Waste Management

Qualification Standard Reference Guide

August 2010
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<td>applicable or relevant and appropriate requirements</td>
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<td>EV</td>
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<td>Fe₂O₃</td>
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<td>FONSI</td>
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<td>FS</td>
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<td>GIS</td>
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<tr>
<td>H⁺</td>
<td>hydrogen ion</td>
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<td>HAP</td>
<td>hazardous air pollutants</td>
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<td>high efficiency particulate air</td>
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<td>KE</td>
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<td>------------------------------------------------------</td>
</tr>
<tr>
<td>km</td>
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<tr>
<td>KSA</td>
<td>knowledge, skill, and ability</td>
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<td>large quantity generator</td>
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<td>RI/FS</td>
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<td>SCC</td>
<td>stress corrosion cracking</td>
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<td>solid waste management unit</td>
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<td>TRU</td>
<td>transuranic</td>
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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 Waste Management Functional Area Qualification Standard (FAQS). Information essential to meeting the qualification requirements is provided; however, some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

SCOPE

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

PREFACE
Competency statements and supporting knowledge, skill, and ability (KSA) 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 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 August 2010. However, the candidate is advised to verify the applicability of the information provided. It is recognized that some personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the Technical Qualification Program.
In the cases where information about an FAQS topic in a competency or KSA statement is not available in the newest edition of a standard (consensus or industry), an older version is referenced. These references are noted in the text and in the bibliography.

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

1. Waste management personnel must demonstrate a familiarity level knowledge of chemistry fundamentals.

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

*Ionic*

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

An ionic bond is formed when one or more electrons are 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 1A 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 1B, 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.

![Figure 2. Covalent bond—Methane CH₄](image)

**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.

Another way of looking at this mechanism is to imagine that the valence electrons are not closely associated with individual atoms, but instead move around amongst the atoms within the crystal. Therefore, the individual atoms can slip over one another yet remain firmly held together by the electrostatic forces exerted by the electrons. This is why most metals can be hammered into thin sheets (malleable) or drawn into thin wires (ductile). When an electrical potential difference is applied, the electrons move freely between atoms, and a current flows.

b. Discuss how elements combine to form chemical compounds.

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

There are three basic laws that apply to chemical reactions. They are the Law of Conservation of Mass, the Law of Definite Proportions, and the Law of Multiple Proportions. These laws are described here to help the reader in understanding the reasons elements and compounds behave as they do.

The Law of Conservation of Mass
This law states that in a chemical reaction the total mass of the products equals the total mass of the reactants. Antoine Lavoisier, a French chemist, discovered that when tin reacts with air in a closed vessel, the weight of the vessel and its contents is the same after the reaction as it was before. Scientists later discovered that whenever energy (heat, light, radiation) is liberated during a reaction, a very small change in mass does occur, but this change is insignificant in ordinary chemical reactions.

The Law of Definite Proportions
This law states that no matter how a given chemical compound is prepared, it always contains the same elements in the same proportions by mass. John Dalton, an English physicist, discovered that when various metals are burned or oxidized in air, they always combine in definite proportions by weight. For example, one part by weight of oxygen always combines with 1.52 parts by weight of magnesium or 37.1 parts by weight of tin. This law results from the fact that a compound is formed by the combination of a definite number of atoms of one element with a definite number of atoms of another.

The Law of Multiple Proportions
This law states that if two elements combine to form more than one compound, the masses of one of the elements combining with a fixed mass of the other are in a simple ratio to one another. For example, carbon forms two common compounds with oxygen; carbon monoxide and carbon dioxide.

With carbon monoxide, 1.33 grams of oxygen are combined with 1 gram of carbon. With carbon dioxide, 2.67 grams of oxygen are combined with 1 gram of carbon. Therefore, the masses of oxygen combining with a fixed mass of carbon are in the ratio 2:1.
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.

*Solvent*
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.

*Solubility*
Solubility is defined as the maximum amount of a substance that can dissolve in a given amount of solvent at a specific temperature.

*Solute*
A solute is defined as the substance that dissolves in a solution.

*Solution*
A solution is a homogeneous mixture of two or more substances.

*Equilibrium*
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. The higher an object’s density, the higher its mass per volume will be. The average density of an object equals its total mass divided by its total volume. A denser object (such as iron) will have less volume than an equal mass of some less dense substance (such as water).
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.

\[
\text{Molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}
\]

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 (ppm)
Parts per million is a term used to describe the specific concentration of a solution in 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. Another term, parts per billion (ppb), is defined as one part solute per one billion parts solvent. One ppb is equal to one microgram solute per liter of solution. These two terms are usually used for very dilute solutions.

Acid
Acids are substances that dissociate in water to produce hydrogen ions (H\(^+\)). An example of a common acid is sulfuric acid, H\(_2\)SO\(_4\). In solution, H\(_2\)SO\(_4\) dissociates to form hydrogen and sulfate ions according to the following equation. The designation in parenthesis in the following formulas indicate the state of the reactants and the products, (i.e., liquid, solid, or gas).

\[
\text{H}_2\text{SO}_4(aq) \rightarrow 2\text{H}^+ + \text{SO}_4^{2-}
\]

Additional examples of acids are vinegar, aspirin, and lemon juice. These substances share the following common properties:
- Acid solutions taste sour.
- Acids react with many metals to form hydrogen gas.

Base
Bases are substances that produce hydroxide ions (OH\(^-\)) in water solutions. An example of a common base is sodium hydroxide, NaOH. In solution, it dissociates to form sodium ions and hydroxide ions according to the following equation:

\[
\text{NaOH}_{(aq)} \rightarrow \text{Na}_{(aq)}^+ + \text{OH}_{(aq)}^-
\]
Common types of bases are lye, household ammonia, and most soaps. The following are four characteristic properties of bases:

1. Basic solutions taste bitter and feel slippery to the touch.
2. Bases turn litmus paper blue.
3. Basic solutions conduct electricity.

\[ pOH \]

It is important to understand the relationship between the \([H^+]\) and the \([OH^-]\) concentrations. The pOH of a solution is defined as the negative logarithm of the hydroxyl concentration, represented as \([OH^-]\) in moles/liter.

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

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

For water solutions, the product of the hydrogen ion concentration and the hydroxyl concentration is always \(1 \times 10^{-14}\) at 25 °C. This means that the sum of pH and pOH is equal to 14 under these conditions.

\[ [H^+] \times [OH^-] = 1 \times 10^{-14} \]

\[ pH + pOH = 14 \]

\[ Salt \]

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.

\[ pH \]

pH is defined as the negative logarithm of the hydrogen concentration, represented as \([H^+]\) in moles/liter.

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

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

The negative logarithm is specified because the logarithm of any number less than 1 is negative; thus, multiplication by -1 causes the values of pH to be positive over the range in which we are interested. (The term pH was first defined by a Danish chemist and is derived from p for the Danish word potenz (power) and H for hydrogen.)

2. **Waste management personnel must 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.
The following discussion applies to de-aerated water at room temperature and approximately neutral pH.

The oxidation and reduction half-reactions in the corrosion of iron are as follows.

\[
\text{Fe} \rightarrow \text{Fe}^{+2} + 2e \quad \text{(oxidation)}
\]

\[
\text{H}_3\text{O}^+ \rightarrow \text{H} + \text{H}_2\text{O} \quad \text{(reduction)}
\]

The overall reaction is the sum of these half-reactions.

\[
\text{Fe} + 2 \text{H}_3\text{O}^+ \rightarrow \text{Fe}^{+2} + 2\text{H} + 2\text{H}_2\text{O}
\]

The \(\text{Fe}^{+2}\) ions readily combine with \(\text{OH}^-\) ions at the metal surface, first forming \(\text{Fe (OH)}_2\), which decomposes to \(\text{FeO}\).

\[
\text{Fe}^{+2} + 2\text{OH} \rightarrow \text{Fe (OH)}_2 \rightarrow \text{Fe} + \text{H}_2\text{O}
\]

Ferrous oxide (\(\text{FeO}\)) then forms a layer on the surface of the metal. Below about 1000ºF, however, \(\text{FeO}\) is unstable and undergoes further oxidation.

\[
2\text{FeO} + \text{H}_2\text{O} \rightarrow \text{Fe}_2\text{O}_3 + 2\text{H}
\]

Atomic hydrogen then reacts to form molecular hydrogen, and a layer of ferric oxide (\(\text{Fe}_2\text{O}_3\)) builds up on the \(\text{FeO}\) layer. Between these two layers is another layer that has the apparent composition \(\text{Fe}_3\text{O}_4\). It is believed that \(\text{Fe}_3\text{O}_4\) is a distinct crystalline state composed of \(\text{O}^-\), \(\text{Fe}^{+2}\), and \(\text{Fe}^{+3}\) in proportions so that the apparent composition is \(\text{Fe}_3\text{O}_4\). These three layers are illustrated in figure 3.
Once the oxide film begins to form, the metal surface is no longer in direct contact with the aqueous environment. For further corrosion to occur, the reactants must diffuse through the oxide barrier. It is believed that the oxidation step occurs at the metal-oxide interface. The Fe$^{+2}$ ions and electrons then diffuse through the oxide layer toward the oxide-water interface. Eventually, Fe$^{+2}$ ions encounter OH$^{-}$ ions and form FeO. The electrons participate in the reduction reaction with hydronium ions. These latter reactions are believed to take place predominately at the oxide-water interface, but some reaction may occur within the oxide layer by the diffusion of H$^{+}$, OH$^{-}$, and H$2$O into the layer.

Regardless of the exact diffusion mechanism, the oxide layer represents a barrier to continued corrosion and tends to slow the corrosion rate. The exact effect of this layer on the corrosion rate depends on the uniformity and tenacity of the film. If the film is loosely attached, develops defects, or is removed, the metal surface is again exposed to the environment and corrosion occurs more readily.

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

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

Galvanic corrosion is the process whereby the surface of a metal undergoes a slow, relatively uniform, removal of material. Galvanic corrosion can occur when: 1) two electrochemically
dissimilar metals are joined together (in electrical contact), and 2) in a conducting medium (electrolyte).

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.

**Stress Corrosion Cracking**
Stress corrosion cracking (SCC) is a type of intergranular attack corrosion that occurs at the grain boundaries under tensile stress. SCC occurs in susceptible alloys when the alloy is exposed to a particular, specific environment if the alloy is in a stressed condition. SCC appears to be relatively independent of general uniform corrosion processes. Thus, the extent of general corrosion can be essentially nil, and stress cracking can still occur. Most pure metals are immune to this type of attack.

**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
   - Enhanced evaporation
   - Reverse osmosis
   - Electrodialysis
   - Carbon adsorption
   - Precipitation
   - Flocculation

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

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).
**pH Adjustment**
The following is taken from DOE-STD-1128-98.

This treatment is used on aqueous systems to meet discharge limitations or to make the solution amenable to other treatment. A mineral acid, such as sulfuric, hydrochloric, or nitric, is normally used to lower the pH. A base, such as sodium, potassium hydroxide, or occasionally ammonia, is used to raise the pH. The solubility of some contaminants will be affected by the pH of the solution. For example, an acidic solution containing iron may show a copious precipitate of ferric hydroxide upon the addition of a base.

**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.

- **Separate**—The solids must first be removed from the well or process fluid stream.
- **Collect**—To facilitate a simple system design, all collected or removed solids must be gathered into one central location.
- **Clean**—In many cases the sand or solids may require cleaning for oil or chemical removal, prior to further handling.
- **Dewater**—The total volume of sand slurry to be disposed can be greatly reduced by a dewatering step.
- **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 (e.g., 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 used to disinfect fluids and surfaces. Three common techniques are disinfection ozone, ultraviolet (UV) radiation, and chlorine dioxide.

**Ozone**
Ozone has been used for disinfection of drinking water for over 100 years and is used by a large number of water companies where ozone generator capacities in excess of 100 kg/h are common.
UV Radiation
UV radiation can be an effective viricide and bactericide. In the past, disinfection using UV radiation was more commonly used in wastewater treatment applications, but is finding increased usage in drinking water treatment. Recently it was discovered that UV radiation could treat the microorganism cryptosporidium, which was previously unknown. The findings resulted in two U.S. patents and the use of UV radiation as a viable method to treat drinking water.

Chlorine Dioxide
Chlorine dioxide (ClO₂) is a synthetic yellowish-green gas with a chlorine-like odor. ClO₂ is unstable as a gas and will undergo decomposition into chlorine gas (Cl₂), oxygen gas (O₂), and heat. However, ClO₂ is stable and soluble in an aqueous solution. For example, solutions of approximately 1 percent ClO₂ (10 gallons [g]/liter [L]) may safely be stored if the solution is protected from light and kept chilled. In solution, ClO₂ exists as a true gas.

The instability of ClO₂ has an important consequence. It negates the possibility of creating and transporting cylinders or rail cars of the gas. Instead ClO₂ must be produced and used at the same location.

However, despite the care and safety considerations which must be taken when using ClO₂, the potential advantages of using this chemical greatly outweigh the possible disadvantage of onsite production. When produced and handled properly, ClO₂ is an extremely effective and powerful biocide, disinfectant agent, and oxidizer. ClO₂ is presently used extensively in the pulp and paper industry, and new applications for ClO₂ in other areas, such as municipal water treatment, are increasingly being investigated.

Enhanced Evaporation
The following is taken from the National Center for Atmospheric Research, How Should Rainfall Change as Climate Changes: Prospects for Increases in Extremes?

Enhanced evaporation depends upon the availability of sufficient surface moisture, and over land, this depends on the existing climate. Surface moisture comes directly from evaporation as well as through transpiration in plants, together called evapotranspiration. However, it follows that naturally occurring droughts are likely to be exacerbated by enhanced potential evapotranspiration (drying).

Thus if the water-carrying capacity of the atmosphere increases and there is enhanced evaporation, the actual atmospheric moisture should increase, as is observed to be happening in many places. Over the United States and Gulf of Mexico, for example, moisture amounts in the lowest 20,000 feet of the atmosphere have increased about 10 percent since 1973.

Reverse Osmosis
The following is taken from DOE-STD-1128-98.
This process is highly effective on relatively pure water streams. The water is passed through a semipermeable membrane by mechanical pressure, leaving contaminants behind. The result is generally 80 to 99 percent of the influent water released as pure water, with the remainder containing all of the contaminants. Reverse osmosis has the advantage over ion exchange in that it will remove nonionic contaminants although these often shorten the life of the membrane. It is much more energy-efficient than distillation and requires much less equipment for the same volume of water treated. It is sometimes used as a polishing technique to further treat relatively clean water.

**Electrodialysis**
The following is taken from the Journal of Contemporary Water Research and Education, Overview of Desalination Techniques.

Electrodialysis (ED) uses electromotive force applied to electrodes adjacent to both sides of a membrane to separate dissolved minerals in water. The separation of minerals occurs in individual membrane units called cell pairs. A cell pair consists of an anion transfer membrane, a cation transfer membrane, and two spacers. The complete assembly of cell pairs and electrodes is called the membrane stack. The number of cells within a stack varies depending on the system. The spacer material is important for distributing the water flow evenly across the membrane surface. The ED process is effective with salt removal from feedwater because the cathode attracts the sodium ions and the anode attracts the chloride ions. The required pressure is between 70 and 90 pounds per square inch (psi). In general, ED has a high recovery rate and can remove 75 to 98 percent of total dissolved solids from feedwater.

**Carbon Adsorption**
The following is taken from Energy Technologies, Activated Carbon Absorption & Adsorption.

Activated carbon in very fine powder or granular form is useful to purify both water and air. It is an extremely porous material with high ratios of surface area to unit weight, up to 100 acres per pound. Activated carbon has particular affinity to organic materials such as solvents used in printing inks and common coatings.

When the carbon particle becomes saturated with the contaminant, the exit stream will evidence a breakthrough of that contaminant, at which time the canister will be replaced and/or reactivated (usually by heat). Since the waste stream usually cannot be interrupted during this regeneration, two or more carbon beds are often designed into the system.

Activated carbon particles do not react with most organics, permitting recovery through later heat regeneration and separation or incineration during regeneration from water-borne streams.

Water-borne organic streams are usually mixed with activated carbon particles and removed later by filtration. Granular activated carbon is often used in the filter bed itself. It has been used to remove hydrocarbons, oils, phenols, and low concentrations of metals. It is not
applicable for most heavy metals, nor waste streams with more than 10,000 ppm organics or low molecular weight aliphatic hydrocarbons. Pretreatment of the stream may be advisable where bed clogging by particulates or suspended materials is likely.

*Precipitation*

The following is taken from DOE-STD-1128-98.

Precipitation and co-precipitation are used to decrease the solubility of some compounds. Precipitation involves making the contaminant into an insoluble material by the adjustment of pH or the addition of a chemical. For example, nickel may be rendered insoluble by the addition of sodium dimethylglyoxime. Co-precipitation is similar but is used when the contaminant is not present in sufficient quantity to form a filterable solid but will incorporate into another precipitate as it forms or will adhere to the surface of another precipitate. In some waste treatment processes, a stable isotope of the radioactive contaminate is added to co-precipitate the radioactive material that is not present in sufficient quantity to form a precipitate on its own. Precipitation is always followed by some liquid/solid separation technique.

*Flocculation*

The following is taken from DOE-STD-1128-98.

Flocculation involves the addition of an extremely small quantity of a long chain molecule that has the appropriate electrostatic affinity for the contaminant present. The flocculent molecules gather the contaminant into rather large particles that are amenable to settling and filtration. The flocculent and dosage (addition ratio) are usually selected by trial and error. Flocculents do not add appreciably to the waste volume and usually do not add a contaminant that results in a mixed waste. Residual flocculent may, however, foul ion exchange resins or reverse osmosis membranes, so it is important that the quantity added be closely controlled.

3. **Waste management personnel must demonstrate a familiarity level knowledge of 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.

Variance
The spread, or distance, of each data point from the mean is called the variance.

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 \( \sigma \) is the standard deviation of the data, and \( n \) is the number of data values.

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

The median is 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 $\sigma$. The standard deviation of a population is defined mathematically as:

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

where $\sigma$ = 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-1014/2-92, MA-05.

In almost every aspect of an operator’s work, there is a necessity for making decisions resulting in some significant action. Many of these decisions are made through past experience with other similar situations. One might say the operator has developed a method of intuitive inference: unconsciously exercising some principles of probability in conjunction with statistical inference following from observation, and arriving at decisions which have a high chance of resulting in expected outcomes. In other words, statistics is a method or technique which will enable us to approach a problem of determining a course of action in a systematic manner in order to reach the desired results.

Mathematically, statistics is the collection of great masses of numerical information that is summarized and then analyzed for the purpose of making decisions; that is, the use of past information is used to predict future actions.
**Frequency Distribution**

When groups of numbers are organized, or ordered by some method, and put into tabular or graphic form, the result will show the “frequency distribution” of the data.

Example: A test was given and the following grades were received: the number of students receiving each grade is given in parentheses.

99(1), 98(2), 96(4), 92(7), 90(5), 88(13), 86(11), 83(7), 80(5), 78(4), 75(3), 60(1)

The data, as presented, is arranged in descending order and is referred to as an ordered array. But, as given, it is difficult to determine any trend or other information from the data. However, if the data is tabled and/or plotted some additional information may be obtained. When the data is ordered as shown in table 1, the frequency distribution can be seen that was not apparent in the previous list of grades.

**Table 1. Frequency distribution**

<table>
<thead>
<tr>
<th>Grades</th>
<th>Number of Occurrences</th>
<th>Frequency Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>98</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>96</td>
<td>1111</td>
<td>4</td>
</tr>
<tr>
<td>92</td>
<td>11111 11</td>
<td>7</td>
</tr>
<tr>
<td>90</td>
<td>1111</td>
<td>5</td>
</tr>
<tr>
<td>88</td>
<td>11111 11111 111</td>
<td>13</td>
</tr>
<tr>
<td>86</td>
<td>11111 11111 1</td>
<td>11</td>
</tr>
<tr>
<td>83</td>
<td>11111</td>
<td>7</td>
</tr>
<tr>
<td>80</td>
<td>11111</td>
<td>5</td>
</tr>
<tr>
<td>78</td>
<td>1111</td>
<td>4</td>
</tr>
<tr>
<td>75</td>
<td>111</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Source: DOE-HDBK-1014/2-92, MA-05*

In summary, one method of obtaining additional information from a set of data is to determine the frequency distribution of the data. The frequency distribution of any one data point is the number of times that value occurs in a set of data.

**Normal Distribution**

The concept of a normal distribution curve is used frequently in statistics. In essence, a normal distribution curve results when a large number of random variables are observed in nature, and their values are plotted. While this “distribution” of values may take a variety of shapes, it is interesting to note that a very large number of occurrences observed in nature possess a frequency distribution which is approximately bell-shaped, or in the form of a normal distribution, as indicated in figure 4.
The significance of a normal distribution existing in a series of measurements is two-fold. First, it explains why such measurements tend to possess a normal distribution; and second, it provides a valid basis for statistical inference. Many estimators and decision-makers that are used to make inferences about large numbers of data are really sums or averages of those measurements. When these measurements are taken, especially if a large number of them exist, confidence can be gained in the values, if these values form a bell-shaped curve when plotted on a distribution basis.

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

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

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

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

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

The following is derived from DOE-HDBK-1014/2-92, MA-05.

[Note: Statistical inference means drawing conclusions based on data.]

In almost every aspect of work, there is a necessity for making decisions resulting in some significant action. Many of these decisions are made through past experience with other similar situations. Most decision-makers have developed a method of intuitive inference: unconsciously exercising some principles of probability in conjunction with statistical inference following from observation, and arriving at decisions which have a high chance of
resulting in expected outcomes. In other words, statistics is a method or technique which will enable us to approach a problem of determining a course of action in a systematic manner in order to reach the desired results.

Mathematically, statistics is the collection of great masses of numerical information that is summarized and then analyzed for the purpose of making decisions; that is, the use of past information is used to predict future actions.

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

The following is taken from U.S. Environmental Protection Agency, EPA530-D-02-002, RCRA Waste Sampling Draft Technical Guidance: Planning, Implementation, and Assessment.

There are two types of decision error. A type I or false rejection decision error occurs if the null hypothesis is rejected 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 the null hypothesis is accepted when it is false.

Table 2 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: the baseline is true, or 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 \(\alpha\)) and the risk of making a type II (false acceptance) error (denoted by \(\beta\)). Making correct decisions can be improved by reducing \(\alpha\) and \(\beta\) (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>
<thead>
<tr>
<th>Decision Based on Sample Data</th>
<th>True Condition</th>
<th>Type II (false acceptance) error (probability (\beta))</th>
<th>Correct Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline is True</td>
<td>Correct Decision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternative is True</td>
<td>Type I (false rejection) error (probability (\alpha))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. **Waste management personnel must 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 processes 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 world’s 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 deserts 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 quartz, 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.


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 National Resources Conservation Service, *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 and describe the characteristics and effects of water and wind erosion.


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

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

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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 flow of water from the land surface into the subsurface. 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. Percolation is the movement of water through the openings in rock or soil, or the entrance of a portion of the streamflow into the channel materials to contribute to groundwater replenishment. Both processes may contribute to groundwater recharge, the process by which aquifers are replenished by the seepage of precipitation that falls on the land.

**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 water lost to the atmosphere from the ground surface, evaporation from the capillary fringe of the groundwater table, and the transpiration of groundwater by plants whose roots tap the capillary fringe of the groundwater table.

e. **Describe how soil characteristics, slope factors, and land cover conditions impact contaminant detachment and transport 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 onsite, and pollution of natural waters and sedimentation of waterways and reservoirs offsite.

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: Contaminant loading and contaminant delivery ratio are also referred to as pollutant loading and pollutant delivery ratio.]

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. 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 5.

*Source: Schlumberger, Oilfield Glossary.*

**Figure 5.** 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 6.

*Source: Schlumberger, Oilfield Glossary.*

**Figure 6.** 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.
Residual Stress
The following is taken from Washington State Earthquake Hazards, *What are Earthquakes?*

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.

i. **Discuss the use of geological and geotechnical maps.**

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.

j. 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 relative relief
   - Potentially unstable slopes
   - Flood plain
   - Karst 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 over-steepened 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


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.

**k. 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.

**l. Describe and discuss tests that assess weatherability.**

The following is taken from U.S. Geological Survey, True Path Triaxial Cell.

Chemical alteration produces the effect of preconsolidation by changing the physiochemical bonds between the clay particles or by introducing stresses by the expansion or contraction of the grains during the alteration process. Most residual soils and weathered rocks exhibit this kind of preconsolidation. The preconsolidation load can be estimated from the stress-void ratio curve. Preconsolidation is extremely important in foundation engineering. A soil that is inherently compressible usually will not settle appreciably until the stress imposed by the structure exceeds the preconsolidation load.

The triaxial shear test is considered to be the most reliable strength test. The sample is subjected to confining pressure (by the application of axial stress or by holding axial stress constant and increasing confining pressure) until the sample fails in shear. Weathering reduces the strength, increases the compressibility, and reduces the rigidity of intact rock.

The triaxial test system provides control for initial consolidation of the sample followed by control of the shear failure. This provides data to evaluate sediment moduli, ratio of horizontal to vertical effective stress under uniaxial strain, and sediment shear strength. The triaxial experiment has five phases:

1. Sample selection, trimming, and preparation
Phase 1 requires that a sample be selected and carefully trimmed for the triaxial test. The typical sample has a diameter of 3.5 centimeters (cm) and a length of 7cm. The sample is jacketed in a latex membrane and then placed in the triaxial chamber where it is subject to a confining fluid and a pore pressure (phase 2) to obtain total water saturation. Water saturation is checked by performing a B test during phase 2. Phase 3 monitors consolidation of the specimen at a prescribed strain rate under uniaxial strain. This allows monitoring of the vertical stress required for the strain rate and the horizontal stress necessary to maintain uniaxial strain. After the desired consolidation is achieved, the shear portion (phase 4) of the test is initiated until a target strain or stress is achieved. Finally the sample is unloaded and removed from the triaxial chamber (phase 5) so bulk grain volume can be evaluated.

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

The following is taken from the American Society of Civil Engineers, Civil Engineers Database, Material Unit-Based Rock Core Logging for Geotechnical Applications.

The process of rock core logging is the primary means of communicating rock properties that should be considered in the design and construction of underground works, including foundations in and on rock, rock slope and tunnel support, and excavations in rock. The quality of rock descriptions can have far-reaching implications for the success of a project. An appropriate level of detail must be collected and conveyed. Rock descriptions are developed for each rock material unit, defined as a discrete mass, exhibiting a different set of geologic and engineering properties than adjacent materials. Material unit-based rock core logging minimizes the risk of overlooking design-critical rock mass conditions. Material unit descriptions are constructed using a standard descriptive code consisting of well-defined terminology arranged in a consistent format. Standardization of the rock core logging descriptive code results in more useful rock descriptions to facilitate geo-engineering interpretation, spatial correlation of material units, and engineering analysis for developing design recommendations and construction considerations.

5. Waste management personnel must 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 definitions are taken from University of Illinois, WW 2010, High Pressure Centers.
High Pressure
A high pressure center is an area where the pressure has been measured to be the highest relative to its surroundings. This means that moving any direction away from the high will result in a decrease in pressure. High pressure centers often represent the centers of anticyclones. A high pressure center is represented on a weather map by a blue H. Winds flow clockwise around the high in the northern hemisphere. The opposite is true in the southern hemisphere, where winds flow counterclockwise around an area of high pressure. Sinking air in the vicinity of a high pressure center tends to suppress the upward motions required for clouds and precipitation to develop, which is why fair weather is commonly associated with an area of high pressure.

Low Pressure
A surface low pressure center is an area where the pressure has been measured to be the lowest relative to its surroundings. This means that moving any horizontal direction away from the low will result in increasing pressure. Low pressure centers often represent the centers of mid-latitude cyclones. A low pressure center is represented on a weather map by a red L. Winds flow counterclockwise around the low in the northern hemisphere. The opposite is true in the southern hemisphere, where winds flow clockwise around an area of low pressure. The counterclockwise winds associated with northern hemisphere mid-latitude cyclones play a significant role in the movement of air masses, typically transporting warm, moist air northward and ahead of a low, while dragging colder and drier air southward behind it. Rising air in the vicinity of a low pressure center favors the development of clouds and precipitation, which is why cloudy weather (and likely precipitation) is commonly associated with an area of low pressure.

Large-scale horizontal air movements result from the differential heating, including cooling, of the earth’s surface. Basically, this solar energy creates large-scale pressure gradients. Air flow moves laterally from high pressure areas to low pressure areas; this pressure gradient creates local weather conditions (e.g., wind conditions, storm fronts). Classic air pollution episodes—most notably smog—occur when pressure systems allow air motion to stagnate. Stagnant air is also known as light wind. Pollutant concentrations increase with light wind conditions. In periods of high winds of variable direction, pollutants are dispersed over greater lateral distances, and pollutant concentrations are lower.

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

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

A wind rose is any one of a class of diagrams designed to show the distribution of wind direction experienced at a given location over a considerable period; it thus shows the prevailing wind direction.
The most common form consists of a circle from which eight or sixteen lines emanate, one for each compass point. The length of each line is proportional to the frequency of wind from that direction, and the frequency of calm conditions is entered in the center. Many variations exist; some indicate the range of wind speeds from each direction; some relate wind directions with other weather occurrences.

**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 7 is formed by simply taking the maximum recorded value at each direction and plotting the given area.


**Figure 7.** 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.

The lapse rate is defined as the rate that air temperature changes with height. The actual lapse rate in the atmosphere is approximately -6 to -7°C 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 9.8°C 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 8, beginning at various temperatures along the horizontal axis. The slope of the line remains constant, regardless of its initial temperature on the diagram.

![Dry adiabatic lapse rate diagram]

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

Figure 8. 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 9 shows, the temperature profile can vary considerably with altitude, sometimes changing at a rate greater than the dry adiabatic lapse rate and sometimes 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 10. 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 9. Prevailing lapse rate

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

Figure 10. Neutral lapse rate
When the environmental lapse rate is less than the adiabatic lapse rate (cools at less than 9.8°C per km), the air is stable and resists vertical motion. This is a subadiabatic lapse rate (figure 11). 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. A subadiabatic lapse rate is sometimes referred to as a weak adiabatic lapse rate.

![Diagram of atmospheric lapse rates](image)

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

**Figure 11.** 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 12. 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°C per km). As figure 13 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 12.** Lapse rate showing a temperature inversion

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

**Figure 13.** 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, 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 14.

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

**Figure 14. 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. 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, the air is stable and resists vertical motion. This is a subadiabatic lapse rate. 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. 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 element b of this competency statement for information regarding this topic.

6. Waste management personnel must 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 organisms 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, *Terms of Environment Glossary.*
Synergism is the interaction of individual chemicals to produce an effect greater than the sum of the independent effects of the individual chemicals. In other words, synergism is demonstrated when two or more relatively harmless substances become toxic when mixed.

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 which may interact with the original chemical.

7. **Waste management personnel must 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.

   This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information from DOE-HDBK-1016/1-93 may be helpful.

   *Title Block*

   The title block of a drawing, usually located on the bottom or lower right hand corner, contains all the information necessary to identify the drawing and to verify its validity. A title block is divided into several areas, as illustrated by figure 15.
First Area of the Title Block
The first area of the title block contains the drawing title and the drawing number and lists the location, the site, or the vendor. The drawing title and the drawing number are used for identification and filing purposes. Usually the number is unique to the drawing and is a code that contains information about the drawing, such as the site, system, and type of drawing. The drawing number may also contain information such as the sheet number, if the drawing is part of a series, or it may contain the revision level.

Drawings are usually filed by their drawing number because the drawing title may be common to several prints or series of prints.

Second Area of the Title Block
The second area of the title block contains the signatures and approval dates, which provide information as to when and by whom the component/system was designed and when and by whom the drawing was drafted and verified for final approval. This information can be invaluable in locating further data on the system/component design or operation. These
names can also help in the resolution of a discrepancy between the drawing and another source of information.

Third Area of the Title Block
The third area of the title block is the reference block. It lists other drawings that are related to the system/component, or it can list all the other drawings that are cross-referenced on the drawing, depending on the site’s or vendor’s conventions. The reference block can be extremely helpful in tracing down additional information on the system or component. Other information may also be contained in the title block and will vary from site to site and vendor to vendor. Some examples of other information are contract numbers and drawing scale.

Notes and Legend
Drawings are made up of symbols and lines that represent components or systems. Although a majority of the symbols and lines are self-explanatory or standard, a few unique symbols and conventions must be explained for each drawing. The notes and legends section of a drawing lists and explains any special symbols and conventions used on the drawing, as illustrated in figure 16. Also listed in the notes section is any information the designer or drafter felt was necessary to correctly use or understand the drawing. Because of the importance of understanding all of the symbols and conventions used on a drawing, the notes and legend section must be reviewed before reading a drawing.
Revision Block

As changes to a component or system are made, the drawings depicting the component or system must be redrafted and reissued. When a drawing is first issued, it is called revision zero, and the revision block is empty. As each revision is made to the drawing, an entry is placed in the revision block. This entry provides the revision number, a title or summary of the revision, and the date of the revision. The revision number may also appear at the end of the drawing number or in its own separate block, as shown in figure 17. As the component or system is modified, and the drawing is updated to reflect the changes, the revision number is increased by one, and the revision number in the revision block is changed to indicate the new revision number. For example, if a revision 2 drawing is modified, the new drawing showing the latest modifications will have the same drawing number, but its revision level...
will be increased to 3. The old revision 2 drawing will be filed and maintained in the filing system for historical purposes.

Source: DOE-HDBK-1016/1-93

**Figure 17.** Revision block

**Drawing Grid**

Because drawings tend to be large and complex, finding a specific point or piece of equipment on a drawing can be quite difficult. This is especially true when one wire or pipe run is continued on a second drawing. To help locate a specific point on a referenced print, most drawings, especially pipe and instrument drawings (P&IDs) and electrical schematic drawings, have a grid system. The grid can consist of letters, numbers, or both that run horizontally and vertically around the drawing as illustrated in figure 18. Like a city map, the drawing is divided into smaller blocks, each having a unique two-letter or two-number identifier. For example, when a pipe is continued from one drawing to another, not only is
the second drawing referenced on the first drawing, but so are the grid coordinates locating the continued pipe. Therefore the search for the pipe contained in the block is much easier than searching the whole drawing.

Source: DOE-HDBK-1016/1-93

Figure 18. Example of a grid

b. Identify the symbols used on engineering drawings for the following:
   - 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, piping, and vessels
   - Types of materials of construction

The following is taken from DOE-HDBK-1016/1-93
Types of Valves and Actuators

Valves

Valves are used to control the direction, flow rate, and pressure of fluids. Figure 19 shows the symbols that depict the major valve types. It should be noted that globe and gate valves will often be depicted by the same valve symbol. In such cases, information concerning the valve type may be conveyed by the component identification number or by the notes and legend section of the drawing; however, in many instances even that may not hold true.

Source: DOE-HDBK-1016/1-93

Figure 19. Valve symbols
Actuators
Some valves are provided with actuators to allow remote operation, to increase mechanical advantage, or both. Figure 20 shows the symbols for the common valve actuators. Note that although each is shown attached to a gate valve, an actuator can be attached to any type of valve body. If no actuator is shown on a valve symbol, it may be assumed the valve is equipped only with a hand wheel for manual operation.

![Valve Actuator Symbols](image)

*Source*: DOE-HDBK-1016/1-93

**Figure 20.** Valve actuator symbols

**Basic Types of Instrumentation**
One of the main purposes of a drawing is to provide functional information about how instrumentation in a system or piece of equipment interfaces with the system or piece of equipment. Because of this, a large amount of the symbology appearing on drawings depicts instrumentation and instrument loops.

The symbols used to represent instruments and their loops can be divided into four categories. Generally each of these four categories uses the component identifying (labeling) scheme identified in table 3. The first column of table 3 lists the letters used to identify the parameter being sensed or monitored by the loop or instrument. The second column lists the letters used to indicate the type of indicator or controller. The third column lists the letters used to indicate the type of component. The fourth column lists the letters used to indicate the type of signals that are being modified by a modifier.
Table 3. Instrument identifiers

<table>
<thead>
<tr>
<th>Sensed Parameter</th>
<th>Type of Indicator or Controller</th>
<th>Type of Component</th>
<th>Type of signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>F = flow</td>
<td>R = recorder</td>
<td>T = transmitter</td>
<td>I = current</td>
</tr>
<tr>
<td>T = temperature</td>
<td>I = indicator</td>
<td>M = modifier</td>
<td>V = voltage</td>
</tr>
<tr>
<td>P = pressure</td>
<td>C = controller</td>
<td>E = element</td>
<td>P = pneumatic</td>
</tr>
<tr>
<td>I = current</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L = level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V = voltage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z = position</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: DOE-HDBK-1016/1-93

The first three columns above are combined such that the resulting instrument identifier indicates its sensed parameter, the function of the instrument, and the type of instrument. The fourth column is used only in the case of an instrument modifier and is used to indicate the types of signals being modified. The following is a list of example instrument identifiers constructed from table 3:

- FIC = flow indicating controller
- FM = flow modifier
- PM = pressure modifier
- TE = temperature element
- TR = temperature recorder
- LIC = level indicating controller
- TT = temperature transmitter
- PT = pressure transmitter
- FE = flow element
- FI = flow indicator
- TI = temperature indicator
- FC = flow controller

Types of Instrument Signal Controllers and Modifiers

Signal Controllers

Controllers process the signal from an instrument loop and use it to position or manipulate some other system component. Generally they are denoted by placing a “C” in the balloon after the controlling parameter as shown in the left-hand box of figure 21. There are controllers that serve to process a signal and create a new signal. These include proportional controllers, proportional-integral controllers, and proportional-integral-differential controllers. The symbols for these controllers are illustrated in the right-hand box of figure 21. Note that these types of controllers are also called signal conditioners.
Signal Modifiers

Sensors and detectors by themselves are not sufficient to create usable system indications. Each sensor or detector must be coupled with appropriate modifiers and/or transmitters. The exceptions are certain types of local instrumentation having mechanical readouts, such as bourdon tube pressure gages and bimetallic thermometers. Figure 22 illustrates various examples of modifiers and transmitters.

**Figure 21.** Signal controllers and signal conditioners

**Figure 22.** Transmitters and instruments
Types of System Components (Pumps, etc.)

Within every fluid system there are major components such as pumps, tanks, heat exchangers, and fans. Figure 23 shows the engineering symbols for the most common major components.

Source: DOE-HDBK-1016/1-93

Figure 23. Symbols for major components
Types of Lines, Piping and Vessels

The piping of a single system may contain more than a single medium. For example, although the main process flow line may carry water, the associated auxiliary piping may carry compressed air, inert gas, or hydraulic fluid. Also, a fluid system diagram may also depict instrument signals and electrical wires as well as piping. Figure 24 shows commonly used symbols for indicating the medium carried by the piping and for differentiating between piping, instrumentation signals, and electrical wires. Note that, although the auxiliary piping symbols identify their mediums, the symbol for the process flow line does not identify its medium. [NOTE: Vessels (tanks) are included in Table 19 above.]

Source: DOE-HDBK-1016/1-93

Figure 24. Piping symbols

Types of Materials of Construction

Fabrication, construction, and architectural drawings are designed to present the detailed information required to construct or fabricate a part, system, or structure. These three types of drawings differ only in their application as opposed to any real differences in the drawings themselves.

Fabrication drawings are similar to construction and architectural drawing but are usually found in machine shops and provide the necessary detailed information for a craftsman to fabricate a part. All three types of drawings, fabrication, construction, and architectural, are usually drawn to scale.
c. **Identify the symbols used on engineering piping and instrument drawings that denote the location of instruments, indicators, and controllers.**

Figure 25 illustrates the common notations used to indicate the location of an instrument, (e.g., local or board mounted).

![Figure 25. Location symbols](image)

*Source: DOE-HDBK-1016/1-93*

**d. Identify how valve conditions are depicted.**

Before a diagram or print can be properly read and understood, the basic conventions used by drawings to denote valve positions and failure modes must be understood. The reader must be able to determine the valve position, know if this position is normal, know how the valve will fail, and in some cases know if the valve is normally locked in that position. Figure 26 illustrates the symbols used to indicate valve status. Unless otherwise stated, drawings indicate valves in their “normal” position. This is usually interpreted as the normal or primary flow path for the system. An exception is safety systems, which are normally shown in their standby or non-accident condition. 3-way valves are sometimes drawn in the position that they will fail to instead of always being drawn in their “normal” position. This will either be defined as the standard by the system of drawings or noted in some manner on the individual drawings.
Figure 26. Valve status symbols

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

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

8. Waste management personnel must demonstrate a familiarity level knowledge of basic heat transfer, fluid flow, and 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 (ft³/mass [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 1.00g/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. The weight of a body is the force exerted by that body when its mass is accelerated in a gravitational field.

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, or 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.
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/sec²)
g_c = gravitational constant = 32.17 ft-lbm/lbf-sec²

In most practical engineering calculations, the acceleration due to gravity (g) is numerically equal to the gravitational constant (g_c); thus, the 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:

\[
KE = \frac{mv^2}{2g_c}
\]

where
KE = kinetic energy (ft-lbf)
m = mass (lbm)
v = velocity (ft/sec)
g_c = gravitational constant = 32.17 ft-lbm/lbf-sec²

*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 times the displacement.

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° 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.

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 ideal gas constant \( (R) \) may be obtained by dividing the universal gas constant 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’s 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 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 \((pV = \text{constant})\), constant volume, or under adiabatic conditions \( (\text{no heat transfer}) \). 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 on 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.

According to DOE-HDBK-1012/1-92, *DOE Fundamentals Handbook, Thermodynamics, Heat Transfer, and Fluid Flow*, an increase in temperature will tend to decrease the density of any fluid. Conversely, a decrease in temperature will increase a fluid’s density.

h. Describe the two types of heat exchanger construction.

The following is taken from DOE-HDBK-1018/1-93.

Although heat exchangers come in every shape and size imaginable, the construction of most heat exchangers falls into one of two categories: tube and shell, or plate. As in all mechanical devices, each type has its advantages and disadvantages.

*Tube and Shell*

The most basic and the most common type of heat exchanger construction is the tube and shell, as shown in figure 27. This type of heat exchanger consists of a set of tubes in a container called a shell. The fluid flowing inside the tubes is called the tube side fluid and the fluid flowing on the outside of the tubes is the shell side fluid. At the ends of the tubes, the tube side fluid is separated from the shell side fluid by the tube sheet(s). The tubes are rolled and press-fitted or welded into the tube sheet to provide a leak tight seal. In systems where the two fluids are at vastly different pressures, the higher pressure fluid is typically directed through the tubes and the lower pressure fluid is circulated on the shell side. This is due to economy, because the heat exchanger tubes can be made to withstand higher pressures than the shell of the heat exchanger for a much lower cost. The support plates shown on figure 27 also act as baffles to direct the flow of fluid within the shell back and forth across the tubes.
Plate

A plate type heat exchanger, as illustrated in figure 28, consists of plates instead of tubes to separate the hot and cold fluids. The hot and cold fluids alternate between each of the plates. Baffles direct the flow of fluid between plates. Because each of the plates has a very large surface area, the plates provide each of the fluids with an extremely large heat transfer area. Therefore a plate type heat exchanger, as compared to a similarly sized tube and shell heat exchanger, is capable of transferring much more heat. This is due to the larger area the plates provide over tubes. Due to the high heat transfer efficiency of the plates, plate type heat exchangers are usually very small when compared to a tube and shell type heat exchanger with the same heat transfer capacity. Plate type heat exchangers are not widely used because of the inability to reliably seal the large gaskets between each of the plates. Because of this problem, plate type heat exchangers have only been used in small, low pressure applications such as on oil coolers for engines. However, new improvements in gasket design and overall heat exchanger design have allowed some large scale applications of the plate type heat exchanger. As older facilities are upgraded or newly designed facilities are built, large plate type heat exchangers are replacing tube and shell heat exchangers and becoming more common.
i. **Describe hot and cold fluid flow in parallel flow, counter flow, and cross flow heat exchangers.**

Because heat exchangers come in so many shapes, sizes, makes, and models, they are categorized according to common characteristics. One common characteristic that can be used to categorize them is the direction of flow the two fluids have relative to each other. The three categories are parallel flow, counter flow and cross flow.

**Parallel Flow**
Parallel flow, as illustrated in figure 29, exists when both the tube side fluid and the shell side fluid flow in the same direction. In this case, the two fluids enter the heat exchanger from the same end with a large temperature difference. As the fluids transfer heat, hotter to cooler, the temperatures of the two fluids approach each other. Note that the hottest cold-fluid temperature is always less than the coldest hot-fluid temperature.
Counter Flow

Counter flow, as illustrated in figure 30, exists when the two fluids flow in opposite directions. Each of the fluids enters the heat exchanger at opposite ends. Because the cooler fluid exits the counter flow heat exchanger at the end where the hot fluid enters the heat exchanger, the cooler fluid will approach the inlet temperature of the hot fluid. Counter flow heat exchangers are the most efficient of the three types. In contrast to the parallel flow heat exchanger, the counter flow heat exchanger can have the hottest cold-fluid temperature greater than the coldest hot-fluid temperature.

Source: DOE-HDBK-1018/1-93

Figure 30. Counter flow heat exchanger


Cross Flow

Cross flow, as illustrated in figure 31, exists when one fluid flows perpendicular to the second fluid; that is, one fluid flows through tubes and the second fluid passes around the tubes at a 90° angle. Cross flow heat exchangers are usually found in applications where one of the fluids changes state (2-phase flow). An example is a steam system’s condenser, in which the steam exiting the turbine enters the condenser shell side, and the cool water flowing in the tubes absorbs the heat from the steam, condensing it into water. Large volumes of vapor may be condensed using this type of heat exchanger flow.

Source: DOE-HDBK-1018/1-93

Figure 31. Cross flow heat exchanger

j. Discuss the following heat exchanger applications:
   - Evaporator
   - Radiator
   - Condenser
   - Cooling tower

The following is taken from DOE-HDBK-1018/1-93.

Heat exchangers are found in most chemical or mechanical systems. They serve as the system’s means of gaining or rejecting heat. Some of the more common applications are found in heating, ventilation and air conditioning (HVAC) systems, radiators on internal combustion engines, boilers, condensers, and as pre-heaters or coolers in fluid systems.

Evaporator and Condenser

All air conditioning systems contain at least two heat exchangers, usually called the evaporator and the condenser. In either case, evaporator or condenser, the refrigerant flows into the heat exchanger and transfers heat, either gaining or releasing it to the cooling
medium. Commonly, the cooling medium is air or water. In the case of the condenser, the hot, high pressure refrigerant gas must be condensed to a subcooled liquid.

