receiving waters. Permit writers spend a majority of their time deriving appropriate effluent limits based on applicable technology-based and water quality-based standards.
- Monitoring and Reporting Requirements - Used to characterize waste streams and receiving waters, evaluate wastewater treatment efficiency, and determine compliance with permit conditions.
- Special Conditions - Conditions developed to supplement effluent limit guidelines. Examples include: best management practices, additional monitoring activities, ambient stream surveys, and toxicity reduction evaluations.
- Standard Conditions - Preestablished conditions that apply to all NPDES permits and delineate the legal, administrative, and procedural requirements of the permit. Every permit contains these five basic sections, but the contents of sections will vary depending on whether the permit is issued to a municipal or industrial facility and

whether the permit will be issued to an individual facility or to multiple dischargers (i.e., a general permit).

Following the development of effluent limits, the permit writer develops appropriate monitoring and reporting conditions, facility-specific special conditions, and includes standard conditions that are the same for all permits.

EPA is authorized under the CWA to directly implement the NPDES Program. EPA, however, may authorize States, Territories, or Tribes to implement all or parts of the national program. States, Territories, or Tribes applying for authorization may seek the authority to implement the base program (i.e., issue individual NPDES permits for industrial and municipal sources) and additional parts of the national program including permitting of federal facilities, administering the National Pretreatment Program, and/or administering the Municipal Sewage Sludge Program. The EPA retains oversight responsibility.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Water Act.

Section 502(6) of the CWA defines the term pollutant to include radioactive materials. In its implementing regulations (40 CFR 122, "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System" in particular), however, EPA refined the definition of pollutant to exclude radioactive materials regulated under the AEA of 1954, as amended. Thus, although the CWA and its implementing regulations clearly apply to naturally occurring (e.g., radium) and accelerator-produced radioisotopes, they do not apply to source, byproduct, or special nuclear materials (SNMs) as defined by the AEA. Therefore, DOE discharges containing radioactive materials that are not source, byproduct, or SNMs are regulated under the CWA by EPA or states having an EPA-authorized permit program.

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System (NPDES), NPDES Permit Program Basics.

Other NPDES permit programs that can impact DOE site operations include, combined sewer overflows, pretreatment, sanitary sewer overflows, and stormwater.

Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body. During periods of heavy rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called combined sewer overflows, contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris. EPA policies provide methods and guidance on minimizing these overflows and their impact.

POTWs collect wastewater from homes, commercial buildings, and industrial facilities and transport it via a series of pipes to the treatment plant. Here, the POTW removes harmful organisms and other contaminants from the sewage so it can be discharged safely into the

receiving stream. Generally, POTWs are designed to treat domestic sewage only. However, POTWs also receive wastewater from industrial (non-domestic) users. The General Pretreatment Regulations establish responsibilities of Federal, state, and local government, industry and the public to implement Pretreatment Standards to control pollutants from the industrial users which may pass through or interfere with POTW treatment processes or which may contaminate sewage sludge.

Properly designed, operated, and maintained sanitary sewer systems are meant to collect and transport all of the sewage that flows into them to a POTW. However, occasional unintentional discharges of raw sewage from municipal sanitary sewers occur in almost every system. These types of discharges are called sanitary sewer overflows. In addition to requiring proper operation and maintenance, NPDES permits for operators of sanitary sewer systems also require immediate reporting, extensive record keeping, and public notification for unauthorized sewage overflows.

Stormwater runoff is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated. The NPDES stormwater permitting program is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters.

Dredge/Fill Material Permits

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Clean Water Act.

Section 404 of the CWA enables the Corps of Engineers in the Department of the Army to issue permits for the discharge of dredged or fill materials into waters of the United States at specific sites. The Corps specifies a site by applying guidelines promulgated by the EPA (40 CFR 230, “Section 404(B)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material”). Further, any proposal to dump dredged or fill materials into the ocean must comply with the dumping criteria set forth in regulations implementing section 227.13 of the Marine Protection, Research, and Sanctuaries Act.

Under Subsection 404(c) of the CWA, EPA can prohibit or limit the use of a proposed disposal site or withdraw an already designated site, under regulations codified at 40 CFR 231, “Section 404(c) Procedures.” This determination may occur if EPA foresees unacceptable impacts on municipal water supplies, shellfish beds, fishery areas, or wildlife and recreational areas. However, such a determination must be made after consultation with both the Corps and the permit applicant.

A significant feature of section 404 is that the Corps may issue general permits on a state, regional, or nationwide basis for dredging or fill activities that are similar in nature and cause only minimal individual and cumulative adverse impacts. General permits are granted for a period not to exceed five years. The Corps issues individual permits for actions that have a potential for significant environmental impacts.

Various dredged and fill material disposal activities are excluded from CWA section 404 permitting requirements unless the action (1) alters the use of navigable waters or (2) impairs the flow of those waters. Actions thus excluded from permitting that may pertain to DOE projects include maintenance or emergency construction on damaged dams, transportation structures and related structures, drainage ditch maintenance, construction of temporary sediment basins at construction sites, and temporary road construction for moving mining equipment.

d. Describe the reporting requirements identified in the Clean Water Act.

The following is taken from 40 CFR 122.41.

The NPDES permittee shall report any noncompliance (release) which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

The following is taken from U.S. Environmental Protection Agency, *Clean Water Act.*

Reporting requirements resulting from the CWA mainly stem from the NPDES program. In addition to NPDES, the CWA contains a provision in section 311 to immediately report the discharge of oil or a hazardous substance to the U.S. government, CWA section 311(b)(5). This section generally applies to spills rather than permitted discharges. Stemming from section 311 are regulations for determining reportable quantities for hazardous substances outlined in 40 CFR 117, "Determination of Reportable Quantities for Hazardous Substances." This regulation stipulates the quantity in pounds for numerous hazardous substances that would trigger the reporting requirement.

e. Discuss the standards for maximum contaminant levels (primary and secondary) contained in the Safe Drinking Water Act.

The following is taken from U.S. Environmental Protection Agency, Ground Water and Drinking Water, Setting Standards for Safe Drinking Water.

National Primary Drinking Water Standards

A National Primary Drinking Water Regulation primary standard is a legally enforceable standard that applies to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water. They take the form of MCLs or treatment techniques. EPA maintains a list of these contaminants and their associated maximum contaminant level. This list includes microorganisms, disinfectants, disinfection byproducts, inorganic chemicals, organic chemicals, and radionuclides.

The 1996 Amendments to Safe Drinking Water Act require EPA to go through several steps to determine, first, whether setting a standard is appropriate for a particular contaminant, and if so, what the standard should be. These determinations are based on health risks and the likelihood that the contaminant occurs in public water systems at levels of concern.

After reviewing health effects studies, EPA sets an MCLG, the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. Once the MCLG is determined, EPA sets an enforceable standard. In most cases, the standard is an MCL, the maximum permissible level of a contaminant in water which is delivered to any user of a public water system.

The MCL is set as close to the MCLG as feasible, which the Safe Drinking Water Act defines as the level that may be achieved with the use of the best available technology, treatment techniques, and other means which EPA finds are available (after examination for efficiency under field conditions and not solely under laboratory conditions) are available, taking cost into consideration.

When there is no reliable method that is economically and technically feasible to measure a contaminant at particularly low concentrations, a treatment technique is set rather than an MCL. A treatment technique is an enforceable procedure or level of technological performance which public water systems must follow to ensure control of a contaminant.

National Secondary Drinking Water Standards

National Secondary Drinking Water Regulations or secondary standards are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

f. Describe the provisions for notification to consumers as outlined by the Safe Drinking Water Act.

The following is taken from U.S. Environmental Protection Agency, Public Notification, Fact Sheet: Drinking Water Public Notification.

Public notification helps to ensure that consumers will always know if there is a problem with their drinking water. These notices immediately alert consumers if there is a serious problem with their drinking water (e.g., a boil water emergency). For less serious problems (e.g., a missed water test), water suppliers must notify consumers in a timely manner.

Depending on the severity of the situation, water suppliers have from 24 hours to one year to notify their customers after a violation occurs. EPA specifies three categories, or tiers, of public notification. Depending on what tier a violation situation falls into, water systems have different amounts of time to distribute the notice and different ways to deliver the notice:

- Immediate Notice (Tier 1): Any time a situation occurs where there is the potential for human health to be immediately impacted, water suppliers have 24 hours to notify

people who may drink the water of the situation. Water suppliers must use media outlets such as television, radio, and newspapers, post their notice in public places, or personally deliver a notice to their customers in these situations.

- Notice as soon as possible (Tier 2): Any time a water system provides water with levels of a contaminant that exceed EPA or state standards or that hasn't been treated properly, but that doesn't pose an immediate risk to human health, the water system must notify its customers as soon as possible, but within 30 days of the violation. Notice may be provided via the media, posting, or through the mail.
- Annual Notice (Tier 3): When water systems violate a drinking water standard that does not have a direct impact on human health (for example, failing to take a required sample on time) the water supplier has up to a year to provide a notice of this situation to its customers. The extra time gives water suppliers the opportunity to consolidate these notices and send them with annual water quality reports (consumer confidence reports).

All notices must include:

- a description of the violation that occurred, including the potential health effects;
- the population at risk and if alternate water supplies need to be used;
- what the water system is doing to correct the problem;
- actions consumers can take;
- when the violation occurred and when the system expects it to be resolved;
- how to contact the water system for more information; and
- language encouraging broader distribution of the notice.

g. Discuss the Safe Drinking Water Act Underground Injection Control Program.

The following is taken from U.S. Environmental Protection Agency, Underground Injection Control Program (UIC).

An injection well is a device that places fluid deep underground into porous rock formations, such as sandstone or limestone, or into or below the shallow soil layer. These fluids may be water, wastewater, brine (salt water), or water mixed with chemicals. The UIC Program defines an injection well as a bored, drilled, or driven shaft, or a dug hole that is deeper than it is wide, an improved sinkhole, or a subsurface fluid distribution system.

The five classes of injection wells are based on similarity in the fluids injected, activities, construction, injection depth, design, and operating techniques. This categorization ensures that wells with common design and operating techniques are required to meet appropriate performance criteria for protecting underground sources of drinking water (USDWs).

Class I wells inject hazardous wastes, industrial non-hazardous liquids, or municipal wastewater beneath the lowermost USDW.

Class II wells inject brines and other fluids associated with oil and gas production, and hydrocarbons for storage. They inject beneath the lowermost USDW.

Class III wells inject fluids associated with solution mining of minerals beneath the lowermost USDW.

Class IV wells inject hazardous or radioactive wastes into or above USDWs. These wells are banned unless authorized under a federal or state groundwater remediation project.

Class V wells include all injection wells not included in Classes I-IV. In general, Class V wells inject non-hazardous fluids into or above USDWs and are typically shallow, on-site disposal systems. However, there are some deep Class V wells that inject below USDWs.

The UIC Program protects USDWs from endangerment by setting minimum requirements for injection wells. All injection must be authorized under either general rules or specific permits. Injection well owners and operators may not site, construct, operate, maintain, convert, plug, abandon, or conduct any other injection activity that endangers USDWs. The purpose of the UIC requirements is to:

- ensure that injected fluids stay within the well and the intended injection zone, or
- mandate that fluids that are directly or indirectly injected into a USDW do not cause a public water system to violate drinking water standards or otherwise adversely affect public health.

Additional information on UIC permits is contained in 40 CFR 144 through 40 CFR 148.

h. Describe the standard methods for the examination of water and wastewater.

The following is taken from U.S. Environmental Protection Agency, Analytical Methods Developed by the Office of Ground Water and Drinking Water.

The Office of Ground Water and Drinking Water's Technical Support Center is one of the EPA offices responsible for developing analytical methods for drinking water. The Technical Support Center developed, or participated in the development of, many methods for determining the concentrations of chemical and microbial contaminants in drinking water. Many of the chemical methods developed by Technical Support Center are approved for analyses of compliance or unregulated contaminant monitoring samples under the SDWA. Laboratories can verify that a method is approved by checking 40 CFR 141, "National Primary Drinking Water Regulations."

The following is taken from U.S. Environmental Protection Agency, Clean Water Act Analytical Methods.

The EPA publishes laboratory analytical methods that are used by industries and municipalities to analyze the chemical, physical and biological components of wastewater and other environmental samples that are required by regulations under the authority of the CWA. Most of these methods are published as regulations in 40 CFR 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants."

The analytical methods promulgated under the authority of section 304(h) of the CWA are sometimes referred to as the "304(h)" or "Part 136" methods. The methods measure chemical and biological pollutants in media, such as wastewater, ambient water, sediment, and biosolids (sewage sludge). These various CWA methods are tested in a variety of labs and matrices. In addition to Part 136 methods, some approved methods are published or incorporated by reference at 40 CFR Parts 401-503, approved industry-specific methods.

i. Discuss the Safe Drinking Water Act permitting requirements.

The following is taken from U.S. Environmental Protection Agency, Agriculture, Safe Water Drinking Act.

The UIC program (40 CFR Parts 144-148) is a permit program that protects USDWs by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA LDR standards. The UIC permit program is primarily state-enforced, since EPA has authorized all but a few states to administer the program.

j. Describe the aquifer protection (sole source) regulations of the Safe Drinking Water Act.

The following is taken from U.S. Environmental Protection Agency, Agriculture, Safe Water Drinking Act.

The SDWA provides for a federally implemented sole source aquifer program, which prohibits federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area.

The following is taken from 40 CFR 149.

The criteria for critical aquifer protection areas are as follows:

- all or part of an area that was designated as a sole or principal source aquifer prior to June 19, 1986, and for which an area-wide groundwater quality protection plan was approved under section 208 of the CWA
- all or part of a major recharge area to a sole or principle source aquifer, designated before June 19, 1988, for which:
  - the sole or principle source aquifer is particularly vulnerable to contamination due to hydrogeologic characteristics
  - contamination is reasonable or likely to occur unless a program to reduce or prevent such contamination is implemented
  - in the absence of any program to reduce or prevent contamination, reasonably foreseeable contamination would result in significant costs resulting from using alternate drinking water supplies as well as economic and social costs

Any person, group, or community, may petition for an aquifer to be designated as a sole source. The EPA regional administrator reviews these petitions and makes a final determination of whether or not the aquifer is a sole source.

k. Discuss the cross-connection identification/elimination and back-flow prevention regulations described in the Safe Drinking Water Act.

[Note: The SDWA does not address cross-connection identification/elimination and backflow prevention. These requirements are implemented on a state and local level.]

The following is provided for information only and is taken from U.S. Environmental Protection Agency, Potential Contamination Due to Cross-Connections and Backflow and the Associated Health Risks.

Within distribution systems there exist points called cross-connections where nonpotable water can be connected to potable sources. These cross-connections can provide a pathway for backflow of nonpotable water into potable sources. Backflow can occur either because of reduced pressure in the distribution system (termed backsiphonage) or the presence of increased pressure from a nonpotable source (termed backpressure). Backsiphonage may be caused by a variety of circumstances, such as main breaks, flushing, pump failure, or emergency firefighting water drawdown. Backpressure may occur when heating/cooling, waste disposal, or industrial manufacturing systems are connected to potable supplies and the pressure in the external system exceeds the pressure in the distribution system. Both situations act to change the direction of water, which normally flows from the distribution system to the customer, so that nonpotable and potentially contaminated water from industrial, commercial, or residential sites flows back into the distribution system through a cross-connection. During incidents of backflow, these chemical and biological contaminants have caused illness and deaths, with contamination affecting a number of service connections. The number of incidents actually reported is believed to be a small percentage of the total number of backflow incidents in the United States.

The risk posed by backflow can be mitigated through preventive and corrective measures. For example, preventative measures include the installation of backflow prevention devices and assemblies and formal programs to seek out and correct cross-connections within the distribution system and, in some cases, within individual service connections. Corrective measures include activities such as flushing and cleaning the distribution system after a detected incident. These may help mitigate any further adverse health effects from any contaminants that may remain in the distribution system.

I. Describe the groundwater protection requirements applicable to interim status Resource Conservation and Recovery Act's (RCRA) facilities in RCRA's implementing regulations, Subpart F of 40 CFR 265.

The following is taken from U.S. Environmental Protection Agency, RCRA, Superfund & EPCRA Call Center Training Module, Groundwater Monitoring (40 CFR Parts 264/265, Subpart F).

The requirements for groundwater monitoring programs for interim status treatment, storage, and disposal facilities (TSDFs) with regulated units are found in 40 CFR 265, subpart F. The interim status groundwater monitoring program requires the owner and operator of a surface impoundment, landfill, or land treatment facility used to manage hazardous waste to implement a groundwater monitoring program so that releases of hazardous waste from these units to groundwater are detected and measures are implemented to remediate the contamination as soon as possible.

Development and Installation of a Monitoring System

To determine existing groundwater conditions at an interim status facility, the owner and operator must install at least one well hydraulically upgradient from the waste management

area. The well(s) must be able to accurately represent the background quality of groundwater in the uppermost aquifer. The owner and operator must install at least three wells hydraulically downgradient at the limit of the waste management area, which are able to immediately detect any statistically significant evidence of a release. A sampling and analysis plan must specify procedures for sample collection, sample preservation, analytical procedures, and chain-of-custody control.

In addition to establishing the monitoring wells the owners and operators must prepare an outline of a more detailed groundwater monitoring program. This program must be able to determine whether hazardous waste or hazardous waste constituents have leached into the uppermost aquifer in a quantity that would cause a significant change in groundwater quality. This additional program is often referred to as a groundwater assessment program. The groundwater assessment program must be implemented when there has been a statistically significant increase (increase or decrease for pH) of an indicator parameter over background levels. The groundwater assessment program is designed to determine whether hazardous constituents have entered the groundwater. Once the owner and operator make this determination, they have to establish the rate, extent of migration, and the concentrations of constituents in the plume.

Background Monitoring

Background monitoring must be conducted for one year to establish the basis for comparing all future data. Parameters to monitor include drinking water parameters, groundwater quality parameters, and groundwater contamination parameters. Background monitoring must be conducted and reported on a quarterly basis.

Routine Monitoring and Evaluation

The purpose of routine monitoring and evaluation is to examine groundwater for elevated levels of indicator constituents. Routine monitoring includes semiannual monitoring for groundwater contamination indicator parameters, and annual monitoring for groundwater quality indicator parameters. Drinking water parameters are not included in routine monitoring. The results of routine monitoring are examined statistically (compared with background monitoring). If an elevation (or decrease in pH) occurs, the owner/operator must notify the regional administrator within seven days. In addition, the owner/operator must implement the groundwater assessment program. Reports on routine monitoring must be submitted annually along with well elevations and changes in background level. Monitoring must continue for the life of the facility.