The condenser accomplishes this by cooling the gas, transferring its heat to either air or water. The cooled gas then condenses into a liquid. In the evaporator, the subcooled refrigerant flows into the heat exchanger, but the heat flow is reversed, with the relatively cool refrigerant absorbing heat from the hotter air flowing on the outside of the tubes. This cools the air and boils the refrigerant.

**Radiator**

Commonly, heat exchangers are thought of as liquid-to-liquid devices only. But a heat exchanger is any device that transfers heat from one fluid to another. Some of a facility’s equipment depends on air-to-liquid heat exchangers. The most familiar example of an air-to-liquid heat exchanger is a car radiator. The coolant flowing in the engine picks up heat from the engine block and carries it to the radiator. From the radiator, the hot coolant flows into the tube side of the radiator (heat exchanger). The relatively cool air flowing over the outside of the tubes picks up the heat, reducing the temperature of the coolant.

Because air is such a poor conductor of heat, the heat transfer area between the metal of the radiator and the air must be maximized. This is done by using fins on the outside of the tubes. The fins improve the efficiency of a heat exchanger and are commonly found on most liquid-to-air heat exchangers and in some high efficiency liquid-to-liquid heat exchangers.

**Cooling Tower**

The following is taken from DOE-HDBK-1018/2-93.

Before the development of cooling towers, rivers, lakes, and cooling ponds were required to supply cooling. Through the development of the mechanical draft cooling tower, as little as one square foot of area is needed for every 1000 square feet required for a cooling pond or lake. Cooling towers minimize the thermal pollution of the natural water heat sinks and allow the reuse of circulating water.

The cooling of the water in a cooling tower is accomplished by the direct contact of water and air. This cooling effect is provided primarily by an exchange of latent heat of vaporization resulting from evaporation of a small amount of water and by a transfer of sensible heat, which raises the temperature of the air. The heat transferred from the water to the air is dissipated to the atmosphere.

**k. 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. Our bodies are held up almost entirely by the water; wood, ice, and cork float on water. A rock taken from a stream bed suddenly seems heavier out of the water. Boats rely on this buoyant force to stay afloat. The amount of this buoyant effect was first computed and stated
by the Greek philosopher Archimedes. 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.

If a body weighs more than the liquid it displaces, it sinks but will appear to lose an amount of weight equal to that of the displaced liquid, as in the example of the rock. If the body weighs less than that of the displaced liquid, the body will rise to the surface eventually floating at such a depth that will displace a volume of liquid whose weight will just equal its own weight. A floating body displaces its own weight of the fluid in which it floats.

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.

Source: DOE-HDBK-1012/2-92

Figure 32. Pressure versus depth

As shown in figure 32, the pressure at different levels in the tank varies and this causes the fluid to leave the tank at varying velocities. Pressure was defined to be force per unit area. In the case of this tank, the force is due to the weight of the water above the point where the pressure is being determined.
Example:

\[ \text{Pressure} = \frac{\text{Force}}{\text{Area}} \]

\[ = \frac{\text{Weight}}{\text{Area}} \]

\[ P = \frac{mg}{Ag_c} \]

\[ = \frac{\rho Vg}{Ag_c} \]

where

- \( m \) = mass in lbm
- \( g \) = acceleration due to earth’s gravity 32.17 \( \frac{\text{ft}}{\text{sec}^2} \)

\[ g_c = 32.17 \frac{\text{lbm-ft}}{\text{lbm-sec}^2} \]

- \( A \) = area in \( \text{ft}^2 \)
- \( V \) = volume in \( \text{ft}^3 \)
- \( \rho \) = density of fluid in \( \frac{\text{lbm}}{\text{ft}^3} \)

The volume is equal to the cross-sectional area times the height of liquid. Substituting this into the above equation yields:

\[ P = \frac{\rho Ahg}{Ag_c} \]

\[ P = \frac{\rho hg}{g_c} \]

This equation tells us that the pressure exerted by a column of water is directly proportional to the height of the column and the density of the water and is independent of the cross-sectional area of the column. The pressure thirty feet below the surface of a one inch diameter standpipe is the same as the pressure thirty feet below the surface of a large lake.

**m. 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 which 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. The unit of measurement for absolute viscosity is as follows:

\[ \mu = \text{absolute viscosity of fluid (lbf-sec/ft}^2) \]

The viscosity of a fluid is usually significantly dependent on the temperature of the fluid and relatively independent of the pressure. For most fluids, as the temperature of the fluid increases, the viscosity of the fluid decreases. An example of this can be seen in the lubricating oil of engines. When the engine and its lubricating oil are cold, the oil is very viscous, or thick. Once the engine is started and the lubricating oil has increased in temperature, the viscosity of the oil decreases significantly and the oil seems much thinner.

**n. Define the terms head, head loss, and frictional loss, with respect to their use in fluid flow.**

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

**Head**

Since the units for all the different forms of energy are measured in units of distance, these terms are sometimes referred to as heads (pressure head, velocity head, and elevation 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. Each of the energies possessed by a fluid can be expressed in terms of head. The elevation head represents the PE of a fluid due to its elevation above a reference level. The velocity head represents the kinetic energy of the fluid. It is the height in feet that a flowing fluid would rise in a column if all of its kinetic energy were converted to PE. The pressure head represents the flow energy of a column of fluid whose weight is equivalent to the pressure of the fluid.

The sum of the elevation head, velocity head, and pressure head of a fluid is called the total head. Thus, Bernoulli’s equation states that the total head of the fluid is constant.

**Head Loss and Frictional 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 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.
o. Define the terms water and steam hammer and describe their physical effects on piping systems.

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

**Water Hammer**

Water hammer is a liquid shock wave resulting from the sudden starting or stopping of flow. It is affected by the initial system pressure, the density of the fluid, the speed of sound in the fluid, the elasticity of the fluid and pipe, the change in velocity of the fluid, the diameter and thickness of the pipe, and the valve operating time.

During the closing of a valve, kinetic energy of the moving fluid is converted into PE. The elasticity of the fluid and pipe wall produces a wave of positive pressure back toward the fluid’s source. When this wave reaches the source, the mass of fluid will be at rest, but under tremendous pressure. The compressed liquid and stretched pipe walls will now start to release the liquid in the pipe back to the source and return to the static pressure of the source.

This release of energy will form another pressure wave back to the valve. When this shockwave reaches the valve, due to the momentum of the fluid, the pipe wall will begin to contract. This contraction is transmitted back to the source, which places the pressure in the piping below that of the static pressure of the source. These pressure waves will travel back and forth several times until the fluid friction dampens the alternating pressure waves to the static pressure of the source.

Normally, the entire hammer process takes place in under one second. The initial shock of suddenly stopped flow can induce transient pressure changes that exceed the static pressure. If the valve is closed slowly, the loss of kinetic energy is gradual. If it is closed quickly, the loss of kinetic energy is very rapid. A shock wave results because of this rapid loss of kinetic energy. The shock wave caused by water hammer can be of sufficient magnitude to cause physical damage to piping, equipment, and personnel. Water hammer in pipes has been known to pull pipe supports from their mounts, rupture piping, and cause pipe whip.

**Steam Hammer**

Steam hammer is similar to water hammer except it occurs in a steam system. Steam hammer is a gaseous shock wave resulting from the sudden starting or stopping of flow. Steam hammer is not as severe as water hammer for three reasons:

1. The compressibility of the steam dampens the shock wave.
2. The speed of sound in steam is approximately one third the speed of sound in water.
3. The density of steam is approximately 1,600 times less than that of water.

The items of concern that deal with steam piping are thermal shock and water slugs (i.e., condensation in the steam system) as a result of improper warm up.
9. Waste management personnel must demonstrate a working level knowledge of problem analysis principles and techniques necessary to determine potential causes of the problems and identify corrective actions(s) as identified in DOE O 225.1A.

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 descriptions are taken from DOE-NE-STD-1004-92.

*Root Cause Analysis*

Root cause analysis is a term used to denote a class of problem-solving methods aimed at identifying the root causes of problems or events. The practice of root cause analysis is predicated on the belief that problems are best solved by attempting to correct or eliminate root causes. Any root cause analysis method may be used that includes the following steps:

- Identify the problem
- Determine the significance of the problem
- Identify the causes (conditions or actions) immediately preceding and surrounding the problem
- Identify the reasons why the causes in the preceding step existed, working back to the root cause (the fundamental reason which, if corrected, will prevent recurrence of these and similar occurrences throughout the facility)

*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 occurrence. The results are displayed in an events and causal factor chart that gives a picture of the relationships of the events and causal factors. This process is used for multi-faceted problems.

*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.

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 descriptions 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 for 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 ranging from physical conditions (such as an open valve or noise) to attitude or safety culture. The events and conditions as given on the chart describe a causal factor chain. The direct, root, and contributing cause relationships in the causal factor chain are shown in figure 33.

**Figure 33.** Causal factor relationships

**Root Cause Coding**

The following is taken from DOE M 231.1-2.

All causes must be identified as required in DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*, section 11, Occurrence Reporting Model, and included in the occurrence report. The cause codes to be used for reporting are provided in the causal analysis tree, which is also in section 11 of DOE M 231.1-2. Guidance on selecting the appropriate cause code is provided in DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*. The cause description field should include a brief discussion to clearly link the event to the cause code(s).

For those occurrences that require a formal root cause analysis, any of the site-approved root cause analysis methodologies are permitted. The methodology used must be included in the cause description field of the occurrence report.
Recommendation Generation
The following is taken from Quality Progress, *Root Cause Analysis for Beginners*.

Following identification of the root causes for a particular causal factor, achievable recommendations for preventing its recurrence are generated. The root cause analyst is often not responsible for the implementation of recommendations generated by the analysis. However, if the recommendations are not implemented, the effort expended in performing the analysis is wasted. In addition, the events that triggered the analysis should be expected to recur. Organizations need to ensure that recommendations are tracked to completion.

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 G 225.1A-1.

DOE O 225.1A, *Accident Investigations*, provides an accident investigation categorization algorithm as attachment 2. This algorithm provides the criteria for categorizing an accident investigation as either a type A or a type B investigation. Table 4 is a representation of the algorithm that breaks the criteria into four different categories of effects: human, environmental, property, and other.
### Table 4. Accident investigation types

<table>
<thead>
<tr>
<th>Categorization Criteria</th>
<th>Type of Investigation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A</strong></td>
<td><strong>Type B</strong></td>
</tr>
<tr>
<td>Human Effects</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>• serious injury</td>
</tr>
<tr>
<td></td>
<td>• occupational illness (except members of the public)</td>
</tr>
<tr>
<td></td>
<td>• chemical exposure</td>
</tr>
<tr>
<td></td>
<td>• biological exposure</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>One individual radiation exposure (see 10 CFR 835.202) of</td>
</tr>
<tr>
<td></td>
<td>• 25 rem or more total</td>
</tr>
<tr>
<td></td>
<td>• 75 rem or more to the eye</td>
</tr>
<tr>
<td></td>
<td>• 250 rem or more to skin or extremity (shallow dose)</td>
</tr>
<tr>
<td></td>
<td>• 250 rem or more for external exposure (deep dose) or to organ or tissue (committed dose) for other than lens of the eye</td>
</tr>
<tr>
<td></td>
<td>• 2.5 rem or more dose to embryo or fetus of pregnant woman</td>
</tr>
<tr>
<td>Environmental Effects</td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>
Table 4. Accident investigation types (continued)

| Property Effects | Loss or damage* of over $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.  
| 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  
|                  | 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.  

**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 CAPs. These plans contain actions for addressing judgments of need identified in the report and include milestones for completing the actions.

Corrective actions fall into 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.**

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

Kepner-Tregoe is a problem analysis technique that is used when a comprehensive analysis is needed for all phases of an occurrence investigation process. Its strength lies in providing an efficient, systematic framework for gathering, organizing, and evaluating information, and consists of four basic steps:

1. Situation appraisal to identify concerns, set priorities, and plan the next steps
2. Problem analysis to precisely describe the problem, identify and evaluate the causes, and confirm the true cause (similar to change analysis)
3. Decision analysis to clarify purpose, evaluate alternatives, assess the risks of each option, and make a final decision
4. Potential problem analysis to identify safety degradation that might be introduced by the corrective action, identify the likely causes of those problems, take preventive action, and plan contingent action (providing assurance that the safety of no other system is degraded by changes introduced by proposed corrective actions)

These four steps cover all phases of the occurrence investigation process and thus, Kepner-Tregoe can be used for more than causal factor analysis. Separate worksheets (provided by Kepner-Tregoe) provide a specific focus on each of the four basic steps and consist of step-by-step procedures to aid in the analyses. This systems approach prevents overlooking any aspect of the concern. As formal Kepner-Tregoe training is needed for those using this method, a further description is not included in this document.

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

This is a performance-based KSA. The Qualifying Official will evaluate its completion.
10. Waste management personnel must demonstrate a familiarity level of knowledge of the training and qualification requirements for defense nuclear facility personnel described in DOE Order 5480.20A.

a. Discuss the purpose and scope of DOE Order 5480.20A.

[Note: DOE Order 5480.20A has been superseded by DOE O 426.2, from which the following is taken. The ‘scope’ has been replaced by ‘applicability’ in the new Order.]

Purpose
The purpose of DOE O 426.2 is to establish selection, training, qualification, and certification requirements for contractor personnel who can impact the safety basis through their involvement in the operation, maintenance, and technical support of hazard category 1, 2, and 3 nuclear facilities.

Scope (now Applicability)
Departmental Applicability
This Order applies to all departmental elements, including the NNSA, responsible for operations of hazard Category 1, 2, and 3 nuclear facilities.

DOE Contractors
Except for exceptions and exemptions in paragraph 3c, the contractor requirements document (CRD), attachment 1 sets forth requirements of this Order that will apply to contracts that include the CRD. The CRD must be included in contracts that include selection, training, qualification and certification requirements for personnel who can impact the safety basis through their involvement in the operation, maintenance, and technical support of all DOE hazard category 1, 2, and 3 nuclear facilities.

The CRD must be included in all contracts for hazard category 1, 2, or 3 DOE nuclear facilities.

b. Describe the five elements of a systematic approach to training.

The following is taken from DOE-HDBK-1078-94.

The five elements of a systematic approach to training (SAT) are analysis, design, development, implementation, and evaluation. Each is described briefly below.

Analysis
This phase addresses three methods of identifying training/performance requirements: needs analysis, job analysis, and task analysis. The major outputs of the analysis phases are a task list for each position, and a task-to-training matrix. The task-to-training matrix identifies the training disposition of the tasks identified in the task list and lists the existing materials that support task performance. Participation of subject matter experts and facility personnel is emphasized throughout the processes.
Design
The design phase uses the information collected during the analysis phase to provide a “blueprint” for developing training programs based upon the SAT model. This section of the handbook addresses methods for writing learning objectives, setting training standards, designing tests, and preparing training plans. The major outputs of the design phase are learning objectives and test items. For existing programs, contractors are encouraged to determine if their learning objectives are appropriate, cover all required content, and include appropriate criteria and conditions.

Development
Development incorporates the results of the design activities. The major outputs of the development phase are the completed lesson plans and training aids.

Implementation
Implementation encompasses taking the results of the development phase into the training setting and conducting the training. The major output of the implementation phase is trained personnel.

Evaluation
Evaluation consists of a periodic review of the training materials and methods of soliciting feedback from former trainees and their supervisors on the effectiveness of training. The major outputs of evaluation are the decisions made to improve the training program during all phases.

c. Discuss the relationship between training, risk, and safe facility operations.

The following is taken from DOE Order 426.2.

Because the operation of DOE reactor and non-reactor nuclear facilities involves certain risks to employees, the public, and the environment, well-trained and qualified operating organization personnel are of extreme importance. A vital element in ensuring a well-trained and qualified work force is the implementation of a SAT.

Training to support qualification and certification programs shall be based on a SAT. A graded approach shall be used to establish a SAT for operations personnel, maintenance personnel, technicians, and the technical staff. For example, the methods used to develop training programs and materials for personnel at category 3 (low) hazard nuclear facilities do not need to be as detailed or formally developed and implemented as some of the training programs and materials for the category 1 and 2 (higher-hazard) nuclear facilities because the nuclear safety-related risk to the work force, the environment, and the public is significantly less.

The training and qualification program for nuclear facilities should be developed on the basis of the hazards involved and risk associated with the operation of the facility or activity. Accordingly, the level of detail and the content of the training implementation matrix and the
content of the training programs should reflect the training and qualification needs of these facilities to ensure personnel are qualified to carry out their assigned responsibilities.

d. **Discuss key elements of an effective on-the-job training program.**

The following is taken from DOE-HDBK-1206-98.

This handbook briefly addresses each phase of the SAT process. Where appropriate, specific guidance for on-the-job training (OJT) and OJT programs is presented.

**Analysis Phase**

Training requirements can be identified by performing needs analysis, job analysis, and/or task analysis. Correctly done, these analyses provide assurance that training is appropriate for the expected performance and identify requirements that serve as the basis for the design and development of OJT programs.

**Design Phase**

Design phase activities include writing of terminal objectives, selection of appropriate training settings, and development of training/evaluation standards for each task selected for training. It is during the development of the training/evaluation standards that the bulk of the tasks are further analyzed, enabling objectives are written, and decisions are made regarding how training will be conducted and evaluated. On-the-job training may be conducted using general instructions and task-specific evaluation materials for low-hazard potential facilities or tasks.

**Development Phase**

Development phase activities include the writing of training materials such as OJT checklists, qualification standards, and OJT guides. Additional activities include the selection and training of OJT instructors. The specifications generated in the design phase are used to develop an OJT program and all required training materials. Care should be taken to keep OJT materials simple and usable.

**Implementation Phase**

Implementation phase activities for an OJT program include implementing the OJT program’s administrative guidance, assigning an OJT coordinator, implementing the OJT program, conducting in-training evaluations, and maintaining training records.

**Evaluation Phase**

The evaluation phase of performance-based training takes place to determine the effectiveness of training programs and to identify program changes that may be required.

Line management should also be actively involved in the evaluation of an OJT program’s effectiveness. Line management’s observation of facility activities that reflect improving or declining job quality and efficiency are a very important source of feedback for training, especially for an OJT program.
e. Identify the types of training records required to be retained as permanent records.

The following is taken from DOE Order 426.2.

Contractors shall develop and implement administrative procedures that specify requirements for the maintenance of training, qualification, and certification records for operating organization personnel. The guidance in the Nuclear Information and Records Management Association, *Guidelines for Management of Nuclear Related Training Records*, TG-17, should be used to help standardize identification, handling, and storage of training records.

Qualification and certification of personnel shall be documented in an easily auditable format. Individual record documentation shall include the following at a minimum:

- Education, experience, and employment history, and most recent health evaluation summary
- Training programs completed and qualification/certification achieved
- Latest completed checklists, graded written examinations (with answers corrected as necessary or with examination keys), simulator examinations (where applicable), and operational evaluations used for certification (this requires controlling access to training records to maintain examination security; the record should include an evaluation of knowledge and performance during operational evaluations)
- Lists of questions asked and the examiner’s overall evaluation of the responses on oral examinations
- Correspondence relating to exceptions to training requirements and extensions of qualification/certification
- Records of qualification for one-time-only special tests or operations
- Attendance records for required training courses or sessions

A historical record that documents initial qualification or certification and applicable information from the above list that verifies the most recent qualification or certification shall be retained in individual records.

11. Waste management personnel must demonstrate a familiarity level of knowledge of Conduct of Maintenance (DOE O 433.1) principles and DOE requirements to ensure maintenance is performed in a safe and efficient manner.

a. Explain DOE’s role in the oversight of contractor maintenance operations.

The following is taken from DOE M 411.1-1C.

The responsibilities of all DOE elements are delineated in section 9 of DOE M 411.1-1C, *Safety Management Functions, Responsibilities, and Authorities Manual*. These responsibilities include ensuring the following:

- Sufficient resources are budgeted in a timely manner to accomplish the maintenance program’s objective of providing DOE with the highest confidence in the reliable performance of mission-critical safety structures, systems, and components (SSCs) through proactive maintenance practices.
A cost-effective and efficient maintenance program is developed and implemented for all DOE nuclear facilities consistent with DOE’s mission, safety and health, reliability, quality, and environmental protection objectives.

- The responsibility, authority, and accountability for maintenance are clearly defined, appropriately assigned, and executed.
- DOE operational awareness review and analysis capability exists for evaluation of maintenance program performance and effectiveness.
- Where maintenance requirements or accepted maintenance standards cannot be met, such instances are appropriately documented and acknowledged by DOE field elements, including the granting of exemptions by DOE, as appropriate, when requested.
- The requirements and standards for maintenance of nuclear facilities are incorporated into contracts and subcontracts, including support services contracts, as appropriate.

b. **Explain the intent of DOE O 433.1, Maintenance Management Program for DOE Nuclear Facilities.**

[Note: DOE O 433.1 has been superseded by DOE O 433.1B.]

The intent of DOE O 433.1B is to define the safety management program required by 10 CFR 830.204, “Documented Safety Analysis,” for maintenance and the reliable performance of SSCs that are part of the safety basis required by 10 CFR 830.202, “Safety Basis,” at hazard category 1, 2 and 3 DOE nuclear facilities.

c. **Define each of the following maintenance related terms and explain their relationship to each other:**

- Corrective
- Preventive
- Periodic
- Planned
- Reliability Centered

The following definitions are taken from DOE G 433.1-1.

**Corrective**

Corrective maintenance is the repair of failed or malfunctioning equipment, systems, or facilities to restore the intended function or design condition. This maintenance does not result in a significant extension of the expected useful life.

**Preventive**

Preventive maintenance includes all those planned, systematic, periodic, and seasonal maintenance actions taken to prevent SSC or facility failures, to maintain designed-in operating conditions, and to extend operating life. The preventive maintenance process takes into account the inevitability of failures in any simple or complex piece of equipment, although the consequences of failures can be controlled by careful design and effective maintenance.
Periodic
Periodic maintenance includes preventive, predictive, or seasonal maintenance activities performed on a routine basis (typically based on operating hours or calendar time) that may include any combination of external inspections, alignments or calibrations, internal inspections, overhauls, and SSC replacements.

Planned
Planned maintenance includes preventive or seasonal maintenance activities performed before SSC failure that may be initiated by predictive or periodic maintenance results, through vendor recommendations, or by experience/lessons learned. These include actions such as scheduled cold weather protection, valve repacking, replacement of bearings as indicated from vibration analysis, major or minor overhauls based on experience factors or vendor recommendations, and replacement of known life-span components. For example, repacking a valve because of packing leakage would be corrective maintenance, but scheduled repacking before leakage would be planned maintenance.

Reliability Centered
Reliability centered maintenance is a proactive, systematic, decision logic tree approach to 1) identify or revise preventive maintenance tasks or plans to preserve or promptly restore operability, reliability, and availability of facility SSCs, or 2) to prevent failures and reduce risk through types of maintenance action and frequency selection to ensure high performance. Reliability centered maintenance is the performance of scheduled maintenance for complex equipment, quantified by the relationship of preventive maintenance to reliability and the benefits of reliability to safety and cost reduction through the optimization of maintenance task/frequency intervals.

d. Explain the purpose and content of a Master Equipment List.

The following is taken from DOE G 433.1-1.

A master equipment list is a detailed master list of equipment, components, and structures to be included in the maintenance program. This list includes both safety-related and non-safety-related systems and equipment including special tools and equipment. It can be used effectively in establishing the maintenance history program.

e. Describe the procedure development, verification, and validation process.

The following descriptions are taken from DOE G 433.1-1.

Procedure Development
Procedures should be written for, and used in all work that could result in a significant process transient, a condition of degraded facility reliability, or a personnel or equipment hazard. Work complexity is also an indicator of the need for a procedure. Procedures should be written for each preventive maintenance action or written generically for similar preventive maintenance actions (including applicable equipment lists). Because procedures are used repeatedly, they should include information such as personnel and skill levels
required; time needed to accomplish the action; special tools and materials needed; facility or system conditions needed; and clearance, radiological work permit, and other safety requirements and precautions needed to perform the preventive maintenance. Workers should be involved in procedure development and verification whenever possible.

Information provided in procedures should be clear and concise, minimizing the need for interpretation and the possibility of misinterpretation. Experienced craft personnel and engineers can be trained to write maintenance procedures, or procedure writers can be used, with craft personnel or engineers providing technical input.

Maintenance procedures must be written with the users (crafts workers) in mind and should include the following:

- Procedure identification and status (titling or numbering, location, and page and revision identification)
- Procedure purpose and scope
- Consistent organization, presentation, and designation of instruction steps, caution and note style, and page style
- Clearly understood text, using correct grammar and punctuation and the appropriate level of detail; concise instruction steps organized in a logical sequence; specific nomenclature; quantitative and compatible values; referencing and branching methods; coordination of multiple actions; warning and caution location; effective formatting; and clear table, graph, and data sheet layout
- Consistent presentation of illustrations (e.g., preparation, compatibility, views, level of detail, and legibility when reproduced)
- Clear indication of steps that could initiate an equipment trip or transient or the initiation or interruption of any process action
- Clear indication of hold points, independent verification requirements, or data to be recorded
- Systematic nuclear facility and system prerequisites, precautions and limitations, required special tools and materials, and required personnel
- Clear indication of acceptance criteria, follow-on steps, and restoration instructions
- Steps that inform operations personnel of expected alarms or equipment operations
- Guidance to craft personnel to notify the operations organization of maintenance that cannot be completed as originally planned, or that will be delayed and extended past the anticipated due date and/or across shift changes
- Development and preparation using a personal computer, desktop-publishing, and computer-aided writing programs, which aid in providing easy-to-read text and clear illustrations

**Verification**

Verification is the review of a new or revised procedure to determine whether it is technically accurate and properly arranged. This review should ensure that the procedure incorporates human factors principles and appropriate administrative policies. The technical accuracy review should also include a review of the procedure against the design requirements for the
Verification should be conducted by one or more reviewers from the facility producing the procedure who were not involved in writing the procedure. Reviewers from other disciplines, such as health physics, engineering, and operations, should also be considered for involvement in the process.

**Validation Process**
Validation is the review of a procedure to determine its usability and correctness. This review evaluates whether the procedure provides sufficient and understandable guidance and direction to the craft personnel, and that it is compatible with the equipment or system being maintained. Validation may be conducted in a shop, in a training environment, or on a mockup or simulator.

f. **Explain the purpose of maintaining good facility condition and housekeeping.**

The following is taken from DOE G 433.1-1.

Management should conduct periodic inspections of safety equipment and facilities to ensure excellent facility condition and housekeeping 10 CFR 830.122, *Quality Assurance Criteria.* The condition of a facility depends on many factors, including design, fabrication, modifications, ongoing maintenance, facility work control programs, and day-to-day operation. After initial facility construction, ongoing maintenance and the control of modifications are prime contributors to keeping systems and equipment in optimum condition to support safe and reliable operation.

The involvement of facility managers and supervisors in periodic walkdowns and inspections clearly displays management standards to all personnel and can significantly improve the condition of the facility. Establishing a program for the identification and dispositioning of condition deficiencies and housekeeping discrepancies is an important step in maintaining facilities and equipment in a condition of maximum safety, reliability, and availability.

The appearance and proper functioning of facility systems and equipment are key indicators of a well-maintained and well-operated facility. Good facility condition, cleanliness, and housekeeping can be established and maintained by knowledgeable individuals who are alert to onsite deficiencies and who take prompt corrective action. Additionally, there should be a periodic, focused inspection effort, by thoroughly trained personnel, to assist in effective identification and correction of facility deficiencies.

The maintenance of systems and equipment within design conditions produces such benefits as minimizing fluid leakage, minimizing control room alarms caused by malfunctioning equipment, and maintaining environmental integrity of equipment. Providing easier access for operations and maintenance activities by reducing the sources and spread of radioactive contamination constitutes another benefit of good facility condition and housekeeping.
If properly used, a facility condition and housekeeping inspection program is an effective means for identifying and correcting deficiencies.

g. **Conduct a facility observation walk through and identify deficiencies often found with respect to Material, Housekeeping, Industrial Safety, and Radiological areas.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. [Note: Guidance on conducting a walkthrough is available in DOE, Oak Ridge Office, Office of Environmental Management (EM), EM-3.3, *Integrated Assessment Program*, section 5.2, September 2006.]

h. **Describe configuration control and its relationship to the maintenance work control process and the maintenance history file.**

The following is taken from DOE G 433.1-1.

Management should ensure that plant configuration, including the manner in which the facility is maintained, conforms to the established design basis requirements. Many routine activities, if carried out improperly, can have an adverse impact on facility configuration and cause eventual equipment damage or increase the probability or consequences of a significant event. Effective control of facility configuration requires rigorous attention to detail as well as the understanding and commitment of every member of the maintenance organization to observe and report/record material condition and status.

The maintenance policy regarding the control of plant configuration should be clearly defined and communicated to all levels of the organization. The policy should address the scope of configuration management controls, the responsibilities of the maintenance organization, and the principal interfaces between the facility and maintenance organization that directly control material condition assessments and facility design basis requirements. In addition, the policy should identify each maintenance line manager’s responsibility for implementing the necessary controls to ensure effective implementation of the configuration management policy.

Each facility or group of facilities should have an administrative procedure describing the work control system. Administrative requirements may be contained in separate documents covering individual areas or in one overall procedure that describes the administrative control of maintenance activities. The work control procedure helps all personnel understand the requirements and controls required for performing work. The basic intent of the work control system is to identify all facility deficiencies and work needed, avoid redundant identification of deficiencies, and guide the safe accomplishment of work and subsequent post-maintenance activities. If the work control system does not include modifications, in-service tests, surveillance, and preventive maintenance actions, the systems controlling these activities should interface with the work control system.

A maintenance history and trending program should be maintained to document data, provide historical information for maintenance planning, and support maintenance and performance trending of facility systems and components. The documentation of complete, detailed, and
usable history will be increasingly important as plant life extension becomes an issue. Trending should be directed toward identifying improvements for the maintenance program and needed equipment modifications.

The maintenance history program should document SSC maintenance and performance data as a basis for improving facility reliability. This history should assist in ensuring that root causes of failures are determined, corrected, and used in future work planning. This may be accomplished by a thorough review and analysis of maintenance performed, diagnostic monitoring data, and industry experience reports.

Maintenance history files should include component identification numbers and descriptions; complete maintenance records for all components/facilities in the system; diagnostic monitoring data; and relevant correspondence, including correspondence with vendors. To be an effective method for maintenance history control, the files should be computerized, with individual groups responsible for collecting data and populating the system. Provisions should be made for engineering review and analysis of both the history files and the overall program.

One objective of a good equipment maintenance history program is the ability to readily retrieve equipment maintenance, performance, and reference information to improve facility reliability. The work control system may be useful as a maintenance history data collection tool. The maintenance history program should provide a system to document component identification and description, vendor reference information and correspondence, diagnostic monitoring data, corrective and preventive maintenance or modification information, and spare parts information. This system may be maintained centrally or locally by the group responsible for collecting the data. In either case, easy access should be provided to all groups needing the information. The historical data, combined with operating experience at similar facilities, operating logs and records, and facility performance monitoring data, can be effective in analyzing trends and failures in equipment performance and making adjustments to the maintenance program. The maintenance history program should clearly define systems and equipment to be included, data to be collected, methods for recording data, and uses for the data.

i. Explain facility management’s role in facility maintenance.

The following is taken from DOE G 433.1-1.

Management involvement in control of maintenance activities should ensure that maintenance practices are effective in maintaining safe and reliable facility operation. This control should extend to all facility, contractor, and subcontractor personnel involved in maintenance activities. Rigorous control of maintenance activities should be directed toward achieving high-quality work performance, personnel safety (including radiological protection), equipment and system protection, and facility safety and reliability.
Facility management should develop performance measures to monitor the progress toward meeting facility maintenance goals. Progress toward meeting these goals should be evaluated frequently and reported to facility management.

j. **Describe the purpose and scope of the Maintenance Implementation Plan.**

The following is taken from DOE G 433.1-1.

A maintenance implementation plan (MIP) is a contractor’s documentation of a maintenance management program at DOE nuclear facilities in conformance with the objectives of DOE O 433.1. If approved by DOE, the MIP and the program implementation and baseline activities part of the site maintenance plan constitute agreements between the DOE field element and the contractor on the implementation of DOE O 433.1.

In coordination with the appropriate field element, each DOE contractor should develop, implement, and document a program in conformance with the policy and objectives of DOE O 433.1B in a site maintenance plan and/or a MIP. The format and content of the MIP should include appropriate elements of section 4 of DOE G 433.1-1, using a graded approach for each nuclear facility. Each of the 18 major elements of section 4 of DOE G 433.1-1 should be addressed. If an element is not included in a facility’s maintenance program, an explanation should be provided justifying why the element is not applicable to the facility.

k. **Identify the types of data and records required to be retained as permanent records.**

The following is taken from DOE G 433.1-1.

Maintenance history files should include component identification numbers and descriptions; complete maintenance records for all components/facilities in the system; diagnostic monitoring data; and relevant correspondence, including correspondence with vendors. To be an effective method for maintenance history control, the files should be computerized, with individual groups responsible for collecting data and populating the system. Provisions should be made for engineering review and analysis of both the history files and the overall program.

12. **Waste management personnel must demonstrate a familiarity level knowledge of Department of Energy Technical Standard DOE-STD-1073-93, Guide for Operational Configuration Management Program.**


a. **Describe the purpose and objectives of the Operational Configuration Management Program.**

The following is taken from DOE-STD-1073-2003
Purpose
The purpose of this standard (configuration management) is to define the objectives of a configuration management process for DOE nuclear facilities (including activities and operations), and to provide detailed examples and supplementary guidance on methods of achieving those objectives.

Objectives
The objectives of configuration management are to establish consistency among design requirements, physical configuration, and documentation (including analysis, drawings, and procedures) for the activity, and maintain this consistency throughout the life of the facility or activity, particularly as changes are being made.

b. Discuss what constitutes acceptable contractor compliance consistent with the requirements of DOE-STD-1073-93, Guide for Operational Configuration Management Program, for the following elements of the contractor's Configuration Management Plan:
   - Program planning
   - Equipment scope criteria
   - Concepts and terminology
   - Interfaces
   - Databases
   - Procedures

The following is taken from DOE-STD-1073-2003.

Program Planning
DOE contractors are expected to use an integrated safety management system (ISMS) to integrate safety into all aspects of work planning and execution. All safety management systems and programs should be designed to fit together to permit safe and efficient performance. Consistent with that goal, configuration management should function as an integrated process that marries seamlessly with other safety management processes at the facility or activity, and not as a separate and distinct program. In addition, the contractor must flow down the configuration management process to subcontractors and suppliers as appropriate to the work and ensure subcontractors and suppliers are implementing it appropriately.

Equipment Scope Criteria
Contractors must develop configuration management equipment databases that cross-reference SSCs with their design requirements, design basis, and associated documents. These databases will make up the primary information source for design requirements. Contractors should use the best available design information when filling in the database fields.

The configuration management equipment database can be used to contain and correlate key information such as the following:
   - System designators
- Component designators
- Component descriptive information, such as type, manufacturer, model, and size
- Grades/priority/classification
- Design requirements or references to design requirements
- Design basis references
- Design topical area references (e.g., seismic, environmental qualification, fire protection)
- The range of acceptable set points
- Facility document references (e.g., drawings, procedures, DSAs)
- Technical safety requirement references
- Maintenance equipment lists
- Other desired system and component information

Linking the configuration management equipment database with other databases, such as the maintenance equipment lists, will not only result in greater efficiency because there are fewer databases to maintain, it will also facilitate configuration management as changes will be more thoroughly reviewed and coordinated. The actual format, contents, and capabilities of an organization’s configuration management equipment database will depend greatly on the identified needs and intended uses. The contractor must assign a database owner for the equipment database, with established roles and responsibilities. As most of the information is design information, the design authority is a likely choice. As such, the design authority would be the focal point for resolving discrepancies and updating the database. Other organizations should use the configuration management equipment database as their primary source of design information.

**Concepts and Terminology**

Contractors with existing processes that satisfy the configuration management criteria should continue to use those processes, modifying them only as necessary. DOE-STD-1073-2003, *Configuration Management*, should not be used to justify repackaging existing processes that are already adequate. For example, if a facility has an adequate document control process, there would be little benefit in requiring that facility to repackage the process for the sole purpose of matching the format or terminology in this standard. Improvements can be made to existing processes to ensure they address the criteria in this standard, rather than completely revising existing processes. Contractors who have questions regarding changes that may be necessary to comply with this standard are urged to consult with their DOE line organizations prior to expending significant amounts from their budget.

**Interfaces**

Configuration management supports a number of contractor organizations and initiatives by ensuring conformance with the established design requirements. Figure 34, below, illustrates some of these interfaces.
Source: DOE-STD-1073-2003

**Figure 34. Configuration management interfaces**

**Databases**
Refer to the discussion in this competency on Equipment Scope Criteria for a discussion of databases and configuration management.

**Procedures**
To be effective, procedures should
- facilitate complete and timely change identification and control
- be easy to use and encourage participants to use them
- provide for management tracking and reporting

Contractors should develop and implement procedures that specify the document identification, control, storage, and retrieval requirements. These procedures should establish responsibilities and methods for each document control function. They should also include provisions for the review of controlled documents to ensure they are complete and approved prior to distribution. Document change notices should be used to notify users of document changes.

**c. Discuss the following elements of the Configuration Management Program:**
- Design requirements
- Document control
- Change control
The following definitions are taken from DOE-STD-1073-2003.

Design Requirements
The objective of the design requirements element of configuration management is to document the design requirements. The design requirements define the constraints and objectives placed on the physical and functional configuration. The design requirements to be controlled under configuration management will envelope the safety basis and, typically, the authorization basis. Consequently, proper application of the configuration management process should facilitate the contractor’s efforts to maintain the safety basis and the authorization basis. Contractors must establish procedures and controls to assess new facilities and activities and modifications to facilities and activities to identify and document design requirements.

Document Control
Document control ensures that only the most recently approved versions of documents are used in the process of operating, maintaining, and modifying the nuclear facility. Document control helps ensure that
- important facility documents are properly stored;
- revisions to documents are controlled, tracked, and completed in a timely manner;
- revised documents are formally distributed to designated users;
- information concerning pending revisions is made available.

As controlled documents are updated to reflect changes to the requirements and/or physical installation, the contractor must ensure that 1) each updated document is uniquely identified and includes a revision number and date, and 2) each outdated document is replaced by the latest revision.

Change Control
Contractors must establish and use a formal change control process as part of the configuration management process. The objective of change control is to maintain consistency among design requirements, the physical configuration, and the related facility documentation, even as changes are made. The change control process is used to ensure changes are properly reviewed and coordinated across the various organizations and personnel responsible for activities and programs at the nuclear facility.

Through the change control process, contractors must ensure that
- changes are identified and assessed through the change control process;
- changes receive appropriate technical and management review to evaluate their consequences;
- changes are approved or disapproved;
- waivers and deviations are properly evaluated and approved or denied, and the technical basis for the approval or the denial is documented;
 approved changes are adequately and fully implemented, or the effects of the partial implementation are evaluated and accepted;

- implemented changes are properly assessed to ensure the results of the changes agree with the expectations;

- documents are revised consistent with the changes, and the revised documents are provided to the users.

Assessments
The objective of assessing configuration management is to detect, document, determine the cause of, and initiate correction of inconsistencies among design requirements, documentation, and physical configuration. Properly performed assessments should help identify inconsistencies between these areas, evaluate the root causes for these problems, and prescribe improvements to avoid similar inconsistencies in the future.

Design Reconstitution Adjunct
The design reconstitution adjunct is an adjunct program to the configuration management process that accomplishes the one-time effort of identifying, retrieving, extracting, evaluating, verifying, validating, and regenerating missing critical design requirements and bases. Design reconstitution encompasses the following functions: developing associated program plans and procedures; identifying and retrieving design information from identified source documents; evaluating, verifying, and validating the design information; resolving discrepancies; regenerating missing critical design information; and preparing and issuing design information summaries.

Material Condition and Aging Adjunct
The material condition and aging adjunct is an adjunct program to the configuration management program that encompasses the following functions: developing associated program plans and procedures; screening components to determine those that are potentially life-limiting for the facility; evaluating aging degradation mechanisms; estimating the facility’s remaining lifetime; evaluating the feasibility of continued operations and extended operations; performing detailed material condition and aging analysis; and developing necessary life-extension techniques to achieve the facility desired lifetime defined by DOE.

d. Discuss the purpose, concepts, and general process for applying the graded approach to operational configuration management.

The following is taken from DOE-STD-1073-2003.

The main purpose of using a graded approach is to determine and apply a level of resources that is appropriate when implementing a program. The goal is to apply the highest level of resources to the most important equipment in the most important facilities and to avoid expenditures where they are not warranted.

For a highly hazardous facility, such as a large nuclear reactor which could potentially have serious offsite personnel safety consequences, a significant investment of resources is appropriate for the systems that prevent, detect, or mitigate such consequences. At the other
extreme, for a low-hazard facility—a glovebox operation, for example—where the greatest hazard is localized (i.e., offsite persons and workers at other collocated facilities are not affected), the same investment of resources may not be necessary. The grading system should take into account both facility grades and SSC grades in determining the appropriate level of resources to be applied.

In applying the graded approach to the configuration management process, the factors in table 5 should be considered:

Table 5. Relative importance factors

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<thead>
<tr>
<th>Relative Importance Factors</th>
<th>Situational/Circumstantial Considerations</th>
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<tbody>
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<td>Facility type and technical characteristics</td>
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<td>SSC grades</td>
<td>Facility remaining lifetime</td>
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<td>Facility operational status and life-cycle phase</td>
</tr>
<tr>
<td></td>
<td>Programmatic and technical issues</td>
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<td></td>
<td>Existing programs and procedures</td>
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</table>

Source: DOE-STD-1073-2003

The first column lists factors that can be used to grade based upon relative importance. That is, one item can be identified as more important than another and therefore can be assigned a higher priority. The second column lists special situations and circumstances that are independent of relative importance.

e. Identify the types of data and records required to be retained as permanent records.

The following is taken from DOE-STD-1073-2003.

Contractors must determine what documents need to be controlled. They also must define document owners who are responsible for developing and revising the technical content of the documents and ensuring they are maintained current. Document owners will also establish the schedules for document revisions, distribution, and retrieval.

Documents to be controlled should include those documents that reflect the facility’s requirements, performance criteria, and associated design bases. However, the number of documents that must be controlled should be limited because of the resources required to properly control documents.

DSAs, the TSRs, the documented design requirements, the safety management plans, and any other documents that are referenced by, or support, the DSAs should be controlled documents. Contractors should assess controlled documents to determine if they need to be updated whenever changes are made to the facility or activity configuration, the design...
requirements, or other documentation that might impact them. Typical controlled documents include

- DSAs
- authorization agreements and associated references
- safety management plans
- hazard controls, including TSRs
- documents that identify or define design requirements
- design specification and calculations
- accident analyses
- software data and manuals for operation and maintenance of critical software
- key procedures
- key drawings
- key vendor supplied documents

System design descriptions (SDDs) and other similar documents may contain specific information about preventive and mitigative SSCs that is too detailed to include in the DSA, but which facility personnel need to understand design, operation, and maintenance of the facility, activity, or operation. Whenever a change is initiated, the contractor should also review the applicable SDDs to determine if they need to be updated. The SDDs typically include

- detailed design and operating descriptions
- diagrams, such as electrical schematics and P&IDs
- load lists

f. Using the guidance in DOE-STD-1073-93, Guide for Operational Configuration Management Program, discuss the System Engineer concept as it applies to oversight of safety systems. Specifically address the areas of configuration management, assessment of system status and performance, and the technical support for operation and maintenance activities or for Documented Safety Analysis reviews.

[Note: DOE-STD-1073-93 has been superseded by DOE-STD-1073-2003.]}

The following is taken from DOE-STD-1073-2003.

The cognizant system engineer must be knowledgeable of the system and the related safety basis. The cognizant system engineer must also retain a working knowledge of the facility’s operation and the existing condition of the system. Consequently, the cognizant system engineer is also responsible for overseeing the configuration of the assigned system to ensure that it continues to be able to perform its expected functions. The cognizant system engineer should

- be knowledgeable of the system safety functions, requirements, and performance criteria and their bases
- understand how the system SSCs are designed and how they function to meet the requirements and performance criteria
- understand system operation
be knowledgeable of the testing and maintenance necessary to ensure the system continues to be able to perform its safety functions
be responsible for ensuring that documents related to the system are complete, accurate, and up-to-date, including SDDs, technical drawings, diagrams, and procedures for surveillance, testing, and maintenance
be appropriately involved in the design, review, and approval of changes affecting/impacting system design, operation, and maintenance

Because cognizant system engineers are expected to have a thorough understanding of system design expectations, operating requirements, and current configuration, cognizant system engineers should have a major role in identifying the configuration management SSCs. Each cognizant system engineer should also participate in the identification of the design requirements for their system and the SSCs within the system. Finally, the cognizant system engineer should participate in the configuration management review of any changes that are made to the system for which the cognizant system engineer has cognizance responsibility.

13. Waste management personnel must demonstrate a familiarity level knowledge of monitoring techniques and monitoring equipment related to environmental compliance.

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 71 millimeters long with an internal diameter of 11 millimeters, 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, ppb by volume 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 facility-specific monitoring network is a unique set of groundwater observation points designed to detect releases to the subsurface that have affected the groundwater or may cause groundwater impact in the future. 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. The information provided by this network of wells will allow site managers to determine whether any releases from the facility are occurring that may trigger specific actions included in the site-wide contingency plan.

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. Another example is a series of wells within the site boundary designed to determine whether contaminants from any one of a number of possible sources may potentially affect offsite groundwater resources.

A series of monitoring wells designed to measure the effectiveness of active remediation of a contaminant plume, as a component of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Resource Conservation and Recovery Act (RCRA) remedial action, is another type of groundwater monitoring network. This type of network which is typically developed and described in a regulatory compliance document should also be included in a surveillance monitoring network, either facility-specific or area-specific. Monitoring performed to comply with external regulatory requirements provides the framework for the long-term monitoring program that will provide surveillance and site maintenance information for closed waste management units and passive remediation sites. Eventually, active remediation will be completed and post-closure monitoring and maintenance will become the responsibility of appropriate DOE program offices and field elements.