Reporting Requirements

Reporting requirements are addressed under 40 CFR 265.94, “Recordkeeping and Reporting.” The owner/operator must keep records of monitoring analyses, including groundwater elevation, throughout the active life of the facility and post-closure period. Reports must also be submitted the first year when initial background concentrations are being established for the facility. Quarterly sampling results must be submitted within 15 days after completing sampling. Annual reports must include the concentrations or values of parameters specified in 40 CFR 265.92, “Sampling and Analysis,” (b)(3), and must separately identify any significant differences from initial background analyses found in

upgradient wells. If contamination to groundwater occurs during operations, the annual report must address rate of migration of hazardous waste constituents.

m. Describe the groundwater protection requirements applicable to permitted RCRA facilities in RCRA's implementing regulations, subpart F of 40 CFR 264, and in the facility's permit.

The following is taken from 40 CFR 264.97.

The groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths to yield groundwater samples from the uppermost aquifer that:

- represent the quality of backgroundwater that has not been affected by leakage from a regulated unit;
- represent the quality of groundwater passing the point of compliance; and
- allow for the detection of contamination when hazardous waste or hazardous constituents have migrated from the waste management area to the uppermost aquifer.

The following is taken from U.S. Environmental Protection Agency, RCRA, Superfund & EPCRA Call Center Training Module, Groundwater Monitoring (40 CFR Parts 264/265, Subpart F).

All permitted facilities must comply with 40 CFR 264, subpart F, for releases from solid waste management units. Facilities with permitted regulated units (landfills, surface impoundments, waste piles, or land treatment units) must conduct groundwater monitoring to detect, characterize, and respond to releases of hazardous waste or hazardous waste constituents into the uppermost aquifer. There are three stages to 40 CFR 264, subpart F, groundwater monitoring and follow-up activities:

- detection monitoring - to detect if a release has occurred,
- compliance monitoring - to determine if groundwater protection standards have been exceeded once a release has occurred, and
- corrective action - to remediate a release to the uppermost aquifer.

Detection Monitoring

The goal of a detection monitoring program is to detect and characterize any release of hazardous constituents from a regulated unit into the uppermost aquifer. The detection monitoring system must be installed at the point of compliance and adhere to the basic requirements applicable to all groundwater monitoring systems. The owner and operator must monitor for certain indicator parameters and any other specific waste constituents or reaction products that would provide a reliable indication of the presence of hazardous constituents in groundwater at the point of compliance. The Regional Administrator will designate in the facility's permit what constituents or parameters must be monitored and will specify the frequency for collecting samples and for conducting statistical tests.

Compliance Monitoring

Once it is established that a release has occurred, the owner and operator must institute a compliance monitoring program. The goal of the compliance monitoring program is to ensure that the amount of hazardous constituents released into the uppermost aquifer does not

exceed acceptable levels. Once those levels are exceeded, the owner and operator must initiate corrective action. The compliance monitoring program establishes routine monitoring (at least semiannually) to determine if groundwater protection standards have been exceeded.

Corrective Action

The goal of the Subpart F corrective action program is to bring regulated units back into compliance with groundwater protection standards. The Subpart F corrective action program seeks to accomplish this goal by requiring that the owner and operator either remove the hazardous constituents or treat them in place. The Regional Administrator determines the time period by which the owner and operator must begin corrective action and the specific measures undertaken to achieve corrective action. Examples of corrective measures include excavation, stabilization, solidification, and source control. The owner and operator must also conduct corrective action to remove or treat in place any hazardous constituents between the point of compliance and the downgradient property boundary, and beyond the facility boundary where necessary to protect human health and the environment.

n. Discuss the storm water management aspects of the National Pollutant Discharge Elimination Standard (NPDES).

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System (NPDES), Stormwater Basic Information.

The NPDES Stormwater Program regulates stormwater discharges from three potential sources: municipal separate storm sewer systems, construction activities, and industrial activities. Most stormwater discharges are considered point sources, and operators of these sources may be required to receive an NPDES permit before they can discharge. This permitting mechanism is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters. Most states are authorized to implement the NPDES Stormwater Program and administer their own permitting programs.

Municipal Separate Storm Sewer Systems (MS4s)

Polluted stormwater runoff is commonly transported through MS4s, from which it is often discharged untreated into local waterbodies. To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an NPDES permit and develop a stormwater management program. MS4s are usually covered by a general permit.

Construction Activities

Operators of construction sites that are one acre or larger (including smaller sites that are part of a larger common plan of development) may be required to obtain authorization to discharge stormwater under an NPDES construction stormwater permit. Where EPA is the permitting authority, operators must meet the requirements of EPA's Construction General Permit. The Construction General Permit outlines a set of provisions construction operators must follow to comply with the requirements of the NPDES stormwater regulations.

Industrial Activities

Industrial sectors may require authorization under an NPDES industrial stormwater permit for stormwater discharges. Where EPA is the permitting authority, operators must meet the requirements of EPA's Multi-Sector General Permit (MSGP). The MSGP specifies steps that facility operators must take prior to becoming eligible for permit coverage, including submitting a Notice of Intent (NOI), installing stormwater control measures to minimize pollutants in stormwater runoff, and developing a stormwater pollution prevention plan.

o. Explain the spill prevention and control requirements of the Clean Water Act (40 CFR 109-114).

The following is taken from U.S. Environmental Protection Agency, Agriculture, Clean Water Act, Oil Spill Prevention, Control, and Countermeasures (SPCC) Program.

In 1973, EPA issued the Oil Pollution Prevention regulation to address the oil spill prevention provisions contained in the CWA of 1972. The regulation forms the basis of EPA's oil spill prevention, control, and countermeasures, or SPCC, program, which seeks to prevent oil spills from certain aboveground and underground storage tanks.

In December 2006, EPA amended the SPCC rule to streamline some of its requirements. As part of the Oil Pollution Prevention regulation, the SPCC rule outlines requirements for prevention of, preparedness for, and response to oil discharges. Regulated facilities, including some farms, must develop and implement SPCC Plans that establish procedures and equipment requirements to help prevent oil discharges from reaching waters of the United States or adjoining shorelines.

The following is taken from U.S. Environmental Protection Agency, SPCC Guidance for Regional Inspectors.

Section 112.1 establishes the general applicability of the SPCC rule by describing the facilities, activities, and equipment that are subject to the rule and those that are excluded. In general, SPCC-regulated facilities are non-transportation related, have aboveground oil storage capacity of more than 1,320 gallons or an underground oil storage capacity of more than 42,000 gallons on site, and could reasonably be expected to discharge oil to navigable waters or adjoining shorelines in quantities that may be harmful.

Facilities that are covered by this regulation are required to submit an SPCC plan. The purpose of the plan is to prevent oil and hazardous substances from reaching surface waters in the event of a spill. SPCC plans identify instances where the installation of equipment or practices will achieve this objective. The time frame for preparation is generally within six months of initial operation. The SPCC plan must then be fully implemented within one year of initial operation. A copy of the SPCC plan must be kept on site. Furthermore, a registered professional engineer must certify that the SPCC plan is in accordance with good engineering practices.

The SPCC plans must include the physical layout of the facility and include a facility diagram which must mark the location and contents of each container. The facility diagram must include all transfer stations and connecting pipes. The plan must also address:

- the type of oil in each container and its storage capacity;
- discharge prevention measures including procedures for routine handling of products (loading, unloading, and facility transfers, etc.);
- discharge or drainage controls such as secondary containment around containers and other structures, equipment, and procedures for the control of a discharge;
- countermeasures for discharge discovery, response, and cleanup (both the facility's capability and those that might be required of a contractor);
- methods of disposal of recovered materials in accordance with applicable legal requirements; and
- contact list and phone numbers for the facility response coordinator, National Response Center, cleanup contractors with whom you have an agreement for response, and all appropriate Federal, state, and local agencies who must be contacted in case of a discharge.

33. Environmental restoration personnel shall demonstrate the ability to appraise the contractor's program(s) and/or permits to assess compliance with the requirements for the environmental medium of water.

a. Given a proposed permit, verify that the water quality criteria and stream use classification as identified in the CWA has been correctly applied.

b. Review the contractor's program for compliance with the CWA's reporting requirements.

c. During an assessment of an existing facility, verify that the pre-treatment standards contained in the CWA are being met.

d. During an assessment of the contractor's sampling and monitoring program, verify that the standards for maximum contaminant levels (primary and secondary) provided by the SDWA are being met.

e. Conduct an assessment of the contractor's program to verify that the SDWA provisions for notification to consumers have been established.

f. Perform an assessment of underground injection procedures and monitoring, and assess for compliance with the restrictions and controls provided by the SDWA.

g. Conduct an assessment to ensure the contractor's program is in compliance with the Standard Methods for the examination of water and wastewater or other acceptable protocol as detailed in 40 CFR 136, Analytical Test Procedures.

h. Review the contractor's program(s) for adequate provisions to ensure that the cross-connection identification/elimination and back-flow prevention is as described by the SDWA.

i. Prior to closure of a permit, review it for compliance with the RCRA requirements for groundwater protection.

Items a through i are performance-based KSAs. The Qualifying Official will evaluate their completion.

34. Environmental restoration personnel shall demonstrate a working-level knowledge of the implementation of the regulations and requirements of the National Environmental Policy Act (NEPA).

a. Explain the purpose and scope of the Council on Environmental Quality regulations implementing the National Environmental Policy Act (40 CFR 1500-1508).

The following is taken from U.S. Environmental Protection Agency, National Environmental Policy Act, Basic Information.

NEPA was signed into law on January 1, 1970. The Act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment, and it provides a process for implementing these goals within the federal agencies. The Act also establishes the Council on Environmental Quality (CEQ).

Title I of NEPA contains a Declaration of National Environmental Policy that requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. Section 102 requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as EISs. Section 102 also requires federal agencies to lend appropriate support to initiatives and programs designed to anticipate and prevent a decline in the quality of mankind's world environment. Title II of NEPA establishes the CEQ.

The CEQ oversees NEPA. The duties and functions of the Council are listed in Title II, section 204 of NEPA and include: gathering information on the conditions and trends in environmental quality; evaluating federal programs in light of the goals established in Title I of the Act; developing and promoting national policies to improve environmental quality; and conducting studies, surveys, research, and analyses relating to ecosystems and environmental quality.

In 1978, CEQ promulgated regulations [40 CFR Parts 1500-1508] implementing NEPA which are binding on all federal agencies. The regulations address the procedural provisions of NEPA and the administration of the NEPA process, including preparation of EISs.

The NEPA process consists of an evaluation of the environmental effects of a federal undertaking including its alternatives. There are three levels of analysis depending on whether or not an undertaking could significantly affect the environment. These three levels include: categorical exclusion (CE) determination; preparation of an environmental assessment/finding of no significant impact (EA/FONSI); and preparation of an EIS.

At the first level, an undertaking may be categorically excluded from a detailed environmental analysis if it meets certain criteria which a federal agency has previously determined as having no significant environmental impact. A number of agencies have developed lists of actions which are normally categorically excluded from environmental evaluation under their NEPA regulations.

At the second level of analysis, a federal agency prepares a written EA to determine whether or not a federal undertaking would significantly affect the environment. If the answer is no, the agency issues a FONSI. The FONSI may address measures which an agency will take to reduce potentially significant impacts.

If the EA determines that the environmental consequences of a proposed federal undertaking may be significant, an EIS is prepared. An EIS is a more detailed evaluation of the proposed action and alternatives. The public, other federal agencies and outside parties may provide input into the preparation of an EIS and then comment on the draft EIS when it is completed.

If a federal agency anticipates that an undertaking may significantly impact the environment, or if a project is environmentally controversial, a federal agency may choose to prepare an EIS without having to first prepare an EA.

After a final EIS is prepared and at the time of its decision, a federal agency will prepare a public record of its decision addressing how the findings of the EIS, including consideration of alternatives, were incorporated into the agency's decision-making process.

In accordance with a Memorandum of Agreement between EPA and CEQ, EPA carries out the operational duties associated with the administrative aspects of the EIS filing process. The Office of Federal Activities in EPA has been designated the official recipient in EPA of all EISs prepared by federal agencies.

b. Discuss the purpose and scope of DOE O 451.1B, National Environmental Policy Act Compliance Program.

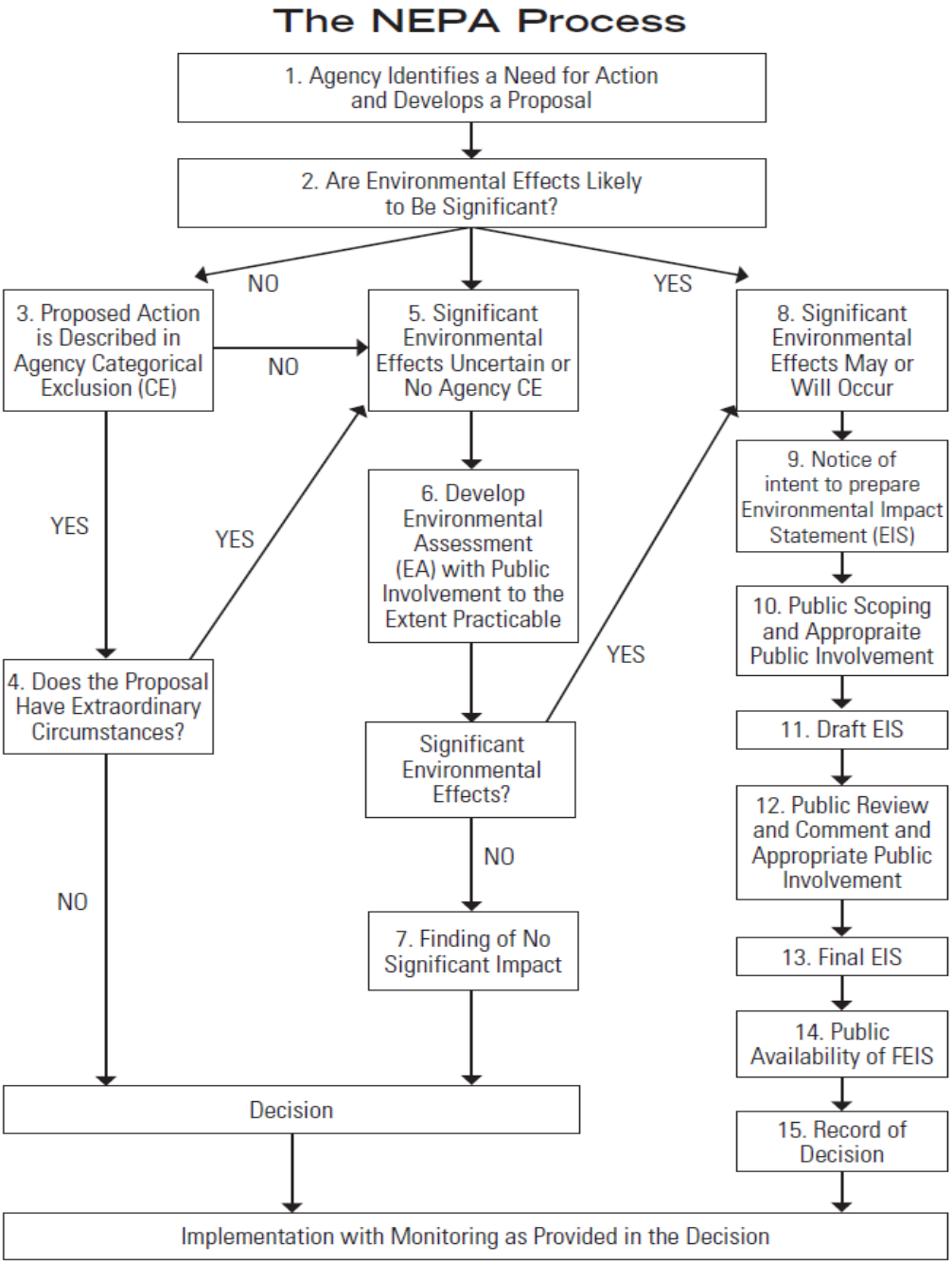
The following is taken from DOE O 451.1B.

The purpose of DOE O 451.1B is to establish internal requirements and responsibilities for implementing NEPA, the CEQ regulations, and the DOE NEPA implementing procedures. DOE O 451.1B sets out the requirements and responsibilities for ensuring efficient and effective implementation of DOE's NEPA compliance program. This Order applies to DOE Elements. Although contractors may assist in DOE's NEPA implementation, the legal obligation to comply with NEPA belongs to DOE. This order does not apply to operations conducted under the authority of the Director, Naval Nuclear Propulsion Program.

c. Describe the public participation process.

The following is taken from Council on Environmental Quality, Executive Office of the President, *A Citizen's Guide to the NEPA.*

The NEPA process begins when an agency develops a proposal to address a need to take an action. The need to take an action may be something the agency identifies itself, or it may be a need to make a decision on a proposal brought to it by someone outside of the agency, for example, an applicant for a permit. Once it has developed a proposed action, the agency will enter the initial analytical approach to help it determine whether the agency will pursue the path of a CE, an EA, or an EIS. Figure 24 illustrates the NEPA public participation process.



Source: Council on Environmental Quality, Executive Office of the President, *A Citizen's Guide to the NEPA*

Figure 24. The NEPA process

d. Discuss the integration of consultation requirements under other environmental legislation (e.g., National Environmental Policy Act and Endangered Species Act and Fish and Wildlife Coordination Act).

The following is taken from Council on Environmental Quality, Executive Office of the President, *A Citizen's Guide to the NEPA.*

NEPA requires Federal agencies to consider environmental effects that include, among others, impacts on social, cultural, and economic resources, as well as natural resources. Citizens often have valuable information about places and resources that they value and the potential environmental, social, and economic effects that proposed federal actions may have on those places and resources.

e. Discuss the content and procedures specified by the Department implementing regulations 10 CFR 1021, Compliance with the National Environmental Policy Act, and DOE O 451.1B, National Environmental Policy Act Compliance Program.

The following is taken from 10 CFR 1021.

Title 10 CFR 1021 establishes procedures for DOE to comply with NEPA. These regulations adopt the CEQ regulations and are supplements to, and to be used in conjunction with, the CEQ regulations. Based on these procedures, DOE shall provide adequate and timely review for the incorporation of NEPA into the planning process. NEPA reviews shall be completed before DOE decisions are made.

DOE DecisionMaking and Planning

DOE shall incorporate NEPA early into the planning process, shall complete the NEPA process before making its decisions, and limit actions during the EIS process that may impact the decision to be made in an ongoing EIS.

Implementing Procedures

DOE shall make NEPA documents available to state, federal, and local governments, American Indian tribes, interested groups, and the general public.

DOE shall notify the host state and tribe of the intent to prepare an EA or EIS, and provide them the opportunity to review and comment.

DOE shall prepare an implementation plan for each EIS to be prepared.

DOE shall prepare programmatic NEPA documents to support programmatic decisions, and prepare site-wide EISs for certain large, multiple projects.

A mitigation action plan shall be prepared upon completion of each EIS and EA and associated ROD or FONSI that addresses mitigation commitments expressed in the ROD.

Classes of Actions

The regulation also identifies the level of NEPA review (EIS, EA, or CE) for typical classes of actions. Appendices A and B list the actions typically categorically excluded, appendix C

lists actions usually requiring an EA, and appendix D lists classes of actions normally requiring an EIS.

The following is taken from DOE O 451.1B.

The purpose of DOE O 451.1B is to establish DOE internal requirements and responsibilities for implementing the NEPA of 1969, the Council on Environmental Quality Regulations Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and the DOE NEPA Implementing Procedures (10 CFR Part 1021).

In addition to requirements established in NEPA and the regulations, DOE's NEPA Compliance Program shall include:

- A system of DOE NEPA Compliance Officers.
- Internal scoping procedures for EAs and EISs that include development of a schedule. For an EIS, the schedule, absent extraordinary circumstances, will provide for completion of a final EIS within 15 months of the issuance of the NOI.
- NEPA QA plans and public participation plans.
- Annual NEPA planning summaries. An annual NEPA planning summary will describe briefly: (1) the status of ongoing NEPA compliance activities, (2) any EAs expected to be prepared in the next 12 months, (3) any EISs expected to be prepared in the next 24 months, and (4) the planned cost and schedule for completion of each NEPA review identified. Every three years starting with 1995, the annual NEPA planning summary for each Field Organization will include an evaluation of whether a site-wide EIS would facilitate future NEPA compliance efforts.
- A DOE NEPA Document Manager for each EIS and EA.
- A system for reporting lessons learned and encouraging continuous improvement.
- Tracking and annually reporting progress in implementing a commitment for environmental impact mitigation that is essential to render the impacts of a proposed action not significant, or that is made in a ROD.

The following is taken from Secretarial Policy on NEPA, dated June 13, 1994.

The NEPA Secretarial Policy Statement establishes policies to streamline the NEPA process, minimize costs and time for document preparation and review, emphasize teamwork, and make the process more useful to decision makers and the public.

The NEPA Secretarial policy statement summarizes delegations of authority for NEPA implementation. Heads of field organizations have full authority for EAs; FONSIs; and associated floodplains and wetlands action documentation requirements related to their proposed actions. To support this delegation, field offices must (1) designate a NEPA compliance officer; (2) prepare internal scoping procedures, public participation plans, and QA plans; and (3) provide adequate legal resources.

Secretarial officers and heads of field organizations will submit annual NEPA planning summaries to the Assistant Secretary for Environment, Safety, and Health. The Assistant Secretary for Environment, Safety, and Health is delegated authority to provide NEPA variances.

The Office of Environment, Safety, and Health will provide NEPA guidance and training. The NEPA Document Manager will conduct an early scoping process for the EIS or EA being prepared, which will include a proposed schedule. EISs will be completed within 15 months of the issuance of the NOI.

DOE will continue to work to improve the NEPA process through (1) contract reform (for contracts to prepare EISs and EAs); (2) enhanced public involvement efforts; and (3) continued process improvement in DOE NEPA document review times, emphasizing quality and encouraging innovation.

The DOE will rely on the CERCLA process for review of actions to be taken under CERCLA and will address NEPA values and public involvement procedures under the CERCLA process.

f. Participate in the preparation of the documents listed below.

- **EIS**
- **EA**
- **FONSI**
- **CX**
- **ROD**

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

g. Discuss the potential liabilities of the Department and its contractors inherent in the enforcement of environmental regulations (i.e., compliance orders, enforcement actions, fines and penalties, and provisions for civil suits).

The following is taken from U.S. Environmental Protection Agency, Compliance and Enforcement at Federal Facilities, Federal Facilities Enforcement.

EPA has explicit authority to assess fines at federal facilities violating environmental statutes. EPA's federal facilities civil enforcement program helps protect public health and the environment by assuring that federal facilities comply with federal environmental laws.

EPA also enforces environmental cleanup requirements at federal facilities. Cleanup enforcement authority is derived from several statutes: the CERCLA (or Superfund), the RCRA, including the UST program, and the OPA, a part of the CWA. These statutes, as well as Presidential Executive Orders, require federal facilities to clean up environmental contamination at their facilities.

CERCLA requires federal agencies to investigate and clean up contamination at their facilities. Federal facilities that are significantly contaminated may be placed on the CERCLA NPL. For such facilities CERCLA requires that EPA and the federal facility enter into an IAG (IAG - sometimes called Federal Facility Agreement) to govern the cleanup to be done. States often are signatories to these IAGs, too. Once an IAG has been signed, EPA monitors the cleanup schedule and milestones and oversees its requirements to ensure proper implementation of each cleanup. EPA can assess stipulated penalties for non-compliance with the terms of the IAG including missed milestones.

35. Environmental restoration personnel shall demonstrate the ability to review and assess the following National Environmental Policy Act documentation:

- **Environmental Impact Statement (EIS)**
- **Environmental Assessment (EA)**
- **Finding Of No Significant Impact (FONSI)**
- **Categorical Exclusion (CX)**
- **Record of Decision (ROD)**

a. Discuss the requirements for each document and describe the process for reviewing the listed documents.

The following is taken from CEQ, Regulations for Implementing NEPA.

EIS

As required by section 102(2)(C) of NEPA, EISs are to be included in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment.

Agencies shall make sure the proposal that is the subject of an EIS is properly defined. Agencies shall use the criteria for scope in section 1508.25 to determine which proposal(s) shall be the subject of a particular statement. Proposals or parts of proposals that are related to each other closely enough to be, in effect, a single course of action, shall be evaluated in a single impact statement.

EISs may be prepared, and are sometimes required, for broad federal actions such as the adoption of new agency programs or regulations. Agencies shall prepare statements on broad actions so that they are relevant to policy and are timed to coincide with meaningful points in agency planning and decision-making.

When preparing statements on broad actions (including proposals by more than one agency), agencies may find it useful to evaluate the proposal(s) in one of the following ways:

- geographically, including actions occurring in the same general location, such as a body of water, region, or metropolitan area;
- generically, including actions which have relevant similarities, such as common timing, impacts, alternatives, methods of implementation, media, or subject matter;
- by stage of technological development, including federal or federally assisted research, development, or demonstration programs for new technologies which, if applied, could significantly affect the quality of the human environment. Statements shall be prepared on such programs and shall be available before the program has reached a stage of investment or commitment to implementation likely to determine subsequent development or restrict later alternatives.

Agencies shall use a format for EISs which will encourage good analysis and clear presentation of the alternatives including the proposed action. The following standard format for EISs should be followed unless the agency determines that there is a compelling reason to do otherwise:

- cover sheet
- summary
- table of contents

- purpose of and need for action
- alternatives including proposed action (sections 102(2)(C)(iii) and 102(2)(E) of the Act)
- affected environment
- environmental consequences (especially sections 102(2)(C)(i), (ii), (iv), and (v) of the Act)
- list of preparers
- list of agencies, organizations, and persons to whom copies of the statement are sent
- index
- appendices (if any)

EA

An EA is a concise public document for which a federal agency is responsible that serves to:

- briefly provide sufficient evidence and analysis for determining whether to prepare an EIS or a FONSI;
- aid an agency's compliance with the Act when no EIS is necessary; and
- facilitate preparation of a statement when one is necessary.

The EA shall include brief discussions of: the need for the proposal; alternatives, as required by section 102(2)(E); the environmental impacts of the proposed action; and alternatives. The EA shall also include a listing of agencies and persons consulted.

FONSI

FONSI means a document by a Federal agency briefly presenting the reasons why an action, not otherwise excluded, will not have a significant effect on the human environment and for which an EIS therefore will not be prepared. It shall include the EA or a summary of it and shall note any other environmental documents related to it. If the assessment is included, the finding need not repeat any of the discussion in the assessment but may incorporate it by reference.

CX (or CE)

Categorical exclusion (CE) means a category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementation of these regulations and for which, therefore, neither an EA nor an EIS is required. An agency may decide in its procedures or otherwise, to prepare EAs for the reasons stated in Sec. 1508.9 even though it is not required to do so. Any procedures under this section shall provide for extraordinary circumstances in which a normally excluded action may have a significant environmental effect.

ROD

At the time of its decision or, if appropriate, its recommendation to Congress, each agency shall prepare a concise public ROD. The record, which may be integrated into any other record prepared by the agency, shall:

- State what the decision was.
- Identify all alternatives considered by the agency in reaching its decision, specifying the alternative or alternatives which were considered to be environmentally

preferable. An agency may discuss preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions. An agency shall identify and discuss all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision.

- State whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why they were not. A monitoring and enforcement program shall be adopted and summarized where applicable

b. Describe the process for performing an assessment of the listed documents and discuss criteria that could be used during an assessment.

See item a of competency 35.

c. Perform a written review/assessment of each of the listed documents.

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

d. Discuss the relationship between 40 CFR 1500, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, and DOE O 451.1B, National Environmental Policy Act Compliance Program.

The CEQ regulations (40 CFR 1500-1508) implement section 102 of NEPA and provide federal agencies with procedures for complying with the intent of NEPA. The DOE regulations (10 CFR 1021) establish the procedures that DOE shall use to comply with section 102 of NEPA and the CEQ regulations. DOE O 451.1B establishes the internal requirements and responsibilities for implementing NEPA, the CEQ regulations (40 CFR 1500-1508), and the DOE implementing procedures.

36. Environmental compliance personnel shall demonstrate a working-level knowledge of the following laws, regulations, and Department of Energy Orders as related to environmental radiation:

- **AEA**
- **40 CFR 61 Subpart H, National Emission Standards for Hazardous Air Pollutants**
- **40 CFR 141, National Primary Drinking Water Regulations**
- **DOE Order 5400.1, General Environmental Protection Program**
- **DOE Order 5400.5, Radiation Protection of the Public and the Environment**
- **DOE O 435.1, Radioactive Waste Management**
- **40 CFR 122, EPA Administered Permit Programs: The NPDES**

a. Discuss the application of the above listed documents to DOE and its facilities.

AEA

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Atomic Energy Act and Related Legislation.

The purpose of the AEA (42 U.S.C. Sect. 2011 - Sect. 2259) is to assure the proper management of source, special nuclear, and byproduct material. The AEA and the statutes that amended it delegate the control of nuclear energy primarily to DOE, the NRC, and the EPA. DOE authority extends to:

- source material - (1) uranium, thorium, or any other material that is determined by the NRC pursuant to the provisions of section 61 of the AEA to be source material; or (2) ores containing one or more of the foregoing materials, in such concentration as the NRC may by regulation determine from time to time [AEA, section 11(z)];
- SNM - (1) plutonium, uranium enriched in the isotope 233 or the isotope 235, and any other material that the NRC, pursuant to the provisions of section 51 of the AEA, determines to be SNM, but does not include source material; or (2) any material artificially enriched by any of the foregoing, but does not include source material [AEA, section 11(aa)]; and
- byproduct material - (1) any radioactive material (except SNM) yielded in or made radioactive by exposure to radiation incident to the process of producing or utilizing SNM, and (2) the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content [AEA, section 11(e)].

The Energy Reorganization Act of 1974 redirected federal energy efforts. Congress determined that the public interest would best be served by separating the licensing and related functions of the Atomic Energy Commission (AEC) from energy development and related functions. To achieve this Congress replaced the AEC with the NRC and a second agency called the Energy Research and Development Administration (which later became DOE under the Department of Energy Organization Act of 1977).

The Department of Energy Organization Act of 1977 clarified Congressional intent related to DOE's environmental functions. This authorized the establishment of eight Assistant Secretaries, including one with environmental responsibilities and functions. The duties of the latter included advising the Secretary on how well DOE's activities conform to environmental protection laws and principles. Section 102, the Congressional declaration of purpose, listed some of DOE's fundamental purposes as assuring incorporation of national environmental protection goals in the formulation and implementation of energy programs; advancing the goals of restoring, protecting, and enhancing environmental quality; and assuring public health and safety.

40 CFR 61 Subpart H, National Emission Standards for Hazardous Air Pollutants

See item b of competency 31.

40 CFR 141, National Primary Drinking Water Regulations

40 CFR 141 establishes primary drinking water regulations pursuant to the Public Health Service Act, as amended by the SDWA, and related regulations applicable to public water systems. This part applies to all DOE facilities that have water systems that meet at least one of the following conditions of a public water system:

- consists of not only distribution and storage facilities, but also of collection and treatment facilities,

- does not obtain all of its water from, or is owned or operated by, a public water system to which such regulations apply,
- sells water to any person, and
- is a carrier which conveys passengers in interstate commerce.

Since most, if not all DOE facilities collect and treat water, part 141 applies to DOE facilities.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Safe Drinking Water Act.

In 1974 Congress enacted the Safe Drinking Water Act to manage potential contamination threats to groundwater. The act instructed EPA to establish a national program to prevent underground injections of contaminated fluids that would endanger drinking water sources. Primary drinking water standards promulgated under the SDWA apply to drinking water "at the tap" as delivered by public water supply systems. As such, the standards apply directly to those DOE facilities that meet the definition of a public water supply system (e.g., the DOE Oak Ridge Reservation is a public water supply system because it provides water to the City of Oak Ridge).

DOE Order 5400.1, General Environmental Protection Program

[Note: DOE Order 5400.1 was cancelled by DOE O 450.1, which was subsequently superseded by DOE O 450.1A, *Environmental Protection Program.*]

The following is taken from DOE O 450.1A.

The purpose of this order is to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, and by which DOE cost effectively meets or exceeds compliance with applicable environmental, public health, and resource protection requirements.

DOE Order 5400.5, Radiation Protection of the Public and the Environment

See items a and b of competency 22.

DOE O 435.1, Radioactive Waste Management

The following is taken from DOE O 435.1

The objective of this order is to ensure that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety, and the environment. This Order applies to the management of all high-level waste, transuranic waste, low-level waste, radioactive mixed waste for which DOE is responsible, DOE accelerator-produced radioactive waste, and DOE radioactive byproduct material.

40 CFR 122, EPA Administered Permit Programs: The National Pollutant Discharge Elimination System

See items a, c, and n of competency 32.

b. Define the following terms and their implications for regulation in DOE:

- **Source material**
- **SNM**
- **Byproduct material**
- **Naturally occurring or accelerator-produced radioactive material**

The following definitions are taken from U.S. Environmental Protection Agency, Radiation Protection, Radiation Glossary.

Source Material

Source material consists of uranium or thorium ores mined from the Earth. Source material is defined in 10 CFR 20.1003, "Standards for Protection Against Radiation, Definitions," as:

- Uranium, or thorium or any combination of uranium and thorium in any physical or chemical form.
- Ores that contain, by weight, one-twentieth of 1 percent (0.05 percent), or more, of uranium, thorium, or any combination or uranium and thorium. Source material does not include SNM.

SNM

SNM is defined in 10 CFR 20.1003 as:

- plutonium, uranium-233, uranium enriched in the isotope 233 or in isotope 235, and any other material that the NRC, pursuant to the provisions of section 51 of the AEA, determines to be SNM (does not include source material)
- any material artificially enriched by any of the foregoing (does not include source material)

By-Product Material

By-product materials are radioactive materials left over from the production or use of SNM or the tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Naturally Occurring or Accelerator-Produced Radioactive Material

Radioactive materials not covered under the AEA that are naturally occurring or produced by an accelerator. Accelerators are used in sub-atomic particle physics research. These materials have been traditionally regulated by States. This waste is not covered under the AEA, is not a form of low level waste, and is not regulated by NRC.

c. Describe the concept of reportable quantity and identify that quantity for a given radionuclide.

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Superfund Reportable Quantities (RQs).

Under the CERCLA, also known as the Superfund Law, Congress established an initial RQ of one pound for Superfund hazardous substances. Congress also required EPA to issue regulations to adjust these initial RQs to more accurately reflect their potential to threaten public health and welfare and the environment. EPA has established or proposed adjustments to the RQs for all of the roughly 800 Superfund substances. In addition, there are

approximately 1,500 known radionuclides, approximately 760 of which are listed individually with RQ values in (curies) in 40 CFR 302.4, table 302.4, appendix B.

d. Describe the system for classifying mixed waste and the general requirements for treatment, storage and disposal.

The following is taken from U.S. Environmental Protection Agency, Radiation Protection, About Mixed Waste.

A dual regulatory framework exists for mixed waste, with the EPA or authorized states regulating the chemically hazardous portion of the waste and the NRC, the NRC agreement states, and DOE regulating the radioactive portion of the waste. NRC generally regulates commercial and non-DOE federal facilities and their wastes. DOE is currently largely self-regulating in the management of its wastes through its Environmental Management program. The exception is the Waste Isolation Pilot Plant for which EPA has regulatory oversight. DOE wastes are largely legacy wastes from the development of nuclear weapons. DOE's orders apply to DOE sites and contractors who work at those facilities.

NRC and DOE use their authority under the AEA to regulate the radioactive components of mixed waste. EPA uses its authority under the RCRA authority to regulate the hazardous waste portion. NRC is authorized by the AEA to issue licenses to commercial users of radioactive materials. RCRA gives EPA the authority to control hazardous waste from "cradle to grave."

Once a waste is determined to be a mixed waste, the waste handlers must comply with both AEA and RCRA regulations. The requirements of RCRA and the AEA are generally consistent and compatible. However, the provisions in section 1006(a) of RCRA allow the AEA to take precedence in the event provisions of the two acts are found to be inconsistent.

DOE's 1995 Baseline Environmental Management Report estimated that the life-cycle costs for high level waste, transuranic waste, and low level mixed waste were $34 billion, $13 billion, and $13 billion respectively over a 75 year period. As mandated by the Federal Facilities Compliance Act, which was signed into law on October 6, 1992, DOE has developed Site Treatment Plans (STPs) for its mixed wastes. DOE is implementing these plans through orders issued by EPA or the states. It also developed a Waste Management Programmatic EIS for treatment, storage, and disposal of radioactive and hazardous waste. This plan will assist DOE in selecting waste management facilities. DOE, EPA, NRC, and the states work together to ensure the proper management and disposal of legacy wastes from the Cold War.

e. Describe the basic monitoring and reporting requirements of radionuclides in NESHAP and state the dose limit.

See item e of competency 31.

f. Describe the basic limits for radionuclides in drinking water and their application to Department operations.

The following is taken from U.S. Environmental Protection Agency, Radionuclides in Drinking Water, Radionuclides in Drinking Water Rule.