The monitoring network developed to provide information on current remediation activities should continue to be modified to address needs for long-term site surveillance. The description of the site-wide surveillance monitoring network, and identification of facility- and area-specific networks should be included in a site-wide monitoring plan, as discussed later in this section. Each network should be made up of designated wells or observation points. The plan should specify frequency of sampling and specific data to be obtained from
each well at each sampling event. Each network design should be based on the conceptual site model and should be regularly reevaluated based on numeric modeling using monitoring network results.

**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 to 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 rain gauge—used for measuring precipitation. The measuring stick is inserted and records the amount. The water is discarded and the gauge is available for the next storm. The rain gauge measures precipitation to the nearest 100th of an inch (0.01 inches). Still the primary rain gauge of the National Weather Service because of its simplicity and reliability (no moving parts and needs no electricity).

**River and Stream Contamination**


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 (i.e., 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 volatile organic chemical (VOC) sampler. Figure 35 illustrates these sampler types.

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 complement of data such as pH, particle size analysis, cation exchange capacity, base saturation, organic carbon content, etc. are determined for all major soil layers.


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
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 2.5 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 36.


Figure 36. 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, 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 onsite or offsite. 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*.

Ecological risk assessments (RAs) 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 RA 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 macroinvertebrates 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 offsite, 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:

- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- National Environmental Policy Act (NEPA)
- 40 CFR 61, NESHAPs

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The following is taken from U.S. Environmental Protection Agency, Superfund Environmental Indicators Guidance Human Exposure Revisions.

U.S. Environmental Protection Agency (EPA) developed three initial program-based environmental indicators (EI) to document and communicate environmental progress towards cleaning up Superfund sites. The three original Superfund EIs were: populations protected; progress towards permanent cleanup; and cleanup technologies applied. Currently, two of these three program-based indicators, populations protected and cleanup volumes (formerly cleanup technologies applied), are in place. Progress toward permanent cleanup was functionally replaced by the development of the construction completion category. In 2001,
two additional indicators, human exposure under control and migration of contaminated groundwater under control, were developed to measure the interim progress in meeting the Superfund goal to protect human health and the expectation to return usable groundwaters to their beneficial use. The site-wide human exposure EI was developed in 2004 to further refine the progress categories and extend the focus of the human exposure EI beyond current conditions to measure progress in achieving long-term human health protection.

*Resource Conservation and Recovery Act (RCRA)*

The following is taken from U.S. Environmental Protection Agency, Region 10 Compliance and Enforcement Homepage.

Compliance monitoring is used to verify a handler complying with RCRA regulatory requirements. Monitoring allows EPA and the authorized states to assess the effectiveness of specific legal actions that may have been taken against a handler, and enabling EPA to gather data in support of a future rulemaking. The overall compliance monitoring program allows EPA to evaluate the effectiveness of state programs and to monitor nationwide compliance with RCRA. The primary method of gathering compliance monitoring data is through an inspection.

Either EPA or an authorized state may lead inspections. The inspections must be conducted annually at all Federal- or state-operated facilities and at least once every two years at each treatment, storage, and disposal facility (TSDF). The six types of inspections conducted under the RCRA program are:

1. Compliance Evaluation Inspection. Routine inspections (includes a file review prior to the site visit; onsite examination of generation, treatment, storage, or disposal areas; review of records; and an evaluation of the facility’s compliance with RCRA) to evaluate compliance with RCRA.
2. Case Development Inspection. An inspection to gather data to support an enforcement action when significant RCRA violations are known, suspected, or revealed.
3. Comprehensive Groundwater Monitoring Evaluation. An inspection to ensure that groundwater monitoring systems are designed and functioning properly at RCRA land disposal facilities.
4. Compliance Sampling Inspection. Inspections to collect samples for laboratory analysis.
5. Operations and Maintenance Inspection. Inspections to ensure that groundwater monitoring and other systems at closed land disposal facilities continue to function properly.
6. Laboratory Audit. Inspections of laboratories performing groundwater monitoring analysis to ensure that these laboratories are using proper sample handling and analysis protocols.

*National Environmental Policy Act (NEPA)*

The following is taken from U.S. Environmental Protection Agency, National Environmental Policy Act, Basic Information.
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 (CX) determination; preparation of an environmental assessment/finding of no significant impact (EA/FONSI); and preparation of an environmental impact statement (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 that an agency will take to reduce (mitigate) 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.

40 CFR 61, National Emission Standards for Hazardous Air Pollutants (NESHAPs)
The following is taken from Idaho Department of Environmental Quality, Air Toxics: Hazardous Air Pollutants and MACT Standards (Clean Air Act Section 112).

Hazardous air pollutants 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 Clean Air Act (CAA) requires the EPA to regulate emissions of 187 hazardous air pollutants (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 NESHAPs.
The NESHAPs are air quality standards, issued under section 112 of the CAA, that 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.

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 quality assurance program (QAP) 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 QAP 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 QAP. The graded application of facility/activity requirements is dependent on the hazards and/or level of risk associated with the activity or SSCs 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 quality assurance (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. 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 Groundwater and Drinking Water.

The Office of Groundwater 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 Safe Drinking Water Act (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 Clean Water Act (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.

e. 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.

f. 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.

g. 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 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 Bubbler
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 react chemically with contaminants in the air stream can improve 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, section II, chapter 3*.

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.

**h. 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 filter (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.

i. Describe the purpose for measuring each of the following parameters during field surveys of water quality:
   - Temperature
   - Dissolved oxygen
   - Conductivity
   - pH

Temperature

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

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


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 water bodies. 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 water body 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 water body 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.

j. 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 in element i of this competency.

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 phosphoric acid/copper sulfate. It should be noted that a chemical preservative for one sample may be a source of contamination for another.

k. Identify the types of data and records required to be retained as permanent records.


“…all books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the United States government under Federal
law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations or other activities of the government or because of the information value of the data in them.”

Maintenance of documents and records is required by the QA requirements in 10 CFR 830.122(d). 48 CFR 945.102-71, “Maintenance of Records,” provides additional guidance.

14. Waste management personnel must demonstrate a familiarity level knowledge of basic pneumatic and hydraulic systems in the areas of components, operations, and theory.

a. Define the following and discuss their relationship:
   - Force
   - Pressure
   - Pneumatic
   - Hydraulic

The following definitions are taken from DOE-HDBK-1018/2-93.

Force/Pressure
Force may be defined as a push or pull exerted against the total area of a surface. It is expressed in pounds.

Pressure is the amount of force on a unit area of the surface. That is, pressure is the force acting upon one square inch of a surface.

Pneumatic
Pneumatic means inflated or operated by air (pressure).

Hydraulic
Hydraulic describes a system that uses fluids under pressure to transmit force or power.

b. Describe the basic operation of a pneumatic system.


A modern industrial compressed air system is composed of several major sub-systems and many sub-components. Major sub-systems include the compressor, prime mover, controls, treatment equipment and accessories, and the distribution system. The compressor is the mechanical device that takes in ambient air and increases its pressure. The prime mover powers the compressor. Controls serve to regulate the amount of compressed air being produced. The treatment equipment removes contaminants from the compressed air, and accessories keep the system operating properly. Distribution systems are analogous to wiring in the electrical world—they transport compressed air to where it is needed. Compressed air
storage can also serve to improve system performance and efficiency. Figure 37 shows a representative industrial compressed air system and its components.

![Compressed Air System Components](image)


**Figure 37.** Components of a typical industrial compressed air system.

c. **Describe the basic operation of a hydraulic system.**

The following is taken from DOE-HDBK-1018/2-93.

The operation of a typical hydraulic system is illustrated in figure 38. Oil from a tank or reservoir flows through a pipe into a pump. Often a filter is provided on the pump suction to remove impurities from the oil. The pump, usually a gear-type, positive displacement pump, can be driven by an electric motor, air motor, gas or steam turbine, or an internal combustion engine. The pump increases the pressure of the oil. The actual pressure developed depends upon the design of the system.
Most hydraulic systems have some method of preventing overpressure. As seen in figure 38, one method of pressure control involves returning hydraulic oil to the oil reservoir. The pressure control box shown on figure 38 is usually a relief valve that provides a means of returning oil to the reservoir upon over-pressurization.

*Source: DOE-HDBK-1018/2-93.*

**Figure 38.** Basic hydraulic system

The high pressure oil flows through a control valve (directional control). The control valve changes the direction of oil flow, depending upon the desired direction of the load. In figure 38 the load can be moved to the left or to the right by changing the side of the piston to which the oil pressure is applied. The oil that enters the cylinder applies pressure over the area of the piston, developing a force on the piston rod. The force on the piston rod enables the movement of a load or device. The oil from the other side of the piston returns to a reservoir or tank.

**d. Identify the hazards associated with pneumatic and hydraulic systems and their components.**

The following is taken from DOE-HDBK-1018/2-93.
Pneumatic Systems

People often lack respect for the power in compressed air because air is so common and is often viewed as harmless. At sufficient pressures, compressed air can cause serious damage if handled incorrectly. To minimize the hazards of working with compressed air, all safety precautions should be followed closely.

Small leaks or breaks in the compressed air system can cause minute particles to be blown at extremely high speeds. Always wear safety glasses when working in the vicinity of any compressed air system. Safety goggles are recommended if contact lenses are worn.

Compressors can make an exceptional amount of noise while running. The noise of the compressor, in addition to the drain valves lifting, creates enough noise to require hearing protection. The area around compressors should normally be posted as a hearing protection zone.

Pressurized air can do the same type of damage as pressurized water. Treat all operations on compressed air systems with the same care taken on liquid systems. Closed valves should be slowly cracked open, and both sides should be allowed to equalize prior to opening the valve further. Systems being opened for maintenance should always be depressurized before work begins.

Hydraulic Systems

Any use of a pressurized medium can be dangerous. Hydraulic systems carry all the hazards of pressurized systems and special hazards that are related directly to the composition of the fluid used. When using oil as a fluid in a high pressure hydraulic system, the possibility of fire or an explosion exists. A severe fire hazard is generated when a break in the high pressure piping occurs, and the oil is vaporized into the atmosphere. Extra precautions against fire should be practiced in these areas. If oil is pressurized by compressed air, an explosive hazard exists if the high pressure air comes into contact with the oil, because it may create a diesel effect and subsequent explosion. A carefully followed preventive maintenance plan is the best precaution against explosion.

15. Waste management personnel must demonstrate a familiarity level knowledge of valve construction, operations, and theory.

a. Given a drawing of a valve, identify the major component parts.

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

b. Given a drawing of a valve, identify which of the following type of valve it is:
   - Gate
   - Globe
   - Relief/Safety
   - Ball
   - Check

This is a performance-based KSA. The Qualifying Official will evaluate its completion.
c. Describe the construction and principle of operation for the following types of valve actuators:

- Manual
- Electric
- Solenoid
- Pneumatic
- Hydraulic

The following descriptions are taken from DOE-HDBK-1018/2-93.

**Manual**

Manual valve actuators, by definition, require no outside power source. Manual actuators are capable of placing the valve in any position but do not permit automatic operation. The most common type of mechanical actuator is the handwheel, including handwheels fixed to the stem, hammer handwheels, and handwheels connected to the stem through gears.

**Electric**

Electric motor actuators use a motor to drive a combination of gears that generate the desired torque or thrust level. Electric motors permit manual, semi-automatic, and automatic operation of the valve. Motors are used mostly for open-close functions, although they are adaptable to positioning the valve to any point opening. The motor is usually a reversible, high-speed type connected through a gear train to reduce the motor speed and thereby increase the torque at the stem. Direction of motor rotation determines direction of disk motion. The electrical actuation can be semi-automatic, as when the motor is started by a control system. A hand wheel, which can be engaged to the gear train, provides for manual operating of the valve. Limit switches are normally provided to stop the motor automatically at full-open and full-closed valve positions. Limit switches are operated either physically by position of the valve or torsionally by torque of the motor.

**Solenoid**

A solenoid consists of an electromagnet and sometimes a ferrous plunger. Some solenoids are used to actuate switch contacts, and in such usage, are referred to as relays. Solenoid-actuated valves provide for automatic open-close valve positioning. Most solenoid-actuated valves also have a manual override that permits manual positioning of the valve for as long as the override is manually positioned.

Solenoids position the valve by attracting a magnetic slug attached to the valve stem. In single solenoid valves, spring pressure acts against the motion of the slug when power is applied to the solenoid. These valves can be arranged such that power to the solenoid either opens or closes the valve. When power to the solenoid is removed, the spring returns the valve to the opposite position.

Two solenoids can be used to provide for both opening and closing by applying power to the appropriate solenoid. Single solenoid valves are termed fail-open or fail-closed depending on the position of the valve with the solenoid de-energized. Fail-open solenoid valves are opened by spring pressure and closed by energizing the solenoid. Fail-closed solenoid valves...
are closed by spring pressure and opened by energizing the solenoid. Double solenoid valves typically fail “as is.” That is, the valve position does not change when both solenoids are de-energized. One application of solenoid valves is in air systems such as those used to supply air to pneumatic valve actuators. The solenoid valves are used to control the air supply to the pneumatic actuator and thus the position of the pneumatic-actuated valve.

**Pneumatic**

Pneumatic actuators provide for automatic or semiautomatic valve operation. These actuators translate an air signal into valve stem motion by air pressure acting on a diaphragm or piston connected to the stem. Pneumatic actuators are used in throttle valves for open-close positioning where fast action is required. When air pressure closes the valve, and spring action opens the valve, the actuator is termed direct-acting. When air pressure opens the valve, and spring action closes the valve, the actuator is termed reverse-acting. Duplex actuators have air supplied to both sides of the diaphragm. The differential pressure across the diaphragm positions the valve stem. Automatic operation is provided when the air signals are automatically controlled by circuitry. Semi-automatic operation is provided by manual switches in the circuitry to the air control valves.

**Hydraulic**

Hydraulic actuators provide for semi-automatic or automatic positioning of the valve, similar to the pneumatic actuators. These actuators use a piston to convert a signal pressure into valve stem motion. Hydraulic fluid is fed to either side of the piston while the other side is drained or bled. Water or oil is used as the hydraulic fluid. Solenoid valves are typically used for automatic control of the hydraulic fluid to direct either opening or closing of the valve. Manual valves can also be used for controlling the hydraulic fluid, thus providing semi-automatic operation.

16. Waste management personnel must demonstrate a familiarity level knowledge of basic strainer and filter construction, operations, and theory.

a. Describe the following types of filters, including an example of typical use:
   - **Cartridge filters**
   - **Pre-coated filters**
   - **Deep-bed filters**
   - **HEPA filters**

The following descriptions are taken from DOE-HDBK-1018/2-93.

**Cartridge Filters**

Cartridge filters are shaped like cylinders and usually consist of a fiber yarn wound around a perforated metal core. The liquid being filtered is forced through the yarn, which is approximately one-half inch thick, and then through the perforations in the metal core to the filter outlet, which can be at either end. A cartridge filter may include several cartridges, with the exact number depending on the liquid flow rate that must be handled.
Cartridge filters have the advantage of being relatively inexpensive to install and operate. Depending on the fiber or metal that is used, cartridges are available that will filter out all particle matter down to a specified size. For example, a certain cartridge might be designed to remove all particles larger than 10 microns, 1 micron, or even 0.1 micron. When the cartridges are removed from radioactive systems, the radiation levels can be very high, so they are not typically used in these applications.

**Pre-Coated Filters**

Pre-coated filters are much more complicated than cartridge filters, and the equipment required is much more expensive to install and maintain. The major advantage of pre-coated filters is the remote operation, which eliminates the physical handling of highly radioactive filter cartridges.

Inside the filter housing is a bundle of septa (vertical tubes on which the filter medium is deposited). The septa in some filters are approximately 1 inch in diameter and 3 feet long, and are usually made of perforated or porous metal (normally stainless steel). There may be several hundred of these septa in a filter. Septa in other filters are approximately 3 inches in diameter and 3 feet long, and are made of porous stone or porous ceramic material. There are usually fewer than 100 of these larger septa in a filter.

**Deep-Bed Filters**

A deep-bed filter is based on a support screen (decking), which is mounted a few inches above the bottom of the tank. The screen is perforated to allow water to flow through it. A coarse, aggregate layer of crushed rock or large lumps of charcoal are placed on top of the screen, and the deep bed itself (two to four feet of granular anthracite or charcoal) is placed on top of the aggregate. The filter is sized so that there is one to two feet of “free board” above the deep bed.

Deep-bed filters are usually found only in makeup water systems, where they are used to filter water after it has been treated in a clarifier. They are used to remove organic matter, chlorine, and very fine particulate matter.

**HEPA Filters**

The following is taken from DOE HDBK-1169-2003.

A HEPA filter is a throw-away extended-pleated-medium dry-type filter with: 1) a rigid casing enclosing the full depth of the pleats, 2) a minimum particle removal efficiency of 99.97 percent for particles with a diameter of 0.3 micrometers.

They are widely used in nuclear ventilation, air cleanup, and confinement systems to remove particulate matter from air and gas streams.

b. Describe the following types of strainers, including an example of typical use:
   - Bucket strainer
   - Duplex strainer
The following descriptions are taken from DOE-HDBK-1018/2-93.

**Bucket Strainer**
The bucket strainer is literally a bucket to catch debris. The bucket can be removed for cleaning by loosening the strongback screws, removing the cover, and lifting the bucket out by its handle. It is usually used in systems expected to have larger debris.

**Duplex Strainer**
A duplex strainer is a strainer consisting of two sides with a basket in each side. Only one side is placed in service at a time. These are commonly used in fuel oil and lubricating oil lines, where it is essential to maintain an uninterrupted flow of oil. The flow may be diverted from one basket to the other, while one is being cleaned.

17. Waste management personnel must demonstrate a familiarity level of knowledge of the following DOE Orders:
   - DOE O 420.1A, Facility Safety
   - DOE O 414.1A, Quality Assurance

   [Note: DOE O 420.1B, chg 1, Facility Safety, and DOE O 414.1C, Quality Assurance, are the current versions of these Orders.]

   a. Discuss the purpose, scope, and application of the listed Orders. Include in this discussion key terms, essential elements, and personnel responsibilities and authorities.

**DOE O 420.1B, chg. 1, Facility Safety**
The purpose of DOE O 420.1B, chg. 1, Facility Safety, is to establish facility and programmatic safety requirements for DOE, including NNSA, for the following:
   - Nuclear and explosives safety design criteria
   - Fire protection
   - Criticality safety
   - Natural phenomena hazards mitigation
   - The system engineer program

Except for the exclusions in paragraph 3c, DOE O 420.1B applies to all DOE elements with responsibility for DOE-owned or DOE-leased facilities.

The CRD in DOE O 420.1B sets forth requirements that are to be applied to contractors with responsibility for the design, construction, management, operation, decontamination, decommissioning, or demolition of DOE sites or facilities.

In complying with DOE O 420.1B, DOE and contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of 48 CFR 970.5223-1, “Integration of Environment, Safety, and Health into Work Planning and Execution,” and the QA requirements of either
subpart A of 10 CFR 830, “Nuclear Safety Management”, or DOE O 414.1C, Quality Assurance, or successor document, as applicable. All new construction, at a minimum, must comply with national consensus industry standards and the model building codes applicable for the state or region, supplemented in a graded manner with additional safety requirements for the associated hazards in the facility that are not addressed by the codes.

Personnel Responsibilities/Authorities
The responsibilities of the Director, Office of Security and Safety Performance Assurance, include
- acting as an independent authority responsible for environment, safety, and health (ES&H) oversight for the Department
- planning and conducting appraisals to determine compliance with requirements of DOE O 420.1B

The responsibilities of heads of field elements include
- ensuring that the facilities, activities, and programs under their purview operate in compliance with the requirements of DOE O 420.1B and the CRD
- notifying contracting officers when contracts are affected by DOE O 420.1B
- coordinating with contracting officers the revision of contracts to comply with requirements of DOE O 420.1B and requiring contractors to appropriately flow down requirements to subcontractors
- ensuring that procurement requests include applicable requirements in the CRD for DOE O 420.1B to be applied to awards or sub-awards
- conducting comprehensive self assessments and assessments of contractor fire protection programs and criticality safety programs
- specifying the frequency of the contractor’s periodic facility assessment for fire protection
- reviewing and approving
  - fire department baseline needs assessments, where applicable
  - CSP description documents
  - plans for upgrades to correct deficiencies in natural phenomena hazards mitigation for existing SSCs
  - recommendations to update natural phenomena hazard assessments
  - the qualification program for criticality safety staff
  - shipping containers for offsite shipment that are used to exclude materials from the requirement for a criticality alarm system or a criticality detection system
  - the method for preparing criticality safety evaluations

- ensuring that all procurement requests for work within the scope of DOE O 420.1B, including work requests to be performed through subcontracts, include the appropriate requirements of the attached CRD
- unless otherwise directed by the secretarial officer, fulfilling the role and responsibilities for the authority having jurisdiction for matters involving fire protection as defined by the National Fire Protection Association (NFPA) codes and standards
ensuring any comments from designated fire protection subject matter experts are appropriately addressed

The responsibilities of contracting officers include
- incorporating the CRD into affected contracts in a timely manner when notified
- ensuring applicable building codes and NFPA codes and standards are incorporated in contracts and other procurement documents

**DOE O 414.1C, Quality Assurance**

The purpose of DOE O 414.1C, *Quality Assurance*, is to
- ensure DOE, including NNSA, products and services meet or exceed customers’ expectations
- achieve QA for all work based on the following principles:
  - Quality is assured and maintained through a single, integrated, effective QA program (i.e., management system).
  - Management support for planning, organization, resources, direction, and control is essential to QA.
  - Performance and quality improvement require thorough, rigorous assessment and corrective action.
  - Workers are responsible for achieving and maintaining quality.
  - ES&H risks and impacts associated with work processes can be minimized while maximizing reliability and performance of work products.
- establish quality process requirements to be implemented under a QAP for the control of suspect/counterfeit items (S/CIs), safety issue corrective actions, and safety software

Except for the exclusions in paragraph 3c of DOE O 414.1C, this Order applies to all primary DOE organizations and their associated field elements. Except for the exclusions in paragraph 3c in the CRD of DOE O 414.1C, requirements of this Order apply to contractors whose contracts include the CRD.

Each DOE organization must develop and implement a QAP. The QAP must address management, performance, and assessment criteria. QAP implementation, assessment, and improvement are senior management responsibilities.

**Personnel Responsibilities/Authorities**

Responsibilities of field element managers include the following:
- Develop and implement approved QAPs governing the work under their purview, including software development/use, S/CI prevention requirements, corrective action management program (CAMP) requirements, and safety software quality requirements.
- Identify the senior management position assigned this responsibility.
- Submit QAPs to the appropriate secretarial officers for review, resolution of differences of opinion, and approval.
Review and, where delegated authority to do so, approve new and revised QAPs for contractors within their purview. QAPs must be reviewed and approved or rejected within 90 calendar days of receipt.

Perform independent assessments of contractor organizations to evaluate the adequacy and QAP implementation effectiveness.

Periodically report management assessment results to their organizations’ secretarial officers describing the effectiveness of field element and contractor QA implementation.

Prepare and implement a corrective action plan (CAP) to address all findings in the CAMP assessment report, and enter, track, and report the status of the CAP in the corrective action tracking system.

Complete the CAP, conduct follow-up review on the effectiveness of the corrective actions in resolving and preventing recurrence of all findings, and approve the effectiveness review report and follow-up report recommendations.

Contracting officers include the CRD in contracts falling within the scope of this Order in a timely manner, as directed by the secretarial officer.

b. Discuss the contractor's responsibilities for environmental safety and health protection as stated in the above documents.

In complying with DOE O 420.1B, DOE and contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of 48 CFR 970.5223-1, and the QA requirements of either subpart A of 10 CFR 830, or DOE O 414.1C, or successor document, as applicable.

18. Waste management personnel must demonstrate a working level knowledge of the Occupational Safety and Health Act (OSH Act) requirements (and Mine Safety and Health Act [Mine Act] 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
- 30 CFR 58, Health Standards for Metal and Nonmetal Mines
- All other applicable portions of MSHA regulations found at 30 CFR Subchapters A-K (Parts 1-199)

[Note: DOE O 440.1A has been superseded by DOE O 440.1B, Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees, for Federal employees, and 10CFR 851 “Worker Safety and Health Program,” for contract employees.]
a. Discuss the application and impact of OSHA and/or MSHA on Department projects.

The following is taken from the Occupational Safety and Health Administration’s, OSHA’s Mission.

Under the Occupational Safety and Health Act of 1970, OSHA’s role is to assure safe and healthful working conditions for working men and women by authorizing enforcement of the standards developed under the Act by assisting and encouraging the states in their efforts to ensure safe and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health.

The following is taken from the Mine Safety and Health Administration, MSHA’s Mission.

The mission of the Mine Safety and Health Administration (MSHA) is to administer the provisions of the Federal Mine Safety and Health Act of 1977 (Mine Act) and to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents; to reduce the frequency and severity of nonfatal accidents; to minimize health hazards; and to promote improved safety and health conditions in the nation’s mines.

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.

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

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

DOE has exercised its authority over working conditions at its GOCO facilities by developing and promulgating DOE Orders and conducting an extensive program of internal oversight at these facilities. In May 1993, however, Secretary O’Leary announced that DOE would immediately begin the process of shifting from internal oversight of occupational safety and health to external enforcement by OSHA.
c. Discuss the contractor's responsibility for providing necessary training to employees in the area of safety and health on the worksite.

The following is taken from 10 CFR 851.25 “Training and Information.”

Contractors must develop and implement a worker safety and health training and information program to ensure that all 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.

The contractor must provide

- training and information for new 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
- additional training when safety and health information or a change in workplace conditions indicates that a new or increased hazard exists

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

d. Discuss the project manager's responsibility for onsite safety and health inspections.

The following is taken from DOE G 440.1-2.

DOE O 440.1B clarifies the requirement of 29 CFR 1926.20(b) (2) which calls for “frequent and regular inspections of the job sites” by each employer (i.e., the construction contractor and all subcontractors). Consistent with requirements of the Federal Acquisition Regulation, which call for the onsite presence of a superintendent during the performance of any project work activities, the Order calls for daily inspections of the job site by the construction contractor during periods of active work. It should be noted that the frequency of required job site inspections by the project manager or his or her designee (i.e., support staff or construction manager) is given as “frequent and regular” as opposed to any specific frequency (such as weekly or monthly). The desired frequency of project inspections, consistent with project size, complexity, and risk level, should be addressed within local implementation guidance.

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

The following is taken from DOE G 440.1-8.

10 CFR 851, “Worker Safety and Health Program,” requires contractors to provide for prompt response to the reports and recommendations made by workers under 10 CFR 851.20, “Management Responsibilities and Worker Rights and Responsibilities.”
The term “prompt” is a subjective term, the meaning of which depends on the specific context in which the term is used. The meaning of this term in a situation should be determined by DOE line management starting with the head of the DOE field element and progressing to the under secretary depending on the impact of the meaning. DOE line managers should obtain input from safety and health professionals and other relevant subject matter experts in making their determinations.

19. Waste management personnel must demonstrate a working level knowledge of Department of Energy radiation protection requirements sufficient to assess the effectiveness of radioactive material containment, exposure control, and radiological work practices.

a. Discuss the relevant Departmental requirements related to the following radiological control elements:
   - Contamination control
   - Radiation work permits
   - Radiation safety training
   - Posting and labeling
   - Respiratory protection
   - Records
   - X-Ray generating devices

All of the information for this KSA is taken from DOE-STD-1098-2008.

Contamination Control

Individuals shall be monitored as appropriate for the presence of surface contamination when exiting contamination, high contamination, and airborne radioactivity areas. In addition, individuals exiting a radiological buffer area containing contamination, high contamination, or airborne radioactivity areas should, at a minimum, perform a hand and foot frisk. Where frisking cannot be performed at the exit from contamination, high contamination, or airborne radioactivity areas due to high background radiation levels, individuals should
   - remove all protective equipment and clothing at the exit
   - proceed directly to the nearest designated monitoring station
   - conduct a whole body frisk

Personnel frisking should be performed after removal of protective clothing and prior to washing or showering. Guidelines for personnel frisking are provided in appendix 3D of this standard.

A surface is considered contaminated if either the removable or total surface contamination is detected above the levels in table 2-2 of this standard. Controls shall be implemented for these surfaces commensurate with the nature of the contaminant and level of contamination.

Surfaces exceeding the values of table 2-2 for total contamination may be covered with a fixative coating to prevent the spread of contamination. However, reasonable efforts should be made to decontaminate an area before a coating is applied. A fixative coating should not
be applied without the approval of the radiological control manager or designee. Appropriate controls for areas of fixed contamination are provided in article 224 of this standard.

Due to reduced concerns regarding contamination spread, areas having only fixed contamination may not warrant the full range of entry controls established for areas having removable contamination levels exceeding the table 2-2 values. Areas located outside of radiological areas having measured total contamination exceeding the total surface contamination values specified in table 2-2 (removable contamination levels below table 2-2 values) are subject to the following controls:

- Periodic surveys shall be conducted to ensure the surface contamination remains fixed to the surface and removable surface contamination levels remain below table 2-2 values.
- Markings indicating the status of the area shall be applied. These markings should be applied directly to the surface (or at the access points) to provide appropriate warning. These markings may also provide appropriate instructions to individuals entering the area or contacting the surface.

Appropriate written procedures should be implemented to prevent unplanned or uncontrolled removal of the contamination. These procedures should address issues such as access controls, fixative coatings (if needed), survey techniques and frequency, area tracking and maintenance, and required markings.

**Radiation (or Radiological) Work Permits (RWP)**

The RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities.

- The RWP should be integrated with other work authorizations that address safety and health issues, such as those for industrial safety and hygiene, welding, or confined space entry. An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in articles 321, 322 and 323 of DOE-STD-1098-2008. The RWP should include the following information, unless the information is contained in other related work-control documents:
  - Description of work
  - Work area radiological conditions
  - Dosimetry requirements, including any bioassay requirements
  - Pre-job briefing requirements, as applicable
  - Training requirements for entry
  - Protective clothing and respiratory protection requirements
  - Radiological control coverage requirements and stay time controls, as applicable
  - Limiting radiological conditions that may void the RWP
  - Special dose or contamination reduction considerations
  - Special personnel frisking considerations
  - Technical work document number, as applicable
- Unique identifying number
- Date of issue and expiration
- Authorizing signatures

- If necessary to ensure appropriate accounting, the RWP number should be used in conjunction with the radiation dose accounting system to relate individual and/or collective dose to specific activities.

Use of Radiological Work Permits

Many facilities find it effective to use two different types of RWPs. General RWPs are used for entry and repetitive work in areas with known and stable low-hazard radiological conditions. Job-specific RWPs are used for more complex work and for entry into higher-hazard areas.

- RWPs should be used to control the following activities:
  - Entry into radiological areas
  - Handling of materials with removable contamination that exceed the values of table 2-2 of this standard
  - Work in localized bench top areas, laboratory fume hoods, sample sinks, and containment devices that has the potential to generate contamination in areas that are otherwise free of contamination
  - Work that disturbs the soil in soil contamination areas
  - Work that involves digging in underground radioactive material areas

- Job-specific RWPs should be used to control non-routine operations or work in areas with changing radiological conditions. The job-specific RWP should remain in effect only for the duration of the job.

- General RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with well-characterized and stable radiological conditions. General RWPs should be periodically reviewed and updated, consistent with the site ISM process.

- RWPs should be updated if radiological conditions change to the extent that protective requirements need modification.

- RWPs should be posted at the access point to the applicable radiological work area or otherwise made available at the work location.

- Workers should acknowledge by signature or through electronic means where automated access systems are in place that they have read, understand, and will comply with the RWP prior to initial entry to the area and after revisions to the RWP that affect the radiological controls.

- If needed for dose accounting purposes, worker pocket or electronic dosimeter readings should be recorded in a format that identifies and provides linkage to the applicable RWP.

- An alternative formal mechanism, such as written procedures or experiment authorizations, may be used in lieu of an RWP as the administrative control over radiological work activities. If an alternative mechanism is used, it should meet the standards established in article 321, 322 and 323 of DOE-STD-1098-2008.
Radiological Work Permit Preparation

- The responsibility for ensuring adequate planning and control of work activities resides with line management. The lead work group responsible for the planned activity or for the area should initiate the preparation of the RWP.
- The RWP should be based on current radiological surveys and anticipated radiological conditions.
- The RWP, including any revisions or extensions, should be approved by the supervisor responsible for the work or area, followed by review and concurrence by the appropriate radiological control supervisor.

Radiation Safety Training

10 CFR 835.901, “Radiation Safety Training,” establishes requirements for radiation safety training programs for two classes of individuals: 1) individuals who are permitted unescorted access to controlled areas or are occupationally exposed to radiation; and 2) individuals who are permitted unescorted access to radiological areas or perform unescorted assignments as a radiological worker. In addition, 10 CFR 835.103, “Education, Training, and Skills, establishes requirements for the education, training, and skills of individuals who are responsible for developing and implementing measures necessary for ensuring compliance with 10 CFR 835, “Occupational Radiation Protection.”

Radiation safety training shall include the following topics, to the extent appropriate to each individual’s prior training, work assignments, and degree of exposure to potential radiological hazards:

- Risks of exposure to radiation and radioactive materials, including prenatal radiation exposure
- Basic radiological fundamentals and radiation protection concepts
- Controls, limits, policies, procedures, alarms, and other measures implemented at the facility to control doses, including both routine and emergency actions
- Individual rights and responsibilities as related to implementation of the facility radiation protection program
- Individual responsibilities for implementing as low as is reasonably achievable (ALARA) measures
- Individual exposure reports that may be requested

General employee radiological training and radiological worker training shall be completed at intervals not to exceed 24 months.

Posting and Labeling

Radiological postings are intended to alert individuals to the presence of radiation and radioactive materials and to aid them in controlling exposures and preventing the spread of contamination.

Signs shall contain the standard radiation symbol (radiation warning trefoil) colored magenta or black on a yellow background. Lettering should be either magenta or black. Magenta is the
preferred color. Standardized signs, as described in DOE’s core training and 10 CFR 835
guides, should be used where practicable.

Signs shall be conspicuously posted at each access point, clearly worded, and where
appropriate, may include radiological control instructions. Radiological postings should be
displayed only to signify actual or potential radiological conditions. Signs used for training
should be clearly marked, such as “For Training Purposes Only.”

Postings should be maintained in a legible condition and updated based upon the results of
the most recent surveys. If more than one radiological condition (such as contamination and
high radiation) exists in the same area, each condition shall be identified. In areas of ongoing
work activities, the dose rate and contamination level or range of each should be included on
or in conjunction with each posting as applicable.

Postings at entrance points to areas of ongoing work activities controlled for radiological
purposes should state basic entry requirements, such as dosimetry, RWP or other written
authorization, and respiratory protection requirements.

Rope, tape, chain, and similar barriers used to designate the boundaries of posted areas
should be yellow and magenta in color.

Physical barriers should be placed so that they are clearly visible from all directions and at
various elevations. They should not be easily walked over or under, except at identified
access points. These barriers shall be set up such that they do not impede the intended use of
emergency exits or evacuation routes.

Areas shall be clearly and conspicuously posted. Posting of doors should be such that the
postings remain visible when doors are open or closed.

A radiological posting that signifies the presence of an intermittent radiological condition
should include a statement specifying when the radiation is present, such as “CAUTION:
RADIATION AREA WHEN RED LIGHT IS ON.”

Areas shall be posted to alert individuals to the presence of external radiation. In addition,
hot spots should be labeled to provide warning of discrete radiation sources.

Radiation areas and high radiation areas shall be identified based on the dose rates at a
distance of 30 centimeters either from the source or from any surface penetrated by the
radiation. Very high radiation areas shall be identified based on the dose rate at a distance of
100 centimeters either from the source or from any surface penetrated by the radiation.

Hot spots are localized sources of radiation, normally located within piping or components,
which have contact radiation levels that are greater than 100 millirems per hour (penetrating
radiation dose) and are more than 5 times greater than the general area dose rate. Contact
readings should be used to determine the need for labeling hot spots.
A label reading “Caution, Hot Spot” and marking the location of the hot spot should be placed on or as near the spot as practicable. Labeling of hot spots is not required in areas with general area dose rates greater than 1 rem/hr. However, the locations of such hot spots should be noted on area surveys and discussed in pre-job briefings.

Dose received in an hour may be used as the criterion for posting. At very high doses received at high dose rates (such as doses received in a very high radiation area), dose rates should be measured and recorded in units of “rads” rather than “rem” in an hour. Areas shall be posted to alert individuals to the presence (or likely presence) of surface contamination and airborne radioactivity.

Derived air concentration values found in 10 CFR 835 shall be used in posting airborne radioactivity areas. Accessible areas where items or containers of radioactive material in quantities exceeding the values provided in appendix 4A of DOE-STD-1098-99 are used, handled, or stored shall be posted “CAUTION, RADIOACTIVE MATERIAL.”

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

General Provisions

- Use of respiratory protection shall be reduced to the minimum practicable by implementing engineering controls and work practices to contain radioactivity at the source.
- Respirators shall be issued only to individuals who are trained, fitted, and medically qualified to wear the specific type of respirator. Training and qualification testing shall be performed annually.
- Positive controls should be maintained for the issue, use, and return of respirators to ensure that only qualified individuals wear respirators.
- 29 CFR 1910.134 mandates that breathing air meet the specifications of ANSI/Compressed Gas Association G-7.1 Grade D breathing air.
- Compressed air supplied to respirators shall be tested quarterly. Compressors shall be of the breathing air type and shall not allow oil or other chemicals and fumes to enter the breathing air supply. Special attention shall be focused on the location of compressor air supply intakes and on cross-connections to other compressed gas systems to prevent contamination [see 29 CFR 1910.134].
- Facility safety analyses should not take credit for the use of respiratory protection for routine work involving potential exposure to airborne radioactive materials.
Records

A radiological records management program should be established. This program should ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable), and disposition. The records management program shall be sufficient to ensure that records are maintained as necessary to document compliance with 10 CFR 835 and should include records of the following:

- Radiological control policy statements
- Radiological control procedures
- Individual radiological doses
- Internal and external dosimetry policies and procedures (including bases documents)
- Personnel training (course records and individual records)
- ALARA program implementation
- Radiological instrumentation test, maintenance, and calibration
- Radiological surveys
- Area monitoring dosimetry results
- RWPs
- Radiological performance indicators and assessments
- Radiological safety analysis and evaluation reports
- QA measures
- Radiological incident and occurrence reports (and critique reports, if applicable)
- Sealed radioactive source accountability and control
- Release of material to controlled areas
- Reports of loss of radioactive material

Where radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service. Records of results should reside in the custody of the originating contract organization.

Detailed information concerning an individual’s exposure shall be made available to that individual, upon request. An individual’s exposure information may be provided to others consistent with the Privacy Act of 1974, which contains requirements to protect the privacy of individual records.

X-Ray Generating Devices

Special considerations associated with the use of radiation generating devices include the presence of extremely high dose rates and the potential for uncontrolled exposures. Operation of these devices requires stringent physical and administrative controls to prevent overexposure to operating and support personnel and those in adjacent work areas.
The following procedures should be considered when developing site-specific procedures for applicable types of radiation generating devices:


- ANSI N43.2, *Radiation Safety for X-Ray Diffraction and Fluorescence Analysis Equipment*, provides guidelines for operations involving the following devices:
  - Analytical diffraction and fluorescence
  - Flash X-ray
  - Sealed source irradiators used for diffraction studies.

- Line management, in conjunction with the radiological control organization, should establish the radiological control requirements for incidental X-ray devices such as electron microscopes and electron beam welders.

- Devices for medical use should be registered with the appropriate regulatory agency.

- Control requirements for radiographic devices include the following:
  - ANSI/HPS N43.3-2008 establishes acceptable guidelines for onsite operations with devices other than sealed sources for radiographic use.
  - Onsite operations conducted by offsite contractors should be approved by line management in coordination with the site radiological control organization. This process should ensure the contractor has a valid Nuclear Regulatory Commission (NRC) or agreement state license and that the operational and emergency procedures are current and available.

- Safety devices and interlocks at fixed installations that are required to ensure compliance with 10 CFR 835.501, “Radiation Areas,” shall be operational prior to and during generation of a radiation field. Operational status should be periodically verified by testing. Safety devices and interlocks should be fail-safe.

**b. Describe and explain the radiological concerns in the design, construction, and operation of containment and confinement systems.**

The following is taken from Defense Nuclear Facilities Safety Board, Recommendation 2004-2, *Active Confinement Systems*.

There is a long-standing safety practice in the design, construction, and operation of nuclear facilities to build in and maintain SSCs that contain or confine radioactive materials. DOE establishes requirements to ensure such containment or confinement. In the hierarchy of safety controls, passive design features are preferred over active systems; however, controls must be capable of performing their intended function. Passive confinement systems are not necessarily capable of containing hazardous materials with confidence because they allow a quantity of unfiltered air contaminated with radioactive material to be released from an operating nuclear facility following certain accident scenarios. Safety-related active confinement ventilation systems will continue to function during an accident, thereby
ensuring that radioactive material is captured by filters before it can be released into the environment.

c. Discuss the design and operational characteristics of containment and confinement systems that minimize personnel radiation exposure.

The following is taken from International Atomic Energy Agency, Safety Reports Series No. 36, *Safety Considerations in the Transition from Operation to Decommissioning of Nuclear Facilities*.

During transition phases, areas within containment and/or confinement barriers may be open for access to personnel which were previously secured during facility operation. These areas need to be assessed to ensure that proper atmospheric controls are present to support human activities. Effective radiation monitoring and personnel exposure controls have to be established based on the conditions prevailing during the activity. This takes into account transient radiation levels that could result from the modification or dismantling of SSCs, system flushes and decontamination, or changes to installed or temporary radiation barriers consisting of water, metal, concrete, or plastic materials. Furthermore, dismantling or making changes to structures and ventilation systems may represent unanalyzed changes in air pathways, which can significantly affect radiation dose modeling. Appropriate controls need to be the subject of formal procedures and must be implemented to account for changes. Installation of additional radiation monitoring devices needs to be considered and personnel need to be trained to recognize that decommissioning has a high potential to increase radiation exposure or to give rise to unanalyzed pathways for the release of radiation.

20. Waste management personnel must demonstrate a working level knowledge of the requirements for the use of personal protective equipment for chemical hazards, requirements for hazardous substances, and the impact of hazardous waste operations on worker safety and health.

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 National Institute for Occupational Safety and Health, Publication No. 2009-132, *Recommendations for the Selection and Use of Protective Clothing and Respirators against Biological Agents*.

Respiratory protection and other PPE should be used in the context of a comprehensive program or incident command system that provides for a safety and health program. The program should contain the following elements:
   - Job safety analyses and a health and safety plan
• Provision for a health/safety surveillance and medical monitoring program (onsite medical monitoring for fatigue, heat stress, behavioral health, and other elements as appropriate)
• Pre-exposure immunization and post-exposure responder prophylaxis and medical monitoring

When using respiratory protection, the type of respirator is selected on the basis of the hazard and its airborne concentration. Recommendations for selection of respirators can be found in the National Institute for Occupational Safety and Health (NIOSH) Reservoir Selection: Logic 2004 Publication No. 2005-100. Additionally, guidance specific for chemical, biological, radiological, and nuclear (CBRN) incidents can be found in the NIOSH document Guidance on Emergency Responder Personal Protective Equipment (PPE) for Response to CBRN Terrorism Incidents Publication No. 2008-132.

For a biological agent, the air concentration of particles will depend upon the method used to release the agent, the initial amount of agent in the dispersal device, the particle size (very small particles will remain suspended in the air for prolonged periods, while large particles fall more quickly out of the air), and the elapsed time since the release. Secondary re-aerosolization generated from disturbing the contaminated area may contribute to an increase in particle concentration in the air. NIOSH-approved CBRN SCBA, which many first responders currently use for entry into potentially hazardous atmospheres, will provide responders with respiratory protection against biological exposures associated with a suspected act of biological terrorism. When site concentrations allow for the use of lower levels of protection, NIOSH-approved CBRN full facepiece air-purifying respirators or CBRN full facepiece powered air-purifying respirators may be used.

Protective Clothing

The following is taken from National Institute for Occupational Safety and Health Publication No. 2009-132.

Protective clothing, including garments, gloves and booties, also are necessary for the response to a suspected act of biological terrorism to reduce exposures to potential dermal, chemical, and physical hazards. Protective clothing must have physical performance properties adequate for the mission (e.g. tensile strength, puncture resistance, seam breaking strength, abrasion resistance). Protective clothing is used to prevent skin exposures and/or contamination of other clothing. The type of protective clothing needed will depend upon the biological agent, concentration, route of exposure, and anticipated work operations.

MSHA Approved Self-Rescue Devices (At Applicable Sites)

The following is taken from Mine Safety and Health Administration, MSHA Proposed Rule: Safety Standards for Self-Rescue Devices in Underground Coal and Underground Metal and Nonmetal Mines.

Miners wear breathing apparatuses known as self-rescue devices to exit a mine during emergencies such as fires, explosions, or other incidents which contaminate the environment. There are two types of self-rescue devices used in underground mines. A filter self-rescue
device removes hazardous carbon monoxide through filtration of the mine air. A self-contained self-rescue device (SCSR) is a closed-circuit breathing apparatus that isolates the users’ lungs providing breathable air. Because an SCSR functions in a closed circuit, all contaminants in the surrounding mine air can be eliminated from the air the miner is breathing.

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

The following is taken from DOE- STD-5503-94.

Personal protective equipment is divided into two broad categories: respiratory protective equipment and personal protective clothing. Both of these categories are incorporated into the four levels of protection (levels A, B, C, and D) based on the potential severity of the hazard.

Modifications to these levels should be made under the direction of the site safety and health officer (SSHO) in consultation with a qualified industrial hygienist and/or health physicist. Such modifications are routinely employed during site work activity to maximize efficiency and to meet site-specific needs without compromising worker safety and health. The SSHO and project manager should make the final determination on the appropriate level of PPE.

Respiratory protective gear and protective clothing should complement one another.

The specific levels of PPE and necessary components for each level have been divided into four categories according to the degree of protection afforded. General guidelines for use are as follows:

- **Level A:** Worn when the highest level of respiratory, skin, and eye protection is needed.
- **Level B:** Worn when the highest level of respiratory protection is needed, but a lesser level of skin protection is needed.
- **Level C:** Worn when the criteria for using air-purifying respirators are met, and a lesser level of skin protection is needed.
- **Level D:** Applies to work conducted without respiratory protection, and should be used only when the atmosphere contains no known or suspected airborne chemical or radiological contaminants and oxygen concentrations are between 19.5 percent and 23 percent.