In 2000, EPA revised the radionuclides regulation, which had been in effect since 1977. The revisions required new monitoring provisions to ensure that all customers of community water systems will receive water that meets the maximum contaminant level for radionuclides in drinking water. EPA also issued a standard for uranium, as required by the 1986 amendments to the SDWA. The current standards are: combined radium 226/228 of 5 picocurie (pCi)/L; a gross alpha standard for all alphas of 15 pCi/L (not including radon and uranium); a combined standard of 4 mrem/year for beta emitters. The new maximum contaminant level for uranium is 30 µg/L.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Safe Drinking Water Act.

Of significance to DOE is that the drinking water standards are used to determine groundwater protection regulations under a number of statutes (e.g., RCRA). Therefore, many of the SDWA requirements apply to DOE activities, especially cleanup of contaminated sites and storage and disposal of materials containing radionuclides, inorganic chemicals, organic chemicals, and hazardous wastes.

g. Describe the following types of radioactive waste and the associated requirements:
- **Low-level waste**
- **High-level waste**
- **Transuranic waste**

The following is taken from DOE M 435.1-1.

DOE M 435.1-1, *Radioactive Waste Management Manual*, lists detailed requirements for handling each of the types of waste listed below. These requirements include:
- management of mixed wastes,
- complex/site wide management programs,
- QA programs,
- contingency storage plans,
- corrective action and operations curtailment plans,
- waste acceptance plans covering storage, pretreatment, treatment, and packaging,
- waste characterization and certification,
- transfer, packaging, storage, and transportation,
- site/facility design,
- treatment, disposal, and monitoring, and
- site closure.

Low-Level Waste

Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

High-Level Waste

High-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations, and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

Transuranic Waste

Transuranic waste is radioactive waste containing more than 100 nanocuries [3700 becquerels (Bq)] of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for:

- high-level radioactive waste;
- waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 191, "Environmental Radiation Protection Standards For Management And Disposal Of Spent Nuclear Fuel, High-Level And Transuranic Radioactive Wastes," disposal regulations; or
- waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

37. Environmental restoration personnel shall demonstrate the ability to appraise the contractor's program(s) to assess compliance with the requirements for environmental radiation protection.

a. Assess whether the effluent monitoring from a facility meets the requirements of DOE O 5400.5, Radiation Protection of the Public and the Environment.

b. Assess whether adequate methods are used to characterize effluents for purposes of limiting doses to the public in accordance with regulatory and "as low as reasonably achievable (ALARA)" limits.

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

38. Environmental compliance personnel shall demonstrate a working-level knowledge of the supporting environmental laws and regulations, including:

- **Pollution Prevention Act (PPA)**
- **Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)**
- **Toxic Substances Control Act (TSCA)**
- **Endangered Species Act (ESA)**
- **Comprehensive Environmental Response, Compensation & Liability Act/Superfund Amendments and Reauthorization Act (Superfund)**

- **Emergency Planning and Community Right-to-Know Act (EPCRA)**
- **AEA**
- **FFCA**

a. Describe the deadlines identified in the PPA.

The following is taken from U.S. Environmental Protection Agency, Toxic Release Inventory (TRI) Program, What is the Toxics Release Inventory (TRI) Program?

The EPCRA was enacted in 1986. EPCRA's primary purpose is to inform communities and citizens of chemical hazards in their areas. Sections 311 and 312 of EPCRA require businesses to report the locations and quantities of chemicals stored on-site to state and local governments in order to help communities prepare to respond to chemical spills and similar emergencies. EPCRA section 313 requires EPA and the States to annually collect data on releases and transfers of certain toxic chemicals from industrial facilities, and make the data available to the public in TRI. In 1990 Congress passed the PPA, which required that additional data on waste management and source reduction activities be reported under TRI. The goal of TRI is to empower citizens, through information, to hold companies and local governments accountable in terms of how toxic chemicals are managed.

The following is taken from U.S. Department of Health and Human Services, *HHS General Administration Manual Part 30 Environmental Protection*.

The initial deadline for the annual Toxic Chemical Release Inventory Reporting Form (Form R) was July 1, 1995 with subsequent reports due July 1 of each year.

b. Identify the disciplines/areas in which PPA applies.

The following is taken from U.S. Environmental Protection Agency, The Emergency Planning and Community Right-to-Know Act, Section 313, Release and Other Waste Management Reporting Requirements.

A plant, factory, or other facility is subject to the provisions of section 313 if it meets all three of the following criteria:

- It is included in a covered standard industrial classification code.
- It has 10 or more full-time employees (or the equivalent of 20,000 hours per year).
- It manufactures, imports, processes, or otherwise uses any of the EPCRA section 313 chemicals.

c. Describe the process for licensing applicators as defined in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

The following is taken from U.S. Environmental Protection Agency, Civil Enforcement, Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) Enforcement.

Under FIFRA, no one may sell, distribute, or use a pesticide unless it is registered by the EPA, or it meets a specific exemption as described in the regulations. Registration includes approval by the EPA of the pesticide's label, which must give detailed instructions for its safe use. The EPA must classify each pesticide as either "general use," "restricted use," or

both. “General use” pesticides may be applied by anyone, but “restricted use” pesticides may only be applied by certified applicators or persons working under the direct supervision of a certified applicator. Because there are only limited data for new chemicals, most pesticides are initially classified as restricted use. Applicators are certified by a state if the state operates a certification program approved by the EPA.

The following is taken from 40 CFR 171.

Standards for certification of commercial pesticide applicators are found in 40 CFR 171.4, “Standards for Certification of Commercial Applicators,” with standards for certification of private applicators appearing in 40 CFR 171.5, “Standards for Certification of Private Applicators.” The commercial applicator must demonstrate competency in the use and handling of pesticides as determined by passing a written examination (in conjunction with performance testing, if required). General requirements include a demonstration of practical knowledge with regard to pest control and pesticide safety in the following areas: label/labeling and instruction comprehension; pesticide safety; environmental factors; pest identification and biology; pesticide types, interactions, persistence, toxicity, hazards, effectiveness, and dilution procedures; pertinent equipment use and maintenance; application techniques; and knowledge of the applicable federal and state laws.

In addition, specific standards of competency must be demonstrated for each of the different applicable categories of commercial pesticide application; agricultural pest control (plants and animal); forest pest control; ornamental and turf pest control; seed treatment; aquatic pest control; right-of-way pest control; industrial, institutional, structural, and health-related pest control; public health pest control; regulatory pest control; and demonstration and research pest control.

In contrast, certification of a private pesticide applicator requires the applicator to demonstrate a practical knowledge of the pest problems and pest control practices associated with his agricultural operations; proper storage, use, handling, and disposal of pesticides and containers; and his related legal responsibility.

d. Discuss the purpose and history of the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act (Superfund).

The following is taken from U.S. Environmental Protection Agency, Superfund, CERCLA Overview.

The CERCLA, commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, $1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites. CERCLA:

- established prohibitions and requirements concerning closed and abandoned hazardous waste sites;

- provided for liability of persons responsible for releases of hazardous waste at these sites; and
- established a trust fund to provide for cleanup when no responsible party could be identified.

The law authorizes two kinds of response actions:

- Short-term removals, where actions may be taken to address releases or threatened releases requiring prompt response.
- Long-term remedial response actions, that permanently and significantly reduce the dangers associated with releases or threats of releases of hazardous substances that are serious, but not immediately life threatening. These actions can be conducted only at sites listed on EPA's NPL.

The following is taken from U.S. Environmental Protection Agency, Superfund, *SARA Overview*.

The SARA amended the CERCLA on October 17, 1986. SARA reflected EPA's experience in administering the complex Superfund program during its first six years and made several important changes and additions to the program. SARA:

- stressed the importance of permanent remedies and innovative treatment technologies in cleaning up hazardous waste sites;
- required Superfund actions to consider the standards and requirements found in other state and Federal environmental laws and regulations;
- provided new enforcement authorities and settlement tools;
- increased State involvement in every phase of the Superfund program;
- increased the focus on human health problems posed by hazardous waste sites;
- encouraged greater citizen participation in making decisions on how sites should be cleaned up; and
- increased the size of the trust fund to $8.5 billion.

SARA also required EPA to revise the HRS to ensure that it accurately assessed the relative degree of risk to human health and the environment posed by uncontrolled hazardous waste sites that may be placed on the NPL.

e. Explain how the RQs specified by CERCLA are applied.

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Superfund Reportable Quantities (RQs).

Under CERCLA, also known as the Superfund Law, Congress established an initial RQ of one pound for Superfund hazardous substances. Congress also required EPA to issue regulations to adjust these initial RQs to more accurately reflect their potential to threaten public health and welfare and the environment. To date, EPA has established or proposed adjustments to the RQs for all of the roughly 800 Superfund substances.

RQs under CERCLA are adjusted to one of five levels: 1, 10, 100, 1,000, or 5,000 pounds. EPA bases adjustments to the RQs on the intrinsic characteristics of each hazardous substance, such as the aquatic toxicity, acute and chronic toxicity, ignitability, reactivity, and

potential carcinogenicity. An RQ value is established for each of these characteristics of a hazardous substance, with the most stringent RQ value (i.e., the lowest quantity) becoming the final RQ or reporting trigger for that hazardous substance.

f. Describe the removal/cleanup actions required by CERCLA/RCRA.

The following is taken from U.S. Environmental Protection Agency, Superfund, Cleanup Process.

The Superfund cleanup process begins with site discovery or notification to EPA of possible releases of hazardous substances. Sites are discovered by various parties, including citizens, state agencies, and EPA Regional offices. Once discovered, sites are entered into the Comprehensive Environmental Response, Compensation, and Liability Information System, EPA's computerized inventory of potential hazardous substance release sites. Some sites may be cleaned up under other authorities. EPA then evaluates the potential for a release of hazardous substances from the site through these steps in the Superfund cleanup process. Community involvement, enforcement, and emergency response can occur at any time in the process.

The following is taken from U.S. Environmental Protection Agency, Cleanup Enforcement, RCRA Cleanup.

The RCRA regulates hazardous and non-hazardous wastes. RCRA Subtitle C establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal. Facilities that generate, treat, store, or dispose of hazardous waste are regulated under Subtitle C.

RCRA Subtitle C has two general paths to protecting human health and the environment:

- preventing environmental problems by ensuring that wastes are well managed from "cradle to grave", reducing the amount of waste generated, conserving energy and natural resources, and
- cleaning up environmental problems caused by the mismanagement of wastes.

The RCRA Corrective Action program, part of Subtitle C, addresses when action is needed to clean up contamination at a facility. RCRA corrective action usually takes place at facilities that treat, store, or dispose of hazardous waste. Corrective action may be prompted through the enforcement mechanisms found in RCRA, through a RCRA permit, or through voluntary agreements. Corrective action can take place while a facility continues operating.

g. Discuss the interface/coordination with environmental restoration efforts required by Comprehensive Environmental Response, Compensation, and Liability Act/Resource Conservation and Recovery Act.

The following is taken from U.S. Environmental Protection Agency, Coordination between RCRA Corrective Action and Closure and CERCLA Site Activities.

Generally, cleanups under RCRA corrective action or CERCLA will substantively satisfy the requirements of both programs. EPA RCRA and CERCLA site managers can defer cleanup activities for all or part of a site from one program to another with the expectation that no

further cleanup will be required under the deferring program. For example, when investigations or studies have been completed under one program, there should be no need to review or repeat those investigations or studies under another program. Similarly, a remedy that is acceptable under one program should be presumed to meet the standards of the other.

It has been EPA's policy to defer facilities that may be eligible for inclusion on the NPL to the RCRA program if they are subject to RCRA corrective action (unless they fall within certain exceptions, such as federal facilities). EPA expanded on this policy by issuing criteria for deleting sites that are on the NPL and deferring their cleanup to RCRA corrective action. When a site is deleted from the NPL and deferred to RCRA, problems of jurisdictional overlap and duplication of effort are eliminated, because the site will be handled solely under RCRA authority. Corrective action permits or orders should address all releases at a CERCLA site being deferred to RCRA; some RCRA permits or orders may need to be modified to address all releases before a site is deleted from the NPL.

While EPA's general policy is for facilities subject to both CERCLA and RCRA to be cleaned up under RCRA, in some cases, it may be more appropriate for the federal CERCLA program or a state/tribal "Superfund-like" cleanup program to take the lead. In these cases, the RCRA permit/order should defer corrective action at all of the facility to CERCLA or a state/tribal cleanup program. For example, where program priorities differ, and a cleanup under CERCLA has already been completed or is underway at a RCRA facility, corrective action conditions in the RCRA permit/order could state that the existence of a CERCLA action makes separate RCRA action unnecessary. In this case, there would be no need for the RCRA program to revisit the remedy at some later point in time. Where the CERCLA program has already selected a remedy, the RCRA permit could cite the CERCLA decision document (e.g., ROD), but would not necessarily have to incorporate that document by reference. RCRA permits/orders can also defer corrective action in a similar way for cleanups undertaken under state/tribal programs provided the state/tribal action protects human health and the environment to a degree at least equivalent to that required under the RCRA program.

While deferral from one program to another is typically the most efficient and desirable way to address overlapping cleanup requirements, in some cases, full deferral will not be appropriate and coordination between programs will be required. The goal of any approach to coordination of remedial requirements should be to avoid duplication of effort (including oversight) and second-guessing of remedial decisions. Several approaches for coordination between programs at facilities subject to both RCRA and CERCLA are currently in use. These approaches include:

- Craft CERCLA or RCRA decision documents so that cleanup responsibilities are divided. CERCLA and RCRA decision documents do not have to require that the entire facility be cleaned up under one or the other program. For example, at some facilities being cleaned up under CERCLA, the RCRA units (regulated or solid waste) are physically distinct and could be addressed under RCRA. In these cases, the CERCLA decision documents can focus CERCLA activities on certain units or areas, and designate others for action under RCRA.
- Establish timing sequences in RCRA and CERCLA decision documents. RCRA and CERCLA decision documents can establish schedules according to which the requirements for cleanup at all or part of a facility under one authority would be

determined only after completion of an action under the other authority. For example, RCRA permits/orders can establish schedules of compliance which allow decisions as to whether corrective action is required to be made after completion of a CERCLA cleanup or a cleanup under a state/tribal authority. After the state or CERCLA response is carried out, there should be no need for further cleanup under RCRA and the RCRA permit/order could simply make that finding.

h. Describe the application of the Emergency Planning and Community Right-to-Know Act to Department facilities (e.g., toxic release inventory and coordination requirements with local emergency planning committees).

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Emergency Planning and Community Right-to-Know Act.

Appendix A of 40 CFR 355, "The List of Extremely Hazardous Substances and Their Threshold Planning Quantities," defines extremely hazardous substances. Any DOE facility that manages any such substances in quantities exceeding the Threshold Planning Quantities noted in the appendix must comply with EPCRA.

Under 40 CFR 355 facilities must notify the emergency response commission that they are subject to these requirements. The facilities must notify the local emergency planning unit of releases exceeding a RQ of Extremely Hazardous Substances, as defined under Title III, and Hazardous Substances, as defined under CERCLA. In addition, the facilities must report their chemical inventories and provide material safety data sheets to the local emergency planning organizations as outlined in 40 CFR 370, "Hazardous Chemical Reporting: Community Right-To-Know." DOE voluntarily complies with these provisions.

i. Discuss the Endangered Species Act consultation requirements.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Endangered Species Act and the Fish and Wildlife Coordination Act.

The ESA section 7 consultation process sometimes requires DOE to prepare and submit a biological assessment discussing any endangered or threatened species that is likely to be affected by a proposed action. After formal consultation, the Secretary of the Interior renders a biological opinion on the impacts of DOE's proposed action on the species or its habitat. If the proposed action jeopardizes or adversely modifies the species or its habitat, the Secretary suggests alternatives to the proposed action that would not violate section 7. Then DOE must decide whether to modify the project as suggested, abandon it, or file an application for an exemption.

j. Discuss the marking of polychlorinated biphenyls (PCB) and PCB items required by the Toxic Substances Control Act (TSCA).

The following is taken from DOE, Office of Health, Safety, and Security, TSCA Information Brief, The PCB Mark.

Due to findings that PCBs may cause adverse health effects and due to their persistence and accumulation in the environment, the TSCA, enacted on October 11, 1976, banned the

manufacture of PCBs after 1978. The first PCB regulations, promulgated at 40 CFR 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," were finalized on February 17, 1978, and were most recently amended on June 29, 1998.

These PCB regulations include requirements specifying disposal methods and marking. Most PCB items require "PCB marks," a descriptive name, instructions, cautions, or other information applied to PCB items or other objects subject to these regulations. The marking regulations include requirements for PCB marks on PCB items, storage areas, and temporary storage areas.

The PCB mark is a label with black striping around the border that contains certain information specified in the regulations that apply to PCB items (i.e., any manufactured item containing or contaminated with PCBs). There are two marking formats, "Mark ML" and "Mark MS"; the only difference between the two is the size of the mark. PCB Mark ML is a 6" x 6" square; PCB Mark MS is a 1" x 2" rectangle. The text of the mark includes the warning "Caution Contains PCBs," instructions in case of accident or spill, and the telephone number of the National Response Center. The PCB mark must have either a yellow or white background. An example is shown in figure 25.

Source: DOE, TSCA Brief, The PCB Mark

Figure 25. PCB Mark

k. Describe how the Federal Facilities Compliance Act will impact Department compliance actions.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Federal Facility Compliance Act.

Before the passage of the Federal Facility Compliance Act (FFCA), the federal government maintained and was supported by Supreme Court rulings that it was not subject to administrative and civil fines and penalties under solid and hazardous waste law because of the doctrine of "sovereign immunity." As a result, Congress enacted the FFCA (October 6, 1992), which effectively overturned the Supreme Court's ruling. In the legislation Congress specifically waived sovereign immunity with respect to RCRA for federal facilities.

Under section 102, The FFCA amends section 6001 of RCRA to specify that federal facilities are subject to all civil and administrative penalties and fines, regardless of whether such penalties or fines are punitive or coercive in nature.

The FFCA was effective upon enactment on October 6, 1992, with the exception that "departments, agencies, and instrumentalities of the executive branch of the Federal Government" would not be subject to the sovereign immunity waiver until three years after enactment for violations of RCRA section 3004(j) "involving storage of mixed waste that is not subject to an existing agreement, permit, or administrative or judicial order, so long as such waste is managed in compliance with all other applicable requirements." Section 3004(j) forbids the storage of hazardous waste prohibited from land disposal unless the storage is for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal. After October 6, 1995, the waiver of sovereign immunity shall still not apply to DOE so long as DOE "is in compliance with both (i) a plan that has been submitted and approved pursuant to section 3021(b) of the Solid Waste Disposal Act (SWDA) and which is in effect and (ii) an order requiring compliance with such plan which has been issued pursuant to such section 3021(b) and which is in effect." The plan required under section 3021(b) is for the development of treatment capacities and technologies to treat all of the mixed wastes at each DOE facility.

Many DOE facilities are now subject to federal facility compliance agreements and other binding administrative clean-up orders. The FFCA will allow regulators to impose fines or penalties on federal entities that fail to meet milestones or deadlines contained in such agreements or orders. Penalties specified in the agreements will now be enforceable and may result in substantial financial penalties to noncompliant facilities.

Not later than 180 days after the date of enactment, the Secretary of Energy had to submit (1) reports containing a national inventory of mixed wastes on a state-by-state basis and (2) a national inventory of mixed waste treatment capacities and technologies to the EPA Administrator and the governors of states in which DOE stored or generated mixed wastes.

Additionally, the Secretary of Energy was directed to prepare and submit STPs for developing treatment capacities and technologies for all facilities generating or storing mixed waste that are not subject to any permit, agreement, or order. Such plans were to include schedules for developing treatment capacity where treatment technologies exist and schedules for identifying and developing treatment technologies where none is currently available. These plans were to be reviewed and approved either by EPA or the states, depending on whether the state is authorized to regulate mixed waste. Upon approval of the submitted plans, EPA or the states were to issue orders requiring compliance with the plans.

Section 108 of the FFCA added a new section 3023, "Federally Owned Treatment Works," to Subtitle C of RCRA. This new section provides that if certain conditions are met, FOTWs are essentially exempted from RCRA regulation based on the domestic sewage exclusion to the definition of solid waste.

39. Environmental compliance personnel shall demonstrate a working-level knowledge of the management and negotiation of regulatory agreements and permits.

a. Describe the responsibilities involved with the management of the following documents:
- **NPDES permit**
- **Federal facility agreement**
- **Consent orders and settlement agreements**
- **Record of Decision**
- **RCRA part B permit**
- **Grant conditions**

NPDES Permit

See items a, c, and n of competency 32.

Federal Facility Agreement

The following is taken from DOE, Environmental Management, Background: Section 120 of CERCLA.

The SARA Amendments to CERCLA (1986) enacted a section devoted to the cleanup of Federal facilities (section 120). Under section 120(a)(1), CERCLA specifies that Federal departments, agencies, and instrumentalities must comply with CERCLA in the same manner and to the same extent as non-governmental entities.

Section 120(c) of CERCLA requires the EPA to compile information about contaminated sites at Federal facilities and to enter the information into the Federal Agency Hazardous Waste Compliance Docket. The docket must also include information about Federal facilities where hazardous wastes are generated and managed under sections 3005 and 3010 of the RCRA, even if these facilities are not contaminated.

Once sites are listed on the compliance docket, timetables are prepared for addressing problems. Within 18 months, PAs and site inspections are required. The facility is then scored under the HRS to place it on the NPL. If listed, the facility must begin an RI/FS within six months. During the RI/FS stage, consultation/negotiation with EPA must occur. Within 180 days after the completion of EPA's review, Federal agencies must enter into IAGs with the EPA for expeditious completion of RA at the facility. The contents of IAGs must include:
- a review of alternative RAs and selection of a RA;
- a schedule for the completion of the RA; and
- arrangements for long-term operation and maintenance of the facility.

Consent Orders and Settlement Agreements

The following is taken from U.S. Environmental Protection Agency, Cleanup Enforcement, Types of Superfund Settlements.

EPA negotiates cleanup agreements with potentially responsible parties. These agreements are in the form of administrative orders on consent, administrative agreements, or judicial consent decrees. Negotiations are based on model settlement documents, which can be modified to fit site circumstances.

Administrative orders on consent are legal documents that formalize an agreement between EPA and one or more potentially responsible parties to address some or all of the parties' responsibility for a site. EPA uses Administrative orders on consent for removal activity (short-term cleanup), investigation, and remedy design work. EPA also uses administrative orders on consent for cost recovery when the payments are made as part of an agreement for work and for *de minimis* cash out payments. Administrative orders on consent do not require approval by the court.

Administrative agreements are legal documents that formalize an agreement between EPA and one or more potentially responsible parties to reimburse EPA for costs already incurred, or for costs to be incurred at a Superfund site. Administrative agreements do not require approval by the court. All types of payment agreements that do not include performance of work are generally written as administrative agreements.

Judicial consent decrees are legal agreements entered into by the United States (through EPA and the Department of Justice) and potentially responsible parties and lodged with a court. Consent decrees are the only settlement type that EPA can use for the final cleanup phase (remedial action) at a Superfund site. EPA also uses consent decrees to recover cleanup costs in cost recovery and cash out settlements and on rare occasions to perform removal work or RI/FS. A consent decree is final when it is approved and entered by a U.S. district court.

EPA prefers that potentially responsible parties do the work of investigating, cleaning up, and maintaining the cleanup of Superfund sites. EPA negotiates an agreement (in the form of an administrative order on consent or consent decree) with the potentially responsible parties that outlines the work that is to be done. The term "work agreement" is used to cover a variety of agreements that involve the PRP doing the work (versus EPA doing the work). The most common agreements are for site investigation (RI/FS), short-term clean up (removal action), and long-term cleanup (RD/RA).

When EPA performs investigations or cleanup work, it can recover these costs from potentially responsible parties through a cost recovery agreement. When an agreement only addresses reimbursing EPA costs, it is referred to as a cost recovery agreement and takes the form of an administrative agreement. Administrative orders on consent for work may include a provision for the potentially responsible parties to reimburse EPA for past work costs and will include a provision for the potentially responsible party to pay EPA's future costs in overseeing the potentially responsible parties' work (considered "cost recovery" because such costs are billed to potentially responsible parties after they are incurred).

There are a few situations when it is more appropriate for potentially responsible parties not to be involved in performing work at a site. In such cases, EPA may negotiate a cash out agreement with the potentially responsible party, where the potentially responsible party pays an appropriate amount of estimated site costs in advance of the work being done. That money will be used to help pay for the clean up. Agreements to cash out *de minimis* potentially responsible parties are done as agreements orders on consent, and agreements to cash out peripheral and other ability to pay parties are done as administrative agreements. All types of cost recovery and cash out agreements may be done as consent decrees.

ROD

See item a of competency 35.

RCRA Part B Permit

The following is taken from DOE, Environmental Guidance, *RCRA Permitting Guide for Hazardous & Radioactive Mixed Waste Management Facilities*.

Hazardous waste TSDFs must submit both the Part A and Part B permit applications to the regulatory agency at the same time. For new facilities, the Part A and Part B permit applications must be submitted at least 180 days before construction of the facility is expected to begin.

The RCRA permit application consists of two parts - Part A and Part B. The Part A permit application is a standard form that requests general information about the facility and its operations. The RCRA Part B permit application provides comprehensive information about the facility and has no standard format. Some of the required information in the Part B application is common to all types of facilities (e.g., facility description, waste analysis plan, description of security procedures and equipment, general inspection schedule, etc.) while other information items are specific to the types of units included in the application. Common information items are outlined in 40 CFR 270.14, “Contents of Part B: General Requirements”. Unit-specific information requirements are located in 40 CFR 270.15 through 270.26. Table 9 summarizes the required information.

Table 9. Overview of the contents of RCRA permit applications

EXHIBIT 2-1
OVERVIEW OF THE CONTENTS OF RCRA PERMIT APPLICATIONS

Part A (40 CFR 270.13)	Part B: Information Addressing General Requirements (40 CFR 270.14)	Part B: Information Addressing Specific Requirements Applicable to the Units Listed (40 CFR 270.15-270.26)
Installation EPA ID #	Facility Description	Containers
Name of Facility	Waste Characterization	Tank Systems
Facility Location	Process Information	Surface Impoundments
Facility Mailing Address	Groundwater Monitoring	Waste Piles
Facility Contact	Procedures to Prevent Hazards	Incinerators
Facility Contact Address	Contingency Plan	Land Treatment Facilities
Operator Information	Personnel Training	Landfills
Facility Owner	Closure Plans	Boilers and Industrial Furnaces
SIC Codes	Post-Closure Plans	Miscellaneous Units
Existing Environmental Permits	Financial Assurance for Closure, Post Closure, and Third Party Liability*	Process Vents
Nature of Business	Corrective Action for Solid Waste Management Units	Equipment Subject to Standards for Equipment Leaks
Process Codes and Design Capacities	Public Participation	Drip Pads
Additional Treatment Processes	Part B Certification	Air Emission Standards for Containers, Tanks, and Surface Impoundments
Description of Hazardous Wastes	Other Federal Laws	Containment Buildings
Map		
Facility Drawing		
Photographs		
Certification(s)		
Comments		

* Not required for Federal Facilities.

Source: DOE, Office of Health, Safety, and Security, Environmental Guidance, Resource Conservation and Recovery Act, *RCRA Permitting Guide for Hazardous & Radioactive Mixed Waste Management Facilities*

Grant Conditions

The following is taken from U.S. Environmental Protection Agency, *Environmental Review Guide for Special Appropriation Grants*.

Federal funding of the design and construction of a project funded in whole or in part under an EPA appropriations act is subject to NEPA. Under NEPA, EPA must evaluate the environmental impacts of its action and all reasonable alternatives (including the no-action alternative), before taking the action (grant award). EPA may award a grant for planning and preliminary design and later amend it to include final design and construction once the NEPA environmental review process has been completed.

Once the EPA appropriations bill is signed into law, the Office of Water in EPA Headquarters in Washington, D.C. begins developing national guidelines for administering the Special Appropriations Act Project grants.

During pre-application planning, EPA and the grant recipient may discuss submission of the grant application and the scope of the environmental review information needed. These discussions may also include the project scope, environmental review, environmental

benefits and results, grant work plan, cost eligibility of project components, engineering data, and other items of importance for submitting a grant application.

During the environmental review, the applicant provides information to EPA to support a request for a CE determination, submits an environmental impact document or draft EA to EPA, or provides information for preparation of an EIS. EPA reviews the CE request, the environmental impact document, draft EA, or EIS and prepares or finalizes the appropriate NEPA document.

Discussions between the EPA point of contact and the potential grantee continue throughout the application process. The grant applicant prepares the application and submits it to EPA. EPA reviews the application for completeness, undertakes the appropriate NEPA review, and awards the grant, if appropriate. Once the grantee fulfills the conditions of the grant, it is closed out.

40. Environmental compliance personnel shall demonstrate a working-level knowledge of the requirements for managing environmental compliance data.

a. Describe the relationship of the following documents to the data management requirements of environmental compliance:
- **DOE O 414.1C, Quality Assurance**
- **NQA-1, Quality Assurance Program Requirements for Nuclear Facilities**
- **DOE G 1324.5B, Implementation Guide for Use with 36 CFR Chapter XII, Subchapter B, Records Management**
- **DOE Order 5400.5, Radiation Protection of the Public and the Environment**

DOE O 414.1C, Quality Assurance

The following is taken from DOE O 414.1C.

The objective of the DOE QA Program is to ensure that DOE and NNSA products and services meet or exceed customers' expectations. One of the management criteria to achieve this objective is to monitor how the QA Program addresses DOE work processes.

Work processes must be performed consistent with technical standards, administrative controls, and hazard controls adopted to meet regulatory or contract requirements using approved instructions and procedures. Items utilized in the work process must be identified and controlled to ensure their proper use. These items must also be properly maintained to prevent their damage, loss, or deterioration. Additionally, work process equipment must be properly calibrated and maintained when used for process monitoring or data collection.

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

A graded approach that doesn't compromise public, employee, or facility safety or adversely impact the environment and complies with requirements, rules, and regulations must be used to implement the DOE QA Program. The graded application of facility/activity requirements is dependent on the hazards and/or level of risk associated with the activity or structures, systems, and components under consideration. The scope, depth, and rigor of the quality management system's application of requirements should be determined by the use of a

grading process before performing the activity. The purpose of grading is to select the controls and verifications to be applied to various items and activities consistent with their importance to safety, cost, schedule, and success of the program.

The following is taken from U.S. Environmental Protection Agency, Guidance for Quality Assurance Project Plans, EPA QA/G-5.

A QA project plan describes the activities of an environmental data operations project involved with the acquisition of environmental information whether generated from direct measurements activities, collected from other sources, or compiled from computerized databases and information systems. Performance and acceptance criteria are often expressed in terms of data quality indicators. The principal indicators of data quality are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. Measurement quality objectives are the acceptance thresholds or goals for this project's data, usually based on the individual data quality indicators for each matrix and analyte group or analyte.

NQA-1, Quality Assurance Program Requirements for Nuclear Facilities

The following is taken from DOE, Audit Report, *The Procurement of Safety Class/Safety-Significant Items at the Savannah River Site*.

DOE O 414.1C requires the application of *Quality Assurance Requirements for Nuclear Facility Applications* (NQA-1) for nuclear-related activities. The NQA-1 standard provides requirements and guidelines for the establishment and execution of QA programs during the siting, design, construction, operation, and decommissioning of nuclear facilities.

Relevant NQA-1 standards include requirements that prime contractors:

- Evaluate subcontractors' capabilities to provide an SSC in accordance with specified requirements prior to contract award.
- Perform periodic audits and inspections of subcontractors to ensure continued compliance with procurement requirements.
- Ensure that QA requirements are "flowed down" in procurement documents. Additionally, contracts shall provide for access to subcontractor facilities for audits and inspections.
- Verify that the item procured conforms with procurement requirements prior to receiving and installing an SSC. This may be done through receiving inspections, source verifications, certificates of conformance, post installation tests or a combination of these methods.
- Employ special processes that control or verify quality, such as those used in welding, heat treating, and nondestructive examination. These processes must be performed by qualified personnel using qualified procedures in accordance with specified requirements.
- Ensure that items that do not conform to specified requirements are not inadvertently installed and used.

DOE G 1324.5B, Implementation Guide for Use with 36 CFR Chapter XII, Subchapter B, Records Management

[Note: DOE Order 1324.5B, Records Management Program was superseded by DOE O 200.1, *Information Management Program*. DOE O 200.1A, *Information Technology*

***Management*, subsequently superseded DOE O 200.1. DOE O 200.1A requires that a records management program is maintained, consistent with DOE O 243.1, *Records Management Program*.]**

The following is taken from DOE O 243.1.

DOE O 243.1 sets forth requirements and responsibilities for implementing and maintaining a cost-effective records management program throughout DOE and provides for:

- awareness that records management is a part of the job of every DOE employee and contractor (i.e., documentation of activities is essential to ensuring that DOE's performance and accomplishments can be preserved and made available to the citizens of the United States and DOE's staff);
- adequate and proper documentation of DOE activities, organization, functions, policies, decisions, procedures, and essential transactions;
- maintenance and use of records supporting DOE activities;
- proper records disposition; and
- economy and efficiency in the execution of the DOE Records Management Program.

DOE Order 5400.5, Radiation Protection of the Public and the Environment

See items a and b of competency 22.

b. Describe the quality assurance requirements for monitoring radiological air emissions specified in the NESHAP.

The following is taken from U.S. Environmental Protection Agency, Radiation Protection, Subpart H: Department of Energy Facilities.

Subpart H protects the public and the environment from the hazards of radionuclide emissions, other than radon, from DOE facilities. The regulation pertaining to subpart H is 40 CFR 61. It sets a limit on the emission of radionuclides that ensures no member of the public receives an effective dose equivalent of more than 10 mrem/year. Radon emissions are addressed in Subpart Q.

The DOE administers about 30 major and other smaller facilities. Owners/operators of each facility have specific responsibilities:

- continuously monitoring and tracking emissions,
- calculating the highest effective dose equivalent to a member of the public at an offsite point where there is a residence, school, business or office, and
- reporting this information annually to EPA, their EPA Regional office, or the state.

Calculations use data from all release points with a potential to contribute an effective dose equivalent of more than 0.1mrem/year.

All sampling must follow EPA-approved procedures. Computer models CAP-88 and AIRDOS-PC are approved for calculating effective dose equivalents, and EPA may approve other procedures with advanced notice. EPA's COMPLY model may be used under some conditions.

The following is taken from 40 CFR 61.93.

To determine compliance with NESHAP, radionuclide emissions shall be determined, and effective dose equivalent values to members of the public calculated, using EPA-approved sampling procedures.

Radionuclide emission rates from existing point sources (stacks or vents) shall be measured in accordance with the following requirements.

Effluent flow rate measurements shall be made using the following methods:

- Reference method 2 of appendix A to part 60 of NESHAP is used to determine velocity and volumetric flow rates for stacks and large vents.
- Reference method 2A of appendix A to part 60 of NESHAP is used to measure flow rates through pipes and small vents.
- The frequency of the flow rate measurements depend on the variability of the effluent flow rate. For variable flow rates, continuous or frequent flow rate measurements are made. For relatively constant flow rates, only periodic measurements are necessary.

Radionuclides shall be directly monitored or extracted, collected, and measured using the following methods:

- Reference method 1 of appendix A to part 60 of NESHAP is used to select monitoring or sampling sites.
- The effluent stream shall be monitored continuously with an in-line detector or representative samples of the effluent stream is withdrawn continuously from the sampling site following the guidance presented in American National Standards Institute, ANSI N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, including the guidance presented in appendix A of ANSI N13.1. The requirements for continuous sampling are applicable to batch processes when the unit is in operation. Periodic sampling (grab samples) may be used only with EPA's prior approval. Such approval may be granted in cases where continuous sampling is not practical, and radionuclide emission rates are relatively constant. In such cases, grab samples are collected with sufficient frequency so as to provide a representative sample of the emissions.
- Radionuclides are collected and measured using procedures based on the principles of measurement described in appendix B, method 114. Use of methods based on principles of measurement different from those described in appendix B, method 114, must have prior approval from the Administrator. EPA reserves the right to approve measurement procedures.
- A QA program shall be conducted that meets the performance requirements described in appendix B, method 114.

When it is impractical to measure the effluent flow rate at an existing source in accordance with the requirements, or to monitor or sample an effluent stream at an existing source in accordance with the site selection and sample extraction requirements of paragraph (b)(2) of this section, the facility owner or operator may use alternative effluent flow rate measurement procedures or site selection and sample extraction procedures provided that:

- it can be shown that the requirements are impractical for the effluent stream;
- the alternative procedure will not significantly underestimate the emissions;
- the alternative procedure is fully documented; and
- the owner or operator has received prior approval from EPA.

Radionuclide emission measurements are made at all release points that have a potential to discharge radionuclides into the air in quantities that could cause an effective dose equivalent in excess of 1 percent of the standard. All radionuclides that could contribute greater than 10 percent of the potential effective dose equivalent for a release point are measured. With prior EPA approval, DOE may determine these emissions through alternative procedures. For other release points that have a potential to release radionuclides into the air, periodic confirmatory measurements are made to verify the low emissions. To determine whether a release point is subject to the emission measurement requirements, it is necessary to evaluate the potential for radionuclide emissions for that release point. In evaluating the potential of a release point to discharge radionuclides into the air, the estimated radionuclide release rates are based on the discharge of the effluent stream that would result if pollution control equipment did not exist, but the facilities operations were otherwise normal.