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 (A, B, C & D) of protection for workers at hazardous waste sites or for those workers conducting emergency response activities as defined by the Environmental Protection Agency.

The following is taken from 29 CFR 1910.120.

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

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

Level A—To be selected when the greatest level of skin, respiratory, and eye protection is required.

The following constitute level A equipment; may be used as appropriate:
- Positive pressure, full face-piece SCBA, or positive pressure supplied air respirator with escape SCBA, approved by the NIOSH
- Totally-encapsulating chemical-protective suit
- Coveralls(1)
- Long underwear(1)
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, chemical-resistant, steel toe and shank
- Hard hat (under suit)(1)
- Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit)

(1) indicates optional, as applicable.

Level B—The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

The following constitute level B equipment; may be used as appropriate:
- Positive pressure, full-face-piece SCBA, or positive pressure supplied air respirator with escape SCBA, approved by the NIOSH
- Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls)
- Coveralls(1)
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots, outer, chemical-resistant steel toe and shank
- Boot-covers, outer, chemical-resistant (disposable)\(^{(1)}\)
- Hard hat\(^{(1)}\)
- Face shield\(^{(1)}\)

\(^{(1)}\) indicates optional, as applicable.

Level C - The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met.

The following constitute level C equipment; may be used as appropriate:
- Full-face or half-mask, air purifying respirators, approved by the NIOSH
- Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls)
- Coveralls\(^{(1)}\)
- Gloves, outer, chemical-resistant
- Gloves, inner, chemical-resistant
- Boots (outer), chemical-resistant steel toe and shank\(^{(1)}\)
- Boot-covers, outer, chemical-resistant (disposable)\(^{(1)}\)
- Hard hat\(^{(1)}\)
- Escape mask\(^{(1)}\)
- Face shield\(^{(1)}\)

\(^{(1)}\) indicates optional, as applicable.

Level D - A work uniform affording minimal protection: used for nuisance contamination only.

The following constitute level D equipment; may be used as appropriate:
- Coveralls
- Gloves\(^{(1)}\)
- Boots/shoes, chemical-resistant steel toe and shank
- Boots, outer, chemical-resistant (disposable)\(^{(1)}\)
- Safety glasses or chemical splash goggles\(^{(1)}\)
- Hard hat\(^{(1)}\)
- Escape mask\(^{(1)}\)
- Face shield\(^{(1)}\)

\(^{(1)}\) indicates optional, as applicable.

e. Discuss the hazards associated with the use of corrosives (acids and alkalis).

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

Acids are compounds of hydrogen and one or more other elements (with the exception of carbon) that dissociate or break down to produce hydrogen ions when dissolved in water or certain other solvents.
Acids are corrosive in any form, and in high concentrations destroy body tissue and cause severe burns on contact with the skin. The eyes are very susceptible, and permanent damage or loss of sight may result from contact with acids. The inhalation of excessive concentrations of vapor or mist is extremely irritating to the respiratory system and to mucous membranes in particular.

Accidental swallowing of concentrated acids may result in severe irritation of, and damage to, the throat and stomach which, in some cases, may prove fatal. Some of these materials are specifically poisonous as well as irritating. In lower concentrations, repeated skin contact may result in inflammation.

Concentrated aqueous solutions of acids are not in themselves flammable. The potential hazard is the danger of their mixture with other chemicals or combustible materials which may result in fire or explosion. Acids also react with many metals resulting in the liberation of hydrogen, a highly flammable gas, which upon ignition in air may cause an explosion. Some of the acids are strong oxidizing agents and can react destructively and violently when in contact with organic or other oxidizable materials.

Alkalies (bases) are corrosive caustic substances that dissociate in water and yield hydroxyl ions. Alkalies include: ammonia, ammonium hydroxide; calcium hydroxide and oxide; potassium, potassium hydroxide and carbonate; sodium, sodium hydroxide; carbonate, peroxide and silicate; and trisodium phosphate.

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

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

Even though alkalies are not flammable and will not support combustion, much heat is evolved when the solid material is dissolved in water. Therefore, cold water must be used to dissolve solid alkalies, otherwise the solution may boil, and splatter corrosive liquid over a wide area.
f. Describe the general safety precautions necessary for the handling, storage, and disposal of corrosives.

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

Handling and Storage

Corrosives are available in numerous forms and varying concentrations. Some forms and concentrations are more hazardous than others, but the potential for serious accidents exists regardless of the substance in question.

Many of the safety precautions necessary for safe handling and storage are equally applicable to acids and alkalis. Specific corrosives may require specific precautions, and material safety data sheets (MSDS) must be consulted in all cases.

Safety in handling hazardous chemicals depends to a great extent on effective employee education, proper safety practices, intelligent supervision, and the use of safe equipment.

Workers should be thoroughly informed of the hazards that may result from improper handling. Each employee should know what to do in an emergency and should be fully informed about proper first-aid measures. Hazards from spills and leaks should be minimized by an adequate supply of water for washing-down. Drainage of hard-surfaced or diked areas should be directed to minimize the exposure of personnel and equipment. Adequate ventilation should be provided in areas where chemical mist or dust is present.

The use of PPE is not intended as a substitute for adequate control measures, but because corrosives can cause extensive damage to the body this equipment must be available as needed. During handling operations where spills or splashes are possible, whole body protection (eyes, head, body, hands, and feet) may be necessary. All PPE should be carefully cleaned and stored following use, and any equipment that cannot be decontaminated should be discarded.

For the protection of the eyes, chemical safety goggles should be worn. Face shields should be worn if complete face protection is necessary. Eyewash fountains and safety showers must be available at any location where eye and/or skin contact may occur. Protection against mist or dust can be provided by proper respiratory protective equipment. The wearing of protective clothing is also advisable to avoid skin contact. This may consist of rubber gloves, aprons, shoes or boots, and cotton coveralls which fit snugly. Safety shoes or boots made of rubber, chlorobutadiene, or other chemical-resistant materials with built-in steel toecaps are recommended for workers handling drums or in process areas where leakage may occur.

Containers should be stored in rooms with trapped floor drains. Curbs or a drained gutter, covered with an appropriate grill, should be constructed at door openings where floor drains are not provided.

Tanks should be entered for cleaning or repairing only after these have been drained, flushed thoroughly with water, ventilated, and sampled. Workers entering tanks should be monitored.
by someone on the outside of the tank. A supplied-air respirator or SCBA, together with rescue harness and lifeline, should be on hand for rescue purposes.

Disposal
The following is taken from the Canadian Centre for Occupational Health and Safety, How Do I Work Safely with Corrosive Liquids and Solids?

Corrosive wastes are hazardous and must always be handled safely. All containers for corrosive wastes must be made from corrosion-resistant materials. Identify the contents of these containers with suitable labels.

“Empty” drums, bottles and other containers often have hazardous corrosive residues inside them. Never use these “empty” containers for anything else, no matter how clean they seem to be. Treat them as corrosive wastes. It may be possible to safely decontaminate “empty” containers. The chemical manufacturer or supplier can give advice about this.

Never dispose of corrosives down sinks or drains that connect to sanitary or storm sewers. Dispose of them according to the manufacturer’s or supplier’s directions, or through hazardous waste collection and disposal companies. In all cases, dispose of corrosive wastes according to the environmental laws that apply to the appropriate jurisdiction. Contact the appropriate environmental officials for details about the disposal laws that apply for specific corrosives.

g. Discuss the general safety precautions regarding toxic compounds.

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

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

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

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

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

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

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

In general, industrial poisonings usually result from inhalation, ingestion, and absorption.
- The inhalation and absorption of toxic agents by the lungs depends on the solubility in body fluids, the diffusion through the lungs, the volume of inhalation, the volume of blood in the lungs, and the concentration gradient of vapors between the inhaled air and the blood.
- Ingestion of the toxic agent can occur to some extent; however, there would generally be considerable inhalation of the material where such conditions exist.
- Absorption through the skin can occur upon exposure to some toxic agents. Some liquids and vapors are known to pass through the skin in concentrations high enough such that respiratory protection is not adequate.

It should also be noted that toxic materials can enter the body by injection through cuts and wounds and accidentally via improper use of syringes and needles.

i. Discuss the general safety precautions regarding the use, handling, and storage of compressed gases, including but not limited to hydrogen, oxygen, and nitrogen.

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

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

Practically all gases can act as simple 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 breathing apparatus with a self-contained or hose-line air supply. A number of gases have characteristic odors which can warn of their presence in air. Others, however, like the atmospheric gases, have no odor or color. Warning labels are required for compressed and liquefied gas shipping containers. Similar warning signs are placed at the approaches to areas in which the gases are regularly stored and used.

Some gases can also have a toxic effect on the human system, either inhalation, through high vapor concentrations, or by liquefied gas coming in contact with the skin or the eyes. Adequate ventilation of enclosed areas serves as the chief precaution against high concentrations of gas.
In addition, for unusually toxic gases, automatic devices can be purchased or built to monitor the gas concentration constantly and set off alarms if the concentration approaches a danger point. Precautions against skin or eye contact with liquefied gases that are toxic or very cold, or both, include thorough knowledge and training for all personnel handling such gases, the development of proper procedures and equipment for handling them, and special protective clothing and equipment (for example, protective garments, gloves, and face shields).

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

**Handling and Storage**

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. For example, cylinders should never be struck nor allowed to fall, because if the cylinder is charged to a high pressure and the cylinder valve is broken off, it could become a projectile. Cylinders should not be dragged or rolled across the floor; they should be moved by a hand truck. Also, when they are upright on a hand truck, floor, or vehicle, they should be chained securely to keep them from falling over.

Moreover, cylinders should not be heated to the point at which any part of their outside surface exceeds a temperature of 125ºF, and they should never be heated with a torch or other open flame. Similar precautions are taken with larger shipping and storage containers. 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.

**Hydrogen**

Hydrogen (H\(_2\)) is the lightest of all elements. Its presence cannot be detected by any of the senses. It is flammable in oxygen or air, and has a flammable range of from 4.1 percent to 74.2 percent by volume in air. A mixture of 10 to 65 percent hydrogen by volume in air will explode if ignited. Pure hydrogen burns quietly in air with an almost invisible flame, and when burned with pure oxygen, a very high temperature may be reached. Hydrogen will burn readily in chlorine gas, and under proper conditions, will combine with nitrogen, forming ammonia. Some chemical reactions produce hydrogen as a byproduct. A lead-acid battery will produce hydrogen when it is being charged. Metallic sodium and potassium are examples of some chemicals that react violently when exposed to water, producing hydrogen, which may flame spontaneously due to the heat of the reaction. Many electroplating processes produce hydrogen.
Some chemicals used to remove scale from the water side of boilers give off hydrogen. Whatever the operation, it is important to know whether hydrogen will be produced, and if so, precautions must be taken to prevent its accumulation and ignition. The precautions to take include adequate ventilation to prevent its accumulation and the elimination of possible sources of ignition. Hydrogen is classified as an asphyxiant.

**Oxygen**

Oxygen ($O_2$) supports combustion, but does not burn. Even so, it must be considered a potentially hazardous element from a fire hazard standpoint. The results of an enriched oxygen atmosphere include a lowered ignition temperature, an increased flammable range, and an acceleration of the burning rate. Oxygen readily combines with other elements and compounds, with spontaneous ignition in some cases. When oxygen comes in contact with oil, grease, or fuel oils, it may ignite violently. Every possible precaution must be taken to prevent this combination.

Oxygen sustains life, but if pure oxygen were inhaled continuously for extended periods, the reactions in the body would be too rapid and would cause harmful effects. Oxygen should always be referred to as oxygen, and not air, to prevent confusion. It should never be used to run pneumatic equipment because of the possibility of coming in contact with oil that may be inside the equipment. Finally, oxygen valves should be operated slowly. Abruptly starting and stopping oxygen flow may ignite contaminants in the system.

**Nitrogen**

Nitrogen ($N_2$) makes up more than 78 percent of the earth’s atmosphere. It will not burn nor support combustion. It cannot be detected by any of the senses and it is not toxic. Although it is often referred to as an inert gas because it does not oxidize readily, it nevertheless forms many compounds. It is frequently used to inert systems that contain, or have contained, flammable liquids or gases. Inerting a system means replacing the oxygen with an inert gas in order to reduce the possibility of fire or explosion.

Nitrogen is fairly soluble in the blood, and a considerable amount will dissolve in the blood of a person when the air pressure is increased, as in diving, caisson, and some tunnel work. If these employees are not properly decompressed, the dissolved nitrogen escapes from the blood in the form of small bubbles in the bloodstream causing intense pain and is often fatal. This disorder is commonly known as the bends.

If a large amount of nitrogen were released into the air of an enclosed space, it could cause a serious oxygen deficiency. Nitrogen is an asphyxiant.

**j. Discuss the safety precautions for working with cryogenic liquids.**

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

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

**k. Explain the difference between a flammable liquid and a combustible liquid.**

According to DOE-HDBK-1015/2-93, *DOE Fundamentals Handbook: Chemistry*, flammable liquids have a flash point below 100°F and have a vapor pressure not exceeding 40 psia at 100°F. Combustible liquids are those with flash points at or above 100°F, but below 200°F.

**l. Describe the general safety precautions regarding the use, handling, and storage of flammable and combustible liquids.**

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

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

- The vapor-air mixture formed from the evaporation of the liquid poses a hazard; therefore, exposures of large liquid surface areas and sources of heat shall be avoided or prevented during handling or storage of these liquids.
- Accidental mixture of flammable and combustible liquids shall be avoided.
- Fill and discharge lines and openings, as well as control valves associated with flammable and combustible systems, shall be identified by labels, color coding, or both to prevent mixing different substances.
All storage tanks shall be clearly labeled with the name of the contents.
Transfer lines from different types and classes of flammable products should be kept separate, and preferably, different pumps should be provided for individual products.
When handling quantities of flammable liquids up to five gallons, a portable approved container should be used. The container should be clearly labeled.
Suitable NO SMOKING signs should be posted conspicuously in those buildings and areas where smoking is prohibited.
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.

m. **Describe the industrial process associated with hazardous waste operations as they pertain to waste management.**

The following is taken from U.S. Environmental Protection Agency, Waste—Hazardous Waste—Treatment and Disposal.

Treatment is any process that changes the physical, chemical, or biological character of a waste to make it less of an environmental threat. Treatment can neutralize the waste; recover energy or material resources from a waste; render the waste less hazardous; or make the waste safer to transport, store, or dispose.

One common method of treatment is hazardous waste combustion or incineration, which is used to destroy hazardous organic constituents and reduce the volume of waste.

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 Land Disposal Restrictions Program.

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 Underground Injection Control (UIC) Program.

**n. Explain the personnel hazards associated with the following:**
- Polychlorinated Biphenyls (PCB) handling
- Asbestos handling
- Biological hazards (such as Hanta virus, animal carcasses, and medical waste)
- Solvents
- Paint residual handling
- Waste oil
Polychlorinated Biphenyls (PCB) Handling
The following is taken from U.S. Environmental Protection Agency, Polychlorinated Biphenyls, 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. The potential health effects of PCB exposure are discussed in greater detail in the following paragraphs.

Cancer
Studies in animals provide conclusive evidence that PCBs cause cancer. Studies in humans raise further concerns regarding the potential carcinogenicity of PCBs. Taken together, the data strongly suggest that PCBs are probable human carcinogens.

In addition to the animal studies, a number of epidemiological studies of workers exposed to PCBs have been performed. Results of human studies raise concerns for the potential carcinogenicity of PCBs. Studies of PCB workers found increases in rare liver cancers and malignant melanoma. The presence of cancer in the same target organ (liver) following exposures to PCBs both in animals and in humans and the finding of liver cancers and malignant melanomas across multiple human studies add weight to the conclusion that PCBs are probable human carcinogens.

Immune Effects
In humans, a recent study found that individuals infected with Epstein-Barr virus had a greater association of increased exposures to PCBs with increasing risk of non-Hodgkin’s lymphoma than those who had no Epstein-Barr infection. This finding is consistent with increases in infection with Epstein-Barr virus in animals exposed to PCBs. Since PCBs suppress the immune system and immune system suppression has been demonstrated as a risk factor for non-Hodgkin’s lymphoma, suppression of the immune system is a possible mechanism for PCB-induced cancer. Immune effects were also noted in humans who experienced exposure to rice oil contaminated with PCBs, dibenzofurans and dioxins.

Taken together, the studies in animals and humans suggest that PCBs may have serious potential effects on the immune systems of exposed individuals.

Reproductive Effects
Reproductive effects of PCBs have been studied in a variety of animal species, including Rhesus monkeys, rats, mice and mink. Rhesus monkeys are generally regarded as the best laboratory species for predicting adverse reproductive effects in humans. Potentially serious effects on the reproductive system were seen in monkeys and a number of other animal species following exposures to PCB mixtures. Most significantly, PCB exposures were found
to reduce the birth weight, conception rates and live birth rates of monkeys and other species and PCB exposure reduced sperm counts in rats. Effects in monkeys were long-lasting and were observed long after the dosing with PCBs occurred.

Studies of reproductive effects have also been carried out in human populations exposed to PCBs. Children born to women who worked with PCBs in factories showed decreased birth weight and a significant decrease in gestational age with increasing exposures to PCBs. Studies in fishing populations believed to have high exposures to PCBs also suggest similar decreases. This same effect was seen in multiple species of animals exposed to PCBs, and suggests that reproductive effects may be important in humans following exposures to PCBs.

Neurological Effects
Effects of PCBs on nervous system development have been studied in monkeys and a variety of other animal species. Newborn monkeys exposed to PCBs showed persistent and significant deficits in neurological development, including visual recognition, short-term memory and learning. Some of these studies were conducted using the types of PCBs most commonly found in human breast milk.

Studies in humans have suggested effects similar to those observed in monkeys exposed to PCBs, including learning deficits and changes in activity associated with exposures to PCBs. The similarity in effects observed in humans and animals provide additional support for the potential neurobehavioral effects of PCBs.

Endocrine Effects
There has been significant discussion and research on the effects of environmental contaminants on the endocrine system. While the significance of endocrine disruption as a widespread issue in humans and animals is a subject of ongoing study, PCBs have been demonstrated to exert effects on thyroid hormone levels in animals and humans. Thyroid hormone levels are critical for normal growth and development, and alterations in thyroid hormone levels may have significant implications.

It has been shown that PCBs decrease thyroid hormone levels in rodents, and that these decreases have resulted in developmental deficits in the animals, including deficits in hearing. PCB exposures have also been associated with changes in thyroid hormone levels in infants in studies conducted in the Netherlands and Japan. Additional research will be required to determine the significance of these effects in the human population.

A variety of other non-cancer effects of PCBs have been reported in animals and humans, including dermal and ocular effects in monkeys and humans, and liver toxicity in rodents. Elevations in blood pressure, serum triglyceride, and serum cholesterol have also been reported with increasing serum levels of PCBs in humans.

In summary, PCBs have been demonstrated to cause a variety of serious health effects. PCBs have been shown to cause cancer and a number of serious non-cancer health effects in animals, including effects on the immune system, reproductive system, nervous system, and endocrine system. Studies in humans provide supportive evidence for the potential
carcinogenicity 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 regulatory systems of the body.

Asbestos Handling
The following is taken from U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Asbestos: Health and Exposure.

Chronic Effects (Non-cancer):
Chronic (long-term) inhalation exposure to asbestos in humans can lead to a lung disease termed asbestosis, which is a diffuse fibrous scarring of the lungs. Symptoms of asbestosis include shortness of breath, difficulty in breathing, and coughing. Asbestosis is a progressive disease, (i.e., the severity of symptoms tends to increase with time, even after the exposure has stopped). In severe cases, this disease can lead to death, due to impairment of respiratory function.

Other effects from asbestos exposure via inhalation in humans include pulmonary hypertension and immunological effects.

Cancer Risk
A large number of occupational studies have reported that exposure to asbestos via inhalation can cause lung cancer and mesothelioma (a rare cancer of the membranes lining the abdominal cavity and surrounding internal organs).

Individuals who smoke and are also exposed to asbestos have a greater than additive increased risk of developing lung cancer.

Several occupational studies have reported an increase in gastrointestinal cancer from inhalation exposure to asbestos and subsequent oral ingestion.

Long- and intermediate-range asbestos fibers appear to be more carcinogenic than short fibers.

Several epidemiological studies have found an association between asbestos in drinking water and cancer of the esophagus, stomach, and intestines; however confounding factors and the short follow-up time relative to the long latent period for tumor formation make it difficult to interpret the results.

A series of large-scale lifetime feeding studies in animals reported that intermediate-range asbestos fibers increased the incidence of a benign tumor of the large intestine in male rats, while short-range asbestos fibers showed no significant increase in tumor incidence.

EPA considers asbestos to be a human carcinogen (cancer-causing agent) and has ranked it in EPA’s group A.
EPA uses mathematical models, based on human and animal studies, to estimate the probability of a person developing cancer from breathing air containing a specified concentration of a chemical. EPA calculated an inhalation unit risk estimate of $2.3 \times 10^{-1}$. EPA estimates that, if an individual were to breathe air containing asbestos at 0.000004 fibers/milliliter (mL) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing 0.00004 fibers/mL would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 0.0004 fibers/mL would result in not greater than a one-in-ten-thousand increased chance of developing cancer.

**Biological Hazards (such as Hanta Virus, Animal Carcasses, and Medical Waste)**

The following is taken from Michigan State University, Office of Radiation, Chemical, and Biological Safety, *Biosafety Manual*.

Biological safety or biosafety is the application of knowledge, techniques, and equipment to prevent personal, laboratory, and environmental exposure to potentially infectious agents or biohazards. Biosafety defines the containment conditions under which infectious agents can be safely manipulated. The objective of containment is to confine biohazards and to reduce the potential exposure of the laboratory worker, persons outside of the laboratory, and the environment to potentially infectious agents. It can be accomplished through the following means:

- **Primary containment.** Protection of personnel and the immediate laboratory environment through good microbiological technique (laboratory practice) and the use of appropriate safety equipment such as a biosafety cabinet.
- **Secondary containment.** Protection of the environment external to the laboratory from exposure to infectious materials through a combination of facility design and operational practices.

Combinations of laboratory practices, containment equipment, and special laboratory design can be made to achieve different levels of physical containment. Currently, four biosafety levels (1-4) define the level of containment necessary to protect personnel and the environment. Biosafety level 1 (BL-1) is the least restrictive, while biosafety level 4 (BL-4) requires a special containment laboratory or facility.

Worldwide there are several systems for classifying human and animal pathogens according to the hazard they present to an individual and the community. Although these classifications differ from each other, they all are based on the notion that some microorganisms are more hazardous than others. In general, the pathogenicity of the organism, the mode of transmission, the host range, the availability of effective preventive measures, and/or effective treatment are some of the criteria taken into consideration when classifying infectious agents.

The most important element in maintaining a safe work environment is strict adherence to good microbiological and laboratory practices and techniques. Everybody working with infectious agents or potentially infected materials must be aware of the potential risks. In
addition, they must be trained and proficient in the practices and techniques required for handling such material. It is the responsibility of the principal investigator or person in charge of the laboratory to provide or arrange for appropriate training of all personnel.

Solvents
The following is taken from Tarleton State University, Chemical Safety Program.

Organic solvents are often the most hazardous chemicals in the work place. Solvents such as ether, alcohols, and toluene, for example, are highly volatile or flammable. Chlorinated solvents such as chloroform are nonflammable, but when exposed to heat or flame, may produce carbon monoxide, chlorine, phosgene, or other highly toxic gases.

Always use volatile and flammable solvents in an area with good ventilation or in a fume hood. Never use ether or other highly flammable solvents in a room with open flames or other ignition sources present.

Health hazards associated with solvents include exposure by the following routes:
- Inhalation of a solvent may cause bronchial irritation, dizziness, central nervous system depression, nausea, headache, coma, or death. Prolonged exposure to excessive concentrations of solvent vapors may cause liver or kidney damage. The consumption of alcoholic beverages can enhance these effects.
- Skin contact with solvents may lead to defatting, drying, and skin irritation.
- Ingestion of a solvent may cause severe toxicological effects. Immediate medical attention is required.

Paint Residual Handling
The following is taken from Montgomery County, Department of Environmental Protection, Indoor Painting.

Residents, property managers, and painting contractors are strongly urged to keep in mind several simple means to reduce short-term residential exposures to harmful chemicals used in some interior household paint and flooring products. These methods include selecting products that are formulated without harmful solvents and properly ventilating spaces that are painted for adequate amounts of time. Usually it is necessary to keep windows wide-open and utilize exhaust fans to ensure proper ventilation. This practice should be maintained continuously both during and for more than 48 hours after painting indoor areas or re-finished floors. Such practices can reduce exposures to residents, neighbors, and painting/flooring workers.

Health Concerns
Most paints and floor finishes, including water-soluble latex formulations, contain solvents that can cause eye irritation and short term central nervous system symptoms such as headaches, nausea, dizziness, and fatigue. Long-term exposure to certain paint components has been associated with chronic damage to the central nervous system, liver, and kidneys. Paint solvent vapors may pose a special risk for pregnant women, young children, and
individuals with respiratory ailments. However, paint vapors can be harmful to everyone exposed to them, even for short periods.

**Waste Oil**

The following is taken from Indiana Department of Environmental Management, Compliance and Technical Assistance Program, *Compliance Manual for Indiana’s Vehicle Maintenance Shops*.

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. **Waste management personnel must demonstrate a working level knowledge of the principles, concepts, and requirements of environmental risk assessment.**

a. **Define risk assessment, risk management, and risk communication.**

**Risk Assessment**

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Basic Information.

The EPA uses RA 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. Note that “risk managers” can be

- Federal or state officials whose job it is to protect the environment
- Business leaders who work at companies that can impact the environment
- Private citizens who are making decisions regarding risk

At EPA, environmental RAs typically fall into one of two areas:

- Human health
- 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
- The inherent toxicity of the chemical

**Risk Management**

The following is taken from U.S. Environmental Protection Agency, Risk Assessment Portal, Basic Information.

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 national ambient air quality standards; 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, as follows:
- Scientific factors provide the basis for the RA, including information drawn from toxicology, chemistry, epidemiology, ecology, and statistics—to name a few.
- Economic factors inform the manager on the cost of risks and the benefits of reducing them, the costs of risk mitigation or remediation options and the distributional effects.
- Laws and legal decisions are factors that define the basis for the agency’s RAs, management decisions, and, in some instances, the schedule, level or methods for risk reduction.
- Social factors, such as income level, ethnic background, community values, land use, zoning, availability of health care, life style, and psychological condition of the affected populations, may affect the susceptibility of an individual or a definable group to risks from a particular stressor.
- Technological factors include the feasibility, impacts, and range of risk management options.
- Political factors are based on the interactions among branches of the Federal government, with other Federal, state, and local government entities, and even with foreign governments; these may range from practices defined by Agency policy and political administrations through inquiries from members of Congress, special interest groups, or concerned citizens.
- Public values reflect the broad attitudes of society about environmental risks and risk management.

**Risk Communication**

The following is taken from the Keystone Center, *A Primer on Perception of Risk, Risk Communication and Building Trust*. 
Risk communication is “an interactive process of exchanging of information and opinion among individuals, groups, and institutions.” It often involves multiple messages related to the types and levels of the risk, or to the concerns, opinions, or reactions to risk messages, or to the legal or institutional arrangements for risk management. A working definition of risk communication is “the method by which the public can be informed as to the potential risks and benefits of specific projects and programs.” It includes all written and oral external communication with the media, interest groups, Congress, other government agencies, and the public at large regarding programs that are controversial or related to the controversial aspects of such programs.

There are many ways in which risk communication has improved over the years, and there now are well-established ground rules that communicators must know and use instinctively as they communicate about various risks and hazards. There has been a decided progression, starting from just trying to get people to behave “rationally” by providing them with information, to today’s more modern view that risk communication is a two-way communication that involves providing information, understanding people’s perception of the risks, and developing solutions in partnership. This progression is demonstrated in the following:

- All we have to do is get the numbers right.
- All we have to do is tell them the numbers.
- All we have to do is explain what we mean by the numbers.
- All we have to do is show them that they’ve accepted similar risks in the past.
- All we have to do is show them that it’s a good deal for them.
- All we have to do is treat them nice.
- All we have to do is make them partners.
- All of the above.

In their seminal paper on risk communication, Vincent Covello, Peter Sandman, and Paul Slovic established seven golden rules for effective risk communication:

1. Accept and involve the public as a legitimate partner.
2. Plan carefully and evaluate performance.
3. Listen to your audience.
4. Be honest, frank, and open.
5. Coordinate and collaborate with other credible sources.
6. Meet the needs of the media.
7. Speak clearly and with compassion.

b. Describe the four steps of a risk assessment.

The following is taken from BJC/OR-271, *Guidance for Conducting Risk Assessments and Related Risk Activities for the DOE-ORO Environmental Management Program*.

An RA consists of four distinct steps: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization. The outcome of an RA is either a set of chemicals, pathways, media, and/or scenarios of concern for which an appropriate action
must be undertaken, or a determination that no action is required. The following paragraphs briefly describe the steps of an RA.

Data Collection and Evaluation
The first step in the RA process, regardless of the type of RA to be performed (e.g., screening, integration point assessment, baseline), is data collection and evaluation. The quantity and quality of available environmental data often determine the level of evaluation (i.e., remedial site evaluation versus remedial investigation, or screening assessment versus baseline assessment) to be performed. The current DOE technical approach to remedial action is to rely heavily on existing/historical data in order to reduce cost and accelerate clean-up, disposal, or reuse. This strategy may be further streamlined by employing a phased approach to data collection; additional data is collected in phases until an appropriate technical decision can be made.

Exposure Assessment
An exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure for each potential or actual receptor population to be evaluated in the RA. During the exposure assessment, the risk assessor
- characterizes the exposure setting to identify the potentially exposed receptors, their activity patterns, and any other characteristics that might increase/decrease their likelihood of exposure
- identifies exposure routes (develops a conceptual site model) and scenarios
- estimates the exposure concentration
- calculates a chemical-specific intake or dose

Once the appropriate exposure routes and scenarios have been identified, the risk assessor must select the appropriate dose equations and associated parameter values. The dose equations are used to calculate either the amount of contaminant that is in contact with the body at an exchange boundary per unit body weight per unit time, or the amount of contaminant that is absorbed by the body per unit body weight per unit time. The output of this activity is used in conjunction with the output from the toxicity assessment to quantify potential risks/hazards to receptors during the risk characterization.

Toxicity Assessment
The purpose of a toxicity assessment is to weigh available evidence regarding the potential for a chemical to cause adverse effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure and the increased likelihood and/or severity of adverse effects.

Risk Characterization
The risk characterization section of a RA incorporates the outcome of the previous activities (i.e., data evaluation, exposure assessment, and toxicity assessment) and calculates the risk or hazard resulting from potential exposure to chemicals via the pathways and routes of exposure determined appropriate for the site. Risk characterization integrates and
summarizes the information presented in the exposure and toxicity assessments for each of the different land-use scenarios in light of the associated uncertainties.

When characterizing risk, the risk assessor may decide to aggregate the data (based on depth, location, etc.) or compare risks on a point-by-point basis. Often the point assessment is a screening step for hot spots, chemicals of concern, etc. The aggregate assessment, based on the appropriate exposure scenarios, is typically the basis for remediation.

c. Describe how risk assessment helps in site decision making.

The following is taken from BJC/OR-271, *Guidance for Conducting Risk Assessments and Related Risk Activities for the DOE-ORO Environmental Management Program*.

Each environmental management program uses RA to aid in making decisions. Environmental restoration project managers rely on the results of human health and ecological RAs, conducted as part of the EPA CERCLA remedial investigation and feasibility study (RI/FS) process, to aid in making decisions regarding the need for, and the extent of remediation necessary at a given site. Waste management programs use RA to identify and develop waste acceptance criteria, to determine risks associated with the transport of hazardous materials, and to quantify the long-term risk from wastes disposed of at offsite disposal facilities. Technology development and demonstration use RA to evaluate the effectiveness of various treatment technologies for hazardous/radioactive waste. Risk assessment is consistently used throughout the environmental management program by decision-makers and project managers to ensure the safety and well-being of the employees, the public, and the environment.

d. Define the term “baseline risk assessment.”

The following is taken from U.S.DOE, Office of Legacy Management Glossary.

A baseline RA describes the source of contamination, how the contamination reaches people and the environment, the amount of contamination to which people or the ecological environment may be exposed, and the health or ecological effects that could result from exposure.

e. Describe the process for a toxicity assessment.

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

f. Describe the process for an exposure assessment.

The following is taken from DOE G 440.1-3.

DOE O 440.1A requires DOE and its contractors to include at least the following items in their assessments:

- Analysis of proposed new designs, operations, processes, materials, or equipment before use to determine potentially hazardous exposures. These analyses should be performed in conjunction with the contractor’s purchasing, engineering, and contracting organizations, as appropriate.
- Analysis of any changes (proposed and completed) in operations, processes, materials, control equipment, work practices, or personnel that have the potential to cause new or additional hazardous exposures.
- A comprehensive baseline or periodic survey of all areas and operations identified by the senior industrial hygienist or senior health physicist as having potential occupational exposure hazards. The survey should include input from line management, occupational medicine, occupational safety, fire protection, radiation protection, environmental protection, maintenance, and engineering, as appropriate.

Beyond the guidance for exposure assessment contained in the “American Industrial Hygiene Association Strategy” document, DOE and its contractors should develop exposure assessment plans that recognize that exposure assessment is an iterative process that begins with basic hazard identification and is linked to various other worker protection activities and requirements. This planning process is the critical step, and, depending on the nature of the hazard and the exposure potential, the planning may lead to a decision that either no monitoring or various degrees and types of monitoring (qualitative or quantitative) may be needed. It is important to involve the workers and appropriate staff (e.g., occupational medical staff and those responsible for hazard control) and to document all rationale, results, and decisions. This aspect should also be integrated into the DOE or contractor-integrated work planning and project management system.

g. Describe the process used to characterize risk.

The following is taken from U.S. Environmental Protection Agency, EPA 100-B-00-002.

Risk characterization is an integral component of the RA process for both ecological and health risks, (i.e., it is the final, integrative step of RA). As defined in the risk characterization policy (appendix A of EPA 100-B-00-002), the risk characterization integrates information from the preceding components of the RA and synthesizes an overall conclusion about risk that is complete, informative, and useful for decision-makers. In
essence, a risk characterization conveys the risk assessor’s judgment as to the nature and existence of (or lack of) human health or ecological risks.

For health RA, the National Academy of Science describes a four step paradigm (NRC, 1983). For each step, the relevant and scientifically reliable information is evaluated. In addition, the related uncertainties and science policy choices are described.

1. Hazard identification—the determination of whether a particular chemical is or is not causally linked to particular health effects.
2. Dose-response assessment—the determination of the relation between the magnitude of exposure and the probability of occurrence of the health effects in question.
3. Exposure assessment—the determination of the extent of human exposure before or after application of regulatory controls.
4. Risk characterization—the description of the nature and often the magnitude of human risk, including attendant uncertainty.

In 1998, EPA published RA guidelines for ecological RA calling for the following:

- Problem formulation—the evaluation of goals, selection of assessment end points, preparation of the conceptual model, and development of an analysis plan.
- Analysis—the evaluation of exposure to stressors and identification of the relationship between stressor levels and ecological effects.
- Risk characterization—the estimation of ecological risks, discussion of overall degree of confidence in the risk estimates, citation of evidence supporting risk estimates, and interpretation of the adversity of ecological risks.

In addition, both the health and ecological RA paradigms suggest to risk-assessors that in order to write an overall risk characterization, each RA section needs to have its own individual characterization. For human health risk, separate characterizations accompany the hazard identification, dose-response assessment and exposure assessment sections. For ecological risk, separate characterizations accompany the analysis plan, the stressor-response profile and the exposure profile. These separate, component characterizations carry forward the key findings, assumptions, strengths and limitations, etc. for each section and provide a fundamental set of information used in an integrative analysis that must be conveyed in the final overall risk characterization.

The overall risk characterization lets the manager, and others know why EPA assessed the risk the way it did in terms of the available data and its analysis, uncertainties, alternative analyses, and the choices made. 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. The risk characterization policy calls for the explanation of the choices made to be highly visible.
h. Identify the types of data and records required to be retained as permanent records.

The following is taken from DOE O 243.1.

Permanent records are those that the National Archives and Records Administration (NARA) has determined to be of sufficient value as to warrant preservation in the National Archives. Permanent records include all records accessioned by NARA’s Office of the National Archives, later increments of the same records, and records for which the disposition is “permanent” on Standard Form 115, Request for Records Disposition Authority, approved by NARA on or after 5-14-73.

22. Waste management personnel must demonstrate a working level knowledge of the purpose and requirements of DOE O 5400.5, Radiation Protection of the Public and the Environment.

The information for the KSAs in this competency statement 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 O 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 for 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 [ICRP]). It is also the policy of DOE to adopt and implement standards generally consistent with those of the NRC for DOE facilities and activities not subject to licensing authority.

Objectives

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

Protecting the Environment. In addition to providing protection to members of the public, it is DOE’s objective to protect the environment from radioactive contamination to the extent practical.
b. Define the following terms:

- As low as is reasonably achievable (ALARA)
- Best available technology (BAT)
- Derived concentration guide (DCG)
- Absorbed dose
- Collective dose equivalent
- Collective effective dose equivalent
- Committed dose equivalent
- Committed effective dose equivalent
- Deep dose equivalent
- Dose equivalent
- Effective dose equivalent
- Public dose
- Weighting factor
- Quality factor
- Effluent monitoring
- Environmental surveillance
- Protective action guides
- Release of property
- Residual radioactive material
- Settleable solids
- Soil column

The following definitions are taken from DOE Order 5400.5.

*As Low as is Reasonably Achievable (ALARA)*

As low as is reasonably achievable is a phrase used to describe an approach to radiation protection to control or manage exposures (both individual and collective to the work force and the general public) and releases of radioactive material to the environment to be as low as social, technical, economic, practical, and public policy considerations permit. ALARA is based on minimizing exposure time, maximizing distance from the radioactive material, and maximizing shielding between the material and the individuals.

*Best Available Technology (BAT)*

Best available technology means the preferred technology for treating a particular process liquid waste selected from among others after taking into account factors related to technology, economics, public policy, and other parameters. As used in this Order, BAT is not a specific level of treatment, but the conclusion of a selection process that includes several treatment alternatives.

*Derived Concentration Guide (DCG)*

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) (0.1 rem) (1 millisievert [mSv]). DCGs do not consider decay products when the parent radionuclide is the cause of the exposure (1 rem = 0.01 sievert).
Absorbed Dose
Absorbed dose is the energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad (or gray) (1 rad = 0.01 gray).

Collective Dose Equivalent and Collective Effective Dose Equivalent
Collective dose equivalent and collective effective dose equivalent are the sums of the dose equivalents or effective dose equivalents of all individuals in an exposed population within an 80-km radius, for the purposes of this Order, and they are expressed in units of person-rem (or person-sievert). When the collective dose equivalent of interest is for a specific organ, the units would be organ-rem (or organ-sievert). The 80-km distance shall be measured from a point located centrally with respect to major facilities or DOE program activities.

Committed Dose Equivalent
Committed dose equivalent, now known as committed equivalent dose, means the equivalent dose calculated to be received by a tissue or organ over a 50-year period after the intake of a radionuclide into the body.

Committed Effective Dose Equivalent
Committed effective dose equivalent, now known as committed effective dose, (E_{50}) means the sum of the committed equivalent doses to various tissues or organs in the body (H_{T,50}), each multiplied by the appropriate tissue weighting factor (W_{T})—that is, \( E_{50} = \sum W_{T} H_{T,50} + W_{\text{Remainder}} H_{\text{Remainder,50}} \). Where \( W_{\text{Remainder}} \) is the tissue weighting factor assigned to the remainder organs and tissues and \( H_{\text{Remainder,50}} \) is the committed equivalent dose to the remainder organs and tissues. Committed effective dose is expressed in units of rem (or Sv).

Deep Dose Equivalent
Deep dose equivalent, as used in this Order, means the dose equivalent in tissue at a depth of 1 cm deriving from external (penetrating) radiation.

Dose Equivalent
Dose equivalent is the product of absorbed dose in rad (or gray) in tissue and a quality factor. Dose equivalent is expressed in units of rem (or sievert).

Effective Dose Equivalent
Effective dose equivalent, now known as effective dose, means the summation of the products of the equivalent dose received by specified tissues or organs of the body (H_{T}) and the appropriate tissue weighting factor (W_{T})— that is, \( E = \sum W_{T} H_{T} \).

Public Dose
Public dose means the dose received by member(s) of the public from exposure to radiation and to radioactive material released by a DOE facility or operation, whether the exposure is within a DOE site boundary or offsite. It does not include doses received from occupational
exposures, doses received from naturally occurring “background” radiation, doses received as a patient from medical practices, or doses received from consumer products.

Weighting Factor
Weighting factor is tissue-specific and represents the fraction of the total health risk resulting from uniform, whole-body irradiation that could be contributed to that particular tissue. The weighting factors recommended by the ICRP (Publication 103) are listed in table 6.

Table 6. Weighting factors

<table>
<thead>
<tr>
<th>Organ or Tissue</th>
<th>Weighting Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gonads</td>
<td>0.25</td>
</tr>
<tr>
<td>Breasts</td>
<td>0.15</td>
</tr>
<tr>
<td>Red bone marrow</td>
<td>0.12</td>
</tr>
<tr>
<td>Lungs</td>
<td>0.12</td>
</tr>
<tr>
<td>Thyroid</td>
<td>0.03</td>
</tr>
<tr>
<td>Bone surfaces</td>
<td>0.03</td>
</tr>
<tr>
<td>Remainder</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Source: International Commission on Radiation Protection, Publication 103

Remainder means the five other organs or tissues with the highest dose (e.g., from among the liver, kidney, spleen, thymus, adrenal, pancreas, stomach, small intestine, or upper and lower large intestine, but excluding skin, lens of the eye, and extremities). The weighting factor for each of these individually is 0.06.

Quality Factor
The quality factor is the principal modifying factor used to regulate the dose equivalent from the absorbed dose.

Effluent Monitoring
Effluent monitoring is the collection and analysis of samples or measurements of liquid and gaseous effluents for purposes of characterizing and quantifying contaminants, assessing radiation exposures of members of the public, and demonstrating compliance with applicable standards.

Environmental Surveillance
Environmental surveillance is the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from DOE sites and their environs and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing radiation exposures of members of the public, and assessing effects, if any, on the local environment.
Protective Action Guides

Protective action guides are projected numerical dose values established by EPA, DOE, or states for individuals in the population. These values may trigger protective actions that would reduce or avoid the projected dose.

Release of Property

Release of property, as used in this Order, means the exercising of DOE’s authority to release property from its control after confirming that residual radioactive material (over which DOE has authority) on the property has been determined to meet the guidelines for residual radioactive material in any applicable radiological requirements. There may be instances in which DOE or some other authority will impose restrictions on the management and/or use of the property if the residual radioactive material guidelines are not met or if applicable Federal, state, or local requirements cause the imposition of such restrictions.

Residual Radioactive Material

Residual radioactive material means any radioactive material which is in or on soil, air, equipment, or structures as a consequence of past operations or activities.

Settleable Solids

Settleable solids are those solids suspended in wastewater that are determined to be settleable using standard methods for examination of water and soil columns.

Soil Column

A soil column is an in situ volume of soil down through which liquid wastes percolate from ponds, cribs, seepage basins, or trenches.
c. **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.**

The following descriptions are taken from DOE Order 5400.5.

**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) is in compliance with the established acceptable levels, and that the contamination has been subjected to the 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.

d. **Identify and discuss the release criteria for:**
   - Soil
   - Air/water
   - Surface
   - Real property

The following descriptions are taken from DOE Order 5400.5.
Soil


Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m².

Hot Spots. If the average concentration in any surface or below-surface area less than or equal to 25, exceeds the limit or guideline by a factor of (100/A), [where A is the area (in square meters) of the region in which concentrations are elevated], limits for “hot-spots” shall also be developed and applied. Procedures for calculating these hot-spot limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

Generic Guidelines. The generic guidelines for residual concentrations of radium (Ra)-226, Ra228, Thorium (Th)-230, and Th-232 are

- 5 pCi/g, averaged over the first 15 cm of soil below the surface; and
- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.

Ingrowth and Mixtures. These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If both Th-230 and Ra-226 or both Th-232 and Ra-228 are present and not in secular equilibrium, the appropriate guideline is applied as a limit for the radionuclide with the higher concentration. If other mixtures of radionuclide occur, the concentrations of individual radionuclides shall be reduced so that either the dose for the mixtures will not exceed the basic dose limit or the sum of the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1. Explicit formulas for calculating residual concentration guidelines for mixtures are given in DOE/CH-8901.

Air/Water

Residual concentrations of radionuclides in air and water shall be controlled to the required levels and as required by other applicable Federal and/or state laws.

Limits for airborne radon decay products are taken from 40 CFR 192, “Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings.” The objective of the remedial action is to achieve an annual average (or its equivalent) of 0.02 “working level,” including background. In no case shall the radon progeny concentration exceed 0.03 working level, including background.
Surface

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 in table 7 and that the contamination has been subjected to the ALARA process.

Table 7. Allowable total residual surface contamination

<table>
<thead>
<tr>
<th>Radionuclides</th>
<th>Average</th>
<th>Maximum</th>
<th>Removable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231</td>
<td>RESERVED</td>
<td>RESERVED</td>
<td>RESERVED</td>
</tr>
<tr>
<td>Th-Natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232</td>
<td>1,000</td>
<td>3,000</td>
<td>200</td>
</tr>
<tr>
<td>U-Natural, U-235, U-238, and associated decay product; alpha emitters</td>
<td>5,000</td>
<td>15,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above</td>
<td>5,000</td>
<td>15,000</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Source: DOE Order 5400.5

Real Property

Release of real property shall be according to the guidelines and provisions for residual radioactive material presented in the Order. 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 the CERCLA, as amended, concerning hazardous substances, and to any other applicable Federal, state, and local requirements. The requirements of 40 CFR 192 are applicable to properties remediated under Title I of the Uranium Mill Tailings Radiation Control Act.

e. Describe the radiological liquid effluent requirements established in DOE Order 5400.5, Radiation Protection of the Public and the Environment, and assess whether the effluent monitoring from a facility meets the requirements.

The ‘describe’ portion of this KSA is taken from DOE Order 5400.5 and is discussed below. The ‘assess’ portion of this KSA is performance-based. The Qualifying Official will evaluate its completion.