Environmental measurements of radionuclide air concentrations at critical receptor locations may be used as an alternative to air dispersion calculations in demonstrating compliance with the standard if the owner or operator meets the following criteria:

- The air at the point of measurement is continuously sampled for collection of radionuclides.
- Those radionuclides released from the facility that are the major contributors to the effective dose equivalent are collected and measured as part of the environmental measurement program.
- Radionuclide concentrations that would cause an effective dose equivalent of 10 percent of the standard are readily detectable and distinguishable from background levels.
- Net measured radionuclide concentrations are compared to the concentration levels in table 2 of appendix E of NESHAP to determine compliance with the standard. In the case of multiple radionuclides being released from a facility, compliance is demonstrated if the value for all radionuclides is less than the concentration level in table 2, and the sum of the fractions that result when each measured concentration value is divided by the value in table 2 for each radionuclide is less than 1.
- A QA program is conducted that meets the performance requirements described in appendix B, method 114.
- Use of environmental measurements to demonstrate compliance with the standard is subject to prior approval by EPA. Applications for approval must include a detailed description of the sampling and analytical methodology and should show how the above criteria will be met.

Radionuclide emission rates from new point sources (stacks or vents) as defined in subpart A are measured according to the following requirements, or other procedures for which EPA has granted prior approval:

- Effluent flow rate measurements are made using the following methods:
  - ANSI/HPS N13.1-1999, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities*, is used to determine velocity and volumetric flow rates for stacks and large vents.
  - ANSI/HPS N13.1-1999 is used to measure flow rates through pipes and small vents.

- The frequency of the flow rate measurements depends on the variability of the effluent flow rate. For variable flow rates, continuous or frequent flow rate, measurements shall be made. For relatively constant flow rates, only periodic measurements are necessary.

- Radionuclides shall be directly monitored or extracted, collected, and measured using the following methods:
  - ANSI/HPS N13.1-1999 is used to select monitoring or sampling sites.
  - The effluent stream is monitored continuously with an in-line detector, or representative samples of the effluent stream are withdrawn continuously from the sampling site following the guidance presented in ANSI/HPS N13.1-1999. The requirements for continuous sampling are applicable to batch processes when the unit is in operation. Periodic sampling (grab samples) may be used only with EPA's prior approval. Such approval may be granted in cases where continuous sampling is not practical, and radionuclide emission rates are relatively constant. In such cases, grab samples are collected with sufficient frequency so as to provide a representative sample of the emissions.
  - Radionuclides are collected and measured using procedures based on the principles of measurement described in appendix B, method 11. Use of methods based on principles of measurement different from those described in appendix B, method 114, must have prior approval from the administrator. EPA reserves the right to approve measurement procedures.
  - A QA program is conducted that meets the performance requirements described in ANSI/HPS N13.1-1999.

When it is impractical to measure the effluent flow rate at a source according to the requirements, or to monitor or sample an effluent stream at a source in accordance with the site selection and sample extraction requirements, the facility owner or operator may use alternative effluent flow rate measurement procedures or site selection and sample extraction procedures provided that:

- it can be shown that the requirements are impractical for the effluent stream;
- the alternative procedure will not significantly underestimate the emissions;
- the alternative procedure is fully documented; and
- the owner or operator has received prior approval from EPA.

Radionuclide emission measurements in conformance with the requirements are made at all release points that have a potential to discharge radionuclides into the air in quantities that could cause an effective dose equivalent in excess of 1 percent of the standard. All radionuclides that could contribute greater than 10 percent of the potential effective dose equivalent for a release point shall be measured. With prior EPA approval, DOE may determine these emissions through alternative procedures. For other release points that have a potential to release radionuclides into the air, periodic confirmatory measurements are made to verify the low emissions.

To determine whether a release point is subject to the emission measurement requirements, it is necessary to evaluate the potential for radionuclide emissions for that release point. In evaluating the potential of a release point to discharge radionuclides into the air for the purposes of this section, the estimated radionuclide release rates are based on the discharge

of the effluent stream that would result if pollution control equipment did not exist, but the facilities operations were otherwise normal.

Environmental measurements of radionuclide air concentrations at critical receptor locations may be used as an alternative to air dispersion calculations in demonstrating compliance with the standard if the owner or operator meets the following criteria:

- The air at the point of measurement is continuously sampled for collection of radionuclides.
- Those radionuclides released from the facility that are the major contributors to the effective dose equivalent are collected and measured as part of the environmental measurement program.
- Radionuclide concentrations that would cause an effective dose equivalent of 10 percent of the standard are readily detectable and distinguishable from background levels.
- Net measured radionuclide concentrations are compared to the concentration levels in table 2 of appendix E of NESHAP to determine compliance with the standard. In the case of multiple radionuclides being released from a facility, compliance is demonstrated if the value for all radionuclides is less than the concentration level in table 2 of appendix E of NESHAP, and the sum of the fractions that result when each measured concentration value is divided by the value in table 2 of appendix E for each radionuclide is less than 1.
- A QA program is conducted that meets the performance requirements described in appendix B, method 114.
- Use of environmental measurements to demonstrate compliance with the standard is subject to prior approval by EPA. Applications for approval must include a detailed description of the sampling and analytical methodology and show how the above criteria will be met.

c. Describe the mean relative difference (MRD) statistical evaluations required by the Quality Assessment Program (QAP) for Department laboratories. Include in your discussion the purpose of the three types of evaluations (duplicate, blind-sample, and split-sample) performed.

[Note: A more widely used method for statistical evaluation of sample results at laboratories is relative percent difference.]

The following is taken from U.S. Environmental Protection Agency, Radon, Glossary of Terms.

Relative percent difference (RPD): A measure of precision, is calculated by:

$$\text{RPD} = \frac{|X_1 - X_2|}{X_{ave}} \times 100$$

where:
X_1 = concentration observed with the first detector or equipment;
X_2 = concentration observed with the second detector, or equipment; and
X_{ave} = average concentration = $((X_1 + X_2) / 2)$

The following is taken from Idaho National Laboratory, *Annual Site Environmental Report – 2007, Chapter 10 – Quality Assurance*.

Blind spikes (blind samples) are used to assess the accuracy of the laboratories selected for analysis. Contractors purchase samples spiked with known amounts of radionuclides or nonradioactive substances from suppliers whose spiking materials are traceable to the National Institute of Standards and Technology. These samples are then submitted to the laboratories with regular field samples, with the same labeling and sample numbering system. The analytical results are expected to compare to the known value within a set of performance limits.

Duplicate sampling occurs when two samples are collected from a single location at the same time. Two separate samples are taken from the same source, stored in separate containers, and analyzed independently. Duplicates are useful in documenting the precision of the sampling process.

Split sampling occurs when a sample is collected and later divided into two portions that are analyzed separately. The samples are taken from the same container and analyzed independently.

d. Describe the program administered by the Department's Environmental Measurements Laboratory (EML) to assess the quality of environmental data reported to the Department.

[Note: The EPA Las Vegas laboratory is now called the Radiation and Indoor Environments National Laboratory. The EML Quality Assessment Program was an external, independent, performance evaluation program designed to test the quality of environmental radiological measurements. The program, funded by U.S. Energy Research and Development Agency and then DOE, was terminated in 2004.]

41. Environmental restoration personnel shall demonstrate familiarity-level knowledge of hazardous waste as described in 40 CFR, Resource Conservation and Recovery Act (RCRA).

a. Define the term "hazardous waste."

The following is taken from U.S. Environmental Protection Agency, Land Disposal Restrictions, Summary of Requirements.

EPA uses the term "hazardous waste" to identify certain wastes that are harmful to human health and the environment. Hazardous wastes can be solid, liquid, contain gas, or sludge, and they can be generated from many different sources. To accommodate this varied universe of waste, we developed a system to identify not only specific substances known to be hazardous, but also other materials that present certain hazards. A waste is considered hazardous in two ways: by being specifically listed as a hazardous waste or by exhibiting a characteristic of hazardous waste. Only those wastes specifically listed or exhibiting a characteristic of hazardous waste are hazardous wastes (see 40 CFR 262.11, "Hazardous Waste Determination").

Listed Wastes

RCRA regulations list specific industrial waste streams and identify them as "Listed Wastes." These wastes are considered hazardous if they meet one of the narrative listing descriptions found in the regulations and do not meet any of the exclusions described in 40 CFR 261.4, "Exclusions." Listed wastes are divided into four different categories:

- F listed waste - wastes from non-specific industrial processes, such as spent solvents used for cleaning or degreasing;
- K listed waste - wastes that are from specific industry sources, such as certain petroleum refining wastes and veterinary pharmaceuticals;
- P listed waste - unused, acutely hazardous commercial chemical products, such as aldrin, a chemical used as an agricultural insecticide; and
- U listed waste - unused, commercial chemical products, such as DDT and formaldehyde.

The definitions and determinations for these listings can be found in 40 CFR 261.31 through 261.33.

Characteristic Wastes

Not all wastes that present a hazard will meet one of the narrative descriptions for listed wastes, yet the wastes can still possess hazardous properties. EPA identified specific properties (or characteristics) that would cause a waste to pose a threat to human health and the environment. Waste considered to be a characteristic hazardous waste has one or more of the following properties:

- Ignitability - waste that can catch fire and sustain combustion;
- Corrosivity - waste that corrodes metals or has a high or low pH;
- Reactivity - waste that readily explodes or undergoes violent reactions; and
- Toxicity - waste category of 40 constituents that are known to be harmful or fatal when ingested and are known to leach into groundwater at certain levels (e.g., arsenic, lead, and mercury).

The definitions and determinations for these characteristics are found in 40 CFR 261.21 through 261.24.

b. Using the decision tree in 40 CFR Part 260, relate RCRA solid waste to hazardous waste and identify the applicable RCRA regulations for each.

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

c. Identify the kinds of hazardous wastes generated within the Department and their sources.

This is a site-specific KSA. Discuss the kinds of hazardous waste generated at your facility. The local Qualifying Official will evaluate its completion.

d. Describe the combination of facilities used to manage hazardous wastes at a site.

This is a site-specific KSA. Discuss the combination of the facilities used to manage hazardous wastes at your site. The local Qualifying Official will evaluate its completion.

e. Discuss the current methods of disposing of hazardous wastes.

The following is taken from U.S. Environmental Protection Agency, Wastes - Hazardous Wastes - Treatment and Disposal, Treatment and Disposal.

Disposal is the placement of waste into or on the land. Disposal facilities are usually designed to permanently contain the waste and prevent the release of harmful pollutants to the environment. The most common hazardous waste disposal practice is placement in a land disposal unit such as a landfill, surface impoundment, waste pile, land treatment unit, or injection well. Land disposal is subject to requirements under EPA's LDR program.

In 1984, Congress created EPA's LDR program. The LDR program ensures that toxic constituents present in hazardous waste are properly treated before hazardous waste is land disposed. Since then, the LDR team has developed mandatory technology-based treatment standards that must be met before hazardous waste is placed in a landfill. These standards help minimize short- and long-term threats to human health and the environment, which directly benefits local communities where hazardous waste landfills are located. 40 CFR 268.40, "Applicability of Treatment Standards," and 40 CFR 268.48, "Universal Treatment Standards," contain tables listing treatment standards for hazardous material disposal.

Underground injection wells are the most commonly used disposal method for liquid hazardous waste. Because of their potential impact upon drinking water resources, injection wells are also regulated under the SDWA and by the UIC Program.

The following is taken from 40 CFR 268.40.

A prohibited waste identified in the table "Treatment Standards for Hazardous Wastes" may be land disposed only if it meets the requirements found in the table. For each waste, the table identifies one of three types of treatment standard requirements:

1. all hazardous constituents in the waste or in the treatment residue must be at or below the values found in the table for that waste ("total waste standards"); or
2. the hazardous constituents in the extract of the waste or in the extract of the treatment residue must be at or below the values found in the table ("waste extract standards"); or
3. the waste must be treated using the technology specified in the table ("technology standard"), which are described in detail in section 268.42, Table 1—Technology Codes and Description of Technology-Based Standards.

The following is taken from 40 CFR 268.48.

The Universal Treatment Standards table identifies the hazardous constituents, along with the non-wastewater and wastewater treatment standard levels, that are used to regulate most prohibited hazardous wastes with numerical limits. For determining compliance with treatment standards for underlying hazardous constituents as defined in section 268.2(i), these treatment standards may not be exceeded. Compliance with these treatment standards is measured by an analysis of grab samples, unless otherwise noted.

f. Explain the relationship between the Resource Conservation and Recovery Act and the Federal Facilities Compliance Act (FFCA). Include in your discussion the development of STPs and waste treatment technologies.

The following is taken from DOE, Office of Health, Safety, and Security, Environmental Policy, Federal Facility Compliance Act.

Before the passage of the FFCA, the federal government maintained and was supported by Supreme Court rulings that it was not subject to administrative and civil fines and penalties under solid and hazardous waste law because of the doctrine of "sovereign immunity." As a result, Congress enacted the FFCA (October 6, 1992), which effectively overturned the Supreme Court's ruling. In the legislation Congress specifically waived sovereign immunity with respect to RCRA for federal facilities.

Under section 102, The FFCA amends section 6001 of RCRA to specify that federal facilities are subject to all civil and administrative penalties and fines, regardless of whether such penalties or fines are punitive or coercive in nature.

The FFCA was effective upon enactment on October 6, 1992, with the exception that "departments, agencies, and instrumentalities of the executive branch of the Federal Government" would not be subject to the sovereign immunity waiver until three years after enactment for violations of RCRA section 3004(j) "involving storage of mixed waste that is not subject to an existing agreement, permit, or administrative or judicial order, so long as such waste is managed in compliance with all other applicable requirements." Section 3004(j) forbids the storage of hazardous waste prohibited from land disposal unless the storage is for the purpose of accumulating such quantities as necessary to facilitate proper recovery, treatment, or disposal. After October 6, 1995, the waiver of sovereign immunity shall still not apply to DOE so long as DOE "is in compliance with both (i) a plan that has been submitted and approved pursuant to section 3021(b) of the SWDA and which is in effect and (ii) an order requiring compliance with such plan which has been issued pursuant to such section 3021(b) and which is in effect." The plan required under section 3021(b) is for the development of treatment capacities and technologies to treat all of the mixed wastes at each DOE facility.

Many DOE facilities are now subject to federal facility compliance agreements and other binding administrative clean-up orders. The FFCA will allow regulators to impose fines or penalties on federal entities that fail to meet milestones or deadlines contained in such agreements or orders. Penalties specified in the agreements will now be enforceable and may result in substantial financial penalties to noncompliant facilities.

Not later than 180 days after the date of enactment, the Secretary of Energy had to submit (1) reports containing a national inventory of mixed wastes on a state-by-state basis and (2) a national inventory of mixed waste treatment capacities and technologies to the EPA Administrator and the governors of states in which DOE stored or generated mixed wastes.

Additionally, the Secretary of Energy was directed to prepare and submit STPs for developing treatment capacities and technologies for all facilities generating or storing mixed waste that are not subject to any permit, agreement, or order. Such plans were to include

schedules for developing treatment capacity where treatment technologies exist and schedules for identifying and developing treatment technologies where none is currently available. These plans were to be reviewed and approved either by EPA or the states, depending on whether the state is authorized to regulate mixed waste. Upon approval of the submitted plans, EPA or the states were to issue orders requiring compliance with the plans.

Section 108 of the FFCA added a new section 3023, "Federally Owned Treatment Works," to Subtitle C of RCRA. This new section provides that if certain conditions are met, FOTWs are essentially exempted from RCRA regulation based on the domestic sewage exclusion to the definition of solid waste.

g. Describe the types of facilities that need Resource Conservation and Recovery Act (RCRA) permits; list differences between a RCRA Part A and a RCRA Part B permit application; and give examples of RCRA Part B permit application requirements that apply to all facilities and those that apply to specific types of facilities.

See item a of competency 39.

h. Describe how to determine if a material is a solid waste. Given a material that is a solid waste, describe how to determine if it is a hazardous or a mixed waste.

The following is taken from U.S. Environmental Protection Agency, Terms of Environment, *Glossary, Abbreviations, and Acronyms*.

Solid wastes are non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid waste also refers to liquids and gases in containers.

The following is taken from U.S. Environmental Protection Agency, Waste Types, Mixed Waste.

Mixed waste contains both radioactive and hazardous waste components. As a result, both treatment and regulation are complex. Mixed wastes are regulated by RCRA and the AEA. In general, the requirements of RCRA and the AEA are consistent and compatible. However, in cases where requirements of the two acts are found to be inconsistent, the AEA takes precedence.

The following is taken from U.S. Environmental Protection Agency, Land Disposal Restrictions, Summary of Requirements.

EPA uses the term "hazardous waste" to identify certain wastes that are harmful to human health and the environment. Hazardous wastes can be solid, liquid, contained gas, or sludge, and they can be generated from many different sources. To accommodate this varied universe of waste, we developed a system to identify not only specific substances known to be hazardous, but also other materials that present certain hazards. A waste is considered hazardous in two ways: by being specifically listed as a hazardous waste or by exhibiting a characteristic of hazardous waste. Only those wastes specifically listed or exhibiting a

characteristic of hazardous waste are hazardous wastes (see 40 CFR 262.11, "Hazardous Waste Determination").

Listed Wastes

RCRA regulations list specific industrial waste streams and identify them as "Listed Wastes." These wastes are considered hazardous if they meet one of the narrative listing descriptions found in the regulations and do not meet any of the exclusions described in 40 CFR 261.4, "Exclusions." Listed wastes are divided into four different categories:

1. F listed waste - wastes from non-specific industrial processes, such as spent solvents used for cleaning or degreasing;
2. K listed waste - wastes that are from specific industry sources, such as certain petroleum refining wastes and veterinary pharmaceuticals;
3. P listed waste - unused, acutely hazardous commercial chemical products, such as aldrin, a chemical used as an agricultural insecticide; and
4. U listed waste - unused, commercial chemical products, such as DDT and formaldehyde.

The definitions and determinations for these listings can be found in 40 CFR 261.31 through 261.33.

Characteristic Wastes

Not all wastes that present a hazard will meet one of the narrative descriptions for listed wastes, yet the wastes can still possess hazardous properties. EPA identified specific properties (or characteristics) that would cause a waste to pose a threat to human health and the environment. Waste considered to be a characteristic hazardous waste has one or more of the following properties:

- Ignitability - waste that can catch fire and sustain combustion;
- Corrosivity - waste that corrodes metals or has a high or low pH;
- Reactivity - waste that readily explodes or undergoes violent reactions; and
- Toxicity - waste category of 40 constituents that are known to be harmful or fatal when ingested and are known to leach into groundwater at certain levels (e.g., arsenic, lead, and mercury).