Standards for liquid effluent discharges are driven by the DOE ALARA policy and objective to minimize contamination in the environment to the extent practicable. DOE Order 5400.5
adopts the BAT as the appropriate level of treatment for liquid wastes containing radioactive material and provides that the BAT be phased in at the earliest practicable time. Technical and economic considerations are included in determining the BAT. Based on cost and benefit considerations, radioactive waste streams that contain radionuclide concentrations of not more than the DCG reference values at the point of discharge to a surface waterway normally will not require treatment to further reduce the concentration. BAT treatment is provided to protect groundwater and to prevent radionuclide buildup in soil.

f. **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.**

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

g. **Assess whether the Environmental Radiological Protection Program is in accordance with DOE Order 5400.5, Radiation Protection of the Public and the Environment.**

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

h. **Identify the types of data and records required to be retained as permanent records.**

The following is taken from DOE Order 5400.5.

Records developed shall include information and data necessary to identify and characterize releases of radioactive material to the environment, their fate in the environment, and their probable impact on radiation doses to the public. Basic information used to assess compliance with the requirements of this Order and the results of such assessments shall be incorporated as part of the record. All reports, notifications, and records developed pursuant to DOE requirements shall present data in the units used in the applicable regulation or DOE Order.

23. **Waste management personnel must demonstrate a familiarity level knowledge of Documented Safety Analyses as described in 10 CFR 830, Subpart B, Nuclear Safety Management.**

a. **Discuss the basic purposes and objectives of Nuclear Safety Analysis Reports.**

[Note: The safety analysis report has been replaced by the documented safety analysis.]

*Purpose*

The following is derived from DOE G 421.1-2.

The safety basis, upon which the DSA is based, is the documentation upon which the contractor and DOE rely to conclude that the facility can be operated safely. Thus, performing work consistent with the safety basis provides reasonable assurance of adequate protection of workers, the public, and the environment from adverse consequences.
Objectives
The following is taken from 10 CFR 830.204.

The DSA for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility
- describe the facility (including the design of safety structures, systems and components) and the work to be performed;
- provide a systematic identification of both natural and man-made hazards associated with the facility;
- evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility;
- derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use;
- define the characteristics of the safety management programs necessary to ensure the safe operation of the facility, including (where applicable) QA, procedures, maintenance, personnel training, conduct of operations, emergency preparedness, fire protection, waste management, and radiation protection;
- with respect to a nonreactor nuclear facility with fissionable material in a form and amount sufficient to pose a potential for criticality, define a criticality safety program that
  - ensures that operations with fissionable material remain subcritical under all normal and credible abnormal conditions
  - identifies applicable nuclear criticality safety standards
  - describes how the program meets applicable nuclear criticality safety standards

b. Describe the responsibilities of contractors authorized to operate defense nuclear facilities regarding the development and maintenance of a nuclear safety analysis report.

[Note: The safety analysis report has been replaced by the documented safety analysis.]

Development
The following is taken from DOE G 421.1-2.

The preparation of DSAs must conform to one of the methodologies set forth in table 2 of appendix A of 10 CFR 830 (included here as table 8 for convenience) or an alternate methodology approved by DOE. These methodologies are called “safe harbors” in 10 CFR 830.

The use of alternative methods or significant deviations from the safe harbor methods, if proposed, must be approved by the responsible DOE organization as defined in DOE M
411.1-1C, Safety Management Functions, Responsibilities, and Authorities Manual (FRAM), including where applicable NNSA, and the concurrence (or comment if an NNSA facility is involved) of the DOE Office of Environment, Safety and Health (EH). Generally, in order to approve an alternative method, the DOE responsible organizations would need to find that the alternative methodology was sufficiently rigorous to provide an equivalent level of safety in the alternative DSA and resulting controls.

Table 8. Safe harbor methods for DSAs

<table>
<thead>
<tr>
<th>The contractor responsible for:</th>
<th>may prepare its documented safety analyses by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) a DOE nuclear facility with a limited operational life</td>
<td>using the method in either: (1) DOE-STD-3009-94, Change Notice No. 1, dated January 2000, or successor document, or (2) DOE-STD-3011-94, Guidance for Preparation of DOE 5480.22 (TSR) and DOE 5480.23 (SAR) Implementation Plans, dated November 1994, or successor document.</td>
</tr>
<tr>
<td>(4) the deactivation or the transition surveillance and maintenance of a DOE nuclear facility</td>
<td>using the method in either: (1) DOE-STD-3009, Change Notice No. 1, dated January 2000, or successor document, or (2) DOE-STD-3011-94 or successor document.</td>
</tr>
<tr>
<td>(5) the decommissioning of a DOE nuclear facility</td>
<td>(1) using the method in DOE-STD-1120-98, Integration of Environment, Safety, and Health into Facility Disposition Activities, dated May 1998, or successor document; (2) using the provisions in 29 CFR 1910.120 (or 29 CFR 1926.65 for construction activities) for developing safety and health programs, work plans, and emergency response plans; and (3) deriving hazard controls based on the safety and health programs, the work plans, and the emergency response plans.</td>
</tr>
<tr>
<td>(6) a DOE environmental restoration activity that involves either work not done within a permanent structure or the decommissioning of a facility with only low-level residual fixed radioactivity.</td>
<td>(1) using the method in DOE-STD-1120-98 or successor document, and (2) using the provisions in 29 CFR 1910.120 (or 29 CFR 1926.65 for construction activities) for developing a safety and health program and a site-specific HASP (including elements for emergency response plans, conduct of operations, training and qualifications, and maintenance management).</td>
</tr>
</tbody>
</table>
Table 8. Safe harbor methods for DSAs (continued)

<table>
<thead>
<tr>
<th>The contractor responsible for:</th>
<th>may prepare its documented safety analyses by:</th>
</tr>
</thead>
</table>
| (7) a DOE nuclear explosive facility and the nuclear explosive operations conducted therein | developing its DSA in two pieces:  
(1) a safety analysis report for the nuclear facility that considers the generic nuclear explosive operations and is prepared in accordance with DOE-STD-3009, Change Notice No. 1, dated January 2000, or successor document, and  
(2) a hazard analysis report for the specific nuclear explosive operations prepared in accordance with DOE-STD-3016-99, *Hazards Analysis Reports for Nuclear Explosive Operations*, dated February 1999, or successor document. |
| (8) a DOE Hazard Category 3 nonreactor nuclear facility | using the methods in Chapters 2, 3, 4, and 5 of DOE-STD-3009, Change Notice No. 1, dated January 2000, or successor document to address in a simplified fashion:  
(1) the basic description of the facility/activity and its operations, including safety SSCs;  
(2) a qualitative hazards analysis; and  
(3) the hazard controls (consisting primarily of inventory limits and safety management programs) and their bases. |
| (9) transportation activities | (1) preparing a safety analysis report for packaging in accordance with DOE O 460.1A, *Packaging and Transportation Safety*, or successor document and  
(2) preparing a transportation safety document in accordance with DOE G 460.1-1, *Implementation Guide for Use with DOE O 460.1A, Packaging and Transportation Safety*, dated 6-5-97, or successor document. |
| (10) transportation and onsite transfer of nuclear explosives, nuclear components, Naval nuclear fuel elements, Category I and Category II special nuclear materials, special assemblies, and other materials of national security | (1) preparing a safety analysis report for packaging in accordance with DOE O 461.1, *Packaging and Transportation of Materials of National Security Interest*, dated 9-29-00, or successor document and  

1 A limited life facility is one which has an approved deactivation plan (removal of hazards) calling for cessation of operations within a stated period (5 years). This plan should include required funding action and plan change control to ensure relevancy.


**Maintenance**

During design and construction, the governing safety basis document is the preliminary documented safety analysis (PDSA). It is updated as the design matures and is approved prior to procurement and construction activities. Until approval, the PDSA and its updates serve to keep DOE informed as to how DOE nuclear safety design criteria are being
addressed in the design. Project design reviews provide the vehicle by which safety-related changes are reviewed and DOE can provide guidance to the contractor.

Prior to operations, the PDSA evolves to a final DSA that reflects the facility as actually constructed. During mission-oriented operations and for each phase thereafter until, through deactivation or decontamination and decommissioning, the facility falls below the Category 3 threshold for nuclear facilities, the DSA must be kept current, considering any changes to the facility or its operations. The unreviewed safety question (USQ) process is key to this requirement. The USQ process must be integrated with the configuration management process that must be a part of the safety management program commitments of a DSA. The USQ process is an important tool to evaluate whether changes affect the safety basis.

DOE must approve any changes to the facility or its operations.

c. Define the following terms and discuss the purpose of each:

- **Design basis**
- **Authorization basis**
- **Engineered safety features**
- **Safety analysis**
- **Safety systems**

**Design Basis**

DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosives Safety Criteria Guide for Use with DOE O 420.1, Facility Safety*, defines design basis as information that identifies the specific functions to be performed by an SSC of a facility, and the specific values or range of values chosen for controlling parameters as reference bounds of design. These values may be restraints derived from generally accepted state-of-the-art practices for achieving functional goals, or requirements derived from analyses (based on calculations and/or experiments) of the effects of a postulated accident for which a SSC must meet its functional goals.

**Authorization Basis**

DOE M 450.4-1, *Integrated Safety Management System Manual*, defines authorization basis as those aspects of the facility design basis and operational requirements relied on by DOE to authorize operation. These aspects are considered important to the safety of facility operations. The authorization basis is described in documents such as the facility DSA and other safety analyses; hazard classification documents, the TSRs, DOE-issued safety evaluation reports, and facility-specific commitments made in order to comply with DOE Orders or policies.

**Engineered Safety Features**

DOE Order 5480.30, *Nuclear Reactor Safety Design Criteria*, defines engineered safety features as SSCs that prevent and/or mitigate the consequences of potential accidents described in the DSA, including the bounding design basis accidents (DBAs).
Safety Analysis
DOE-STD-3009-94, DOE Standard: Preparation Guide for U.S Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses defines safety analysis as a documented process to 1) provide systematic identification of hazards within a given DOE operation, 2) describe and analyze the adequacy of the measures taken to eliminate, control, or mitigate identified hazards; and 3) analyze and evaluate potential accidents and their associated risks.

Safety Systems
The following is taken from International Atomic Energy Agency, Nusafe, Nuclear Installation Safety Net, Glossary.

A safety system is a system important to safety provided to ensure the safe shutdown of the reactor or the residual heat removal from the core, or to limit the consequences of anticipated operational occurrences and DBAs.

Safety systems consist of the protection system, the safety actuation systems, and the safety system support features. Components of safety systems may be provided solely to perform safety functions, or they may perform safety functions in some plant operational states and non-safety functions in other operational states.

d. Describe the requirements for the scope and content of a nuclear safety analysis report and discuss the general content of each of the required sections of nuclear safety analysis report.

[Note: The safety analysis report has been replaced by the documented safety analysis.]

The following is taken from DOE-STD-3009-94.

The following is a brief summary of the content of each of the required sections of a DSA.

Executive Summary
This section identifies the facility for which the DSA has been prepared and presents general information on the background of the facility as it relates to the stage of facility life cycle. It clearly presents the current mission statement for which the DSA documents the safety basis (i.e., the purpose for which authorization is sought).

It should contain any relevant information (e.g., short facility life cycle, anticipated future change in facility mission, approved DOE exemptions) impacting the extent of safety analysis documented in the DSA and explain its impact in terms of application of the graded approach.

Chapter 1, Site Characteristics
The purpose of this DSA chapter is to provide information necessary to support the safety basis requirements of 10 CFR 830.
This chapter provides a description of site characteristics necessary for understanding the facility environs important to the safety basis. Information is provided to support and clarify assumptions used in the hazard and accident analyses to identify and analyze potential external and natural event accident initiators and accident consequences external to the facility.

Chapter 2, Facility Description

The purpose of this DSA chapter is to provide information necessary to support the safety basis requirements of 10 CFR 830.

This chapter provides descriptions of the facility and processes to support assumptions used in the hazard and accident analyses. These descriptions focus on all major facility features necessary to understand the hazard analysis and accident analysis, not just safety SSCs.

Chapter 3, Hazard and Accident Analyses

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830 to evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility.

This chapter describes the process used to systematically identify and assess hazards to evaluate the potential internal, man-made external, and natural events that can cause the identified hazards to develop into accidents. This chapter also presents the results of this hazard identification and assessment process. Hazard analysis considers the complete spectrum of accidents that may occur due to facility operations; analyzes potential accident consequences to the public and workers; estimates likelihood of occurrence; identifies and assesses associated preventive and mitigative features; identifies safety-significant SSCs; and identifies a selected subset of accidents, designated DBAs, to be formally defined in accident analysis. Subsequent accident analysis evaluates these DBAs for comparison with the evaluation guideline. This chapter covers the topics of hazard identification, facility hazard categorization, hazard evaluation, and accident analysis.

Chapter 4, Safety Structures, Systems, and Components

The purpose of this DSA chapter is to provide information necessary to support the safety basis requirements of 10 CFR 830 for derivation of hazard controls.

This chapter provides details on those facility SSCs that are necessary for the facility to protect the public, provide defense in depth, or contribute to worker safety. Similarly, this chapter provides details on specific administrative controls that are significant to specific accident risk reduction. Descriptions are provided of the attributes (i.e., functional requirements and performance criteria) required to support the safety functions identified in the hazard and accident analyses and to support subsequent derivation of TSRs.
Chapter 5, Derivation of Technical Safety Requirements

The purpose of this DSA chapter is to provide information necessary to support the safety basis requirements for the derivation of hazard controls in 10 CFR 830.

This chapter builds upon the control functions determined to be essential in chapter 3, “Hazard and Accident Analyses,” and chapter 4, “Safety Structures, Systems, and Components,” to derive TSRs. This chapter is meant to support and provide the information necessary for the separate TSR document required by 10 CFR 830.205, “Technical Safety Requirements.”

Derivation of TSRs consists of summaries and references to pertinent sections of the DSA in which design (i.e., SSCs) and administrative features (i.e., non-SSCs) are needed to prevent or mitigate the consequences of accidents. Design and administrative features addressed include ones which: 1) provide significant defense in depth; 2) provide for significant worker safety; or 3) provide for the protection of the public.

Chapter 6, Prevention of Inadvertent Criticality

The purpose of this chapter is to provide information that will support the development of a safety basis in compliance with the provisions of 10 CFR 830.204(b) (6) regarding the definition of a criticality safety program. If this information is available in a site-wide criticality safety program description, and it complies with 10 CFR 830 requirements, then it can be included by reference and summarized in this chapter.

Chapter 7, Radiation Protection

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the radiation protection program. It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter summarizes provisions for radiation protection. Summaries focus on radiation protection based on facility hazards to provide a basic understanding of the scope of the radiation protection program.

Chapter 8, Hazardous Material Protection

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the hazardous material protection program. It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter summarizes provisions for hazardous material protection other than radiological hazards. Summaries focus on hazardous material protection based on facility hazards to provide a basic understanding of the scope of the hazardous material protection program.
Chapter 9, Radioactive and Hazardous Waste Management
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the radioactive and hazardous waste management program. It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter describes the provisions for radioactive and hazardous waste management.

Chapter 10, Initial Testing, In-Service Surveillance, and Maintenance
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the surveillance, testing, or maintenance programs. It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter describes the essential features of the testing, surveillance, and maintenance programs.

Chapter 11, Operational Safety
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of an operational safety or fire protection program. It is intended to describe the essential characteristics of the programs as they relate to facility safety.

This chapter discusses general aspects of operational safety. It specifically focuses on the bases for the conduct of operations program specified by DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities. It is recognized, however, that DOE Order 5480.19 addresses many of the other DSA topics covered in 10 CFR 830 (e.g., management, organization, and the institutional safety provisions, procedures and training, human factors). The attachment to DOE 5480.19 specifically notes that “these guidelines have, therefore, been prepared to assist facilities in the review and development of programs important to operations.” Therefore, elements of conduct of operations are discussed elsewhere in this standard. Major issues of operations organization and administration and training are covered in chapter 12, “Procedures and Training,” and chapter 17, “Management, Organization, and Institutional Safety Provisions.” Major issues of notification and reporting practices, and investigation of abnormal events are covered in chapter 17. Control of procedures is covered in chapter 12.

Discussion of all the sub-headings of attachment 1 to DOE 5480.19 is not necessary in this chapter. Again, this chapter is not intended to be the vehicle for demonstrating compliance with DOE 5480.19 (i.e., review and approval of a conduct of operations program). It is intended to acknowledge the intent of conduct of operations, indicate the aspects of conduct of operations directly applicable to the facility, and summarize the main aspects of conduct of operations implementation at the facility.
This chapter describes: 1) the bases for the conduct of operations program; and 2) the fire protection program.

Chapter 12, Procedures and Training
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the procedures or training programs. It is intended to describe the essential characteristics of the programs as they relate to facility safety.

This chapter describes the processes by which the technical content of the procedures and training programs are developed, verified, and validated. These processes will ensure that the facility is operated and maintained by personnel who are well qualified and competent to carry out their job responsibilities using procedures and training elements that have been well developed and are kept current by the use of feedback and continuous improvement. A programmatic commitment to ongoing procedures and training programs is considered to be a necessary part of safety assurance.

Chapter 13, Human Factors
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the human factors process. It is intended to describe the essential characteristics of the process as it relates to facility safety.

This chapter focuses on human factors engineering, its importance to facility safety, and the design of the facility to optimize human performance. Human factors consists of

- human factors engineering that focuses on designing facilities, systems, equipment, and tools so they are sensitive to the capabilities, limitations, and needs of humans
- human reliability analysis that quantifies the contribution of human error to the facility risk

This chapter focuses exclusively on human factors engineering. Use of the term human factors in DOE-STD-3009-94 does not connote an expectation of or requirement for human reliability analysis.

This chapter demonstrates that human factors are considered in facility operations where humans are relied upon for preventive actions (e.g., surveillance and maintenance activities during normal operations), and for operator mitigative actions during abnormal and emergency operations. In this respect, the human-machine interface is an integral part of facility safety and, thus, requires special treatment in the DSA. The emphasis is on human-machine interfaces required for ensuring the safety function of safety SSCs that are important to safety and on the provisions made for optimizing the design of those human-machine interfaces to enhance reliable human performance.
A complete discussion of human factors without application of the graded approach includes a description of:

- the human-factors process for systematically inquiring into the importance of human factors in facility safety
- human-machine interfaces with safety-significant SSCs and safety-class SSCs that are important to safety
- the systematic inquiry into the optimization human-machine interfaces with safety-significant SSCs and safety-class SSCs to enhance human performance

Existing supporting documentation is to be referenced. Brief abstracts of referenced documentation with enough of the salient facts to provide an understanding of the referenced documentation and its relation to this chapter should be included.

*Chapter 14, Quality Assurance*

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the QAP to ensure compliance with 10 CFR 830 subpart A, “Quality Assurance Requirements.” It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter describes the provisions for a QAP. Expected products of this chapter, as applicable based on the graded approach, include the following:

- Description of QAP and organization
- Description of document control and records management
- Description of the QA process ensuring that performed safety-related work meets requirements

Existing supporting documentation is to be referenced. Brief abstracts of referenced documentation with enough of the salient facts to provide an understanding of the referenced documentation and its relation to this chapter should be included.

*Chapter 15, Emergency Preparedness Program*

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830. This chapter is not intended to be the vehicle for review and approval of the emergency preparedness program. It is intended to describe the essential characteristics of the program as it relates to facility safety.

This chapter summarizes the emergency preparedness functions and response at the facility.

*Chapter 16, Provisions for Decontamination and Decommissioning (D&D)*

The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830 to define the characteristics of the provisions for D&D necessary to ensure safe operation of the facility.

This chapter describes provisions that facilitate future D&D of a facility. Design of significant modifications to an existing facility must consider provisions for D&D. This
chapter also contains guidance on the description of the conceptual D&D plan for existing facilities.

Chapter 17, Management, Organization, and Institutional Safety Provisions
The purpose of this DSA chapter is to provide information that will satisfy the requirements of 10 CFR 830 to define the management, organization and institutional safety provision necessary to ensure safe operation of the facility.

This chapter presents information on management, technical, and other organizations that support safe operation. This chapter also enumerates the requirements used to develop the safety management programs, includes descriptions of the responsibilities of, and relationships between the non-operating organizations having a safety function and their interfaces with the line operating organization, and presents sufficient information on the safety management policies and programs to demonstrate that the facility operations are embedded in a safety conscious environment.

e. Discuss the ways that contractor management makes use of nuclear safety analysis reports.

[Note: The safety analysis report has been replaced by the documented safety analysis.]

The following is taken from Accident Analysis Guidance for Completion of 10 CFR 830-Compliant DSAs by D.Y. Chung and K.R. O’Kula.

The safety basis and DSA rules, contained in 10 CFR 830 require DOE contractors to establish and maintain a safety basis for hazard category 1, 2, and 3 nuclear facilities. In establishing the safety basis for a nuclear facility, subpart B of the rule describes how the responsible contractor must prepare a DSA that, in part 1) describes the facility, activities, and operations, 2) provides systematic identification of hazards, 3) evaluates normal, abnormal, and accident conditions, and 4) derives hazard controls to provide an adequate level of safety to the public, workers, and the environment. The safety basis and DSA rules give the contractor flexibility in proposing a method for DSA development, including “safe harbor” methods. While the safe harbor approaches promote systematic, overarching DSA guidance for the accident and consequence analysis, there still may be considerable hurdles for analysis of category 2 facilities in terms of appropriate methods and software. Concurrent with the complexity issue are schedule constraints associated with the safety basis rule.

f. Discuss the transportation safety requirements of 10 CFR 830, Subpart B.

The following is taken from 10 CFR 830.204, appendix A.

The contractor responsible for transportation activities may prepare its DSA by preparing a safety analysis report for packaging in accordance with DOE O 460.1C, Packaging and Transportation Safety, or successor document and preparing a transportation safety document in accordance with DOE G 460.1-1, Packaging and Transportation Safety, or successor document.

g. Identify the types of data and records required to be retained as permanent records.

10 CFR 830 states that a contractor must maintain complete and accurate records as necessary to substantiate compliance with the requirements of this part.


The information for all of the KSAs in this competency statement is taken from DOE-STD-1027-92.


*Purpose*

The purpose of DOE-STD-1027-92 is to establish guidance for the preparation and review of hazard categorization and accident analyses techniques as required in 10 CFR 830. DOE-STD-1027-92 imposes no new requirements on nuclear facilities. Instead, it focuses on 1) the definition of the standard identifying nuclear facilities required to have DSAs in order to comply with 10 CFR 830, 2) the DSA implementation plan and schedule, 3) the hazard categorization methodology to be applied to all facilities, and 4) the accident analysis techniques appropriate for the graded approach.

*Applicability/Scope*

DOE-STD-1027-92 is to be used with 10 CFR 830 and may not be applicable to DOE Orders. Regarding the applicability of other nuclear safety Orders to those facilities which fall below category 3 criteria, as defined by DOE-STD-1027-92, the program secretarial officers (PSOs) shall provide guidance, as appropriate.

b. State the three levels of facility hazard categorization.

*Hazard Category 1*

Definition. Hazard analysis shows the potential for significant offsite consequences. Hazard category 1 applies to category A reactors and facilities designated by the PSO.
Considerations. Category A reactors are those that have a steady-state power level greater than 20 megawatts.

Hazard Category 2
Definition. Hazard analysis shows the potential for significant onsite consequences. This category applies to facilities with the potential for nuclear criticality events or with sufficient quantities of hazardous material and energy so as to require onsite emergency planning activities.

Radiological Criteria. The criterion is that which is given in 10 CFR 30, “Rules of General Applicability to Domestic Licensing of Byproduct Material,” with re-baselined calculation. This criterion is essentially possession of quantities of material whose unmitigated release could produce total doses of 1 rem in the range of 100 meters from the facility.

In addition, any facility containing fissile material in quantities greater than the theoretical minimum mass limits for criticality emergencies as specified in ANSI/American Nuclear Society (ANS-8.1)-1998, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors, should be included. For aqueous solutions of U233, U235, and Pu239, these values, are 500, 700, and 450 grams, respectively. Credit may be taken if segmentation or nature of process precludes potential for criticality.

Considerations. The intent of this threshold is to capture those quantities of material whose unmitigated release would require an emergency plan for onsite evacuation. The NRC has specified certain values in 10 CFR 30 with a defined threshold of a 1 rem dose at 100 meters. DOE has evaluated these numbers and made certain modifications to release fractions which are explicitly allowed in the regulation. DOE has also modified the meteorology used in the threshold calculation.

Specific ground rules for category 2 hazard categorization are as follows:
- In general, it is necessary to consult the individual threshold values only if an individual isotope is being isolated and collected for some purpose. For example, if a facility processes weapons grade plutonium, it can simply be classified on the aggregate amount of Pu239 present without specifying quantities of trace isotopes (i.e., Pu238, Pu240, Am241, etc.) carried along in the mixture. Likewise, if a fuel reprocessing plant has more than 1000 curies of mixed fission products, it is a category 2 facility with no need to consider individual radionuclide make-up.
- Facilities are considered category 2 if the potential for criticality exists in the storage arrays and the processing means used.

Hazard Category 3
Definition. Hazard analysis shows the potential for significant but localized consequences. This category applies to facilities with quantities of hazardous radioactive materials which meet or exceed the table A.1 values in DOE-STD-1027-92.

Radiological Criteria. This category applies to quantities of radioactive materials as specified in table A.1 of DOE-STD-1027-92.
Considerations. The definition of the category 3 threshold is designed to exclude those facilities which cannot have a significant radiological impact outside the facility.

25. Waste management personnel must demonstrate a familiarity level knowledge of nuclear criticality safety, with respect to its impact on Department nuclear safety.

a. Discuss the purpose and policy associated with the DOE O 420.1B, Facility Safety, criticality safety requirements.

DOE O 420.1B establishes requirements for a criticality safety program applicable to DOE nuclear facilities and activities, including transportation activities, with potential for criticality hazards so that adequate protection is provided to the public, workers, and the environment.

b. Define the following terms associated with nuclear criticality safety:
   - Criticality incident
   - Double contingency principle
   - Geometry control
   - Nuclear criticality safety
   - Significant quantity of fissionable material
   - Temporary exemption

Criticality Incident
DOE Order 5480.30 defines a criticality incident as an accidental, self-sustained nuclear chain reaction.

Double Contingency Principle
The following is taken from DOE G 421.1-1.

Process designs shall incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

Protection shall be provided by either the control of at least two independent process parameters, which is the approach that is completely consistent with the double contingency principle as stated in ANSI/American Nuclear Society (ANS-8.1)-1998, and which, when practical, is the approach preferred by DOE to be taken to prevent common-mode failure, or a system of multiple controls on a single process parameter, which shall be the alternative approach to be taken only when the preferred approach is shown to be impractical.

The number of controls required upon a single controlled process parameter shall be based upon control reliability and any features that mitigate the consequences of control failure. In all cases, no single credible event or failure shall result in the potential for a criticality accident, except where single contingency operations are permissible, as presented in paragraph 5.1 of ANSI/ANS-8.10-1983, Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement. This exception applies to operations with
shielding and confinement (e.g., hot cells or other shielded facilities). Double contingency shall be demonstrated by documented evaluations.

**Geometry Control**
According to DOE G 421.1-1, geometry control is physically controlling the shape, dimensions, and configuration of fissionable material or of equipment containing fissionable material to maintain such systems safely subcritical.

**Nuclear Criticality Safety**
According to DOE Nuclear Criticality Safety Engineer Training, nuclear criticality safety is protection against the consequences of an inadvertent nuclear chain reaction, preferably by prevention of the reaction.

**Significant Quantity of Fissionable Material**
According to DOE Guidance for Determining if Personnel Handling Fissionable Materials Require Certification, a significant quantity of fissionable material is the minimum quantity of fissionable material for which control is required to maintain subcriticality under all normal and credible abnormal conditions.

**Temporary Exemption**
According to DOE M 440.1-1A, DOE Explosives Safety Manual, the DOE site office or NNSA site manager may grant a temporary exemption while the PSO is processing an exemption request. The temporary exemption is limited to the shorter of 180 days from its granting or until the exemption is approved or denied. Exemptions will be reviewed for applicability and currency at intervals not to exceed five years.

c. **Discuss the contractor responsibilities for the following in relation to criticality safety activities:**
   - Criticality safety evaluations
   - Monitoring
   - Surveillance
   - Transportation
   - Storage

The following is taken from DOE G 421.1-1.

**Criticality Safety Evaluations**
Only trained, technically competent, authorized personnel shall perform nuclear criticality safety evaluations/calculation and peer reviews. Qualification of these individuals should include formal and informal instruction, on-the-job training, and training by peer resources and by external sources (as necessary).

Before starting a new operation with fissionable materials or before an existing fissionable material operation is changed, an evaluation shall be performed to determine that the entire process will be subcritical under normal and credible abnormal conditions. The evaluation shall be documented with sufficient detail, clarity, and lack of ambiguity to allow
independent evaluation and judgment of results, and explicitly identify the controlled nuclear and process parameters and their associated limits upon which nuclear criticality safety depends.

In an emergency or otherwise in the interest of safety, the evaluation and its documentation may be performed in whole or in part after the fact. The documentation shall also include a justification for performing recovery actions prior to completing the normal evaluation process.

The nuclear criticality safety calculations used to demonstrate subcriticality for actual process criticality safety analyses should be reported in a traceable document. The calculations should be documented in a stand-alone report or be included in a criticality safety analysis that includes the following:

- A verification of the accuracy of the information provided
- A list of the nuclear parameters, associated controls, and contingencies along with
  - a justification for excluding consideration of any nuclear parameters perceived not to be affected by the operation or identified contingencies
  - identification of the method(s) of control (physical and administrative) for each nuclear parameter
- Identification of contingencies including normal and credible abnormal process conditions and external events such as natural phenomena, floods, and fires
- Changes that may require a new or modified criticality safety analysis, which would include, but not be limited to, changes or modifications in
  - the location of a piece of equipment or glovebox in which fissionable material will be handled, processed, or stored
  - the geometry of a piece of equipment that will contain fissionable material or a change in the geometry of fissionable material itself
  - fissionable material nuclide or enrichment
  - physical or chemical form of the fissionable material
  - the density or concentration of the fissionable material
  - the quantity of fissionable material or batch size
  - the moderation or reflection of fissionable material
  - a processing sequence involving fissionable material
  - the method of containment of fissionable material
  - the method or location of storing fissionable material, including changes in the spacing of containers or type of containers
  - the quantity or type of neutron poisons, including changes in the decision to use or discontinue use of neutron poisons
  - the method of moving fissionable material within a facility or around the site
  - credible errors or accidents, or change in the probability of accidents, in handling, processing, or storing fissionable material
  - passive or active engineered controls or administrative controls whose purpose is to satisfy the double-contingency principle, including changes in the type of equipment, its independency, or its reliability
An evaluation for each of the controls and contingencies identified that justifies the subcriticality of the fissionable material operation, given the failure of a single control or the occurrence of any credible event.

**Monitoring**

Provide monitoring or surveillance, or both, to forewarn of unacceptable or unsafe accumulations of a significant quantity of fissionable materials in process equipment, storage areas, piping, and ventilation systems, thus permitting normal corrective actions. If unacceptable or unsafe accumulations of a significant quantity of fissionable materials are detected, corrective actions should be taken in conjunction with the area criticality safety organization.

Plutonium storage facilities and containers should be monitored and checked periodically to ensure continued integrity of containment. When required by the form or hazard potential of the stored material, procedures should be developed to detect contamination or loss of primary containment when personnel enter the plutonium storage facility.

Nuclear criticality safety controls should include provisions for periodic evaluation by an inspection program, use of corrosion specimens, or other techniques, if credible corrosion or erosion could change the geometry (or thickness) in a system that depends on geometry (or thickness) for nuclear criticality safety.

For operations in which nuclear criticality safety depends on control of neutron moderation, there should be assurance that the prescribed extent of moderation remains unchanged or that, if a credible change occurs, the reactivity of the system remains below acceptable subcritical limits. Such assurance should include consideration of all credible accidents involving any moderator or combination of moderators.

**Surveillance**

Surveillance processes must be established to forewarn of unacceptable or unsafe accumulations of a significant quantity of fissionable materials in process equipment, storage areas, piping, and ventilation systems, thus permitting normal corrective actions. If unacceptable or unsafe accumulations of a significant quantity of fissionable materials are detected, corrective actions should be taken in regard to the area.

**Transportation**

The transportation of fissionable materials onsite and offsite shall be governed by written procedures that comply with DOE O 420.1B, DOE O 460.1C, 49 CFR; “Transportation,” 10 CFR 71; “Packaging and Transportation of Radioactive Material,” and other applicable Federal requirements.

**Onsite Transfers**

The design and use of onsite shipping containers shall provide criticality safety protection of fissionable material consistent with that protection provided by DOE, NRC, or U.S. Department of Transportation (DOT) packages used in interstate transport. Considerations
should be given to onsite resources and conditions of material transport that eliminate or mitigate interstate transport hazards (e.g., resources of prompt fire fighting, speed limits of transport, traffic control, method of transport, compensation for weather conditions, lifting height restraints, and others).

Onsite Transport Safety Analysis
The packaging requirements for onsite transfer of fissionable material are contained in DOE O 460.1C. Safety analysis for onsite transfers shall be in accordance with requirements in this DOE Order. The safety analysis, computational evaluations, and the documentation of the package safety analysis shall be performed in accordance with DOE O 420.1B.

Operating Procedures
Approved operating procedures applicable to an onsite transfer or shipment of fissionable materials shall be posted or readily available within the loading, unloading, or storage areas for such materials.

Offsite Transfers
All transfers of fissionable materials offsite shall be performed in DOE, NRC, or DOT approved fissionable material packages. All required administrative controls and procedures specified for the package use shall be performed. Such DOE, NRC, or DOT approved packages do not require additional criticality safety review for receipt or shipment.

Storage
Procedures should be developed and used for storing fissionable material. These should set forth limits on the total quantity of fissionable material, allowable quantity of individual units, allowable container dimensions, and required spacing of containers in storage areas.

Storage Facility Plans and Layouts
Storage facilities and structures shall be designed, fabricated, and maintained in accordance with good engineering practices. Plans and layouts should be developed that contain a description of the storage facility, including dimensions and materials used in construction of the enclosure and shelving, cubicles, cages, and other equipment within the storage area.

Admonitions about Moderating and Reflecting Materials
Procedures developed for storing fissile material should contain precautions to avoid entry of water or other moderating materials into a storage area where moderating and reflecting effects of such materials would be unsafe. Nonessential combustible materials should not be stored in a fissionable material storage area.

Removal and Return of Materials
Procedures shall be developed and used that control the removal, or transfer, of fissionable material from storage and the return of such material to storage. These procedures should incorporate means of verifying the weight, isotopic content, chemical composition, and degree of moderation, as appropriate.
Exclusion of Superfluous Materials
Process operations, storage of non-nuclear materials or equipment that is not directly required for fissionable materials storage operations, and all other functions not directly a part of normal fissionable materials storage operations should be excluded from the storage area.

Readiness Inspections
Documented inspections, in situ tests, and preventive maintenance shall be performed periodically on fissionable material storage areas to ensure that the safety systems and components necessary for criticality safety control are maintained in a state of readiness.

Postings
Nuclear criticality safety limits shall be conspicuously posted. Postings at the entrance and inside fissionable material storage areas, as applicable, should be considered.

Instructions
Signs or other devices should be utilized as appropriate at strategic locations in or near fissionable material storage locations to provide instructions regarding interpretations of, and required responses to, alarms, evacuation routes, and fire fighting.

d. **Identify the types of data and records required to be retained as permanent records.**

The following is taken from DOE G 421.1-1.

Ensure the maintenance of records during the period of their applicability and at least for periods specified in DOE O 200.1A, *Information Management Program*, for

- nuclear criticality safety analyses
- criticality accident alarm systems, criticality accident detection systems, and nuclear accident dosimeter placement evaluations
- nuclear criticality accident evacuation zone evaluations
- fissionable material process audits and violation/procedural reviews
- quality and configuration control of software and data sets used for nuclear criticality safety evaluations and nuclear criticality accident alarm or detection system placement and evacuation zone evaluations

26. **Waste management personnel must demonstrate a familiarity level knowledge of the Price-Anderson Amendments Act of 1988 and its impact on Department of Energy nuclear safety activities.**

a. **Describe the purpose and scope of the Price-Anderson Amendments Act.**

The following is taken from American Nuclear Society, Price-Anderson Act, *Background for Position Statement 54*. 
The Price-Anderson Act was enacted into law in 1957 and has been revised several times. It constitutes section 170 of the Atomic Energy Act. The latest revision was enacted through the “Energy Policy Act of 2005,” and extended it through December 31, 2025.

The main purpose of the Price-Anderson Amendments Act is to ensure the availability of a large pool of funds (currently about $10 billion) to provide prompt and orderly compensation of members of the public who incur damages from a nuclear or radiological incident no matter who might be liable. The Act provides “omnibus” coverage, that is, the same protection available for a covered licensee or contractor extends through indemnification to any persons who may be legally liable, regardless of their identity or relationship to the licensed activity. Because the Act channels the obligation to pay compensation for damages, a claimant need not sue several parties but can bring its claim to the licensee or contractor.

The Price-Anderson Act requires NRC licensees and DOE contractors to enter into agreements of indemnification to cover personal injury and property damage to those harmed by a nuclear or radiological incident, including the costs of incident response or precautionary evacuation and the costs of investigating and defending claims and settling suits for such damages. The scope of the Act includes nuclear incidents in the course of the operation of power reactors; test and research reactors; DOE nuclear and radiological facilities; and transportation of nuclear fuel to and from a covered facility.

b. Discuss the Act’s applicability to the Department nuclear safety activities.


In the case of most DOE activities, the system of financial protection currently takes the form of an indemnification by DOE for legal liability for a nuclear incident or a precautionary evacuation arising from activity under a DOE contract. The DOE Price-Anderson indemnification
- provides omnibus coverage of all persons who might be legally liable for injuries related to a nuclear incident
- indemnifies fully all legal liability up to the statutory limit on such liability, which is currently approximately $8.96 billion for a nuclear incident in the U.S.
- covers all DOE contractual activity that might result in a nuclear incident in the U.S.
- is not subject to the availability of funds
- is mandatory and exclusive

c. Discuss the civil and criminal penalties imposed on the Department, management and operating contractors, and subcontractors as the result of a violation of applicable rules and regulations related to nuclear safety.

The following is taken from DOE, Enforcement Process Overview.
Civil penalties are monetary sanctions designed to emphasize the need for lasting remedial action, deter future violations, and underscore the importance of contractor self-identification, reporting, and correction of noncompliances.

Civil penalties are authorized under 10 CFR 820.20, “Purpose and Scope,” 10 CFR 824.4, “Civil Penalties,” and 10 CFR 851.5, “Enforcement,” for nuclear safety, classified information security, and worker safety and health noncompliances, respectively. The Office of Enforcement imposes civil penalties through the issuance of a preliminary notice of violation.

d. Discuss the requirements associated with the topics below, as they are affected by the rule-making aspect of the Price-Anderson Amendments Act:
   - Safety analysis reports (SARs)
   - Unreviewed safety questions (USQ)
   - Quality assurance (QA) requirements
   - Technical safety requirements (TSRs)

Safety Analysis Reports

[Note: DSAs have replaced SARs.]

The following is taken from 10 CFR 830.204.

The contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must obtain approval from DOE for the methodology used to prepare the DSA for the facility unless the contractor uses a methodology set forth in table 2 of appendix A in 10 CFR 830.

The DSA for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility
   - describe the facility (including the design of safety structures, systems and components) and the work to be performed;
   - provide a systematic identification of natural and man-made hazards associated with the facility;
   - evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility;
   - derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use;
   - define the characteristics of the safety management programs necessary to ensure the safe operation of the facility, including (where applicable) QA, procedures, maintenance, personnel training, conduct of operations, emergency preparedness, fire protection, waste management, and radiation protection; and
• with respect to a nonreactor nuclear facility with fissionable material in a form and amount sufficient to pose a potential for criticality, define a criticality safety program that
  o ensures that operations with fissionable material remain subcritical under all normal and credible abnormal conditions,
  o identifies applicable nuclear criticality safety standards, and
  o describes how the program meets applicable nuclear criticality safety standards.

Unreviewed Safety Questions (USQs)
The following is taken from 10 CFR 830.203.

The contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must establish, implement, and take actions consistent with a USQ process that meets the requirements of 10 CFR 830.

The contractor responsible for a hazard category 1, 2, or 3 DOE existing nuclear facility must submit for DOE approval a procedure for its USQ process by April 10, 2001. Pending DOE approval of the USQ procedure, the contractor must continue to use its existing USQ procedure. If the existing procedure already meets the requirements of 10 CFR 830, the contractor must notify DOE by April 10, 2001 and request that DOE issue an approval of the existing procedure.

The contractor responsible for a hazard category 1, 2, or 3 DOE new nuclear facility must submit for DOE approval a procedure for its USQ process on a schedule that allows DOE approval in a safety evaluation report.

The contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must implement the DOE-approved USQ procedure in situations where there is a
  • temporary or permanent change in the facility as described in the existing DSA
  • temporary or permanent change in the procedures as described in the existing DSA
  • test or experiment not described in the existing DSA
  • potential inadequacy of the DSA because the analysis potentially may not be bounding or may be otherwise inadequate

A contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must obtain DOE approval prior to taking any action determined to involve a USQ.

The contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must annually submit to DOE a summary of the USQ determinations performed since the prior submission.

If a contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility discovers, or is made aware of a potential inadequacy of the DSA, it must
  • take action, as appropriate, to place or maintain the facility in a safe condition until an evaluation of the safety of the situation is completed
  • notify DOE of the situation
- perform a USQ determination and notify DOE promptly of the results
- submit the evaluation of the safety of the situation to DOE prior to removing any operational restrictions initiated to meet the requirements of 10 CFR 830

**Quality Assurance (QA) Requirements**

The following is taken from 10 CFR 830.121.

Contractors conducting activities, including providing items or services, that affect, or may affect, the nuclear safety of DOE nuclear facilities must conduct work in accordance with the QA criteria in 10 CFR 830.122.

The contractor responsible for a DOE nuclear facility must
- submit a QAP to DOE for approval and regard the QAP as approved 90 days after submittal, unless it is approved or rejected by DOE at an earlier date
- modify the QAP as directed by DOE
- annually submit any changes to the DOE-approved QAP to DOE for approval and justify in the submittal why the changes continue to satisfy the QA requirements
- conduct work in accordance with the QAP

The QAP must
- describe how the QA criteria of 10 CFR 830.122 are satisfied
- integrate the QA criteria with the safety management system, or describe how the QA criteria apply to the safety management system
- use voluntary consensus standards in its development and implementation, where practicable and consistent with contractual and regulatory requirements, and identify the standards used
- describe how the contractor responsible for the nuclear facility ensures that subcontractors and suppliers satisfy the criteria of 10 CFR 830.122

**Technical Safety Requirements (TSRs)**

The following is taken from 10 CFR 830.205.

A contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must
- develop TSRs that are derived from the DSA
- prior to use, obtain DOE approval of TSRs and any change to TSRs
- notify DOE of any violation of a TSR

A contractor may take emergency actions that depart from an approved TSR when no actions consistent with the TSR are immediately apparent, and when these actions are needed to protect workers, the public or the environment from imminent and significant harm. Such actions must be approved by a certified operator for a reactor or by a person in authority as designated in the TSR for nonreactor nuclear facilities. The contractor must report the emergency actions to DOE as soon as practicable.

A contractor for an environmental restoration activity may follow the provisions of 29 CFR 1910.120, “Hazardous Waste Operations and Emergency Response,” or 29 CFR 1926.65,
“Hazardous Waste and Emergency Response,” to develop the appropriate hazard controls, provided the activity involves either
- work not done within a permanent structure, or
- the decommissioning of a facility with only low-level residual fixed radioactivity

27. **Waste management personnel must demonstrate a working level knowledge of DOE O 450.1, Environmental Protection Program.**

[Note: DOE O 450.1 has been superseded by DOE O 450.1A.]

a. **Define the following terms:**
   - Effluent
   - Effluent monitoring
   - Environmental monitoring
   - Environmental protection standard
   - Environmental surveillance
   - Environmental occurrence
   - Pollution prevention

**Effluent**
Biology Online, Dictionary, defines effluent as liquid waste from sewage treatment or industrial processes, especially such liquid waste that is released into a river or other waterway; water mixed with waste matter that is flowing outward.

**Effluent Monitoring**
The following is taken from Oak Ridge Reservation Annual Site Environmental Report for 1995, chapter 4, 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 Monitoring**
The following is taken from the Lawrence Berkeley National Laboratory, Pub-3000, chapter 11, Environmental Protection.

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

**Environmental Protection Standard**
The following is taken from DOE Order 5400.1.
An 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.

*Environmental Surveillance*
The following is taken from DOE Order 5400.1.

Environmental surveillance is the collection and analysis of samples of air, water, soil,
foodstuffs, biota, and other environmental media, and the measurement of external radiation
and radioactive materials and chemicals for purposes of demonstrating compliance with
applicable standards, assessing radiation or chemical exposures to members of the public,
and assessing the effect, if any, on the local environment.

*Environmental Occurrence*
The following is taken from DOE Order 5400.1.

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

*Pollution Prevention*
The following is taken from the Pollution Prevention Act of 1990.

Pollution prevention is a source reduction as defined in the Pollution Prevention Act and
other practices that reduce or eliminate the creation of pollutants through 1) increased
efficiency in the use of raw materials, energy, water, or other natural resources, or 2)
protection of natural resources by conservation. DOE has expanded this definition to include
recycling.

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

The following is taken from DOE G 450.1-1A.

An ISMS represents DOE’s overall umbrella framework for managing ES&H. It was
developed in response to recommendations 95-2 and 98-1 issued by the Defense Nuclear
Facility Safety Board and was implemented at virtually all DOE sites by October 2000. The
framework for ISMS is provided in DOE P 450.4, *Integrated Safety Management System
Policy*, and guidance is provided in DOE G 450.4-1B, *Integrated Safety Management System
Guide*. In addition, ISMS is incorporated in DOE contracts through several Department of
Energy Acquisition Regulations clauses. Within ISMS, the term “safety” is defined to
encompass ES&H, including pollution prevention.

In April 2000, Executive Order (EO) 13148, *Greening the Government through Leadership
in Environmental Management*, required Federal agencies to implement environmental
Management systems (EMSs) at all appropriate facilities by December 31, 2005. Responsive to EO 13148, DOE issued DOE O 450.1, which requires DOE elements to establish an EMS that is integrated into the DOE ISMS. DOE O 450.1 has been superseded by DOE O 450.1A.

An EMS is a systematic and structured approach for addressing the environmental consequences of an organization’s activities, products, and services. DOE O 450.1A defines an EMS as “a continuous cycle of planning, implementing, evaluating and improving processes and actions undertaken to achieve environmental missions and goals.”

Several recognized EMS frameworks exist. Most are based on the International Organization for Standardization (ISO) 14001 EMS standard. As a result, ISO 14001 is the framework on which organizations most frequently choose to base their EMSs. DOE O 450.1A does not prescribe the type of EMS framework that DOE elements must use.

c. Discuss the requirements for Notification and Reports. Include the following at a minimum:
   - Office of Management and Budget (OMB) Circular A-106

Office of Management and Budget (OMB) Circular A-106 Reporting

OMB Circular No. A-106, Reporting Requirements in Connection with the Prevention, Control, and Abatement of Environmental Pollution at Existing Federal Facilities, December 31, 1974, required all Federal agencies to develop a pollution abatement plan (commonly referred to as the FEDPLAN or the A-106 Report) to track the status of all environmental projects, regardless of the source of funding. The FEDPLAN, including annual status report supplements, is used by the EPA Office of Federal Activities as a management tool to justify the environmental portion of the President’s annual budget.

This circular was rescinded in April 1996, and for ongoing data requirements, agencies will report under EO 12088, Federal Compliance with Pollution Control Standards, using their own in-house data systems. This action was part of President Clinton’s Reinventing Government effort.

Pollution Prevention and Toxics Release Inventory Reporting

As directed by EO 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, all Federal agencies must comply with the reporting requirements of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and the Pollution Prevention Act of 1990. Thus, each DOE site is subject to reporting to the EPCRA, section 313 (commonly referred to as the Toxics Release Inventory, or TRI) if 1) the facility has 10 or more full-time employees, and 2) the facility manufactures, processes, or otherwise uses any listed toxic chemical in quantities greater than the established threshold in the course of a calendar year.

Reporting of Low-Level Radioactive Waste Disposal

EH-41 prepared and distributed on September 30, 1993, a report entitled, Disposal of Low-Level and Mixed Low-Level Radioactive Waste During 1990. The report presents isotopic inventories and other data for low-level waste (LLW) and mixed LLW disposed of during
calendar year 1990 at commercial disposal facilities and DOE sites. DOE disposal information in the report includes data from the Savannah River Site, the Nevada Test Site, Los Alamos National Laboratory, Idaho National Laboratory, the Hanford Site, the Y-12 Site, and Oak Ridge National Laboratory. The report also provides information on LLW stored at DOE sites and makes suggestions regarding improving LLW disposal data.

**Federal Facility Hazardous Waste Compliance Docket**

CERCLA section 120(c) requires EPA to establish and maintain the Federal Agencies Hazardous Waste Compliance Docket which consists of a list of Federal facilities that manage hazardous waste or have potential hazardous waste contamination. The docket identifies the Federal facilities that should be evaluated to determine if they pose a risk to public health or the environment. This information is available to the public through EPA’s Federal Facility Compliance Oversight website: [www.epa.gov/compliance/assistance/sectors/Federalsectors.html](http://www.epa.gov/compliance/assistance/sectors/Federalsectors.html).

**National Priorities List (NPL) Listing**

EH-41 provides DOE’s CERCLA docket coordinator who responds to EPA’s proposed listing of DOE facilities on the docket. Information is verified and/or corrected in conjunction with the field offices. This information is then transmitted to EPA. EH-41 has developed and maintains a database of information regarding the listing of DOE facilities and their status on the CERCLA docket.

CERCLA section 105 (a)(8)(B) requires that the National Contingency Plan include a list of national priorities among the known releases and hazardous sites in the United States. This National Priorities List (NPL) is updated at least annually and contains Federal as well as private facilities. The latest information on the NPL may be found at [EPA’s Site Information Web site](http://www.epa.gov/compliance/assistance/sectors/Federalsectors.html).

d. **Discuss the requirements for an environmental monitoring plan.**

The following is taken from DOE/WIPP 99-2194.

DOE O 450.1A requires each DOE site to conduct environmental monitoring and measurement as part of its EMS. This environmental monitoring should be conducted to:

- verify and support compliance with applicable Federal, state, and local environmental laws, regulations, permits, and orders;
- establish baselines and characterize trends in the physical, chemical, and biological condition of effluent and environmental media;
- identify potential environmental problems and evaluate the need for remedial actions or measures to mitigate the problem;
- detect, characterize, and report unplanned releases;
- evaluate the effectiveness of effluent treatment and control and pollution abatement programs; and
- determine compliance with commitments made in EISs, EAs, SARs, or other official DOE documents.
An environmental monitoring plan should be written to contain the rationale and design criteria for monitoring and tracking the environmental aspects and targets identified in the site EMS, the extent and frequency of monitoring and measurements, procedures for laboratory analyses, QA requirements, program implementation procedures, and direction for the preparation and disposition of reports. Changes to the monitoring plan, identified through audit of the site EMS, may be necessary to allow the use of advanced technology and new data collection techniques.

28. Waste management personnel must demonstrate a familiarity level knowledge of the Clean Air Act (CAA) and implementing regulations.

a. Discuss the application of the Clean Air Act to the Department of Energy and its facilities.

The CAA establishes a regulatory framework for attaining and maintaining air quality standards. The CAA was enacted in 1970 and amended in 1990. The purposes of the Act are:

- to protect and enhance the quality of the nation’s air resources so as to promote the public health and welfare and the productive capacity of its population
- to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution
- to provide technical and financial assistance to state and local governments in connection with the development and execution of the air pollution prevention and control programs
- to encourage and assist in the development and operation of regional air pollution control programs

The CAA applies not only to environmental activities at DOE facilities, but also to plant utilities, new sources (e.g., generators), and vehicle operation activities without exception, unless exempted by the President of the United States for reasons paramount to the country. The DOE must also comply with all Federal, state, interstate, and local requirements to the same extent as any non-government entity.

b. Identify the National Ambient Air Quality Standards (primary and secondary) and the National Emission Standards for Hazardous Air Pollutants (NESHAP) as they apply to attainment and non-attainment areas.

National Ambient Air Quality Standards

The following is taken from U.S. Environmental Protection Agency, Air and Radiation, National Ambient Air Quality Standards.

The CAA, as amended in 1990, requires EPA to set national ambient air quality standards (NAAQS) for wide-spread pollutants from numerous and diverse sources 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 visibility impairment, damage to
animals, crops, vegetation, and buildings. The CAA requires periodic review of the science upon which the standards are based and the standards themselves. EPA has set NAAQS for six principal pollutants, which are called “criteria” pollutants. The criteria pollutants are ozone, particulate matter, cobalt, sulfur dioxide, nitrous oxides, and lead. The primary and secondary standards are presented in table 9.

Table 9. National ambient air quality standards

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Primary Standards</th>
<th>Averaging Times</th>
<th>Secondary Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>9 ppm (10 mg/m³)</td>
<td>8-hour&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>35 ppm (40 mg/m³)</td>
<td>1-hour&lt;sup&gt;(1)&lt;/sup&gt;</td>
<td>None</td>
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<tr>
<td>Lead</td>
<td>1.5 µg/m³</td>
<td>Quarterly Average</td>
<td>Same as Primary</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>0.053 ppm (100 µg/m³)</td>
<td>Annual (Arithmetic Mean)</td>
<td>Same as Primary</td>
</tr>
<tr>
<td>Particulate Matter (PM&lt;sub&gt;10&lt;/sub&gt;)</td>
<td>Revoked&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>Annual&lt;sup&gt;(1)&lt;/sup&gt; (Arithmetic Mean)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>150 µg/m³</td>
<td>24-hour&lt;sup&gt;(13)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Particulate Matter (PM&lt;sub&gt;2.5&lt;/sub&gt;)</td>
<td>15.0 µg/m³</td>
<td>Annual&lt;sup&gt;(1)&lt;/sup&gt; (Arithmetic Mean)</td>
<td>Same as Primary</td>
</tr>
<tr>
<td></td>
<td>35 µg/m³</td>
<td>24-hour&lt;sup&gt;(12)&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Ozone</td>
<td>0.08 ppm</td>
<td>8-hour&lt;sup&gt;(6)&lt;/sup&gt;</td>
<td>Same as Primary</td>
</tr>
<tr>
<td></td>
<td>0.12 ppm</td>
<td>1-hour&lt;sup&gt;(2)&lt;/sup&gt; (Applies only in limited areas)</td>
<td>Same as Primary</td>
</tr>
<tr>
<td>Sulfur Oxides</td>
<td>0.03 ppm</td>
<td>Annual (Arithmetic Mean)</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>0.14 ppm</td>
<td>24-hour&lt;sup&gt;(14)&lt;/sup&gt;</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>-----</td>
<td>3-hour&lt;sup&gt;(11)&lt;/sup&gt;</td>
<td>0.5 ppm (1300 µg/m³)</td>
</tr>
</tbody>
</table>

Source: EPA, Air and Radiation, NAAQS

<sup>(1)</sup> Not to be exceeded more than once per year.
<sup>(2)</sup> Due to a lack of evidence linking health problems to long-term exposure to coarse particle pollution, the agency revoked the annual PM<sub>10</sub> standard in 2006 (effective December 17, 2006).
<sup>(3)</sup> Not to be exceeded more than once per year on average over 3 years.
<sup>(4)</sup> To attain this standard, the 3-year average of the weighted annual mean PM<sub>2.5</sub> concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m³.
<sup>(5)</sup> To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³ (effective December 17, 2006).
<sup>(6)</sup> To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
<sup>(7)</sup> (a) The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is ≤ 1, as determined by appendix H.
(b) As of June 15, 2005 EPA revoked the 1-hour ozone standard in all areas except the fourteen 8-hour ozone nonattainment early action compact areas.
The CAA defines compliance areas as “attainment” or “non-attainment” areas. An attainment area is defined as a geographic area in which levels of a criteria air pollutant meet the health-based primary standard (NAAQS) for the pollutant. By contrast, a non-attainment area is a geographic area in which the level of a criteria air pollutant is higher than the level allowed by the Federal standards. An area may have an acceptable level for one criteria air pollutant, but may have unacceptable levels for others. Thus, an area could be both attainment and non-attainment at the same time. Attainment areas are defined using Federal pollutant limits set by EPA.

National Emissions Standards for Hazardous Air Pollutants (NESHAPs)
The following is taken from the United States Office of Air Quality EPA-453/R-01-005.

Section 112 of the CAA requires the development of NESHAP for the control of HAP from new and existing major or area sources. The statute requires the standard to reflect the maximum degree of reduction in emissions of HAP that is achievable, taking into consideration the cost of achieving the emission reduction, any non-air quality health and environmental reduction, and energy requirements. This level of control is commonly referred to as MACT.

Emission reductions may be accomplished through application of measures, processes, methods, systems or techniques including, but not limited to: 1) reducing the volume of, or eliminating emissions of, such pollutants through process changes, substitution of materials, or other modifications, 2) enclosing systems or processes to eliminate emissions, 3) collecting, capturing, or treating such pollutants when released from a process, stack, storage or fugitive emissions point, 4) design, equipment, work practice, or operational standards.

New Source Performance Standards
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, “Standard of Performance for New Stationary Sources.”

Generally, state and local air pollution control agencies are responsible for implementation, compliance assistance, and enforcement of the new source performance standards (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.
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 the DOE, Office of Health, Safety, and Security, Clean Air Act.

Title V of the CAA Amendments established a Federal permitting program, similar to the CWA 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 is 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 hazardous air pollutant sources
- Major sources under NAAQS
- All affected sources under Title IV
- All sources subject to NSPS

On July 21, 1992, EPA promulgated a rule that defined the minimum elements of a state operating permit program. This rule applies directly to the states, but ultimately to sources.

Any air pollutant-emitting modification or new facility planned will require a permit under the CAA. Requirements exist for applications, permits and requirements for mathematical modeling, field measurements, and associated engineering aspects. Title V requires each state to develop, implement, and administer a comprehensive operating permit program for pollution sources. EPA reviews and approves programs and has authority to review and approve individual permits. Any modification or new facility will undergo a new source review (NSR) permitting process.

**NSR Permitting Process**

The following is taken from U.S. Environmental Protection Agency, New Source Review.

Congress established the NSR permitting program as part of the 1977 Clean Air Act Amendments. NSR is a preconstruction permitting program that serves two important purposes.
First, it ensures that air quality is not significantly degraded from the addition of new and modified factories, industrial boilers and power plants. In areas with unhealthy air, an NSR ensures that new emissions do not slow progress toward cleaner air. In areas with clean air, especially pristine areas like national parks, the NSR ensures that new emissions do not significantly worsen air quality.

Second, the NSR program assures people that any large new or modified industrial source in their neighborhoods will be as clean as possible, and that advances in pollution control occur concurrently with industrial expansion.

NSR permits are legal documents that the facility owners/operators must abide by. The permit specifies what construction is allowed, what emission limits must be met, and often how the emissions source must be operated.

**Nonattainment Area Permitting**

The CAA mandates that areas designated as nonattainment for any pollutant develop an implementation plan to achieve attainment of NAAQS for that pollutant within five years of being designated nonattainment. New major sources or major modifications to existing major sources in nonattainment areas must obtain a nonattainment NSR permit before beginning any new construction or modification. The nonattainment NSR application must include lowest achievable emission rate technology, applicable emission offsets, impact analysis, and other information relative to improving air quality.

**Monitoring**
The following is taken from U.S. Environmental Protection Agency, Air Quality Planning and Standards.

The Office of Air Quality Planning and Standards (OAQPS) is responsible for setting the NAAQS, which control pollutants harmful to people and the environment. There are two types of standards: primary and secondary. Primary standards protect against adverse health effects; secondary standards protect against welfare effects, such as damage to farm crops and vegetation, and damage to buildings. The six criteria pollutants addressed in the NAAQS are carbon monoxide, nitrogen dioxide, lead, ozone (or smog), particulate matter, and sulfur dioxide. If the levels of these pollutants are higher than what is considered acceptable by EPA, the area in which the level is too high is called a nonattainment area. OAQPS monitors very closely many areas for criteria pollutants and attainment.

Through various programs, OAQPS monitors for criteria pollutants. One such program is the ambient air monitoring program. Through this program, air quality samples are collected to judge attainment of ambient air quality standards, to prevent or alleviate air pollution emergencies, to observe pollution trends throughout regions, and to evaluate the effects of urban, land use, and transportation planning relating to air pollution. There are other
important types of pollution monitoring programs, two of which are the enhanced ozone monitoring program and the air pollution monitoring program.

The air pollution monitoring program monitors all of the six criteria pollutants. Measurements are taken to assess areas where there may be a problem, and to monitor areas that already have problems. The goal of this program is to control areas where problems exist and to try to keep other areas from becoming problem air pollution areas.

The enhanced ozone monitoring program goes one step further. The chief objective of the enhanced ozone monitoring program is to provide an air quality database that will assist air pollution control agencies in evaluating, tracking the progress of, and, if necessary, refining control strategies for attaining the ozone NAAQS. EPA has required more extensive monitoring of ozone and its precursors in areas with persistently high ozone levels (mostly large metropolitan areas). It is important that ozone be monitored in this way as it greatly affects health.

**Recordkeeping**

The following is taken from 40 CFR 60.7.

Any owner or operator subject to the provisions of 40 CFR 60 shall maintain records of the occurrence and duration of any startup, shutdown, or malfunction in the operation of an affected facility; any malfunction of the air pollution control equipment; or any periods during which a continuous monitoring system or monitoring device is inoperative.

Each owner or operator required to install a continuous monitoring device shall submit an excess emissions and monitoring systems performance report (excess emissions are defined in applicable subparts) and/or summary report form to the Administrator semiannually, except when: more frequent reporting is specifically required by an applicable subpart; or the Administrator, on a case-by-case basis, determines that more frequent reporting is necessary to accurately assess the compliance status of the source. All reports shall be postmarked by the 30th day following the end of each six-month period. Written reports of excess emissions shall include the following information:

- The magnitude of excess emissions computed in accordance with 40 CFR 60.13, “Monitoring Requirements,” any conversion factor(s) used, and the date and time of commencement and completion of each time period of excess emissions. The process operating time during the reporting period.
- Specific identification of each period of excess emissions that occurs during startups, shutdowns, and malfunctions of the affected facility. The nature and cause of any malfunction (if known), the corrective action taken or preventative measures adopted.
- The date and time identifying each period during which the continuous monitoring system was inoperative except for zero and span checks and the nature of the system repairs or adjustments.
- When no excess emissions have occurred or the continuous monitoring system(s) have not been inoperative, repaired, or adjusted, such information shall be stated in the report.
d. 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, EPA 315-B-98-011.

The EPA enforcement policy for GOCO facilities sets forth EPA’s general policy with respect to who should apply for a permit, identification of appropriate GOCO enforcement responses, and special considerations for CERCLA enforcement actions. The policy states that where EPA has the authority under a given statute to initiate an enforcement action against an owner or an operator at a facility, and the contractor (or subcontractor) fits the statutory or regulatory definition of an operator, EPA may exercise its discretion to pursue enforcement against the Federal agency, the contractor-operator, or both. The policy further states that when EPA takes enforcement action against a contractor, EPA will treat the contractor the same as it treats all other private parties.

The major pollution control statutes provide two general mechanisms for the enforcement of environmental requirements: administrative and judicial actions. Each of these enforcement mechanisms is discussed below.

Administrative Actions
An administrative action is EPA’s mechanism for enforcing environmental requirements at Federal facilities. Generally, the major pollution control statutes provide authority for EPA to issue orders that

- require compliance immediately or within a specified schedule
- require steps to remedy the consequences of the violation
- suspend or revoke a permit required for the facility to operate

In addition, CAA, RCRA, and SDWA also provide authority to issue penalty orders. If EPA commences an action under 40 CFR 22, “Consolidated Rules of Practice Governing the Administrative Assessment of Civil Penalties and the Revocation or Suspension of Permits,” any person (including a Federal agency) can challenge an EPA administrative action by filing an answer to EPA’s complaint with the regional hearing clerk. The initial decision of a presiding officer or administrative law judge (ALJ) shall become the final order within 45 days after its service upon parties and without further proceedings, unless an appeal is taken to the EAB or the appeals board elects to review the initial decision. If the decision of the presiding officer or ALJ is appealed, the appeals board will issue a final order as soon as practicable after receiving appellate briefs or oral arguments, whichever is later.

Judicial Actions
There are two types of judicial actions: civil and criminal. With regard to civil judicial actions, the Department of Justice has concluded that EPA may not sue another executive branch agency in Federal district court for violating environmental requirements. Instead, EPA enforcement against another agency is accomplished through administrative actions. However, civil judicial actions still are available to parties other than EPA (e.g., states,
private citizens) for the purpose of enforcing environmental requirements as each statute provides.

Most Federal environmental statutes specify violations for which criminal sanctions may be sought. Typically, these violations involve conduct that poses serious risks of endangerment to human health or the environment. Any Federal employee can be subject to criminal fines and imprisonment if convicted of a criminal violation. The employee against whom criminal charges are filed probably will be defended by the Department of Justice only if it is determined to be in the best interest of the United States.

e. Identify the types of data and records required to be retained as permanent records.

The following is taken from the Clean Air Act, section 311, “Records and Audit.”

For each recipient of assistance the CAA shall keep such records as the Administrator shall prescribe, including records that fully disclose the amount and disposition by such recipient of the proceeds of such assistance, the total cost of the project or undertaking in connection with which such assistance is given or used, and the amount of that portion of the cost of the project or undertaking supplied by other sources, and such other records as will facilitate an effective audit.

The Administrator and the Comptroller General of the United States, or any of their duly authorized representatives, shall have access for the purpose of audit and examinations to any books, documents, papers, and records of the recipients that are pertinent to the grants received under this Act.

29. Waste management personnel must demonstrate a familiarity level knowledge of the following laws and regulations 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)

a. Discuss the application of the above laws to the Department of Energy and its facilities.

Clean Water Act (CWA)

The following is taken from DOE, Office of Health, Safety, and Security, Clean Water Act.

The sections of the CWA most relevant to DOE deal with requirements for technology-based effluent limitations, water quality-based effluent limitations, individual control strategies for toxic pollutants, NSPS, regulation of toxics and indirect discharges, Federal facilities’ pollution control, thermal discharges, permits under the NPDES, and permits for the discharge of dredged or fill materials into navigable waters.
All DOE facilities that discharge wastewaters to either a surface water body or a publicly owned treatment works must comply with the CWA. Facilities that directly discharge wastewaters must obtain an NPDES permit. 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. 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 BAT economically achievable. 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.

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. 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.

*Safe Drinking Water Act (SDWA)*

The following is taken from DOE, Office of Health, Safety, and Security, 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.
Public water systems, as defined in 40 CFR 141.2, “Definitions,” provide piped water for human consumption and have at least 15 connections or regularly serve at least 25 people. Public water systems are either

- community water systems: public water systems that serve at least 15 connections used by year-round residents or regularly serve at least 25 year-round residents;
- non-transient non-community water systems: public water systems that are not community water systems but that regularly serve at least the same 25 people for six months per year (e.g., workplaces and hospitals); or
- non-community water systems: all other water systems (e.g., campgrounds and gas stations).

National Primary Drinking Water Regulations

The SDWA requires EPA to establish national primary drinking water regulations (NPDWRs) for contaminants that may cause adverse public health effects. The regulations include both mandatory levels [maximum contaminant levels (MCLs)] and non-enforceable health goals [maximum contaminant level goals (MCLGs)] for each included contaminant. MCLGs have extra significance because they can be used under Superfund as applicable or relevant and appropriate requirements (ARARs) in NPL cleanups.

The 1986 SDWA amendments required EPA to apply future NPDWRs to both community and non-transient non-community water systems when it evaluated and revised current regulations. The first case in which this was applied was the final rule on July 8, 1987. At that time NPDWRs were promulgated for certain synthetic volatile organic compounds (VOCs) and applied to non-transient non-community water systems as well as community water systems. This rulemaking also clarified that non-transient non-community water systems were not subject to MCLs that were promulgated before July 8, 1987.

Future NPDWR standards will apply to non-transient non-community water systems because of concern for the long-term exposure of a stable population. It is important to note that EPA’s decision to apply future NPDWRs to non-transient non-community water systems may have a significant impact on those DOE facilities that operate their own drinking water systems.

Underground Injection Control

Another provision of the SDWA established programs to prevent contamination of underground sources of drinking water by underground injection of contaminated fluids. Prohibitions mandated by the hazardous and solid waste amendments to the RCRA on the underground injection of hazardous wastes were promulgated on July 26, 1988. This rule amended existing UIC regulations as they pertained to hazardous waste injection. It also codified at 40 CFR 148, “Hazardous Waste Injection Restrictions,” the applicable sections of 40 CFR 268, “Land Disposal Restrictions,” EPA’s regulatory framework for implementing the land disposal restrictions (LDRs). The direct impact of UIC regulations on DOE has diminished with the cessation of the hydrofracture project in Oak Ridge, but the requirements are still important in governing the plugging and abandonment of wells used in some past practices.
States have primary enforcement authority for the SDWA, although if states do not properly enforce SDWA requirements, EPA will assume the authority to do so. The Federal government provides funds to assist in state enforcement of the Act. In certain circumstances states may consider cost, benefits, alternatives, public interest, and the protection of human health and the environment in granting variances and exemptions from the national regulation. For example, many of the regulations affecting groundwater provide for exemptions, variances, or alternate concentration limits. Thus, if DOE believes that direct application of a drinking water standard for groundwater protection is not justified on the basis of expected risk to the public at a specific site, DOE may request an exemption, variance, or alternate concentration limit.

Resource Conservation and Recovery Act (RCRA) (Groundwater Provisions)

The following is taken from Office of Environmental Policy and Guidance: Coalgate: 6-6075, Applicability of RCRA Section 3020 to In-Situ Treatment of Groundwater.

On December 27, 2000, the EPA, Office of the Solid Waste issued a memorandum, Applicability of RCRA Section 3020 to In-Situ Treatment of Groundwater, clarifying the applicability of section 3020 of the RCRA to reinjection of groundwater which has been treated to remove contaminants.

The subject memorandum responds to questions received regarding the applicability of RCRA to the reinjection of groundwater contaminated with hazardous wastes during cleanups. Of particular concern is the applicability of section 3020(b) of RCRA to groundwater remedies involving in situ bioremediation and other forms of in situ treatment.

Previously, the EPA had issued a memorandum clarifying that the provisions of 3020 were applicable to a reinjection of treated groundwater, and that reinjection was exempted from section 3020(a) as part of a CERCLA response action or RCRA corrective action remedy.

Section 3020(a) bans the disposal of hazardous waste by underground injection into a formation that contains an underground source of groundwater within one-quarter mile of the injection well.

Section 3020(b) exempts reinjection of treated contaminated groundwater from the section 3020(a) ban and the LDRs if: 1) the reinjection is a CERCLA response action, or part of a RCRA corrective action remedy intended to clean up the contamination; 2) the contaminated groundwater is treated to substantially reduce hazardous constituents prior to such reinjection, and 3) the response action or corrective action is part of a legitimate effort to clean up contamination and is sufficient to protect human health and the environment upon completion.

In the subject memorandum, EPA interprets 3020(b)(2) to require that contaminated groundwater withdrawn from an aquifer be treated prior to reinjection and that treatment be intended to “substantially reduce” hazardous constituents in the groundwater. The EPA notes that the reduction in contaminant levels may occur either before or after (in situ) reinjection of the groundwater into the aquifer.
National Groundwater Protection Policy (NGPP)

The following is taken from U.S. Environmental Protection Agency, Groundwater & Drinking Water.

The Office of Groundwater and Drinking Water (OGWDW), together with states, tribes, and its many partners, protects public health by ensuring safe drinking water and protecting groundwater. OGWDW, along with EPA’s ten regional drinking water programs, oversees implementation of the SDWA, which is the national law safeguarding tap water in America.

EPA finalized the groundwater rule in the Federal Register on November 08, 2006. The purpose of the rule is to provide for increased protection against microbial pathogens in public water systems that use groundwater sources. EPA is particularly concerned about groundwater systems that are susceptible to fecal contamination since disease-causing pathogens may be found in fecal contamination.

Comprehensive State Groundwater Protection Policy (CSGWPP)

The following is taken from the Office of Solid Waste and OSWER Directive 9283.1-09, The Role of CSGWPPs in EPA Remediation Process.

One of the primary purposes of a CSGWPP is to provide a framework for EPA to give greater flexibility to a state for management and protection of its groundwater resources. Such a program was first envisioned in EPA’s Groundwater Strategy for the 1990s, which states that:

To the extent authorized by EPA statute and consistent with Agency program implementation objectives, EPA will defer to State policies, priorities, and standards once a State has developed an adequate program.

EPA’s CSGWPP Guidance

Guidance describing what the agency meant by an adequate groundwater program was issued in 1992. This document, entitled Final Comprehensive State Groundwater Protection Program identified six strategic activities that should be included in a comprehensive state groundwater protection program to be considered adequate by EPA.

The 1992 final CSGWPP guidance describes how developing a CSGWPP is a three-stage process. First, a state develops a core CSGWPP and submits it to the EPA regional office for review and endorsement. The core program need include only one groundwater protection or remediation program to demonstrate whether the state’s CSGWPP approach is consistent with the guidance. Several states have already developed or are developing a core CSGWPP. Second, after the core program is endorsed by EPA, joint state-EPA discussions should result in a “multi-year planning agreement” for incorporating additional state and EPA programs into the CSGWPP, leading to a “fully integrating CSGWPP.” The core CSGWPP provides the basis for multi-year planning discussions. Third, at the completion of the multi-year planning and implementation processes, a “fully integrating” CSGWPP occurs when the six strategic activities, referenced in the final CSGWPP guidance, fundamentally influence and
are supported by the day-to-day operations of Federal, state and local groundwater related protection and remediation programs. Adequacy criteria, which describe what EPA expects from a state for both a core and fully integrating CSGWPP, are described in the 1992 final CSGWPP guidance.

**Oil Pollution Act (OPA)**

The following is taken from U.S. Environmental Protection Agency, Emergency Management, Oil Pollution Act Overview.

The OPA was signed into law in August 1990, largely in response to rising public concern following the Exxon Valdez incident. The OPA improved the nation’s ability to prevent and respond to oil spills by establishing provisions that expand the Federal government’s ability, and provide the money and resources necessary, to respond to oil spills. The OPA also created the national oil spill liability trust fund, which is available to provide up to one billion dollars per spill incident.

In addition, the OPA provided new requirements for contingency planning by government and industry. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) has been expanded in a three-tiered approach: the Federal government is required to direct all public and private response efforts for certain types of spill events; area committees—composed of Federal, state, and local government officials—must develop detailed, location-specific area contingency plans; and owners/operators of vessels and certain facilities that pose a serious threat to the environment must prepare their own facility response plans.

Finally, the OPA increased penalties for regulatory noncompliance, broadened the response and enforcement authorities of the Federal government, and preserved state authority to establish law governing oil spill prevention and response.

**b. Discuss the Clean Water Act permitting requirements including monitoring and reporting. Include in the discussion the National Pollutant Discharge Elimination System Program and the Rivers and Harbors Act Dredge/Fill material permits, as applicable.**

**National Pollutant Discharge Elimination System**

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System.

Water pollution degrades surface waters making them unsafe for drinking, fishing, swimming, and other activities. As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In most cases, the NPDES permit program is administered by authorized states. Since its introduction
in 1972, the NPDES permit program is responsible for significant improvements to our nation’s water quality.

The following is taken from 40 CFR 122.48.

All permits shall specify
- requirements concerning the proper use, maintenance, and installation, when appropriate, of monitoring equipment or methods (including biological monitoring methods when appropriate);
- required monitoring including type, intervals, and frequency sufficient to yield data which are representative of the monitored activity including, when appropriate, continuous monitoring;
- applicable reporting requirements based upon the impact of the regulated activity and as specified in 40 CFR 122.44, “Establishing Limitations, Standards, and Other Permit Conditions.” Reporting shall be no less frequent than specified in the above regulation.

The following is taken from 40 CFR 122.44.

In addition to 40 CFR 122.48, “Requirements for Recording and Reporting on Monitoring Results,” the monitoring requirements include the following:
- To ensure compliance with permit limitations, requirements to monitor
  - the mass for each pollutant limited in the permit;
  - the volume of effluent discharged from each outfall;
  - other measurements as appropriate including pollutants in internal waste streams; pollutants in intake water for net limitations; frequency, rate of discharge, etc., for non-continuous discharges; pollutants subject to notification requirements; and
  - pollutants in sewage sludge or other monitoring; or as determined to be necessary on a case-by-case basis;
  - according to test procedures for the analyses of pollutants. In the case of pollutants for which there are no approved methods, monitoring must be conducted according to a test procedure specified in the permit for such pollutants.
- Requirements to report monitoring results shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the discharge, but in no case less than once a year. For sewage sludge use or disposal practices, requirements to monitor and report results shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the sewage sludge use or disposal practice; but in no case less than once a year.
- Requirements to report monitoring results for stormwater discharges associated with industrial activity which are subject to an effluent limitation guideline shall be established on a case-by-case basis with a frequency dependent on the nature and effect of the discharge, but in no case less than once a year.
- Requirements to report monitoring results for stormwater discharges associated with industrial activity shall be established on a case-by-case basis with a frequency
dependent on the nature and effect of the discharge. At a minimum, a permit for such a discharge must require
  o the discharger to conduct an annual inspection of the facility site to identify areas contributing to a stormwater discharge associated with industrial activity and evaluate whether measures to reduce pollutant loadings identified in a stormwater pollution prevention plan are adequate and properly implemented in accordance with the terms of the permit or whether additional control measures are needed;
  o the discharger to maintain for a period of three years a record summarizing the results of the inspection and a certification that the facility is in compliance with the plan and the permit, and identifying any incidents of non-compliance; such report and certification should be signed; and
  o permits for stormwater discharges associated with industrial activity from inactive mining operations may, where annual inspections are impracticable, require certification once every three years by a registered professional engineer that the facility is in compliance with the permit, or alternative requirements.

- Permits that do not require the submittal of monitoring result reports at least annually shall require that the permittee report all instances of noncompliance not reported at least annually.

Rivers and Harbors Act Dredge/Fill Material Permits
The following is taken from the U.S. Fish and Wildlife Service, Rivers and Harbors Appropriation Act of 1899.

Section 9 of the Rivers and Harbors Appropriation Act of 1899, prohibits the construction of any bridge, dam, dike or causeway over or in navigable waterways of the U.S. without congressional approval. Administration of section 9 has been delegated to the Coast Guard. Structures authorized by state legislatures may be built if the affected navigable waters are totally within one state, provided that the plan is approved by the chief of engineers and the Secretary of Army.

Under section 10 of the Act, the building of any wharfs, piers, jetties, and other structures is prohibited without congressional approval, and excavation or fill within navigable waters requires the approval of the chief of engineers. Service concerns include contaminated sediments associated with dredge or fill projects in navigable waters.

Authority of the Corps of Engineers to issue permits for the discharge of refuse matter into or affecting navigable waters was modified by the Federal Water Pollution Control Act, which established the National Pollutant Discharge Elimination System Permits.

The following is taken from the U.S. Army Corps of Engineers (USACE), Philadelphia District Regulatory Branch, Permitting Overview.

The legislative origins of the dredge/fill material permitting program are the Rivers and Harbors Act of 1899. Various sections establish permit requirements to prevent unauthorized obstruction or alteration of any navigable water of the United States. The most frequently
exercised authority is contained in section 10, which covers construction, excavation, or deposition of materials in, over, or under such waters, or any work that would affect the course, location, condition, or capacity of those waters. The authority is granted to the Secretary of the Army. Other permit authorities in the act are section 9 for dams and dikes, section 13 for refuse disposal, and section 14 for temporary occupation of work built by the United States. Various pieces of legislation have modified these authorities, but have not removed them.

As established in 1972, section 404 of the CWA enables the USACE to issue permits for the discharge of dredged or fill materials into waters of the United States at specific sites. The USACE specifies a site by applying guidelines promulgated by the EPA. 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. 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 the USACE and the permit applicant.

A significant feature of section 404 is that the USACE 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 USACE 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. Placement of riprap and construction of new dams also fall under the purview of section 404 permits.

Much of the remainder of section 404 deals with the role of the USACE and EPA in state-administered programs in which states elect to issue dredge and fill permits themselves. In these cases, the EPA and the USACE review state programs and ensure coordination with Federal water-related programs, and EPA receives copies of all permit applications.

c. Discuss the standards for maximum contaminant levels (primary and secondary) contained in the Safe Drinking Water Act.

The following is taken from ExToxNetFAQs, orst.edu, Drinking Water Standards.
Federal drinking water standards are in force for public water systems. Private water supplies are not subject to these standards.

The EPA sets two types of standards:

- **Primary standards** are set to provide the maximum feasible protection to public health. They regulate contaminant levels based on toxicity and adverse health effects. The goal of standard-setting is to identify maximum contaminant levels (MCLs) which prevent adverse health effects.

- **Secondary standards** regulate contaminant levels based on aesthetics such as color and odor, which do not pose a risk to health. These secondary maximum contaminant levels (SMCLs) are guidelines, not enforceable limits. They identify acceptable concentrations of contaminants which cause unpleasant tastes, odors, or colors in the water. SMCLs are for contaminants that will not cause adverse health effects.

Public water suppliers are required to monitor the quality of the water they supply. Consumers must be notified if a primary standard is exceeded.

[Note: The SDWA was last amended in 1996 and no longer uses primary and secondary standards.]

The following is taken from EPA 816-F-04-037.

EPA uses the following steps to set enforceable, health-based drinking water standards:

- Set a maximum contaminant level goal (MCLG)—the level of a contaminant in drinking water below which there is no known or expected health risk. MCLGs (similar to SMCLs above) allow for a margin of safety. These goals take into account the risks of exposure for certain sensitive populations, such as infants, the elderly, and persons with compromised immune systems. These goals are not enforceable levels because they do not take available technology into consideration, and therefore are sometimes set at levels which public water systems cannot meet.

- Propose an enforceable standard in the form of a MCL (the maximum amount of a contaminant allowed in water delivered to a user of any public water system) or a treatment technique (required procedure or level of technological performance set when there is no reliable method to measure a contaminant at very low levels). MCLs are set as close to MCLGs as feasible, considering available technology and cost. Examples of rules requiring treatment techniques are the surface water treatment rule (requires disinfection and filtration) and the lead and copper rule (requires optimized corrosion control). Water samples that contain lead or copper exceeding the action level trigger additional treatment or other requirements that a water system must follow. Required testing (monitoring) schedules are part of the enforceable standard.

**d. Identify the groundwater protection requirements applicable to interim status Resource Conservation and Recovery Act (RCRA) facilities in RCRA's implementing regulations, subpart F of 40 CFR 265.**

The following is taken from subpart F of 40 CFR 265.
**Groundwater Monitoring System**

A groundwater monitoring system must be capable of yielding groundwater samples for analysis and must consist of the following:

- Monitoring wells installed hydraulically upgradient from the limit of the waste management area. Their number, locations, and depths must be sufficient to yield groundwater samples that are
  - representative of background groundwater quality in the uppermost aquifer near the facility; and
  - not affected by the facility.

- Monitoring wells installed hydraulically downgradient at the limit of the waste management area. Their number, locations, and depths must ensure that they immediately detect any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer.

- The facility owner or operator may demonstrate that an alternate hydraulically downgradient monitoring well location will meet the criteria outlined below. The demonstration must be in writing and kept at the facility. The demonstration must be certified by a qualified groundwater scientist and establish that
  - an existing physical obstacle prevents monitoring well installation at the hydraulically downgradient limit of the waste management area;
  - the selected alternate downgradient location is as close to the limit of the waste management area as practical;
  - the location ensures detection that, given the alternate location, is as early as possible of any statistically significant amounts of hazardous waste or hazardous waste constituents that migrate from the waste management area to the uppermost aquifer; and
  - lateral expansion, new, or replacement units are not eligible for an alternate downgradient location under this paragraph.

Separate monitoring systems for each waste management component of a facility are not required provided that provisions for sampling upgradient and downgradient water quality will detect any discharge from the waste management area.

- In the case of a facility consisting of only one surface impoundment, landfill, or land treatment area, the waste management area is described by the waste boundary (perimeter).
- In the case of a facility consisting of more than one surface impoundment, landfill, or land treatment area, the waste management area is described by an imaginary boundary line which circumscribes the several waste management components.

All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well bore hole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed with a suitable material to prevent contamination of samples and the groundwater.
Sampling and Analysis

The owner or operator must obtain and analyze samples from the installed groundwater monitoring system. The owner or operator must develop and follow a groundwater sampling and analysis plan. He must keep this plan at the facility. The plan must include procedures and techniques for the following:

- Sample collection
- Sample preservation and shipment
- Analytical procedures
- Chain of custody control

The owner or operator must determine the concentration or value of the following parameters in groundwater samples:

- Parameters characterizing the suitability of the groundwater as a drinking water supply
- Parameters establishing groundwater quality:
  - Chloride
  - Iron
  - Manganese
  - Phenols
  - Sodium
  - Sulfate
- Parameters used as indicators of groundwater contamination:
  - Ph
  - Specific Conductance
  - Total Organic Carbon
  - Total Organic Halogen

For all monitoring wells, the owner or operator must establish initial background concentrations or values of all parameters specified in 40 CFR 265.92, “Sampling and Analysis.” The owner or operator must do this quarterly for one year.

For each of the indicator parameters specified, at least four replicate measurements must be obtained for each sample and the initial background arithmetic mean and variance must be determined by pooling the replicate measurements for the respective parameter concentrations or values in samples obtained from upgradient wells during the first year.

After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies:

- Samples collected to establish groundwater quality must be obtained and analyzed for the parameters specified at least annually.
- Samples collected to indicate groundwater contamination must be obtained and analyzed for the parameters specified at least semi-annually.

Elevation of the groundwater surface at each monitoring well must be determined each time a sample is obtained.
Preparation, Evaluation, and Response

Within one year after the effective date of these regulations, the owner or operator must prepare an outline of a groundwater quality assessment program. The outline must describe a comprehensive groundwater monitoring program capable of determining:

- whether hazardous waste or hazardous waste constituents have entered the groundwater
- the rate and extent of migration of hazardous waste or hazardous waste constituents in the groundwater
- the concentrations of hazardous waste or hazardous waste constituents in the groundwater

For each indicator parameter specified in 40 CFR 265.92(b)(3), the owner or operator must calculate the arithmetic mean and variance, based on at least four replicate measurements on each sample, for each well monitored in accordance with 40 CFR 265.92(d)(2), and compare these results with its initial background arithmetic mean. The comparison must consider individually each of the wells in the monitoring system, and must use the student’s t-test at the 0.01 level of significance to determine statistically significant increases over initial background.

If the comparisons for the upgradient wells show a significant increase, or pH decrease, the owner or operator must submit this information in accordance with 40 CFR 265.94, “Recordkeeping and Reporting.”

If the comparisons for downgradient wells show a significant increase, or pH decrease, the owner or operator must then immediately obtain additional groundwater samples from those downgradient wells where a significant difference was detected, split the samples in two, and obtain analyses of all additional samples to determine whether the significant difference was a result of laboratory error.

If the analyses performed confirm the significant increase, or pH decrease, the owner or operator must provide written notice to the regional administrator—within seven days of the date of such confirmation—that the facility may be affecting groundwater quality.

Within 15 days after the notification, the owner or operator must develop a specific plan, based on the outline required certified by a qualified geologist or geotechnical engineer, for a groundwater quality assessment at the facility. This plan must be placed in the facility operating record and be maintained until closure of the facility.

The plan to be submitted must specify:

- the number, location, and depth of wells
- sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility
- evaluation procedures, including any use of previously-gathered groundwater quality information
- a schedule of implementation
The owner or operator must implement the groundwater quality assessment plan, and, at a minimum, determine

- the rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater
- the concentrations of the hazardous waste or hazardous waste constituents in the groundwater

The owner or operator must make the first determination as soon as technically feasible, and prepare a report containing an assessment of groundwater quality. This report must be placed in the facility operating record and be maintained until closure of the facility.

If the owner or operator determines that no hazardous waste or hazardous waste constituents from the facility have entered the groundwater, then he or she may reinstate the indicator evaluation program. If the owner or operator reinstates the indicator evaluation program, the owner must so notify the regional administrator in the report.

If the owner or operator determines that hazardous waste or hazardous waste constituents from the facility have entered the groundwater, then the owner

- must continue to make the determinations on a quarterly basis until final closure of the facility, if the groundwater quality assessment plan was implemented prior to final closure of the facility; or
- may cease to make the determinations if the groundwater quality assessment plan was implemented during the post-closure care period.

Any groundwater quality assessment to satisfy the requirements that is initiated prior to final closure of the facility must be completed and reported.

Unless the groundwater is monitored to satisfy the requirements, at least annually the owner or operator must evaluate the data on groundwater surface elevations obtained to determine whether the requirements for locating the monitoring wells continue to be satisfied. If the evaluation shows that the requirements are no longer satisfied, the owner or operator must immediately modify the number, location, or depth of the monitoring wells to bring the groundwater monitoring system into compliance with this requirement.

Recordkeeping and Reporting

Unless the groundwater is monitored to satisfy the requirements, the owner or operator must do the following:

- Keep records of the analyses, the associated groundwater surface elevations required, and the evaluations required throughout the active life of the facility, and, for disposal facilities, throughout the post-closure care period as well; and
- Report the following groundwater monitoring information to the regional administrator:
  - During the first year when initial background concentrations are being established for the facility: Concentrations or values of the parameters for each groundwater monitoring well within 15 days after completing each quarterly analysis. The
owner or operator must separately identify for each monitoring well any parameters whose concentration or value has been found to exceed the MCLs.

- Annually: Concentrations or values of the parameters for each groundwater monitoring well, along with the required evaluations for these parameters. The owner or operator must separately identify any significant differences from initial background found in the upgradient wells. During the active life of the facility, this information must be submitted no later than March 1 following each calendar year.

- No later than March 1 following each calendar year: Results of the evaluations of groundwater surface elevations and a description of the response to that evaluation, where applicable.

If the groundwater is monitored to satisfy the requirements, the owner or operator must do the following:

- Keep records of the analyses and evaluations specified in the plan, which satisfies the requirements throughout the active life of the facility, and, for disposal facilities, throughout the post-closure care period as well; and

- Annually, until final closure of the facility, submit to the regional administrator a report containing the results of his or her groundwater quality assessment program which includes, but is not limited to, the calculated rate of migration of hazardous waste or hazardous waste constituents in the groundwater during the reporting period. This information must be submitted no later than March 1 following each calendar year.

e. Identify the groundwater protection requirements applicable to permitted Resource Conservation and Recovery Act (RCRA) facilities in RCRA’s implementing regulations, subpart F of 40 CFR 264 and in the facility’s permit.

The following is taken from subpart F of 40 CFR 264.

**Required Programs**

- Owners/operators subject to this subpart must conduct a monitoring and response program as follows:
  - Whenever hazardous constituents under Sec. 264.93 from a regulated unit are detected at a compliance point under Sec. 264.95, the owner or operator must institute a compliance monitoring program under Sec. 264.99. Detected is defined as statistically significant evidence of contamination as described in Sec. 264.98(f).
  - Whenever the groundwater protection standard under Sec. 264.92 is exceeded, the owner or operator must institute a corrective action program under Sec. 264.100. Exceeded is defined as statistically significant evidence of increased contamination as described in Sec. 264.99(d).
  - Whenever hazardous constituents under Sec. 264.93 from a regulated unit exceed concentration limits under Sec. 264.94 in groundwater between the compliance point under Sec. 264.95 and the downgradient facility property boundary, the owner or operator must institute a corrective action program under Sec. 264.100.
In all other cases, the owner or operator must institute a detection monitoring program under Sec. 264.98.

The regional administrator will specify in the facility permit the specific elements of the monitoring and response program. The regional administrator may include one or more of the programs identified in paragraph (a) of this section in the facility permit as may be necessary to protect human health and the environment and will specify the circumstances under which each of the programs will be required. In deciding whether to require the owner or operator to be prepared to institute a particular program, the regional administrator will consider the potential adverse effects on human health and the environment that might occur before final administrative action on a permit modification application to incorporate such a program could be taken.