The definitions and determinations for these characteristics are found in 40 CFR 261.21 through 261.24.

i. Discuss the land disposal restriction (LDRs), including the different types of treatment standards, the dilution prohibition, the storage prohibition, and different types of variances and exemptions.

The following is taken from U.S. Environmental Protection Agency, Wastes - Hazardous Wastes - Treatment and Disposal, Treatment and Disposal.

Disposal is the placement of waste into or on the land. Disposal facilities are usually designed to permanently contain the waste and prevent the release of harmful pollutants to the environment. The most common hazardous waste disposal practice is placement in a land disposal unit such as a landfill, surface impoundment, waste pile, land treatment unit, or injection well. Land disposal is subject to requirements under EPA's LDR program.

In 1984, Congress created EPA's LDR program. The LDR program ensures that toxic constituents present in hazardous waste are properly treated before hazardous waste is land disposed. Since then, the LDR team has developed mandatory technology-based treatment standards that must be met before hazardous waste is placed in a landfill. These standards help minimize short- and long-term threats to human health and the environment, which directly benefits local communities where hazardous waste landfills are located. 40 CFR 268.40, "Applicability of Treatment Standards," and 40 CFR 268.48, "Universal Treatment Standards," contain tables listing treatment standards for hazardous material disposal.

Underground injection wells are the most commonly used disposal method for liquid hazardous waste. Because of their potential impact upon drinking water resources, injection wells are also regulated under the SDWA and by the UIC Program.

The following is taken from 40 CFR 268.40.

A prohibited waste identified in the table "Treatment Standards for Hazardous Wastes" may be land disposed only if it meets the requirements found in the table. For each waste, the table identifies one of three types of treatment standard requirements:

1. all hazardous constituents in the waste or in the treatment residue must be at or below the values found in the table for that waste ("total waste standards"); or
2. the hazardous constituents in the extract of the waste or in the extract of the treatment residue must be at or below the values found in the table ("waste extract standards"); or
3. the waste must be treated using the technology specified in the table ("technology standard"), which are described in detail in section 268.42, "Table 1—Technology Codes and Description of Technology-Based Standards."

The following is taken from 40 CFR 268.48.

The Universal Treatment Standards table identifies the hazardous constituents, along with the non-wastewater and wastewater treatment standard levels, that are used to regulate most prohibited hazardous wastes with numerical limits. For determining compliance with treatment standards for underlying hazardous constituents as defined in section 268.2(i), these treatment standards may not be exceeded. Compliance with these treatment standards is measured by an analysis of grab samples, unless otherwise noted.

The following is taken from U.S. Environmental Protection Agency, Land Disposal Restrictions, Summary of Requirements.

All listed and characteristic hazardous wastes that will be land disposed are subject to the LDR program. However, certain exceptions apply if wastes meet an exclusion. There are general exclusions that apply to all RCRA regulations, such as the exclusions from the definition of solid waste (e.g., the domestic sewage exclusion) under 40 CFR 261.4(a) or exclusions from the definition of hazardous waste (e.g., the household hazardous waste exclusion) under 40 CFR 261.4 (b). In addition, the following wastes are not subject to the LDR regulations (40 CFR 268.1(e)):

- waste generated by conditionally exempt small quantity generators;

- waste pesticide and container residues disposed of by farmers on their own land (40 CFR 262.70);
- newly identified or newly listed hazardous wastes for which EPA has not yet promulgated treatment standards; and
- certain low-volume releases of characteristic wastes, known as *de minimis* losses, or characteristic laboratory chemicals that are mixed with a facility's wastewater and discharged under CWA regulation.

Dilution Prohibition

The LDR dilution prohibition states that you cannot in any way dilute a hazardous waste as a substitute for adequate treatment. The dilution prohibition implements 3004(m) of RCRA, which requires that hazardous constituents be destroyed, removed, or immobilized before land disposal. The dilution prohibition serves two main purposes: to ensure the actual treatment of hazardous constituents; and to ensure that wastes are treated appropriately. Dilution is not permitted when it is used to avoid meeting an applicable treatment standard or effective date.

Storage Prohibition

It is permissible under RCRA to temporarily store prohibited hazardous wastes. Storage of prohibited wastes is only allowed to accumulate a sufficient volume of waste to facilitate proper treatment, recovery, or disposal of that waste. If you generate the waste, you are subject to restrictions on accumulation time and other general requirements under 40 CFR 262.34 and 40 CFR 268.50(a)(1) while such waste is in storage. If you own or operate a TSDF, you are subject to marking and labeling requirements for restricted wastes in storage (40 CFR 268.50(a)(2)) in addition to any unit-specific operating requirements in Parts 264 or 265.

A storage limit of up to one year generally provides sufficient time to accumulate enough waste to facilitate proper recovery, treatment, or disposal. If the need to store hazardous waste for a period beyond one year arises, facilities are not required to submit any notification to EPA. However, in the event of an enforcement action, the burden of proof to justify that such storage is necessary to facilitate proper recovery, treatment, or disposal lies with the facility.

Variance, Extensions, and Exemptions

In the LDR program, six provisions allow for delays or exemptions from the application of treatment standards and other LDR requirements. The provisions are:

- National Capacity Variance (40 CFR 268.30–268.39)
- Case-by-Case Extension (40 CFR 268.5)
- Treatability Variance (40 CFR 268.44)
- Equivalent Method Variance (40 CFR 268.42(b))
- No-Migration Petition (40 CFR 268.6)
- Surface Impoundment Exemption (40 CFR 268.4 and 40 CFR 268.14)

A national capacity variance is provided when EPA determines that sufficient treatment capacity for certain hazardous wastes is not available on a nationwide basis. The variance extends the effective date of the waste's treatment standard until the earliest date when

treatment capacity is expected to be available, with a maximum of a two-year extension. Wastes benefitting from a national capacity variance are allowed to be land disposed without meeting treatment standards.

In site-specific cases where adequate treatment capacity for a specific waste cannot reasonably be made available by the effective date of prohibition, one can petition EPA for an extension of the effective date on a case-by-case basis. EPA may grant a case-by-case extension of up to one year, renewable only once, for one additional year.

If you are a generator or treatment facility whose wastes cannot be treated to achieve the established treatment standards, or for which treatment standards are not appropriate, you may petition EPA for a variance from the treatment standard (treatability variance). Wastes that may be eligible for a variance include unique wastes, remediation wastes, wastes formed by inadvertent mixing, or wastes that otherwise are different in physical or chemical properties from those wastes used to set the treatment standards. A treatment variance does not exempt your wastes from treatment, but rather establishes an alternative LDR treatment standard.

For some restricted wastes, EPA expressed treatment standards as a specified treatment method rather than as the constituent concentration levels in the waste. These wastes must be treated using the specified technology in order to comply with the LDR standards. In some situations, however, EPA will allow alternative treatment methods to be used in place of the required technology as long as the method can be demonstrated to be equivalent to the specified treatment standard.

Under certain circumstances EPA will allow wastes to be placed in land disposal units without first meeting their treatment standards. If a petitioner can demonstrate that hazardous constituents will not migrate from a unit at concentrations greater than Agency-approved health-based levels, EPA will grant a no-migration variance. A no-migration variance may be granted for up to 10 years, not to exceed a date beyond the term of the unit's permit. The regulatory relief issued under a no-migration variance applies only to the unit and wastes specified in the petition.

Under LDR there are two exemptions established for surface impoundments. The first exemption, found at 40 CFR 268.4 allows wastes to be placed in surface impoundments for treatment in the impoundment without first meeting the LDR treatment standards. In order to qualify for this exemption the unit must meet the following conditions:

- representative samples must be taken of the wastes in the surface impoundments to determine if they meet the applicable treatment standards;
- liquid and solid treatment residuals not meeting their treatment standards must be removed from the surface impoundment annually; the removed residues must then be treated to meet the applicable standards before being disposed and may not be placed in another surface impoundment; and
- the facility must keep all records concerning such sampling and removal of wastes.

The surface impoundment also must be designed in accordance with specified criteria outlined in 40 CFR 268.4(a)(3), including the minimum technological requirements, such as a double liner, leachate collection system, and groundwater monitoring system.

The second exemption for surface impoundments is found at 40 CFR 268.14. This exemption applies only in situations where a nonhazardous waste surface impoundment is storing a waste that then becomes newly subject to RCRA requirements. Since these wastes are newly regulated, RCRA regulations require these surface impoundments either to be closed or upgraded to meet minimum technical requirements within four years.

j. Discuss the regulatory requirements applicable to federal facility solid waste landfills, including Resource Conservation and Recovery Act, subtitle D).

The following is taken from U.S. Environmental Protection Agency, Region 9: Waste Programs, Solid Waste, Laws and Regulations.

RCRA, Subtitle D regulates the management of nonhazardous solid waste. It establishes minimum federal technical standards and guidelines for state solid waste plans in order to promote environmentally sound management of solid waste. Subtitle D Regulates:

- garbage also known as municipal solid waste (e.g., milk cartons and coffee grounds),
- refuse (e.g., metal scrap, wall board, and empty containers),
- sludges from waste treatment plants, water supply treatment plants, or pollution control facilities (e.g., scrubber slags),
- nonhazardous industrial wastes (e.g., manufacturing process wastewaters and non-wastewater sludges and solids), and
- other discarded materials, including solid, semisolid, liquid, or contained gaseous materials resulting from industrial and commercial activities, (e.g., mining waste, oil and gas waste, construction and demolition debris, medical waste, agricultural waste, household hazardous waste, and Conditionally Exempt Small Quantity Generator Waste).

RCRA Subtitle D focuses on the states as the primary planning, regulating, implementing, and enforcement entities for the management of nonhazardous solid waste, such as household garbage and nonhazardous industrial solid waste.

Each state must submit an application to EPA in order to receive approval for its program. This approval process assesses whether a state's program is sufficient to ensure each landfill's compliance with federal criteria under RCRA, Subtitle D. The proper design and operational criteria for municipal solid waste landfills and other solid waste disposal facilities are covered under RCRA Subtitle D. States may impose requirements that are more stringent than the federal requirements.

k. Discuss the Personal Protective Equipment (PPE) requirements for work activities in hazardous areas.

The following is taken from U.S. Centers for Disease Control, *Managing Hazardous Materials Incidents Volume II, Hospital Emergency Departments*.

The EPA has assigned four levels of protection to assist in determining which combinations of respiratory protection and protective clothing should be employed:

- Level A protection should be worn when the highest level of respiratory, skin, eye, and mucous membrane protection is needed. It consists of a fully-encapsulating chemical-resistant suit and self-contained breathing apparatus.

- Level B protection should be selected when the highest level of respiratory protection is needed but a lesser level of skin and eye protection is sufficient. It differs from Level A only in that it provides splash protection by use of chemical-resistant clothing (overalls, long sleeves, jacket, and self-contained breathing apparatus).
- Level C protection should be selected when the type of airborne substances is known, concentration is measured, criteria for using air-purifying respirators are met, and skin and eye exposures are unlikely. This involves a full-facepiece, air-purifying, canister-equipped respirator and chemical-resistant clothing. It provides the same level of skin protection as Level B, but a lower level of respiratory protection.
- Level D is primarily a work uniform. It should not be worn on any site where respiratory or skin hazards exist. It provides no respiratory protection and minimal skin protection.

Respirators

The following is taken from U.S. Department of Transportation, Federal Highway Administration, Bridge Lead Removal and General Site Safety, FHWA-RD-98-179, *Personal Protective Equipment.*

The type of respirator worn by workers depends on the level of exposure. A medical evaluation will be necessary to determine if an individual can wear a particular respirator. Medical conditions, such as heart disease, emphysema, asthma, or other lung disorders, may make it difficult for an individual to wear a particular type of respirator. There are two major categories of respirators: air purifying respirators and supplied air respirators.

Air purifying respirators purify the air a worker breathes by removing or filtering the contaminant from the air before it enters the wearer's lungs. The filter removes the contaminant from the air before the air enters the inside of the respirator through the inhalation valve and supplies clean or purified air to the wearer. When the wearer exhales, air from the lungs is released through a separate valve called the exhalation valve.

Air purifying respirators are commonly called negative pressure respirators. These masks depend on the wearer's lungs to pull air through the filter or cartridge. When a worker inhales, suction is created that draws air outside the respirator into the mask. This suction is referred to as a negative pressure and means that the air pressure inside the mask becomes negative (lower) compared with the air pressure outside the mask when the wearer inhales. In contrast, when a worker exhales or blows out air, a positive (greater) pressure is created inside the mask compared with the outside air pressure.

Facial features can prevent a good respirator seal from occurring with the wearer's face. Facial hair, such as beards, stubble, and sideburns that lie between the sealing surface of the respirator and the face will result in leaks of contaminated air into the mask. Likewise, deformities on the face, such as scars, acne, and lack of teeth, can cause leaks. Because of the potential for leaks through an improper seal, beards and other facial hair that lies along the sealing surface are not permitted for workers who wear respirators, and special care must be given to proper fitting of respirators for workers with facial deformities. Air purifying respirators can only be used in atmospheres with sufficient oxygen and where air contaminants do not exceed the concentration range specified for the respirator.

All air purifying respirators, whether half-face, full-face, or powered have the following limitations:

- Cartridge life problem. The cartridge has only so much capacity, and when that capacity is reached, the cartridge is no longer any good. If the cartridge is used for organic vapors or gases and the capacity is reached, the contaminants will pass through the filtering material directly into the worker's lung. This is called "breakthrough." Some chemicals have poor warning properties so the worker will not smell the chemical when breakthrough occurs. This will cause serious problems. As a result, this type of respirator cannot be used with substances that have poor warning properties. If the contaminant is a solid, and a HEPA or other particulate filter is used, at some point the worker will have a hard time breathing through the filter as it becomes clogged. It will need to be changed at that point.
- Oxygen limitations. Air purifying respirators can only be used when there is sufficient oxygen in the air. The minimum concentration must be no less than 19.5 percent.
- Toxic concentrations (immediately dangerous to life or health). Under these concentrations it is much too dangerous to trust this type of respirator. It doesn't provide enough margin of safety.

Supplied air respirators do not depend on filters. Instead, they provide an independent supply of uncontaminated air. This type supplies air to the face-piece through a length of hose called an air line. The air line is connected to either a compressed-air cylinder or else to a compressor that is equipped with equipment to purify the air. The air supply can be used to pressurize the mask to achieve a high protection factor.

Limitations of supplied air respirators:

- The air line impairs worker movement. The air line cannot exceed 300 feet (91.4 meters) in length according to regulations. Workers also must retrace their steps coming off of the job.
- The air line is vulnerable to damage. Rough or sharp surfaces can puncture the line. The rubber hose may deteriorate from exposure to chemicals or to sunlight. Falling objects, vehicles, and heavy equipment also can damage the air line.
- The system air compressor must be located away from potential chemical or contamination hazards.
- All filters and alarms must be working properly and the system must be maintained according to the manufacturers' recommendations.
- The maximum inlet pressure cannot exceed 125 psi (862 kilopascal [kPa) or fall below 80 psi (522kPa).

Protective Clothing

The following is taken from U.S. Centers for Disease Control, *Managing Hazardous Materials Incidents Volume II, Hospital Emergency Departments*.

Protective clothing is designed to prevent direct contact of a chemical contaminant with the skin or body of the user. However, there is not one single material that will afford protection against all substances. Thus, multilayered garments are often employed, which may reduce dexterity and agility. Protective clothing is designed to afford the wearer a known degree of protection from a known type, a known concentration, and a known length of exposure to a

hazardous material, but only if it is properly fitted and worn correctly. Improperly worn equipment can expose and endanger the wearer. One factor to keep in mind during the selection process is that most protective clothing is designed to be impermeable to moisture, thus limiting the transfer of heat from the body through natural evaporation. This is a particularly important factor in hot environments or for strenuous tasks since such garments can increase the likelihood of heat injury.

The effectiveness of protective clothing can be reduced by three actions: degradation, permeation, and penetration. Chemical degradation occurs when the characteristics of the material in use are altered through contact with chemical substances. Examples of degradation include cracking and brittleness, and other changes in the structural characteristics of the garment. Degradation can also result in an increased permeation rate through the garment, that is, the molecular absorption by or passage through the protective material of a chemical substance.

Permeation is the process in which chemical compounds cross the protective barrier of protective clothing because of passive diffusion. The rate at which a compound permeates protective clothing is dependent on factors such as the chemical properties of the compound, the nature of the protective barrier in the protective clothing, and the concentration of the chemical on the surface of the protective clothing. Most manufacturers of protective clothing provide charts on the breakthrough time, or the time it takes for the chemical to permeate the material of a protective suit, for a wide range of chemical compounds.

Penetration occurs when there is an opening or a puncture in the protective material. These openings can include unsealed seams, button holes, and zippers. Often such openings are the result of faulty manufacture or problems with the inherent design of the suit. Protective clothing is available in a wide assortment of forms, ranging from fully-encapsulating body suits to gloves, hard hats, earplugs, and boot covers. Protective clothing comes in a variety of materials, offering a range of protection against a number of chemicals.

MSHA Approved Self-Rescue Devices

The following is taken from U.S. Department of Labor, MSHA's Occupational Illness and Injury Prevention Program Health Topic, Filter Self-Rescue Devices.

The filter self-rescue device is a small filter-type respirator designed to provide respiratory protection only against carbon monoxide gas for a limited period of time. The device is approved for protection against carbon monoxide, such as may result from underground fires, in concentrations up to 1 percent by volume (10,000 ppm) for a period of up to one hour. As such, the device is to be used for escape only. It is required that a self-rescue device be provided and available for each worker underground. The filter self-rescue device is not a self-contained nor oxygen-supplying respirator, and must be used only in oxygen-containing atmospheres. Neither does the device provide protection against toxic gases other than carbon monoxide. Thus it must be emphasized that, in an underground mining emergency, the self-rescue device must be used for escape only.

The filter self-rescue device must be carried on the worker, attached to the mobile equipment the worker is operating, or located within 25 feet of the worker, so that it will be readily available in case of an emergency. When the device is worn in the presence of carbon

monoxide, heat is generated within the device, which may become uncomfortable or even painful to the wearer. In such a case, the device must still be kept in place; otherwise, the worker would subject himself/herself to high risk of carbon monoxide poisoning and possibly collapse and death. As indicated above, the self-rescue device is meant for escape only, and is a single-use unit to be discarded after use or after the seal is broken.

There are two filter self-rescue devices approved for use in metal/nonmetal mines. The MSA W65 manufactured by Mine Safety Appliances Company, and the Drager 810 and 910 manufactured by Dragerwerk.