**Groundwater Protection Standard**

The owner or operator must comply with conditions specified in the facility permit that are designed to ensure that hazardous constituents under Sec. 264.93 detected in the groundwater from a regulated unit do not exceed the concentration limits under Sec. 264.94 in the uppermost aquifer underlying the waste management area beyond the point of compliance under Sec. 264.95 during the compliance period under Sec. 264.96. The regional administrator will establish this groundwater protection standard in the facility permit when hazardous constituents have been detected in the groundwater.

**Hazard Constituents**

The regional administrator will specify in the facility permit the hazardous constituents to which the groundwater protection standard of Sec. 264.92 applies. Hazardous constituents are constituents identified in appendix VIII of part 261 of this chapter that have been detected in groundwater in the uppermost aquifer underlying a regulated unit and that are reasonably expected to be in or derived from waste contained in a regulated unit, unless the regional administrator has excluded them as specified below.

The regional administrator will exclude an appendix VIII constituent from the list of hazardous constituents specified in the facility permit if he finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment. In deciding whether to grant an exemption, the regional administrator will consider the following:

- Potential adverse effects on groundwater quality, considering the
  - physical and chemical characteristics of the waste in the regulated unit, including its potential for migration
  - hydrogeological characteristics of the facility and surrounding land
  - quantity of groundwater and the direction of groundwater flow
  - proximity and withdrawal rates of groundwater users
  - current and future uses of groundwater in the area
  - existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality
  - potential for health risks caused by human exposure to waste constituents
potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents

- persistence and permanence of the potential adverse effects

- Potential adverse effects on hydraulically-connected surface water quality, considering the
  - volume and physical and chemical characteristics of the waste in the regulated unit
  - hydrogeological characteristics of the facility and surrounding land
  - quantity and quality of groundwater, and the direction of groundwater flow
  - patterns of rainfall in the region
  - proximity of the regulated unit to surface waters
  - current and future uses of surface waters in the area and any water quality standards established for those surface waters
  - existing quality of surface water, including other sources of contamination and the cumulative impact on surface-water quality
  - potential for health risks caused by human exposure to waste constituents
  - potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
  - persistence and permanence of the potential adverse effects

- In making any determination about the use of groundwater in the area around the facility, the regional administrator will consider any identification of underground sources of drinking water and exempted aquifers made under Sec. 144.8 of this chapter.

Concentration Limits

The regional administrator will specify in the facility permit concentration limits in the groundwater for hazardous constituents established under Sec. 264.93. The concentration of a hazardous constituent

- must not exceed the background level of that constituent in the groundwater at the time that limit is specified in the permit
- for any of the constituents listed in table 1 of this section, must not exceed the respective value given in that table if the background level of the constituent is below the value given in table 1
- must not exceed an alternate limit established by the regional administrator as specified in the following paragraph

The regional administrator will establish an alternate concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded. In establishing alternate concentration limits, the regional administrator will consider the following factors:

- Potential adverse effects on groundwater quality, considering the
physical and chemical characteristics of the waste in the regulated unit, including its potential for migration
hydrogeological characteristics of the facility and surrounding land
quantity of groundwater and the direction of groundwater flow
proximity and withdrawal rates of groundwater users
current and future uses of groundwater in the area;
existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality
potential for health risks caused by human exposure to waste constituents
potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
persistence and permanence of the potential adverse effects

Potential adverse effects on hydraulically-connected surface-water quality, considering the
volume and physical and chemical characteristics of the waste in the regulated unit
hydrogeological characteristics of the facility and surrounding land
quantity and quality of groundwater, and the direction of groundwater flow
patterns of rainfall in the region
proximity of the regulated unit to surface waters
current and future uses of surface waters in the area and any water quality standards established for those surface waters
existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality
potential for health risks caused by human exposure to waste constituents
potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents
persistence and permanence of the potential adverse effects

In making any alternate concentration limit determination about the use of groundwater in the area around the facility the regional administrator will consider any identification of underground sources of drinking water and exempted aquifers made under Sec. 144.8 of this chapter.

Point of Compliance
The regional administrator will specify in the facility permit the point of compliance at which the groundwater protection standard of Sec. 264.92 applies and at which monitoring must be conducted. The point of compliance is a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units.

The waste management area is the limit projected in the horizontal plane of the area on which waste will be placed during the active life of a regulated unit. The waste management area includes horizontal space taken up by any liner, dike, or other barrier designed to contain
waste in a regulated unit. If the facility contains more than one regulated unit, the waste management area is described by an imaginary line circumscribing the several regulated units.

**Compliance Period**

The regional administrator will specify in the facility permit the compliance period during which the groundwater protection standard of Sec. 264.92 applies. The compliance period is the number of years equal to the active life of the waste management area (including any waste management activity prior to permitting, and the closure period).

The compliance period begins when the owner or operator initiates a compliance monitoring program meeting the requirements of Sec. 264.99.

If the owner or operator is engaged in a corrective action program at the end of the compliance period specified above, the compliance period is extended until the owner or operator can demonstrate that the groundwater protection standard of Sec. 264.92 has not been exceeded for a period of three consecutive years.

**General Groundwater Monitoring Requirements**

The owner or operator must comply with the following requirements for any groundwater monitoring program developed to satisfy Sec. 264.98, Sec. 264.99, or Sec. 264.100:

- 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 will accomplish the following:
  - Represent the quality of background groundwater that has not been affected by leakage from a regulated unit:
    - A determination of background groundwater quality may include sampling of wells that are not hydraulically upgradient of the waste management area where hydrogeologic conditions do not allow the owner or operator to determine what wells are hydraulically upgradient; and sampling at other wells will provide an indication of background groundwater quality that is representative or more representative than that provided by the upgradient wells.
  - Represent the quality of groundwater passing the point of compliance.
  - Allow for the detection of contamination when hazardous waste or hazardous constituents have migrated from the waste management area to the uppermost aquifer.

- If a facility contains more than one regulated unit, separate groundwater monitoring systems are not required for each regulated unit provided that provisions for sampling the groundwater in the uppermost aquifer will enable detection and measurement at the compliance point of hazardous constituents from the regulated units that have entered the groundwater in the uppermost aquifer.

- All monitoring wells must be cased in a manner that maintains the integrity of the monitoring-well bore hole. This casing must be screened or perforated and packed
with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space (i.e., the space between the bore hole and well casing) above the sampling depth must be sealed to prevent contamination of samples and the groundwater.

- The groundwater monitoring program must include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide a reliable indication of groundwater quality below the waste management area. At a minimum the program must include procedures and techniques for:
  - Sample collection
  - Sample preservation and shipment
  - Analytical procedures
  - Chain of custody control

- The groundwater monitoring program must include sampling and analytical methods that are appropriate for groundwater sampling and that accurately measure hazardous constituents in groundwater samples.

- The groundwater monitoring program must include a determination of the groundwater surface elevation each time groundwater is sampled.

- In detection monitoring or where appropriate in compliance monitoring, data on each hazardous constituent specified in the permit will be collected from background wells and wells at the compliance point(s). The number and kinds of samples collected to establish background shall be appropriate for the form of statistical test employed, following generally accepted statistical principles. The sample size shall be as large as necessary to ensure with reasonable confidence that a contaminant release to groundwater from a facility will be detected. The owner or operator will determine an appropriate sampling procedure and interval for each hazardous constituent listed in the facility permit which shall be specified in the unit permit upon approval by the regional administrator. This sampling procedure shall be:
  - A sequence of at least four samples, taken at an interval that ensures, to the greatest extent technically feasible, that an independent sample is obtained, by reference to the uppermost aquifer’s effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of the potential contaminants, or
  - An alternate sampling procedure proposed by the owner or operator and approved by the regional administrator.

- The owner or operator will specify one of the following statistical methods to be used in evaluating groundwater monitoring data for each hazardous constituent which, upon approval by the regional administrator, will be specified in the unit permit. The statistical test chosen shall be conducted separately for each hazardous constituent in each well. Where practical quantification limits (pql’s) are used in any of the following statistical procedures to comply with Sec. 264.97(i)(5), the pql must be proposed by the owner or operator and approved by the regional administrator. Use of any of the following statistical methods must be protective of human health and the
environment and must comply with the performance standards outlined in the bullet (●) on statistical methods below.

- A parametric analysis of variance (ANOVA) followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well’s mean and the background mean levels for each constituent.
- An ANOVA based on ranks followed by multiple comparisons procedures to identify statistically significant evidence of contamination. The method must include estimation and testing of the contrasts between each compliance well’s median and the background median levels for each constituent.
- A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data, and the level of each constituent in each compliance well is compared to the upper tolerance or prediction limit.
- A control chart approach that gives control limits for each constituent.
- Another statistical test method submitted by the owner or operator and approved by the regional administrator.

- Any statistical method chosen under Sec. 264.97(h) (see above bullet (●)) for specification in the unit permit shall comply with the following performance standards, as appropriate:
  - The statistical method used to evaluate groundwater monitoring data shall be appropriate for the distribution of chemical parameters or hazardous constituents. If the distribution of the chemical parameters or hazardous constituents is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.
  - If an individual well comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a groundwater protection standard, the test shall be done at a type I error level no less than 0.01 for each testing period. If a multiple comparisons procedure is used, the type I experiment-wise error rate for each testing period shall be no less than 0.05; however, the type I error of no less than 0.01 for individual well comparisons must be maintained. This performance standard does not apply to tolerance intervals, prediction intervals or control charts.
  - If a control chart approach is used to evaluate groundwater monitoring data, the specific type of control chart and its associated parameter values shall be proposed by the owner or operator and approved by the regional administrator if he or she finds it to be protective of human health and the environment.
  - If a tolerance interval or a prediction interval is used to evaluate groundwater monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain, shall be proposed by the owner or operator and approved by the regional administrator if he or she
finds these parameters to be protective of human health and the environment. These parameters will be determined after considering the number of samples in the background database, the data distribution, and the range of the concentration values for each constituent of concern.

- The statistical method shall account for data below the limit of detection with one or more statistical procedures that are protective of human health and the environment. Any pql approved by the regional administrator under Sec. 264.97(h) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.
- If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

- Groundwater monitoring data collected in accordance with paragraph (g) of this section including actual levels of constituents must be maintained in the facility operating record. The regional administrator will specify in the permit when the data must be submitted for review.

**Detection Monitoring Program**

An owner or operator required to establish a detection monitoring program under this subpart must, at a minimum, discharge the following responsibilities:

- The owner or operator must monitor for indicator parameters (e.g., specific conductance, total organic carbon, or total organic halogen), waste constituents, or reaction products that provide a reliable indication of the presence of hazardous constituents in groundwater. The regional administrator will specify the parameters or constituents to be monitored in the facility permit, after considering the following factors:
  - The types, quantities, and concentrations of constituents in wastes managed at the regulated unit
  - The mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated zone beneath the waste management area
  - The detectability of indicator parameters, waste constituents, and reaction products in groundwater
  - The concentrations or values and coefficients of variation of proposed monitoring parameters or constituents in the groundwater background

- The owner or operator must install a groundwater monitoring system at the compliance point as specified under Sec. 264.95. The groundwater monitoring system must comply with Sec. 264.97(a)(2), (b), and (c).

- The owner or operator must conduct a groundwater monitoring program for each chemical parameter and hazardous constituent specified in the permit pursuant to paragraph (a) of this section in accordance with Sec. 264.97(g). The owner or operator must maintain a record of groundwater analytical data as measured and in a form necessary for the determination of statistical significance under Sec. 264.97(h).
The regional administrator will specify the frequencies for collecting samples and conducting statistical tests to determine whether there is statistically significant evidence of contamination for any parameter or hazardous constituent specified in the permit conditions under paragraph (a) of this section in accordance with Sec. 264.97(g).

The owner or operator must determine the groundwater flow rate and direction in the uppermost aquifer at least annually.

The owner or operator must determine whether there is statistically significant evidence of contamination for any chemical parameter or hazardous constituent specified in the permit pursuant to paragraph (a) of this section at a frequency specified under paragraph (d) of this section:

- In determining whether statistically significant evidence of contamination exists, the owner or operator must use the method(s) specified in the permit under Sec. 264.97(h). These method(s) must compare data collected at the compliance point(s) to the background groundwater quality data.
- The owner or operator must determine whether there is statistically significant evidence of contamination at each monitoring well as the compliance point within a reasonable period of time after completion of sampling. The regional administrator will specify in the facility permit what period of time is reasonable, after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of groundwater samples.

If the owner or operator determines pursuant to paragraph (f) of this section that there is statistically significant evidence of contamination for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he or she must do the following:

- Notify the regional administrator of this finding in writing within seven days. The notification must indicate what chemical parameters or hazardous constituents have shown statistically significant evidence of contamination.
- Immediately sample the groundwater in all monitoring wells and determine whether constituents in the list of appendix IX of this part are present, and if so, in what concentration. However, the regional administrator, on a discretionary basis, may allow sampling for a site-specific subset of constituents from the appendix IX list of this part and other representative/related waste constituents.
- For any appendix IX compounds found in the analysis pursuant to paragraph (g)(2) of this section, the owner or operator may resample within one month or at an alternative site-specific schedule approved by the regional administrator and repeat the analysis for those compounds detected. If the results of the second analysis confirm the initial results, then these constituents will form the basis for compliance monitoring. If the owner or operator does not resample for the compounds in paragraph (g)(2) of this section, the hazardous constituents found during this initial appendix IX analysis will form the basis for compliance monitoring.
- Within 90 days, submit to the regional administrator an application for a permit modification to establish a compliance monitoring program meeting the
requirements of Sec. 264.99. The application must include the following information:

- An identification of the concentration of any appendix IX constituent detected in the groundwater at each monitoring well at the compliance point
- Any proposed changes to the groundwater monitoring system at the facility necessary to meet the requirements of Sec. 264.99
- Any proposed additions or changes to the monitoring frequency, sampling and analysis procedures or methods, or statistical methods used at the facility necessary to meet the requirements of Sec. 264.99
- For each hazardous constituent detected at the compliance point, a proposed concentration limit under Sec. 264.94(a) (1) or (2), or a notice of intent to seek an alternate concentration limit under Sec. 264.94(b)

Within 180 days, submit to the regional administrator the following information:

- All data necessary to justify an alternate concentration limit sought under Sec. 264.94(b)
- An engineering feasibility plan for a corrective action program necessary to meet the requirement of Sec. 264.100, unless all hazardous constituents identified under paragraph (g)(2) of this section are listed in table 1 of Sec. 264.94 and their concentrations do not exceed the respective values given in that table; or the owner or operator has sought an alternate concentration limit under Sec. 264.94(b) for every hazardous constituent identified under paragraph (g)(2) of this section

If the owner or operator determines, pursuant to paragraph (f) of this section, that there is a statistically significant difference for chemical parameters or hazardous constituents specified pursuant to paragraph (a) of this section at any monitoring well at the compliance point, he or she may demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the groundwater. The owner or operator may make a demonstration under this paragraph in addition to, or in lieu of, submitting a permit modification application under paragraph (g)(4) of this section; however, the owner or operator is not relieved of the requirement to submit a permit modification application within the time specified in paragraph (g)(4) of this section unless the demonstration made under this paragraph successfully shows that a source other than a regulated unit caused the increase, or that the increase resulted from error in sampling, analysis, or evaluation. In making a demonstration under this paragraph, the owner or operator must do the following:

- Notify the regional administrator in writing within seven days of determining statistically significant evidence of contamination at the compliance point that he intends to make a demonstration under this paragraph
- Within 90 days, submit a report to the regional administrator which demonstrates that a source other than a regulated unit caused the
contamination or that the contamination resulted from error in sampling, analysis, or evaluation

- Within 90 days, submit to the regional administrator an application for a permit modification to make any appropriate changes to the detection monitoring program facility
- Continue to monitor in accordance with the detection monitoring program established under this section

- If the owner or operator determines that the detection monitoring program no longer satisfies the requirements of this section, he or she must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

Compliance Monitoring Program

An owner or operator required to establish a compliance monitoring program under this subpart must, at a minimum, discharge the following responsibilities:

- The owner or operator must monitor the groundwater to determine whether regulated units are in compliance with the groundwater protection standard under Sec. 264.92. The regional administrator will specify the groundwater protection standard in the facility permit, including
  - a list of the hazardous constituents identified under Sec. 264.93
  - concentration limits under Sec. 264.94 for each of those hazardous constituents
  - the compliance point under Sec. 264.95
  - the compliance period under Sec. 264.96

- The owner or operator must install a groundwater monitoring system at the compliance point as specified under Sec. 264.95. The groundwater monitoring system must comply with Sec. 264.97(a)(2), (b), and (c).
- The regional administrator will specify the sampling procedures and statistical methods appropriate for the constituents and the facility, consistent with Sec. 264.97(g) and (h):
  o The owner or operator must conduct a sampling program for each chemical parameter or hazardous constituent in accordance with Sec. 264.97(g).
  o The owner or operator must record groundwater analytical data as measured and in form necessary for the determination of statistical significance under Sec. 264.97(h) for the compliance period of the facility.

- The owner or operator must determine whether there is statistically significant evidence of increased contamination for any chemical parameter or hazardous constituent specified in the permit, pursuant to paragraph (a) of this section, at a frequency specified under paragraph (f) under this section:
  o In determining whether statistically significant evidence of increased contamination exists, the owner or operator must use the method(s) specified in the permit under Sec. 264.97(h). The method(s) must compare data collected at
the compliance point(s) to a concentration limit developed in accordance with Sec. 264.94.

o The owner or operator must determine whether there is statistically significant evidence of increased contamination at each monitoring well at the compliance point within a reasonable time period after completion of sampling. The regional administrator will specify that time period in the facility permit, after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of groundwater samples.

- The owner or operator must determine the groundwater flow rate and direction in the uppermost aquifer at least annually.
- The regional administrator will specify the frequencies for collecting samples and conducting statistical tests to determine statistically significant evidence of increased contamination in accordance with Sec. 264.97(g).
- Annually, the owner or operator must determine whether additional hazardous constituents from appendix IX of this part, which could possibly be present but are not on the detection monitoring list in the permit, are actually present in the uppermost aquifer and, if so, at what concentration, pursuant to procedures in Sec. 264.98(f). To accomplish this, the owner or operator must consult with the regional administrator to determine on a case-by-case basis: which sample collection event during the year will involve enhanced sampling; the number of monitoring wells at the compliance point to undergo enhanced sampling; the number of samples to be collected from each of these monitoring wells; and, the specific constituents from appendix IX of this part for which these samples must be analyzed. If the enhanced sampling event indicates that appendix IX constituents are present in the groundwater that are not already identified in the permit as monitoring constituents, the owner or operator may resample within one month or at an alternative site-specific schedule approved by the regional administrator, and repeat the analysis. If the second analysis confirms the presence of new constituents, the owner or operator must report the concentration of these additional constituents to the regional administrator within seven days after the completion of the second analysis and add them to the monitoring list. If the owner or operator chooses not to resample, then he or she must report the concentrations of these additional constituents to the regional administrator within seven days after completion of the initial analysis, and add them to the monitoring list.
- If the owner or operator determines pursuant to paragraph (d) of this section that any concentration limits under Sec. 264.94 are being exceeded at any monitoring well at the point of compliance he or she must do the following:
  o Notify the regional administrator of this finding in writing within seven days. The notification must indicate what concentration limits have been exceeded.
  o Submit to the regional administrator an application for a permit modification to establish a corrective action program meeting the requirements of Sec. 264.100 within 180 days, or within 90 days if an engineering FS has been previously submitted to the regional administrator under Sec. 264.98(g)(5). The application must at a minimum include the following information:
• A detailed description of corrective actions that will achieve compliance with the groundwater protection standard specified in the permit under paragraph (a) of this section
• A plan for a groundwater monitoring program that will demonstrate the effectiveness of the corrective action. Such a groundwater monitoring program may be based on a compliance monitoring program developed to meet the requirements of this section

- If the owner or operator determines, pursuant to paragraph (d) of this section, that the groundwater concentration limits under this section are being exceeded at any monitoring well at the point of compliance, he or she may demonstrate that a source other than a regulated unit caused the contamination or that the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the groundwater. In making a demonstration under this paragraph, the owner or operator must do the following:
  - Notify the regional administrator in writing within seven days that he or she intends to make a demonstration under this paragraph
  - Within 90 days, submit a report to the regional administrator which demonstrates that a source other than a regulated unit caused the standard to be exceeded or that the apparent noncompliance with the standards resulted from error in sampling, analysis, or evaluation
  - Within 90 days, submit to the regional administrator an application for a permit modification to make any appropriate changes to the compliance monitoring program at the facility
  - Continue to monitor in accord with the compliance monitoring program established under this section.

- If the owner or operator determines that the compliance monitoring program no longer satisfies the requirements of this section, he or she must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

Corrective Action Program
An owner or operator required to establish a corrective action program under this subpart must, at a minimum, discharge the following responsibilities:

- The owner or operator must take corrective action to ensure that regulated units are in compliance with the groundwater protection standard under Sec. 264.92. The regional administrator will specify the groundwater protection standard in the facility permit, including
  - a list of the hazardous constituents identified under Sec. 264.93
  - concentration limits under Sec. 264.94 for each of those hazardous constituents
  - the compliance point under Sec. 264.95
  - the compliance period under Sec. 264.96

- The owner or operator must implement a corrective action program that prevents hazardous constituents from exceeding their respective concentration limits at the
compliance point by removing the hazardous waste constituents or treating them in place. The permit will specify the specific measures that will be taken.

- The owner or operator must begin corrective action within a reasonable time period after the groundwater protection standard is exceeded. The regional administrator will specify that time period in the facility permit. If a facility permit includes a corrective action program in addition to a compliance monitoring program, the permit will specify when the corrective action will begin and such a requirement will operate in lieu of Sec. 264.99(i)(2).

- In conjunction with a corrective action program, the owner or operator must establish and implement a groundwater monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program may be based on the requirements for a compliance monitoring program under Sec. 264.99 and must be as effective as that program in determining compliance with the groundwater protection standard under Sec. 264.92 and in determining the success of a corrective action program under paragraph (e) of this section, where appropriate.

- In addition to the other requirements of this section, the owner or operator must conduct a corrective action program to remove or treat in place any hazardous constituents under Sec. 264.93 that exceed concentration limits under Sec. 264.94 in groundwater:
  - Between the compliance point under Sec. 264.95 and the downgradient property boundary
  - Beyond the facility boundary, where necessary to protect human health and the environment, unless the owner or operator demonstrates to the satisfaction of the regional administrator that, despite the owner’s or operator’s best efforts, the owner or operator was unable to obtain the necessary permission to undertake such action. The owner or operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where offsite access is denied. Onsite measures to address such releases will be determined on a case-by-case basis.
  - Corrective action measures under this paragraph must be initiated and completed within a reasonable period of time considering the extent of contamination.
  - Corrective action measures under this paragraph may be terminated once the concentration of hazardous constituents under Sec. 264.93 is reduced to levels below their respective concentration limits under Sec. 264.94.

- The owner or operator must continue corrective action measures during the compliance period to the extent necessary to ensure that the groundwater protection standard is not exceeded. If the owner or operator is conducting corrective action at the end of the compliance period, he or she must continue that corrective action for as long as necessary to achieve compliance with the groundwater protection standard. The owner or operator may terminate corrective action measures taken beyond the period equal to the active life of the waste management area (including the closure period) if he or she can demonstrate, based on data from the groundwater monitoring program under paragraph (d) of this section, that the groundwater protection standard of Sec. 264.92 has not been exceeded for a period of three consecutive years.
The owner or operator must report in writing to the regional administrator on the effectiveness of the corrective action program. The owner or operator must submit these reports annually.

If the owner or operator determines that the corrective action program no longer satisfies the requirements of this section, he or she must, within 90 days, submit an application for a permit modification to make any appropriate changes to the program.

**Corrective Action for Solid Waste Management Units**

The owner or operator of a facility seeking a permit for the treatment, storage or disposal of hazardous waste must institute corrective action as necessary to protect human health and the environment for all releases of hazardous waste or constituents from any solid waste management unit at the facility, regardless of the time at which waste was placed in such unit.

Corrective action will be specified in the permit in accordance with this section and subpart S of this part. The permit will contain schedules of compliance for such corrective action (where such corrective action cannot be completed prior to issuance of the permit) and assurances of financial responsibility for completing such corrective action.

The owner or operator must implement corrective actions beyond the facility property boundary, where necessary to protect human health and the environment, unless the owner or operator demonstrates to the satisfaction of the regional administrator that, despite the owner’s or operator’s best efforts, he or she was unable to obtain the necessary permission to undertake such actions. The owner or operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where offsite access is denied. Onsite measures to address such releases will be determined on a case-by-case basis.

This section does not apply to remediation waste management sites unless they are part of a facility subject to a permit for treating, storing or disposing of hazardous wastes that are not remediation wastes.

**f. Explain the spill prevention and control requirements of the Clean Water Act (40 CFR 109-114).**

The following is taken from Environmental Health and Safety Online, Spill Prevention Control and Countermeasures Plans Explained.

Spill Prevention Control and Countermeasure (SPCC) plans—On December 5, 2008, the Federal Register published EPA’s final rule to amend the SPCC rule in order to provide increased clarity, to tailor requirements to particular industry sectors, and to streamline certain requirements for those facility owners/operators subject to the rule, which should result in greater protection to human health and the environment.
Overview

As a cornerstone of EPA’s strategy to prevent oil spills from reaching our nation’s waters, the agency requires that certain facilities develop and implement oil spill prevention, control, and countermeasures, or SPCC plans. Unlike oil spill contingency plans that typically address spill cleanup measures after a spill has occurred, SPCC plans ensure that facilities put in place containment and other counter measures that would prevent oil spills that could reach navigable waters. Under EPA’s oil pollution prevention regulation, facilities must detail and implement spill prevention and control measures in their SPCC plans. A spill contingency plan (40 CFR 112.20) is required as part of the SPCC plan if a facility is unable to provide secondary containment (e.g., berms surrounding the oil storage tank).

Each SPCC plan, while unique to the facility it covers, must include certain elements. To ensure that facilities comply with the spill prevention regulations, EPA periodically conducts onsite facility inspections. EPA also requires owners/operators of facilities that experience two or more oil spills within a 12-month period to submit their SPCC plans and other information to EPA for review.

A copy of the entire SPCC plan must be maintained at the facility if the facility is normally attended for at least eight hours per day. Otherwise, it must be kept at the nearest field office. The SPCC plan must be available to EPA for onsite review and inspection during normal working hours.

SPCC Plan Content

The oil pollution prevention regulation requires that the SPCC plan be carefully thought out, prepared in accordance with good engineering practices, and be approved by a person with the authority to commit the resources necessary to implement the SPCC plan. A spill contingency plan (40 CFR 112.20) is required as part of the SPCC Plan if a facility is unable to provide secondary containment (e.g., berms surrounding the oil storage tank).

Each SPCC plan must be unique to the facility. Development of a unique SPCC plan requires detailed knowledge of the facility and the potential effects of any oil spill. Each SPCC plan, while unique to the facility it covers, must include certain standard elements to ensure compliance with the regulations. These elements include the following:

- Written descriptions of any spills occurring within the past year, corrective actions taken, and plans for preventing their reoccurrence
- A prediction of the direction, rate of flow, and total quantity of oil that could be discharged where experience indicates a potential for equipment failure
- A description of containment and/or diversionary structures or equipment to prevent discharged oil from reaching navigable waters (for on-shore facilities, one of the following should be used as a minimum: dikes, berms, or retaining walls; curbing; culverting, gutters, or other drainage systems; weirs, booms, or other barriers; spill diversion ponds; retention ponds; sorbent materials)
- Where appropriate, a demonstration that containment and/or diversionary structures or equipment are not practical and a strong oil spill contingency plan and a written
commitment of manpower, equipment, and materials to quickly control and remove spilled oil

- A complete discussion of the spill prevention and control measures applicable to the facility and/or its operations

The SPCC plan should include a demonstration of management’s approval and should be certified by a registered professional engineer.

**Spill Prevention and Control Measures**

Under EPA’s oil spill prevention regulations, a facility’s SPCC plan must discuss how the facility conforms to the oil spill prevention and containment procedures established for that type of facility or operation. The SPCC regulations provide spill prevention and control measures specific to the different types of oil facilities or operations, including

- onshore facility drainage (excluding production facilities) [40 CFR 112.7(e)(1)]
- onshore bulk storage tanks (excluding production facilities) [40 CFR 112.7(e)(2)]
- facility transfer operations, pumping, and in-plant process (excluding production facilities) [40 CFR 112.7(e)(3)]
- facility tank car and tank truck loading/unloading rack [40 CFR 112.7(e)(4)]
- onshore oil production facilities [40 CFR 112.7(e)(5)]
- onshore oil drilling and workover facilities [40 CFR 112.7(e)(6)]
- offshore oil drilling, production, or workover facilities [40 CFR 112.7(e)(7)]
- inspections and records [40 CFR 112.7(e)(8)]
- security, excluding production facilities [40 CFR 112.7(e)(9)]
- personnel training and spill prevention procedures [40 CFR 112.7(e)(10)]

**SPCC Plan Reviews**

Facilities that spill more than 1,000 gallons of oil into navigable waters or onto adjoining shorelines in a single incident, or have two reportable oil spills within any 12-month period, must submit to the appropriate EPA regional administrator within 60 days from the time the spill occurs

- facility name, location, and date when facility began operations
- facility owner or operator names
- facility maximum storage or handling capacity and normal daily oil throughput
- facility description, including maps, flow diagrams, and topographical maps
- a complete copy of the SPCC plan with any amendments
- the cause(s) of the spill, including a failure analysis of system or subsystem where the failure occurred
- the corrective actions and/or countermeasures taken (e.g., equipment repairs or replacement)
- any other preventive measures taken
- other information the regional administrator may require

EPA regional administrators will review this information and may require the facility owner or operator to amend the SPCC plan if it does not meet the regulations or if an amendment is necessary to prevent and contain oil spills from the facility. Facility owners/operators are
provided an opportunity to submit written information, views, and arguments on the proposed amendment, and may appeal a regional administrator’s final decision. Appeals are made to the administrator of the EPA.

Facility Inspections

EPA regional personnel periodically go onsite to inspect facilities subject to the oil pollution prevention regulation. The inspections have two purposes. First, inspections help to ensure that oil storage facilities comply with the regulations. Second, onsite inspections give EPA personnel the opportunity to educate owners/operators about the regulation and methods for ensuring compliance. In many cases, EPA notifies the facility owner or operator of the inspection prior to arriving at the facility. Announced inspections ensure the availability of appropriate facility people and build a conducive working relationship between the agency and the facility. However, EPA occasionally conducts unannounced facility inspections in order to gauge a facility’s preparedness to prevent or respond to an oil spill.

Once at the facility, EPA inspectors may ask to review the SPCC plan and the facility response plan and conduct a walk-through inspection of the facility to ensure that the facility has implemented spill prevention and response measures. In addition, EPA may interview facility personnel on the SPCC and facility response plans and their role in implementing them.

In some cases, the EPA finds that facilities are in compliance; however, when the agency encounters a facility that violates the oil spill prevention regulations, EPA has the authority under the CWA to assess an administrative penalty. In dealing with out-of-compliance facilities, however, the EPA generally strives to work together with facility owners/operators to remedy any problems identified.

New SPCC Rule

On July 17th, 2002, EPA issued a final rule amending the oil pollution prevention regulation promulgated under the authority of the CWA. This rule addresses requirements for SPCC plans and some provisions may also affect facility response plans. EPA proposed revisions to the SPCC rule on three occasions, in 1991, 1993, and 1997. The new SPCC rule addresses these revisions and became effective August 16, 2002. The SPCC rule can be found in 40 CFR 112.

g. Discuss how the National Pollution Discharge Elimination System applies to and impacts Department waste management programs.

The following is taken from DOE/EH-412/0015/0301, Regulation of Storm Water Discharges under the National Pollutant Discharge Elimination System.

The stormwater rules impact DOE facilities in a variety of ways. DOE facilities will be required to address stormwater discharges associated with construction activities disturbing one acre (0.4 hectare) or more unless they have been granted a waiver for activities disturbing between one and five acres (0.4 to 2 hectare). In some cases DOE facilities may
also be required to get a permit for construction activities disturbing less than one acre (0.4 hectare).

As DOE does not have any facilities where people reside (e.g., Federal prison, hospital, military base), it would not be considered a regulated small municipal separate storm sewer system (MS4). The definition of small MS4 does not include individual Federal buildings (e.g., DOE operations offices) since they usually have at most a parking lot with runoff or a storm sewer that connects with a municipality’s MS4.

Thus, individual DOE buildings are not regulated by the phase II rule. However, the phase II rule could cover any DOE road system with a separate storm sewer system.

Staff at DOE facilities will need to ensure that their stormwater discharges comply with all applicable NPDES requirements and any additional water quality related requirements imposed by a state, tribal, or local government; failure to comply can result in enforcement actions. Individuals at DOE facilities must determine whether a permit application should be submitted if they do not already have one. Those facilities that are unsure of the classification of their stormwater discharges should either file a permit application covering the discharge or consult with the permitting authority before submitting one.

In implementing their stormwater programs, DOE facilities are encouraged to establish cooperative agreements with cities and counties. DOE can, for example, work with neighboring operators of regulated small MS4s, preferably on a watershed basis, to form a shared stormwater management program. Alternatively, DOE can become a co-permittee with a neighboring phase I MS4 through a modification of the phase I MS4’s individual permit. Choosing to work with other governmental entities as a co-permittee, or referencing parts of each other’s plans, can help resolve issues that may arise where multiple regulated jurisdictions exist in the same area. Thus, DOE can avoid duplicative efforts, as well as territorial or regulatory disputes, by working with other government entities to implement the stormwater program.

DOE facilities are also encouraged to act as models for municipal and private sector facilities and to implement or test state-of-the-art management practices and control measures.

h. Identify the types of data and records required to be retained as permanent records.

The following is taken from 40 CFR 122.41, “Conditions Applicable to All Permits”.

Data and Records
Except for records of monitoring information required by this permit related to the permittee’s sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by 40 CFR part 503), the permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for
this permit, for a period of at least three years from the date of the sample, measurement, report or application. This period may be extended by request of the director at any time.

Records of monitoring information shall include the

- date, exact place, and time of sampling or measurements
- individual(s) who performed the sampling or measurements
- date(s) analyses were performed
- individual(s) who performed the analyses
- analytical techniques or methods used
- results of such analyses

30. Waste management personnel must demonstrate the ability to review 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. 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 the Council on Environmental Quality, About CEQ.

The Council on Environmental Quality (CEQ) coordinates Federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. CEQ was established within the Executive Office of the President by Congress as part of the NEPA and additional responsibilities were provided by the Environmental Quality Improvement Act of 1970.

In addition, CEQ oversees Federal agency implementation of the environmental impact assessment process and acts as a referee when agencies disagree over the adequacy of such assessments.

In enacting NEPA, Congress recognized that nearly all Federal activities affect the environment in some way and mandated that before Federal agencies make decisions, they must consider the effects of their actions on the quality of the human environment. Under NEPA, CEQ works to balance environmental, economic, and social objectives in pursuit of NEPA’s goal of productive harmony between humans and the human environment.

NEPA assigns CEQ the task of ensuring that Federal agencies meet their obligations under the Act. The challenge of harmonizing our economic, environmental and social aspirations has put NEPA and CEQ at the forefront of our nation’s efforts to protect the environment.
b. Discuss the purpose and scope of DOE O 451.1B, National Environmental Policy Act Compliance Program, and the relationship with 40 CFR 1500.

The purpose of DOE O 451.1B is to establish DOE internal requirements and responsibilities for implementing the National Environmental Policy Act of 1969 (NEPA), the CEQ Regulations Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), and the DOE NEPA Implementing Procedures (10 CFR Part 1021).

This Order applies to DOE elements, including the National Nuclear Security Administration (NNSA).

The goal of establishing the requirements and responsibilities presented is to ensure efficient and effective implementation of DOE’s NEPA responsibilities through teamwork. A key responsibility for all participants is to control the cost and time for the NEPA process while maintaining its quality.

c. Discuss the content and procedures specified by the Department implementing regulations 10 CFR 1021, Compliance with the National Environmental Policy Act and Secretarial Policy on the National Environmental Policy, June 13, 1994.

Implementing Procedures

The following is taken from 10 CFR 1021.

The purpose of 10 CFR 1021, “National Environmental Policy Act Implementing Procedures and Guidelines,” is to establish procedures that DOE shall use to comply with the NEPA and the CEQ regulations for implementing the procedural provisions of NEPA.

The implementing procedures specified in 10 CFR 1021 and the corresponding sections are provided below:

- Section 301 — Agency review and public participation
- Section 310 — Environmental impact statements
- Section 311 — Notice of intent and scoping
- Section 313 — Public review of environmental impact statements
- Section 314 — Supplemental environmental impact statements
- Section 315 — Records of decision
- Section 320 — Environmental assessments
- Section 321 — Requirements for environmental assessments
- Section 322 — Findings of no significant impact
- Section 330 — Programmatic (including site-wide) NEPA documents
- Section 331 — Mitigation action plans
- Section 340 — Classified, confidential, and otherwise exempt information
- Section 341 — Coordination with other environmental review requirements
- Section 342 — Interagency cooperation
- Section 343 — Variances
Secretarial Policy on NEPA

The following is taken from the Secretarial Policy Statement on the National Environmental Policy.

The NEPA process is a valuable planning tool and provides an opportunity to improve the DOE decisions and build public trust. Reviews of the Department’s NEPA program have shown that the Department must change the way it conducts its business to avoid unnecessary delays and reap the full benefits of the NEPA process. The Department must conduct the process as a team effort to make NEPA work better and cost less. The following new policies will streamline the NEPA process, minimize the cost and time for document preparation and review, emphasize teamwork, and make the process more useful to decision-makers and the public.

Delegations of Authority

To facilitate early integration of the NEPA process with project planning and decision-making, reduce document review times, and foster ownership of NEPA documents, the heads of field organizations will receive full authority for EAs, FONSIs, and associated floodplain and wetland action documentation requirements relating to their proposed actions.

Process Changes

The NEPA process should be a team effort. To establish team leadership and ownership of the NEPA process and thereby improve its management, the cognizant secretarial officer or head of a field organization will designate a Department member of the team working on any project requiring NEPA review as the NEPA document manager, to manage the document preparation process and keep it on schedule.

NEPA Contract Reform

All future contracts for the preparation of EAs and EISs will contain incentives to encourage superior performance in document quality and timeliness.

To improve the quality and timeliness of documents, all contractors preparing NEPA documents will be subject to performance appraisals.

Consistent with the contract reform effort that is underway Department-wide, a quality improvement team comprised of headquarters and field project, procurement, NEPA, and legal personnel will be formed to develop innovative contracting mechanisms and incentives suited particularly to NEPA document preparation contracts.

Additional Reforms for High Priority Projects

Department personnel rather than contractors will be used, to the maximum extent practicable, to prepare EAs and EISs that have short preparation time requirements or present unusually controversial or sensitive issues.

When necessary or helpful in meeting important departmental objectives, the NEPA document manager may form a special team, comprised of relevant field organization and
secretarial office personnel and representatives from the offices of environment, safety and health and general counsel, to carry out the NEPA process from start to finish.

The NEPA document manager is encouraged to consider whether a specific project offers opportunities for innovation in the NEPA process.

The cognizant secretarial officer and the Assistant Secretary for Environment, Safety and Health will consult to determine whether delegation of approval authority for a specific EIS to the secretarial officer or the head of a field organization would be appropriate to expedite the review and approval process.

Enhanced Public Involvement
NEPA document managers will take appropriate action to encourage and facilitate public participation throughout the NEPA process, taking into account office of environment, safety and health guidance on improving public participation.

Whenever possible, the Department will provide enhanced opportunities for public involvement in the EA process.

Continuing Improvement
One year from now (1995), a quality improvement team will be formed to measure the outcome of the NEPA initiatives put forth in this policy statement and to consider what additional reforms are necessary; this team will report its findings and recommendations within 90 days of its formation.

The Office Of Environment, Safety And Health will
  ▪ solicit comments from the NEPA document manager, the NEPA compliance officer, and team members after completing each EIS and EA on lessons learned in the process and will circulate a quarterly summary to all NEPA compliance officers and NEPA document managers;
  ▪ provide NEPA training in order to develop a more knowledgeable and experienced group of headquarters and field personnel capable of carrying out NEPA compliance activities;
  ▪ consider establishing a NEPA certification program to formally recognize the expertise of personnel who have achieved a specified combination of training and practical experience.

The Office of Environment, Safety And Health and the Office Of General Counsel will monitor the progress of and advise the Secretary on the Department’s NEPA compliance program.

In carrying out and improving their NEPA compliance process, heads of departmental elements should make effective use of NEPA compliance officers for advice, assistance, training, and coordination.
d. Discuss the applicability for each of the documents identified above and the responsibilities for reviewing these documents.

The following is taken from Council on Environmental Quality, *Regulations for Implementing NEPA*.

*Environmental Impact Statement*

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 ensure the proposal that is the subject of an EIS is properly defined. Agencies shall use the criteria for scope in Sec.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.

Environmental impact statements 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 that 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)

Environmental Assessment
An EA is a concise public document for which a Federal agency is responsible that serves to accomplish the following:

- 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
- Facilitate preparation of a statement when one is necessary

The EA shall include brief discussions of: the need for the proposal; the environmental impacts of the proposed action; and alternatives. The EA shall also include a listing of agencies and persons consulted.

Finding of No Significant Impact
Finding of no significant impact 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.

Categorical Exclusion
Categorical exclusion 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.

Record of Decision
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 do the following:

- 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.
- Discuss the different areas that are analyzed in an EIS to determine the effect on the environment (i.e., geologic resources, groundwater, meteorology, ecological impacts, public health and safety, etc.).

e. Discuss the different areas that are analyzed in an EIS to determine the effect on the environment (i.e., geologic resources, groundwater, meteorology, ecological impacts, public health and safety, etc.).

The following is taken from DOE, *NEPA Compliance Guide*.

CEQ distinguishes between the “environmental consequences section” of an EIS, which should be devoted largely to a scientific analysis of the impacts of the analyzed alternatives, and the “alternatives section,” which should present a concise comparison of alternatives (based on and summarizing information developed in the “environmental consequences section”). (Question 7, “CEQ’s Forty Questions.”) In both cases, DOE normally presents the impacts of each analyzed alternative by resource area.

Below is a list of resource areas usually analyzed in an EIS:

- Public and occupational safety and health
- Land use
- Geology and soils
- Air quality
- Water resources
- Biological resources
- Socioeconomics
- Cultural resources
- Noise and vibration
- Environmental justice

e. Describe the public participation process.

The following is taken from DOE, *Effective Public Participation under the National Environmental Policy Act, 2nd edition*.

**DOE EIS Scoping Process**

CEQ regulations define scoping as an early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a
proposed action. Required public participation activities related to the DOE EIS scoping process include the following:

- Disseminating the notice of intent
- Holding at least one public meeting
- Soliciting and considering public comments

The notice of intent to prepare an EIS announces the location and time of public meetings, provides the name and address of a person within DOE who can answer questions about the proposed action and EIS, and invites comments and suggestions on the scope of the EIS. The CEQ regulations state that agencies must publish the notice of intent in the Federal Register as soon as practicable after a decision to prepare an EIS. DOE must disseminate the notice in accordance with the CEQ’s public notice requirements, which may involve: observance of public notice procedures of the affected state; publication of the notice in local newspapers; issuance of the notice to state and area-wide clearinghouses, Indian tribes, and potentially interested community organizations; direct mailings; and posting.

DOE requires at least one public meeting as part of the scoping process for EISs. DOE must invite the participation of Federal, state, local, and tribal governments; the proponent of the action; and other interested persons. DOE must announce the location, date, and time of the public meeting(s) in the notice of intent or by other appropriate means, such as additional notices in the Federal Register, news releases to the local news media, or letters to affected persons. DOE may not hold the public scoping meeting(s) until at least 15 days after public notification.

DOE must allow at least 30 days after the publication of the notice of intent for receipt of public comments. DOE must consider all comments received during the announced comment period; DOE may consider comments received after the close of the announced comment period.

**The Draft EIS**

Required public participation activities related to the draft EIS include the following:

- Writing the draft EIS with the public in mind
- Circulating the draft EIS
- Providing public notice of availability
- Soliciting public comments
- Holding at least one public hearing

While writing the draft EIS, DOE must keep in mind that the audience consists of interested members of the public, in addition to the decision-maker. In order to make the document useful for the public, DOE must use plain language, present environmental impacts of the proposed action in comparative form, incorporate material by reference when the effect will be to cut down on the bulk of the EIS without impeding public review, and provide a summary section that emphasizes issues raised by other agencies and the public.
DOE must circulate the draft EIS, providing the entire document to any person, organization, or agency requesting it. DOE may circulate a summary of the draft EIS to other parties if the draft EIS is unusually long.

After completion, DOE files the draft EIS with the EPA. Filing may not precede distribution to the public. The EPA is required to publish each week in the Federal Register a notice of availability of the EISs filed during the preceding week. The comment period on the draft EIS is calculated from this date of publication. The comment period must be at least 45 days.

DOE must use appropriate means to publicize the availability of the draft EIS. The methods chosen should focus on persons potentially interested in or affected by the proposed action.

DOE must request comments on the draft EIS from appropriate state and local agencies authorized to develop and enforce environmental standards, Indian tribes potentially affected by the proposed action, and members of the public. DOE must affirmatively solicit comments from those persons or organizations potentially interested in or affected by the proposed action.

DOE must hold at least one public hearing on a draft EIS. The announcement of the public hearing must precede the hearing by at least 15 days, identify the subject of the draft EIS, and include the location, date, and time of the hearing. DOE must use appropriate means to publicize the public hearing.

*The Final EIS*

Required public participation activities related to the final EIS include the following:
- Considering and responding to public comments on the draft EIS
- Filing the final EIS with the EPA and making it available to the public
- Publishing and disseminating the ROD
- Making copies of any mitigation action plan that is prepared and any relevant monitoring results available to the public

DOE must assess and consider both oral and written comments received on the draft EIS during the public comment period and must respond to these comments in the final EIS. Possible responses are to: 1) modify alternatives; 2) develop and evaluate alternatives not previously considered; 3) supplement, improve, or modify analyses; 4) make factual corrections; and 5) explain why the comment does not warrant further response. DOE must discuss at appropriate points in the final EIS any responsible opposing view that was not adequately discussed in the draft statement, and must indicate the agency’s response to the issues raised.