The operator has the responsibility of training workers in the use of filter self-rescue devices, and also of setting up and carrying out a maintenance program for the devices. The maintenance program should include both visual inspection and weighing. Weight gain indicates leakage and absorption of moisture. Each device should be weighed upon receipt from the vendor and at regular intervals thereafter. The device is weighed by first cleaning it (scraping off debris and wiping with a damp cloth) and then placing it on the balance. The current weight is compared with the manufacture's weight stamped on the case. A weight record should be kept for each device. In addition to regular weighing, the miner should know how to inspect the device and report defects such as a damaged case, a broken seal, or any sign that leakage has occurred. Defective devices should be removed from service immediately.

Workers must be conscious of the filter self-rescue device available for use, and that it is provided for escape only. Proper use, care, and maintenance are necessary for the device to be reliable.

I. Discuss the potential liabilities of the Department of Energy and its contractors inherent in the enforcement of environmental regulations (i.e., compliance orders, enforcement actions, fines and penalties, and provisions for civil suits).

The following is taken from U.S. Environmental Protection Agency, Compliance and Enforcement at Federal Facilities, Federal Facilities Enforcement.

EPA has explicit authority to assess fines at federal facilities violating environmental statutes. EPA's federal facilities civil enforcement program helps protect public health and the environment by assuring that federal facilities comply with federal environmental laws.

EPA also enforces environmental cleanup requirements at federal facilities. Cleanup enforcement authority is derived from several statutes: CERCLA (or Superfund), RCRA, including the UST program, and the OPA, a part of the CWA. These statutes, as well as Presidential Executive Orders, require federal facilities to clean up environmental contamination at their facilities.

CERCLA requires federal agencies to investigate and clean up contamination at their facilities. Federal facilities that are significantly contaminated may be placed on the CERCLA NPL. For such facilities CERCLA requires that EPA and the federal facility enter into an IAG (IAG -- sometimes called Federal Facility Agreement) to govern the cleanup to be done. States often are signatories to these IAGs, too. Once an IAG has been signed, EPA monitors the cleanup schedule and milestones and oversees its requirements to ensure proper

implementation of each cleanup. EPA can assess stipulated penalties for non-compliance with the terms of the IAG including missed milestones.

m. Discuss the waste management requirements for polychlorinated biphenyls (PCBs) outlined by the Toxic Substances Control Act (TSCA).

The following is taken from DOE, Office of Health, Safety, and Security, TSCA Information Brief, PCB Recordkeeping and Reporting.

All owners and operators of facilities must maintain annual records and an annual document log when generating waste containing, using, or storing the following at any one time:

- one or more PCB Transformers (i.e., transformers with ≥ 500 ppm of PCBs),
- voltage regulators (with ≥ 3 lbs. of ≥ 500 ppm of PCBs),
- ≥ 50 ppm PCB Large (High- or Low-Voltage) Capacitors, or
- ≥ 99.4 lbs. of ≥ 50 ppm of PCBs in PCB Containers.

In addition, disposers and commercial storers of PCB waste must submit an annual report to the EPA.

Annual records consist of all signed manifests for PCB waste generated, stored, or disposed of at the facility and all Certificates of Disposal generated or received by the facility during a calendar year, and records of inspections and cleanups performed. An annual document log (i.e., an inventory of PCBs and PCB items) is required only for facilities that must maintain annual records of PCBs. It contains detailed information on the total amount of waste PCBs and number of PCB items shipped from or received by a facility during a calendar year based on annual records. An annual report summarizes the information in the annual document log and annual records for the preceding calendar year. It must be submitted to EPA by disposers and commercial storers of PCB waste by July 15 of the following year.

The following is taken from DOE, Office of Health, Safety, and Security, TSCA Information Brief, PCB Storage Requirements.

Any PCB waste must be disposed of within one year from the date it was determined to be a PCB waste and the decision was made to dispose of it. PCB/radioactive wastes are exempt from the one-year limit if attempts to secure disposal have been unsuccessful and records to this effect are made available to the EPA. Upon written justified request the EPA may grant one-year extensions, and additional extensions as appropriate, for those subject to the one-year storage limit who have been unable to arrange for disposal.

If leaks occur while a PCB item is in storage, the leaking PCB item must be transferred immediately to a properly marked, non-leaking container. The spilled or leaked material must then be cleaned up according to the TSCA PCB Spill Cleanup Policy at 40 CFR Subpart G (if it is a recent spill) or 40 CFR 761.61(a) (if it is not a recent spill). Records of cleanups must be kept with the annual records.

PCBs and PCB items stored in a PCB storage unit or stored in accordance with the temporary storage provisions must be inspected for leaks at least once every 30 days. PCBs and PCB items stored on pallets adjacent to a PCB storage facility must be checked for leaks weekly. Records of inspection must be kept with the annual records.

The following is taken from DOE, Office of Health, Safety, and Security, TSCA Information Brief, PCB Manifesting and Notification Rule.

TSCA regulations require generators of PCB waste to notify EPA of their activities and to implement a manifest system for tracking disposal of PCB waste. The regulations also require commercial storers of PCB waste to obtain EPA approval for such storage and to develop closure plans. The PCB Manifesting and Notification Rule includes the following requirements:

- The transportation of PCB waste must be properly manifested similar to the "cradle-to-grave" concept of RCRA.
- Generators must notify EPA of their PCB waste handling activities and any changes in these activities or their facility location.
- Generators must obtain a unique identification number from EPA.
- DOE facilities that store PCB waste exceeding 500 gallons from non-DOE activities are considered commercial storage facilities.
- For purposes of defining "commercial storer," contractors operating DOE facilities are, in effect, considered employees of DOE and, therefore, what applies to DOE also applies to them.

n. Discuss the Resource Conservation and Recovery Act underground storage tank regulations (subtitle I).

The following is taken from DOE, Office of Health, Safety, and Security, DOE's RCRA Orientation Workshop, Subtitle I Program Overview.

To address uncontrolled releases from product storage tanks, Congress passed the HSWA of 1984. These amendments extended and strengthened the provisions of the SWDA by providing a statutory framework for the development and implementation of a comprehensive regulatory program for USTs.

Consistent with the HSWA statute, EPA defines a UST as any one or combination of tanks that is used to contain an accumulation of regulated substances and the volume of which is 10 percent or more beneath the surface of the ground. Subtitle I affects two categories of regulated substances: petroleum, and hazardous substances under CERCLA section 101(14). Subtitle I excludes some USTs including, wastewater treatment tanks, small capacity private use USTs, and any UST containing radioactive material regulated under the AEA.

All tanks and associated piping must be made from fiberglass-reinforced plastic, cathodically protected steel, or a composite of these two. Alternative designs are acceptable when approved by a corrosion expert or regulatory authority. Any cathodic protection system used in a UST system must be inspected by a qualified person within 6 months of installation and every 3 years thereafter, according to a code of practice developed by a nationally recognized association.

All facilities must have a release detection method that:

- is capable of detecting a release from any portion of the tank or piping;
- is installed and maintained in accordance with the manufacturer's instructions, including routine inspections; and

- is capable of meeting performance standards that have been designed for the chosen release detection method.

Preexisting UST systems must install a release detection system following a 5-year phase-in period, which ended December 22, 1993.

Owners and operators of petroleum tanks may use a variety of release detection methods such as inventory control combined with tank tightness testing, soil gas monitoring, and groundwater monitoring to comply with the release detection requirements. The appropriateness of the different detection methods is highly dependent on whether the UST meets the performance standards for new tanks/upgraded tanks. Petroleum USTs must be monitored at least every 30 days.

In addition to complying with the release detection provisions for petroleum USTs, EPA requires existing hazardous substance UST systems to be retrofitted with secondary containment, or replaced with/surrounded by a double-walled tank or an external liner by December 22, 1998.

Because UST systems are hidden from direct observation, suspected releases must be investigated to identify, or confirm, that an UST system is the source of a release. Monitoring results and other indicators in the environment are only suggestions of a release. In general, corrective action cannot be started until the UST system and UST site are investigated and a release is confirmed.

Owners and operators may discover a release based on the presence of free product or vapors, the sudden loss of product or unexplained presence of water, and/or monitoring results from release detection. As the first step in responding to suspected releases, owners and operators must report to the regulatory agency within 24 hours and investigate and confirm all suspected releases within 7 days.

If an investigation confirms that a leak exists, owners and operators must repair, replace, or upgrade the UST system and begin corrective action under Subpart F of 40 CFR 280.

The principal objective of the UST system closure requirements is to identify and contain existing contamination and to prevent future releases from out-of-service UST systems. To accomplish this, EPA specifies conditions that govern systems that temporarily close for less than 12 months. Closure provisions also address USTs that are taken out of service for 12 months or longer and USTs that do not meet the requirements for new or upgraded USTs (i.e., UST systems that are required to close permanently), as well as UST systems that were taken out of service prior to December 22, 1988.

o. Describe the relationship of the Hazardous Materials Transportation Act (HMTA) (49 CFR Parts 170-179) to the Resource Conservation and Recovery Act transportation regulations (40 CFR 263).

The following is taken from DOE, Office of Health, Safety, and Security, Envirnomental Policy, Hazardous Materials Transportation Act.

The HMTA of 1975, as amended, is the major transportation-related statute affecting DOE. The objective of the HMTA according to the policy stated by Congress is ". . .to improve the regulatory and enforcement authority of the Secretary of Transportation to protect the Nation adequately against risks to life and property which are inherent in the transportation of hazardous materials in commerce." The HMTA empowered the Secretary of Transportation to designate as hazardous material any "particular quantity or form" of a material that "may pose an unreasonable risk to health and safety or property."

DOE and 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. DOE agreed to comply with RCRA requirements for hazardous waste transporters (40 CFR 263, "Standards Applicable to Transporters of Hazardous Waste") 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 Department of Transportation provisions for labeling, marking, placarding, proper container use, and discharge reporting.

42. Environmental Compliance personnel shall demonstrate familiarity-level knowledge of the management of radioactive waste as described in:

- **DOE O 435.1, Radioactive Waste Management**
- **DOE M 435.1-1, Radioactive Waste Management**

a. Discuss the requirements identified in DOE O 435.1, Radioactive Waste Management, for the following types of waste:

- **Low-level**
- **High-level**
- **Transuranic**

The following is taken from DOE M 435.1-1.

DOE M 435.1-1 lists detailed requirements for handling each of the types of waste listed below. These requirements include:

- management of mixed wastes;
- complex/site wide management programs;
- QA programs;
- contingency storage plans;
- corrective action and operations curtailment plans;
- waste acceptance plans covering storage, pretreatment, treatment, and packaging;
- waste characterization and certification;
- transfer, packaging, storage, and transportation;
- site/facility design;
- treatment, disposal, and monitoring; and
- site closure.

Low-Level Waste

Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in section 11e.(2) of the Atomic Energy Act of 1954, as amended), or naturally occurring radioactive material.

High-Level Waste

High-level waste is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

Transuranic Waste

Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 Bq) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for:

- high-level radioactive waste;
- waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR 191 disposal regulations; or
- waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

b. Discuss the Department's performance objectives and performance assessment for disposal of low-level radioactive waste as outlined in DOE M 435.1-1, Radioactive Waste Management.

The following is taken from DOE M 435.1-1.

Performance Objectives

Low-level waste disposal facilities shall be sited, designed, operated, maintained, and closed so that a reasonable expectation exists that the following performance objectives will be met for waste disposed of after September 26, 1988:

- Dose to representative members of the public shall not exceed 25 mrem (0.25 mSv) in a year total effective dose equivalent from all exposure pathways, excluding the dose from radon and its progeny in air.
- Dose to representative members of the public via the air pathway shall not exceed 10 mrem (0.10 mSv) in a year total effective dose equivalent, excluding the dose from radon and its progeny.
- Release of radon shall be less than an average flux of 20 pCi/m^2/s (0.74 Bq/m^2/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/1 (0.0185 Bq/l) of air may be applied at the boundary of the facility.

Performance Assessment.

A site-specific radiological performance assessment shall be prepared and maintained for DOE low-level waste disposed of after September 26, 1988. The performance assessment shall include calculations for a 1,000 year period after closure of potential doses to

representative future members of the public and potential releases from the facility to provide a reasonable expectation that the performance objectives are not exceeded as a result of operation and closure of the facility. The following items will be included in the assessment.

- Analyses performed to demonstrate compliance with the performance objectives in this chapter, and to establish limits on concentrations of radionuclides for disposal based on the performance measures for inadvertent intruders in this chapter shall be based on reasonable activities in the critical group of exposed individuals. Unless otherwise specified, the assumption of average living habits and exposure conditions in representative critical groups of individuals projected to receive the highest doses is appropriate. The likelihood of inadvertent intruder scenarios may be considered in interpreting the results of the analyses and establishing radionuclide concentrations, if adequate justification is provided.
- The point of compliance shall correspond to the point of highest projected dose or concentration beyond a 100 meter buffer zone surrounding the IV-10 DOE M 435.1-1 7-9-99 disposed waste. A larger or smaller buffer zone may be used if adequate justification is provided.
- Performance assessments shall address reasonably foreseeable natural processes that might disrupt barriers against release and transport of radioactive materials.
- Performance assessments shall use DOE-approved dose coefficients (dose conversion factors) for internal and external exposure of reference adults.
- The performance assessment shall include a sensitivity/uncertainty analysis.
- Performance assessments shall include a demonstration that projected releases of radionuclides to the environment shall be maintained ALARA.
- For purposes of establishing limits on radionuclides that may be disposed of near-surface, the performance assessment shall include an assessment of impacts to water resources.
- For purposes of establishing limits on the concentration of radionuclides that may be disposed of near-surface, the performance assessment shall include an assessment of impacts calculated for a hypothetical person assumed to inadvertently intrude for a temporary period into the low-level waste disposal facility. For intruder analyses, institutional controls shall be assumed to be effective in deterring intrusion for at least 100 years following closure. The intruder analyses shall use performance measures for chronic and acute exposure scenarios, respectively, of 100 mrem (1 mSv) in a year and 500 mrem (5 mSv) total effective dose equivalent excluding radon in air.

c. Discuss the low-level waste characterization requirements.

The following is taken from DOE M 435.1-1.

Low-level waste shall be characterized using direct or indirect methods, and the characterization documented in sufficient detail to ensure safe management and compliance with the waste acceptance requirements of the facility receiving the waste. Characterization data shall, at a minimum, include the following information relevant to the management of the waste:

- physical and chemical characteristics;
- volume, including the waste and any stabilization or absorbent media;
- weight of the container and contents;
- identities, activities, and concentrations of major radionuclides;

- characterization date;
- generating source; and
- any other information which may be needed to prepare and maintain the disposal facility performance assessment, or demonstrate compliance with applicable performance objectives.

d. Describe the Department's low-level radioactive waste acceptance criteria.

The following is taken from DOE M 435.1-1.

Waste acceptance requirements for all low-level waste storage, treatment, or disposal facilities, operations, and activities shall specify, at a minimum, the following:

- Allowable activities and/or concentrations of specific radionuclides.
- Acceptable waste form and/or container requirements that ensure the chemical and physical stability of waste under conditions that might be encountered during transportation, storage, treatment, or disposal.
- Restrictions or prohibitions on waste, materials, or containers that may adversely affect waste handlers or compromise facility or waste container performance.
- The following are additional waste acceptance requirements that shall be specified in low-level waste disposal facility waste acceptance requirements:
  - Low-level waste must contribute to and not detract from achieving long-term stability of the facility, minimizing the need for long term active maintenance, minimizing subsidence, and minimizing contact of water with waste. Void spaces within the waste and, if containers are used, between the waste and its container shall be reduced to the extent practical.
  - Liquid low-level waste or low-level waste containing free liquid must be converted into a form that contains as little freestanding liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the waste volume when the low-level waste is in a disposal container, or 0.5 percent of the waste volume after it is processed to a stable form.
  - Low-level waste must not be readily capable of detonation or of explosive decomposition or reaction at anticipated pressures and temperatures, or of explosive reaction with water. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable.
  - Low-level waste must not contain, or be capable of generating by radiolysis or biodegradation, quantities of toxic gases, vapors, or fumes harmful to the public or workers or disposal facility personnel, or harmful to the long-term structural stability of the disposal site.
  - Low-level waste in a gaseous form must be packaged such that the pressure does not exceed 1.5 atmospheres absolute at 20 ºC.

- The basis, procedures, and levels of authority required for granting exceptions to the waste acceptance requirements, which shall be contained in each facility's waste acceptance documentation. Each exception request shall be documented, including its disposition as approved or not approved.

e. Discuss the basic requirements for a low-level disposal site closure and for post closure operations.

The following is taken from DOE M 435.1-1.

A preliminary closure plan shall be developed and submitted to Headquarters for review with the performance assessment and composite analysis. The closure plan shall be updated following issuance of the disposal authorization statement to incorporate conditions specified in the disposal authorization statement. Closure plans shall:

- be updated as required during the operational life of the facility;
- include a description of how the disposal facility will be closed to achieve long-term stability and minimize the need for active maintenance following closure and to ensure compliance with the requirements of DOE Order 5400.5, *Radiation Protection of the Public and the Environment*; and
- include the total expected inventory of wastes to be disposed of at the facility over the operational life of the facility.

Closure of a disposal facility shall occur within a five year period after it is filled to capacity, or after the facility is otherwise determined to be no longer needed.

Prior to facility closure, the final inventory of the low-level waste disposed in the facility shall be prepared and incorporated in the performance assessment and composite analysis which shall be updated to support the closure of the facility. A final closure plan shall be prepared based on the final inventory of waste disposed in the facility, the plan implemented, and the updated performance assessment and composite analysis prepared in support of the facility closure. Institutional control measures shall be integrated into land use and stewardship plans and programs, and shall continue until the facility can be released pursuant to DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. The location and use of the facility shall be filed with the local authorities responsible for land use and zoning.

f. Define the term "mixed waste."

The following is taken from U.S. Environmental Protection Agency, Waste Types, Mixed Waste.

Mixed waste contains both radioactive and hazardous waste components. As a result, both treatment and regulation are complex. Mixed wastes are regulated by RCRA and the AEA. In general, the requirements of RCRA and the AEA are consistent and compatible. However, in cases where requirements of the two acts are found to be inconsistent, the AEA takes precedence.

g. Identify the applicable regulations and DOE Order for managing mixed low-level radioactive waste.

The following is taken from DOE M 435.1-1.

Mixed waste is subject to the requirements of both the AEA of 1954, as amended; RCRA, as amended; DOE O 435.1; and DOE M 435.1-1.

DOE M 435.1-1 further describes the requirements and establishes specific responsibilities for implementing DOE O 435.1, for the management of DOE high-level waste, transuranic waste, low-level waste, and the radioactive component of mixed waste. The purpose of the Manual is to catalog those procedural requirements and existing practices that ensure that all DOE elements and contractors continue to manage DOE's radioactive waste in a manner that is protective of worker and public health and safety, and the environment.

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