DOE files the final EIS with the EPA, which publishes each week in the Federal Register a notice of the EISs filed with the agency during the preceding week. The filing of the final EIS may not precede distribution to the public. DOE must use appropriate means to publicize the availability of the final EIS. The methods of notice chosen should focus on reaching persons potentially interested in or affected by the proposed action.
DOE must circulate the final EIS, providing the entire document to any person, organization, or agency that has requested it or has submitted substantive comments on the draft EIS. DOE may circulate a summary of the final EIS to other parties if the final EIS is unusually long.

DOE must make the final EIS, the comments received, and any referenced support documents available to the public pursuant to the provisions of the Freedom of Information Act, without regard to the exclusion for interagency memoranda when a memorandum transmits a Federal agency’s comments on the environmental impact of the proposed action.

DOE may not make a decision on a proposal covered by an EIS during a 30-day “waiting period” following completion of the final EIS. The 30-day period starts when the EPA’s notice of availability is published in the Federal Register.

Except for interim actions, if DOE decides to take action on a proposal covered by an EIS, a ROD shall be prepared. DOE RODs shall be published in the Federal Register and made available to the public. No action shall be taken until the decision has been made public. DOE may implement the decision before the ROD is published in the Federal Register if the ROD has been signed and the decision and the availability of the ROD have been made public by other means.

DOE must prepare a mitigation action plan that addresses mitigation commitments expressed in the ROD. DOE must make copies of any mitigation action plan available for inspection in the appropriate DOE public reading rooms or in other appropriate locations for a reasonable time, and must make copies available upon written request. In addition, DOE must make the results of any relevant environmental monitoring available to the public upon request.

Recommendations. If there is uncertainty regarding the meaning of submitted comments, commenters should be consulted, especially those who are experts, in the process of considering and preparing responses to comments on the draft EIS.

Clear, definite responses to substantive comments on the draft EIS should be provided. There should be differentiation between philosophical and factual differences. When there is a difference of opinion, the selection of one opinion over others should be explained.

In addition to the EPA’s Federal Register notice of receipt of the final EIS which only lists the name of the document, the usefulness of a DOE notice in the Federal Register regarding the availability of the final EIS should be considered. A DOE notice of availability will attract the attention of those interested in DOE activities and will provide information that is not contained in the EPA’s notice. To facilitate effective public participation, notices should also be placed in local media to reach members of the public who may be interested in or affected by the proposed action.

Where there is a high level of public interest, consideration should be given to issuing a press release to announce the publication of the final EIS and holding a press conference to brief the news media on the final EIS. Consideration should also be given to using a similar process when the ROD is issued.
Final EISs, referenced support documents, and RODs should be made available in the relevant public reading rooms.

The Supplement Analysis and Supplemental EIS

Required public participation activities related to the supplement analysis and supplemental EIS include the following:

- Making the determination of whether to prepare a supplemental EIS and the related supplement analysis and make them available to the public
- For a supplemental EIS, employing all the public participation activities required for other DOE EISs, except for the optional scoping process

When DOE prepares a supplement analysis to determine whether a supplemental EIS is required, DOE must make the determination and the related supplement analysis available to the public. DOE must provide copies upon written request and make copies available in the appropriate public reading rooms or other appropriate locations for a reasonable time.

DOE must prepare, circulate, and file a supplemental EIS in the same manner as any other draft and final EIS, except that scoping is optional for a supplemental EIS.

If DOE decides to take an action on a proposal covered by a supplemental EIS, it must prepare a ROD.

DOE must incorporate a supplemental EIS, or the determination whether or not to prepare a supplement and supporting supplement analysis, into any related formal administrative record on the action that is the subject of the supplemental EIS or determination.

EA and FONSI

Required public participation activities related to EAs and FONSIs include the following:

- Notifying the host state and host tribe, affected states and tribes as appropriate, and the general public whenever possible, of a decision to prepare an EA
- Making a draft EA available to host and affected states and tribes, and on request, to members of the public for pre-approval review
- Making a proposed FONSI available to the public before the final decision in certain circumstances
- Making completed EAs and issued FONSIs available to the public

DOE must notify the host state and host tribe of a DOE determination to prepare an EA for a proposal. DOE should notify any other state or Indian tribe potentially affected by the DOE proposal.

DOE must involve the public to the extent practicable during the preparation of EAs. Under the Secretary’s NEPA policy statement, DOE will ordinarily provide early public notice of the intent to prepare an EA, concurrent with state and tribal notification.

Before approving an EA, DOE must make it available to the host state and host tribe for review and comment. At DOE’s discretion, this review period may be from 14 to 30 days. In
addition, under the Secretary’s NEPA policy statement, DOE will ordinarily provide an
opportunity for interested persons, on request, to review EAs concurrently with state and
tribal review.

In certain circumstances, DOE must make FONSI available for public review and comment
for 30 days prior to approval. These circumstances arise when the proposed action is similar
to one which normally requires an EIS or when the nature of the proposed action is one
without precedent.

DOE must make copies of a FONSI available for inspection in appropriate reading rooms for
a reasonable time and must notify the public of its availability.

g. Discuss the integration of consultation requirements under other environmental
legislation (e.g., National Environmental Policy Act, Endangered Species Act, and
Fish and Wildlife Coordination Act).

The following is taken from 50 CFR 402, “Interagency Cooperation—Endangered Species
Act of 1973, as Amended.”

Consultation, conference, and biological assessment procedures under section 7, Designation
of Lead Agency, may be consolidated with interagency cooperation procedures required by
other statutes, such as the NEPA or the Fish and Wildlife Coordination Act (FWCA).
Satisfying the requirements of these other statutes, however, does not in itself relieve a
Federal agency of its obligations to comply with the procedures set forth in this part or the
substantive requirements of section 7. The Fish and Wildlife Service will attempt to provide
a coordinated review and analysis of all environmental requirements.

Where the consultation or conference has been consolidated with the interagency cooperation
procedures required by other statutes such as NEPA or FWCA, the results should be included
in the documents required by those statutes.

When a particular action involves more than one Federal agency, the consultation and
conference responsibilities may be fulfilled through a lead agency. Factors relevant in
determining an appropriate lead agency include the time sequence in which the agencies
would become involved, the magnitude of their respective involvement, and their relative
expertise with respect to the environmental effects of the action.

h. Discuss the potential liabilities of the Department and its contractors inherent in
the NEPA process.

The following is taken from the National Research Council, Improving the Environment: An
Evaluation of the DOE’s Environmental Management Program, Part II: “Evaluation of

DOE’s environmental restoration activities must be conducted pursuant to applicable
environmental laws. The principal environmental laws dictating how the cleanup is to be
performed at the weapons sites are RCRA, as amended, CERCLA, as amended (also known
as Superfund), and the AEA of 1954, as amended. Many DOE sites are on the NPL
developed under CERCLA. NEPA mandates that all Federal agencies and departments take
into consideration the adverse effects that their actions might have on the environment.
NEPA requires that agency actions be reviewed early in the planning process and that the
process be open to public participation. DOE’s environmental restoration efforts are also
subject to state laws and regulations, including those adopted under the authority of RCRA
and CERCLA.

All high-level radioactive waste and most transuranic (TRU) waste are mixed waste, usually
because of the presence of organic solvents or heavy metals, in addition to the radioactive
components. The hazardous component of mixed waste is regulated under RCRA. In 1992,
Congress passed the Federal Facility Compliance Act, which amended RCRA to make
Federal facilities subject to the same fines and penalties as any private corporation if they violate the law. The law also requires DOE to develop plans for mixed-waste treatment,
subject to approval of the states or EPA.

For sites that are required to undergo CERCLA cleanup, DOE is required to enter an
agreement with EPA regarding how the cleanup should be carried out. EPA has states join in
these compliance agreements. Thus, the agreements are often signed by three parties: DOE,
EPA, and the state where the facility is located. Compliance agreements are also formed with regard to requirements under RCRA and when both CERCLA and RCRA apply. Compliance agreements must include at least a schedule for accomplishing the cleanup, arrangements for operation and maintenance of the site, and a review of the cleanup options considered and the remedy selected. Such agreements are enforceable by states against DOE facilities, and civil penalties may be imposed for failure or refusal of a facility to comply with a compliance agreement. State enforcement under CERCLA agreements occurs through citizen suits, but states have separate enforcement authorities. Compliance agreements might give additional authority from multiple statutes, and enforcement provisions vary because of the construct of the agreement and the underlying regulations.

Sites that have not been placed on the NPL operate only under the regulatory jurisdiction of
RCRA. A major difference between CERCLA and RCRA is that CERCLA coverage
includes both hazardous and radioactive contamination, whereas RCRA and its corrective-
action provisions cover only hazardous waste and the hazardous portion of mixed waste.
Releases of radioactivity to the environment are regulated exclusively by DOE under the
authority of the AEA. DOE has its own set of internal directives (DOE Orders) governing
radioactive-waste management and the limitations of radionuclide releases to the
environment. The AEA gives DOE broad authority over radioactive waste with the exception of facilities for the storage and disposal of high-level radioactive waste and spent nuclear fuel (SNF), which are regulated by the NRC. Thus, DOE Orders are wide-ranging and include environmental protection, worker safety, project management, facility design, transportation, emergency planning, and personnel. In addition, each DOE contractor independently maintains its own sets of guidance documents and internal procedures to implement these Orders.
i. **Identify the types of data and records required to be retained as permanent records.**

The following is taken from *DOE, NEPA Compliance Guide*.

An administrative record is required for each NEPA document prepared by DOE. The DOE NEPA document managers will be responsible for development, control, and maintenance of the record. In general, the administrative record will consist of all documents (hard copies, electronic files, overhead slides, pictures, public/stakeholder comments, transcripts of public meetings, other documents or records) relied upon in preparing the EA, EIS, or supplemental analysis, as well as those that were considered by the decision-maker in arriving at any decisions. The administrative record documents DOE’s consideration of all relevant and reasonable factors and should include evidence of diverging opinions and criticisms of the proposed action and its reasonable alternatives, where they may exist. Overall, it should document that DOE took the “hard look” at the proposed action and its reasonable alternatives that is required by law. Federal agency decisions under NEPA are subject to judicial review, and a well-developed administrative record provides protection against a lawsuit that could challenge DOE’s decisions and its decision-making process, and thus have far-reaching effects on proposed projects or programs. The administrative record also demonstrates that DOE followed the proper process in complying with NEPA’s procedural provisions.

31. Waste management personnel must demonstrate a familiarity level knowledge of the following as it relates to waste management.

- **Atomic Energy Act**
- **Low Level Waste Policy Amendment Act**

a. **Discuss the responsibilities of states and the Federal government identified under the Atomic Energy Act.**

The following is taken from *DOE, Office of Health, Safety, and Security, Atomic Energy Act and Related Legislation*.

The purpose of the AEA is to ensure 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 the following:

- **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
- **Special Nuclear Material.** 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

- **Byproduct Material.** 1) Any radioactive material yielded in or made radioactive by exposure to radiation incident to the process of producing or using 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

With respect to the first definition of byproduct material stated above, DOE issued a final rule with a much narrower interpretation of the term as it applies to DOE-owned or DOE-produced radioactive material having a hazardous waste component. Under this rule, the term “any radioactive material” as used in the first definition of byproduct material refers only to the actual radionuclides suspended or dispersed in the material, and not to the nonradioactive hazardous component of the waste. Thus, although DOE retains authority under the AEA for the actual radionuclides in byproduct material, any nonradioactive hazardous component of the material will be subject to regulation by EPA or its agreement states under RCRA. The rule does not apply to 1) byproduct materials as defined in the second definition, or 2) substances not owned or produced by DOE.

Section 161 of AEA provides the authority to establish “by rule, regulation, or order, such standards and instructions to govern the possession and use of SNM, source material, and byproduct materials as the NRC may deem necessary or desirable to promote the common defense and security or to protect health or to minimize danger to life or property.” This and other sections allow DOE to set radiation protection standards for itself and its contractors. NRC’s licensing powers are defined in sections 101–111. In sections 91 and 110 the AEA provides exclusions from licensing for defense production facilities.

**b. Define the following terms and their implications for regulation in the Department of Energy:**

- **Agreement state**
- **Allocation**
- **Compact**
- **Sited compact region**

The following is taken from the Low Level Waste Policy Amendment Act.

*Agreement State*

The term “agreement state” means a state that has entered into an agreement with the NRC under section 2021 of this Act; and has authority to regulate the disposal of low-level radioactive waste under such agreement.

*Allocation*

The term “allocation” means the assignment of a specific amount of low-level radioactive waste disposal capacity to a commercial nuclear power reactor for which access is required to be provided by sited states subject to the conditions specified under sections 2021b to 2021j of this Act.

*Compact*

The term “compact” means a compact entered into by two or more states pursuant to sections 2021b to 2021j of this Act.
Sited Compact Region

The term “sited compact region” means a compact region in which there is located one of the regional disposal facilities at Barnwell, in the state of South Carolina; Richland, in the state of Washington; or Beatty, in the state of Nevada.

c. Describe the Federal government’s disposal responsibilities under the Low Level Waste Policy Amendment Act (LLWPAA).

The following is taken from the Low-Level Waste Policy Amendment Act.

The Federal government shall be responsible for the disposal of

- low-level radioactive waste owned or generated by DOE
- low-level radioactive waste owned or generated by the United States Navy as a result of the decommissioning of vessels of the United States Navy
- low-level radioactive waste owned or generated by the Federal government as a result of any research, development, testing, or production of any atomic weapon
- any other low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for class C radioactive waste

All radioactive waste designated a Federal responsibility that results from activities licensed by the NRC under the AEA shall be disposed of in a facility licensed by the NRC that the NRC determines is adequate to protect the public health and safety.

Not later than 12 months after January 15, 1986, the Secretary shall submit to the Congress a comprehensive report setting forth the recommendations of the Secretary for ensuring the safe disposal of all radioactive waste designated a Federal responsibility. Such report shall include

- an identification of the radioactive waste involved, including the source of such waste, and the volume, concentration, and other relevant characteristics of such waste
- an identification of the Federal and non-Federal options for disposal of such radioactive waste
- a description of the actions proposed to ensure the safe disposal of such radioactive waste
- a description of the projected costs of undertaking such actions
- an identification of the options for ensuring that the beneficiaries of the activities resulting in the generation of such radioactive wastes bear all reasonable costs of disposing of such wastes
- an identification of any statutory authority required for disposal of such waste

The Secretary may not dispose of any radioactive waste designated a Federal responsibility that becomes a Federal responsibility for the first time until 90 days after the report prepared has been submitted to the Congress.
d. **Identify the Federal government’s responsibilities for disposing of low level waste at a non-Federal facility per the LLWPAA.**

The following is taken from the *Low-Level Waste Policy Amendment Act*.

Low-level radioactive waste owned or generated by the Federal government that is disposed of at a regional disposal facility or non-Federal disposal facility within a state that is not a member of a compact shall be subject to the same conditions, regulations, requirements, fees, taxes, and surcharges imposed by the compact commission, and by the state in which such facility is located, in the same manner and to the same extent as any low-level radioactive waste not generated by the Federal government.

**32. Waste management personnel must demonstrate a working level knowledge of the storage and disposal of Polychlorinated Biphenyl (PCB) waste as regulated by 10 CFR Part 761.**

[Note: 10 CFR 761 corrected to 40 CFR 761]

a. **Describe the structure and properties of PCBs.**

The following is taken from U.S. Environmental Protection Agency, *Polychlorinated Biphenyls (PCBs).*

PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. They have a range of toxicity and vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications.

The PCBs used in these products were chemical mixtures made up of a variety of individual chlorinated biphenyl components, known as congeners.

A PCB congener is any single, unique well-defined chemical compound in the PCB category. The name of a congener specifies the total number of chlorine substituents and the position of each chlorine. For example: 4,4'-Dichlorobiphenyl is a congener comprising the biphenyl structure with two chlorine substituents, one on each of the #4 carbons of the two rings.

Homologs are subcategories of PCB congeners having equal numbers of chlorine substituents. For example, the tetrachlorobiphenyls are all PCB congeners with exactly 4 chlorine substituents that may be in any arrangement.
b. Discuss PCB decomposition products and their toxicity.

The following is taken from U.S. Environmental Protection Agency, Polychlorinated Biphenyls (PCBs).

Examples of dioxins include PCBs, polychlorinated dibenzo dioxins (PCDDs), and polychlorinated dibenzo furans (PCDFs).

Dioxins are a group of anthropogenic chemical compounds created as unintended byproducts through a number of activities including: combustion, certain types of chemical manufacture, chlorine bleaching of pulp and paper, and other industrial processes. Dioxins are produced in very small quantities compared to other pollutants; however, because this family of compounds are thought to be highly toxic, they have been treated as significant environmental pollutants since the early 1970’s.

c. Explain why PCBs are banned or otherwise controlled.

The following is taken from U.S. Environmental Protection Agency, Polychlorinated Biphenyls (PCBs).

According to EPA, 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.

d. Explain the two types of PCB hierarchy and position an item/material in the PCB hierarchy (e.g., PCB liquid / non-liquid, PCB Items).

The following is taken from DOE/EH-413-9914.

The types of waste described are limited to those predominantly found at DOE sites. It is important to properly categorize PCB waste because the type of waste determines which regulations apply. Many of the regulations for PCB waste apply specifically to one of its physical forms. Although the forms of PCBs may be divided into liquids, non-liquids, and multi-phasic mixtures, the most important distinction is whether or not a PCB waste contains liquid PCBs. For example, the regulatory definition of PCB bulk product waste excludes liquid PCBs.

Non-liquid PCBs pose less of a risk to health and the environment because they do not disperse, migrate, or enter the exposure pathway as easily as liquid PCBs. PCB waste may come from a manufactured item or material or from contamination of an item or material.

Liquid PCBs are homogenous materials that flow as a liquid, containing no more than 0.5 percent PCBs by weight as non-dissolved material. Note that when any liquid PCBs contain more than 0.5 percent by weight of non-dissolved material, it needs to be analyzed as a multi-phasic, non-liquid/liquid mixture (i.e., as a combination of liquid and non-liquid forms).
Non-liquid PCBs are materials containing PCBs that, by visual inspection, do not flow at a room temperature of 77°F, or from which no liquid passes when a 100 gram or 100 milliliter representative sample is placed in a mesh number 60 ± 5 percent paint filter and allowed to drain at room temperature for 5 minutes. For materials such as sludges or sediments potentially containing free liquids, use this paint filter test to determine the presence of free liquids.

If the PCBs are multi-phasic mixtures (i.e., both non-liquid and liquid PCBs), separate the phases and perform the appropriate analysis on each phase. If disposing of non-separated or non-separable multi-phasic PCB waste, use the PCB storage or disposal requirements that apply to the phase with the highest PCB concentration, unless otherwise specified.

PCB items may be any one of the following four types: PCB article, PCB container, PCB article container, or PCB equipment that deliberately or unintentionally contains PCBs.

All the general requirements that apply to PCB items also apply to these four sub-types of items. For example, a requirement that a PCB item stored for disposal must be dated would also apply to a PCB article container. Thus, a general requirement that applies to PCB liquids would apply to a PCB liquid drained from a PCB item.

e. Discuss how the PCB concentration is established.

The following is taken from DOE/EH-413-9914.

PCB waste is generally regulated for disposal under the Toxic Substances Control Act (TSCA) at concentrations of 50 ppm of PCBs or more. Many of the sections within the regulations require ascertaining the specific concentrations of PCBs prior to disposal or cleaning up a contaminated area to a particular concentration level.

Use the nameplate, label, or manufacturer’s specifications on a PCB article to ascertain the PCB concentration. If this information is not available, then you may make certain assumptions about the PCB concentrations in certain electrical equipment until you are able or required to sample and analyze for PCBs. Note that these assumptions do not apply to disposal.

Near the time of actual disposal, determine the actual PCB concentration in order to use the proper disposal method. However, because some PCB articles are not amenable to servicing or sampling of the PCBs, use the assumptions made in accordance with 40 CFR 761.2, “PCB Concentration Assumptions for Use for Disposal.” Assume non-liquid PCBs to be 500 ppm or 100 g/100 cm² in lieu of sampling and analysis for the purposes of disposal.

In order to proceed, the concentration of PCBs in contaminated media resulting from a spill or release must be determined when cleaning up. The determinations of PCB concentrations must be made on a wet weight or weight/volume basis for liquids and on a dry weight basis for non-liquids.
Where disposal or cleanup is required by the regulations, neither disposal nor cleanup may be avoided through dilution.

f. Determine whether an item/material is a PCB waste.

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

g. Discuss the marking of PCB transport vehicles.

The following is taken from 40 CFR 761.40.

Transport vehicles loaded with PCB containers that contain more than 99.4 pounds (lbs.) of liquid PCBs at concentrations of 50 ppm or more or with one or more PCB transformers shall be marked on each end and each side with the large PCB mark—M<sub>L</sub>.

The following is taken from 40 CFR 761.45.

Mark M<sub>L</sub> shall be as shown in figure 39, letters and striping on a white or yellow background and shall be sufficiently durable to equal or exceed the life (including storage for disposal) of the PCB article, PCB equipment, or PCB container. The size of the mark shall be at least 15.25 cm (6 inches) on each side.

Source: 40 CFR 761.45

Figure 39. Large PCB mark—M<sub>L</sub>
h. Discuss PCB storage requirements including time limitations, temporary storage, general storage unit requirements, alternate storage units, container requirements, inspection requirements, and markings.

The following is taken from DOE/EH-413-9914.

The discussion of general requirements for storing PCB waste begins with the one-year storage limit. This limit is critical because it is not always possible to secure disposal within this time limit.

The description of the one-year limit is followed by discussion of the other general requirements. These pertain to extensions to the one-year limit, temporary storage, general storage units, alternate storage units, waste containers, checking for leaks, dating, marking, and removal of equipment.

One-Year Storage Limit
EPA distinguishes between storage of PCBs and PCB items for reuse, and storage of PCBs and PCB items for disposal. PCBs and PCB items stored for disposal—otherwise known as PCB waste—are subject to a one-year limit from the date of removal from service. PCB waste must be disposed within one year. A special exception to this limit is granted for PCB/radioactive waste.

Extensions to the One-Year Limit
An extension to the one-year storage limit may be obtained by sending a written notification to the EPA Regional Administrator providing the following information:

- Your identity
- Types, volumes, and locations of the PCB waste
- Reasons for the inability to dispose or secure disposal of the PCB waste

The EPA regional administrator will grant an extension of one additional year for storage of the waste upon receipt of the notification if all of the following conditions are met:

- EPA receives the notification at least 30 days before the initial one-year limit expires.
- Written records are maintained documenting all continuing attempts to secure disposal (until the waste is disposed).
- Written records are made available to EPA upon request.
- Continuing attempts to secure disposal were initiated within 270 days after the time the waste was first subject to the one-year limit.

Failure to initiate and continue attempts to secure disposal throughout the entire time the waste is stored automatically disqualifies eligibility for the extension.

Additional extensions beyond the one-year extension to the one-year storage limit may be requested. Submit a written request to the EPA regional administrator or the director, National Program Chemicals Division and included the following:

- Justification for the request
Information about what measures are being taken to secure disposal of the waste or why disposal could not be conducted during the period of the prior extension.

As a condition of granting any extension, EPA may require specific actions such as marking, inspecting, recordkeeping, periodic reporting, or financial assurance to ensure that the waste does not pose an unreasonable risk of injury to health or the environment. In deciding whether to grant an extension, EPA will consider whether relevant treatment or disposal options are being pursued, additional storage time poses an unreasonable risk of injury, there is an absence of approved treatment technology, or additional time is needed to complete treatment or destruction process.

Temporary Storage

EPA allows temporary storage of PCB wastes in units whose specifications are less stringent than those for general storage units or alternate storage units. Temporary storage must meet two conditions:

- Storage of no longer than 30 days from the date of removal from service
- Notation of the date of removal from service attached to the PCB container or PCB item stored for disposal

You may place the following PCB items into temporary storage:

- Liquids with PCBs 50 ppm in a DOT specified container and under a SPCC Plan for the area
- PCB containers with non-liquid PCBs, such as contaminated soil, rags, and debris
- Non-leaking PCB articles and PCB equipment, and/or
- Leaking PCB articles and PCB equipment if
  - placed into non-leaking PCB containers, and
  - sufficient sorbent materials are inserted to absorb any remaining PCB liquids

General Storage Units

Units for storing PCB waste beyond 30 days must meet all of the following criteria:

- Adequate roof and walls to prevent rain from reaching the PCB waste
- Adequate floor with 6-inch high, continuous curbing (a special exception is provided for PCB/radioactive waste)
- Floor and curbing providing a containment volume equal to the greater of
  - two times the internal volume of the largest PCB article or PCB container, or
  - 25 percent of the total internal volume of all PCB articles or PCB containers stored
- No drain valves, floor drains, expansion joints, sewer lines, or other openings that would permit liquids to flow from the curbed area
- Floors and curbing constructed of Portland cement, concrete, or a continuous, smooth, non-porous surface that prevents or minimizes penetration of PCBs
- On a site above the 100-year floodplain
Alternate Storage Units
In addition to the units meeting the criteria listed in section 3.1.4, of DOE/EH-413-9914, PCB waste may be stored beyond 30 days in alternate storage units. They may be any one of the following units:

- Permitted by EPA under RCRA section 3004 for managing hazardous waste in containers
- Permitted by a state authorized under RCRA section 3006 for managing hazardous waste in containers
- Qualified for interim status under RCRA section 3005 for managing hazardous waste in containers and meets the containment requirements
- Approved, or otherwise regulated, under a state PCB waste management program no less stringent in the protection of health or the environment than the TSCA requirements
- Subject to a TSCA coordinated approval that includes provisions for PCB waste storage
- Given a TSCA PCB waste management approval that includes provisions for PCB waste storage

Note that any spills of PCBs stored in any RCRA unit must be cleaned up. RCRA facilities used for storing PCB waste follow the RCRA containment requirement and not the TSCA containment requirement. The RCRA containment requirement is 10 percent of the volume of all containers or the volume of the largest container, whichever is larger.

Containers for PCB Waste
EPA has adopted the DOT container requirements as the container requirements for holding PCB waste. DOT’s container requirements are part of the hazardous materials regulations (HMRs).

The EPA regulation governing containers for PCB waste is 40 CFR 761.65, “Storage for Disposal.” EPA has provided exceptions to DOT containers for PCB/radioactive waste.

Checking for Leaks
All PCB items in storage must be checked for leaks at least once every 30 days. In the event of a leak, you should do the following:

- Transfer any leaking PCB container or PCB article and the contents to properly marked non-leaking containers
- Clean up and dispose any spilled or leaked material
- Keep records of inspections, maintenance, cleanup, and disposal

Dating
All PCB containers storing bulk PCB liquid wastes for disposal and PCB items in storage for disposal must be dated. For bulk PCB liquid wastes, a record of the following information must be maintained that tracks each batch added or removed from the container:

- Date added or removed
- Quantity added or removed
Disposition of the batch

PCB items must be marked with the date on which they were removed from service for disposal. The storage of PCB items must be managed in such a way that a PCB item can be located by date.

Marking

All storage areas, including temporary storage areas, general storage areas and alternate storage units must be marked.

Removal of Equipment

If movable equipment (e.g., forklifts) came into direct contact with PCBs while handling PCB waste in a storage area, including temporary storage areas general storage areas, and alternate storage units, they must be decontaminated before being removed from the storage area.

i. Define PCB/Radioactive Waste and explain how it differs with regard to exemptions to time and general storage requirements. Discuss how PCB/Radioactive Waste is disposed (e.g., discuss the special provisions of [10]*CFR 761.50(b)(7)].

[Note: 10 CFR 761.50(b)(7) corrected to 40 CFR 761.50(b)(7).]

The following is taken from DOE/EH-413-9914.

PCB waste that is mixed with radioactive constituents is designated as PCB/radioactive waste. The origin of the radioactive constituent can be any of the following:

- Accelerator-produced radioactive material
- Naturally-occurring radioactive material
- Byproduct material
- Source material
- Special nuclear material

If the radioactive component is either byproduct, source, or SNM, the PCB/radioactive waste is also subject to the requirements of the AEA in addition to TSCA.

Time and General Storage Exemptions

Three exceptions apply to the storage of PCB/radioactive waste: 1) a one-year storage limit, 2) curbing under the general storage unit, and 3) non-DOT containers.

PCB/radioactive waste removed from service for disposal is exempt from the one-year limit under the following conditions:

- Maintain written records to document all continuing attempts to secure disposal until the waste is disposed of
- Make these records available to EPA upon request
Manage waste in accordance with all other applicable laws and regulations for radioactive material.

PCB/radioactive waste that is exempt from the one-year storage disposal time limit is also exempt from the exception reporting requirements.

PCB/radioactive wastes are not required to be stored in an area with the minimum 6-inch high curbing required for general storage units. However, the area must still provide a containment volume equal to at least the greater of the following:

- Twice the internal volume of the largest PCB container
- 25 percent of the total internal volume of all PCB containers stored therein

There are two exceptions to the requirement to use DOT containers: non-DOT containers and old DOT-specification containers. Containers other than those specified above, may be used for PCB/radioactive waste if the following apply:

- If they are used for liquid PCB/radioactive wastes, they are non-leaking.
- If they are used for non-liquid PCB/radioactive wastes stored in an area with a containment volume, they are designed to prevent buildup of liquids.
- Whether used for liquids or non-liquids, they meet all requirements pertaining to nuclear criticality safety. Container materials, such as polyethylene and stainless steel, are acceptable contingent upon compatibility with the stored wastes. Other materials may be used if there are data to demonstrate to the EPA regional administrator and other appropriate regulatory authorities that the containers are protective of health, safety, and the environment.

Note that non-DOT containers must still meet other applicable Federal and state regulations governing radioactive materials.

The other exception is that the old DOT-specification containers may be used for PCB/radioactive wastes under one of the following conditions:

- When used for storage (and not for transportation regulated by DOT—for example, movement from one facility to another without crossing a public road)
- When used on a transitional basis as prescribed (for example, the filling of these containers prior to October 1, 1996, without emptying and refilling them after that date)

Disposal Requirements
The following is taken from 40 CFR 761.50

Any person disposing of PCB/radioactive waste must do so taking into account both its PCB concentration and its radioactive properties. If, taking into account only the properties of the PCBs in the waste (and not the radioactive properties of the waste), the waste meets the requirements for disposal in a facility permitted, licensed, or registered by a state as a municipal or non-municipal non-hazardous waste landfill (e.g., PCB bulk product waste under Sec. 761.62(b)(1)), then the person may dispose of the PCB/radioactive waste, without
regard to the PCB component of the waste, on the basis of its radioactive properties in accordance with all applicable requirements for the radioactive component of the waste.

j. **Discuss PCB disposal requirements including disposal prohibitions, combustion, and landfilling.**

The following is taken from DOE/EH-413-9914.

Three types of general requirements must be taken into account for disposal: general prohibitions, health and safety, and processing.

**General Prohibitions**
The use of waste oil containing PCBs at any detectable concentrations is prohibited. The following general prohibitions apply to disposal of all PCB waste:

- No open burning (combustion in an incinerator or high-efficiency boiler or other approved method is not open burning)
- No processing of PCB liquids into non-liquid forms to avoid combustion
- No discharging of water containing PCBs to a Federal or public treatment works or navigable waters unless PCB concentration is

\[ S < 3 \text{ g/L (< 3 ppb)} \text{ or} \]

\[ S \text{ Within the discharge limit set in a Clean Water Act section 307(b) or 402 permit.} \]

- No diluting of PCBs to avoid a regulatory requirement unless specifically provided for

As a reminder, observe all other Federal, state, and local laws and regulations applicable to the disposing PCB waste.

**Health and Safety**
Persons disposing PCB articles must don PPE to avoid dermal contact with or inhalation of PCBs. As a best management practice, apply these practices while handling any PCB waste.

**Processing for Disposal**
In the PCB disposal amendments, EPA clarified the types of processing for disposal requiring approval. In general, processing activities primarily associated with and that facilitate treatment require a TSCA PCB disposal approval.

Such activities include microencapsulation, pulverization, and particle size separation. Any diluting, blending, or other processing of a PCB waste (prior to its introduction for disposal) for the purposes of meeting a PCB concentration limit requires such an approval. Augers or hoppers feeding non-liquid PCBs or other technologies that introduce non-liquid PCBs for disposal are examples of the kinds of processing that require such an approval. Moreover, when the rate of delivery of liquid or non-liquid PCBs into a disposal unit is an operating parameter, the rate is subject to such an approval.
On the other hand, processing activities primarily associated with storage and transportation, and that facilitate disposal, do not require approval. These activities include repackaging, consolidating, pumping, draining, dismantling, and disassembling.

**Combustion**
Liquids with 50 ppm of PCBs must be disposed in an incinerator. However, you may also dispose a liquid with PCBs at a concentration 50 ppm and < 500 ppm in a
- high-efficiency boiler, if a mineral oil dielectric fluid, or
- high-efficiency boilers, if not a mineral oil dielectric fluid

**Landfilling of PCB Liquids**
Generally, PCB liquids are banned from landfills. However, concern expressed about incidental PCB liquids associated with non-liquid wastes, which are usually of an aqueous nature, led EPA to insert the following provision:

A PCB-contaminated liquid (i.e., < 500 ppm of PCBs) may be placed in a chemical waste landfill if all of the following conditions are met:
- It is from an incidental or environmental source, such as listed below:
  - precipitation
  - condensation
  - leachate
  - load separation
- It is associated with PCB articles or non-liquid PCB wastes.
- You provide the owner/operator of the landfill with information showing that the liquid is
  - < 500 ppm of PCBs and
  - not an ignitable waste

Note that this landfill provision does not apply to PCB liquids or liquid PCB remediation waste.

**k. Define PCB Remediation Waste and discuss how it is disposed.**

The following is taken from DOE/EH-413-9914.

PCB remediation waste encompasses soil, rags, and other debris generated as a result of any PCB spill cleaned up under 40 CFR 761.61, “PCB Remediation Waste,” or from other unauthorized disposal.

PCB remediation waste may contain either or both liquid and non-liquid PCBs. For purposes of cleaning, decontaminating, or removing PCB remediation waste, there are five general waste categories: bulk PCB remediation waste, non-porous surfaces, porous surfaces, liquid PCB remediation waste, and cleanup waste.
I. Define PCB Bulk Product Waste and discuss how it is disposed.

The following is taken from DOE/EH-413-9914.

PCB bulk product waste is 50 ppm PCB waste derived from manufactured products containing non-liquid PCBs. PCB bulk product waste excludes PCB items, PCB remediation waste, PCB household waste, and wastes from research and development activities.

Examples of PCB bulk product waste include, but are not limited to the following:
- Non-liquid bulk waste or debris from building demolition that contains PCBs (bulk product waste excludes debris from the demolition of buildings or other man-made structures from which spilled PCBs have not been removed)
- Fluorescent light ballasts containing PCBs in the potting material
- PCB-containing wastes from the shredding of automobiles and appliances (shredder fluff)
- Plastics, preformed or molded rubber parts, applied dried paints, sealants, caulking, adhesives, paper, Galbestos, noise insulation, and felt or fabric products such as gaskets from air-handling system gaskets

PCB bulk product waste may be disposed in four ways: performance-based option, solid waste landfills, risk-based option, and landfill cover or roadbed material.

m. Define PCB Waste from research and development activities and discuss how it is disposed.

The following is taken from DOE/EH-413-9914.

This type of waste consists of waste from authorized research and development activities, including, but not limited to, the following:
- Chemical analysis of PCBs (sample preparation, extraction, extract cleanup, extract concentration, addition of PCB standards, and instrumental analysis), and analyses to determine PCB concentration
- Determinations of the physical properties of PCBs
- Studies of PCB environmental transport processes
- Studies of PCB biochemical transport processes, studies of effects of PCBs on the environment, and studies of the health effects of PCBs (direct toxicity and toxicity of metabolic products of PCBs)

Authorized research and development activities do not include research, development, or analysis for the development of any PCB product. Waste from research and development activities does not include waste from activities conducted for the purposes of research and development into PCB disposal.

Waste from research and development activities can be liquid and/or non-liquid PCBs.
The disposal requirements for such waste are based on size. If the size is greater than the portion designated by a particular method, the disposal depends on whether the waste is liquid or non-liquid.

Portions of samples of a size designated in a chemical extraction and analysis method for PCBs and extracted for purposes of determining the presence of or concentration of PCBs are unregulated for PCB disposal.

Liquid solutions, including rinse solvents, generated from research and development activities, are disposed as liquid PCB remediation wastes. Their disposal is based on their concentration at the time of disposal.

Disposal of non-liquid PCB waste from research and development activities is the same as that for non-liquid cleanup materials and PPE given for PCB remediation waste.

n. Define PCB waste from decontamination waste and residues and discuss how it is disposed.

The following is taken from DOE/EH-413-9914.

Examples of PCB waste from decontamination waste and residues include the following:
- Distillation bottoms or residues and filter media
- PCBs physically separated from regulated waste during decontamination (such as by chopping, shredding, scraping, abrading, or oil/water separation, as opposed to solvent rinsing and soaking)
- Solvents used or reused for decontamination
- Non-liquid cleaning materials and PPE waste, non-porous surfaces, rags, gloves, booties, and other disposable materials or items

Decontamination waste and residue can be in the form of liquid and/or non-liquid PCBs.

Disposal of liquid decontamination waste depends on the type of solvent and the concentration of PCBs. Hydrocarbon-solvent decontamination waste with less than 50 ppm of PCBs must be
- marketed, if applicable, and burned
- disposed of as a PCB liquid by combustion or an alternative to combustion, or
- decontaminated

Chlorinated-solvent decontamination waste at any PCB concentration must be
- incinerated or
- decontaminated

EPA has imposed rather stringent requirements for disposal of chlorinated-solvent decontamination waste in order to discourage the use of such solvents.
Solvents (other than those that are chlorinated) containing ≥50 ppm of PCBs as the result of decontamination use must be
  • disposed of as a PCB liquid at their existing concentration by combustion, or
  • decontaminated

PCB liquids from oil/water separation are regulated for disposal at their original concentration.

Distillation bottoms or residues and filter media are regulated for disposal at their existing concentration as PCB remediation waste. PCBs physically separated during decontamination by chopping, shredding, scraping, or abrading are regulated for disposal at their original concentration.

Non-liquid cleanup materials and PPE waste at any concentration, including nonporous surfaces and other non-liquid materials, such as rags, gloves, and booties, and similar materials resulting from decontamination, must be disposed of as non-liquid cleanup materials.

**o. Discuss PCB spill reporting and cleanup.**

The following is taken from Environmental Health and Safety Online, PCB Record Keeping, Spills and Reporting.

When spills with low concentrations (<500 ppm) and <454 g (1 lb) of PCBs occur, all soil within the spill area (visible boundary plus a 1-lateral-foot buffer zone) must be excavated and backfilled with clean soil. Solid surfaces must be double washed/rinsed. (Double wash/rinse means a minimum requirement to cleanse solid surfaces two times with an appropriate cleaning agent. PCBs must be at least 5 percent soluble by weight in the cleaning agent. A volume of PCB-free fluid sufficient to cover the contaminated surface completely must be used in each wash/rinse. The wash/rinse requirement does not mean the mere spreading of the cleaning agent over the surface, nor does the requirement mean a once-over wipe with a soaked cloth.) This action must be completed within 48 hours after the responsible party was notified or became aware of the spill.

When spills with high concentrations (≥500 ppm) or >454 g (1 lb) of PCBs occur, the National Response Center must be notified immediately. The spill area must be cordoned off with at least a 3-foot buffer zone. Warning signs must be clearly visible. The responsible party must document and record the area of visible contamination, noting the extent and center of the visible trace areas. The cleanup of fluid from hard surfaces and the removal of contaminated soil must be initiated (not necessarily completed) within 24 hours after the responsible party was notified or became aware of the spill. If the spill will result in PCB exposure outside the facility, other spill reporting procedures may be required.

Spill reports (both verbal and written) must be completed only by the environmental protection department personnel and are required to contain the following information:
  • Nature of waste or pollutant
- Quantity of waste or pollutant involved
- Time and duration of the incident
- Cause of the spill
- Estimated size and location of the affected area
- Nature of effects
- Corrective measures taken or planned, and a schedule of these activities
- SPCC, and/or contingency plans, in effect
- Persons notified (include name, organization, date, and times)

33. Waste management personnel must demonstrate a working level knowledge of the reporting of the releases of hazardous chemicals and community right-to-know reporting as regulated by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA).

a. Identify the statutes, regulations, and Executive Orders governing release reporting and community right-to-know reporting.

The following is taken from DOE/EH-0447.

CERCLA Reporting Requirements
The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or Superfund), as amended, creates a broad framework for Federal involvement in response to and cleanup of hazardous substance releases. Under CERCLA, EPA has broad statutory authority to undertake or require responsible parties to undertake response actions addressing releases of hazardous substances or pollutants and contaminants. Recognizing that EPA could exercise that authority in many instances only if EPA receives notice of such releases as they occur, Congress enacted section 103(a) of CERCLA, which requires the person in charge of a facility or vessel to notify the National Response Center as soon as the person has knowledge of a release of a hazardous substance at or above the reportable quantity (RQ) assigned to that substance.

The section 103(a) reporting requirements are triggered only when there is a “release,” which is defined in section 101 (22) of CERCLA as any “spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment.” Thus, when a hazardous substance is spilled, leaked, or discharged, the incident must be reported to the National Response Center if the amount that enters the environment within a 24-hour period equals or exceeds an RQ.

“Environment” is defined in section 101(8) of CERCLA as “the navigable waters, the waters of the contiguous zone, and the ocean waters...of the United States...” and “any other surface water, groundwater, drinking water supply, land surface or subsurface strata, or ambient air...”
**EPCRA Reporting Requirements**

Section 304 of the EPCRA requires owners/operators of facilities where hazardous chemicals are produced, used, or stored to report releases of CERCLA hazardous substances or extremely hazardous substances (EHSs) to state and local authorities.

There currently are 360 EHSs; 138 of the EHSs are also CERCLA hazardous substances. Reportable releases of an RQ or more of a substance that is both an EHS and a CERCLA hazardous substance must be reported to the National Response Center, state emergency response commissions and local emergency planning committees; similar releases of an EHS that is not a CERCLA hazardous substance must be reported only to state and local officials.

When EPCRA was first enacted in 1986, Federal facilities were not required to comply with its provisions, although DOE management always encouraged its facilities to comply voluntarily and to work closely with the communities surrounding each site.

On August 3, 1993, E.O. 12856, was signed by the President. This Executive Order formally requires all Federal facilities to comply with EPCRA and the Pollution Prevention Act. Compliance is no longer voluntary.

The emergency release notification requirements under CERCLA and EPCRA are closely related. For example, both CERCLA and EPCRA rely on RQs as reporting triggers. In addition, reporting exemptions established under CERCLA also apply to EPCRA; EPCRA only requires reports of releases that are reportable under CERCLA or that occur in a manner that would make them reportable under CERCLA. Hence, if a release is exempt from reporting under CERCLA (e.g., the release is not into the environment or the release is federally permitted), it also would be exempt under EPCRA. However, there are some important differences between the exclusions and definitions in CERCLA and EPCRA that affect notification requirements. These differences often cause confusion.

**b. Discuss the importance of complying with the release reporting and community right-to-know reporting.**

The following is taken from EPA, Fact Sheet: Emergency Planning and Community Right-to-Know Act of 1986.

Compliance with release and right-to-know reporting ensures state and local communities are prepared to respond to potential chemical accidents. In accordance with EPCRA, each state has established a state emergency response commission (SERC). In turn, the SERC has designated local emergency planning districts. For each district, the SERC appoints, supervises, and coordinates the activities of a local emergency planning commission (LEPC). The LEPC must, in turn, develop an emergency response plan for its district and review it annually. The membership of the LEPC includes representatives of public and private organizations as well as a representative from every facility subject to EPCRA emergency planning requirements.
The purpose of community right-to-know reporting is to increase community awareness of chemical hazards and to facilitate emergency planning. EPCRA applies to any facility

- required by the OSHA, under its hazard communication standard, to prepare or have available a MSDS for a hazardous chemical;
- that has onsite, for any one day in a calendar year, an amount of a hazardous chemical equal to or greater than the following threshold limits established by the EPA:
  - 10,000 lbs for hazardous chemicals
  - lesser of 500 lbs or the TPQ for EHSs

If a facility is subject to reporting under these sections, it must submit information to the SERC, the LEPC, and the local fire department with jurisdiction over the facility under two categories: MSDS reporting and inventory reporting.

c. **Define a CERCLA hazardous substance.**

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 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 RCRA.
- Any hazardous air pollutant listed under section 112 of the 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 TSCA.

d. **Define Reportable Quantities (RQs) and explain how RQs are applied and used.**

The following is taken from DOE EH-231-001/0490.

An RQ is the amount of a hazardous substance which, when released to the environment, must be reported to the National Response Center. Reportable quantities are action levels that
may trigger an appropriate response to a release under provisions of the CWA, CERCLA, or EPCRA. Because the RQs are set at levels intended to trigger the assessment of possible responses including no action, the RQ values themselves do not necessarily correspond to unacceptable levels based on exposures or RAs.

Under sections 311 of the CWA and 102(a) of CERCLA, RQs for all hazardous substances were initially set at one pound. However, EPA has statutory authority to adjust RQ levels up or down depending on the relative toxicity or carcinogenicity of individual substances.

By regulation, the RQ for radionuclides has been redefined in units of the curie (Ci), and specific RQs—ranging from 0.001 to 1000 Ci—have been promulgated for 757 radionuclides.

e. Discuss how it is determined if a release is reportable under CERCLA. Explain for releases containing only one hazardous substance and for releases containing mixtures of hazardous substances. Discuss exemptions to the reporting requirements.

The following is taken from DOE Office of Health, Safety, and Security, RQ Calculator.

The CERCLA, as amended, creates a framework for Federal involvement in response to and cleanup of hazardous substance releases. Under CERCLA, the EPA has broad statutory authority to undertake or require responsible parties to undertake actions addressing releases of hazardous substances or pollutants and contaminants. Recognizing that EPA could exercise that authority only if it receives notice of such releases, Congress enacted section 103(a) of CERCLA, which requires the person in charge of a facility or vessel to notify the National Response Center as soon as the person in charge has knowledge that the release of a hazardous substance is at or above the RQ for the substance.

Section 103(a) requirements are triggered only when there is a release, which is defined in section 101 (22) of CERCLA as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment. Thus, when a hazardous substance is spilled, leaked, or discharged, the incident must be reported to the National Response Center if the amount that enters the environment within a 24-hour period equals or exceeds its RQ. Environment is defined in section 101(8) of CERCLA as “the navigable waters, the waters of the contiguous zone, and the ocean waters …of the United States…” and “any other surface water, groundwater, drinking water supply, land surface or subsurface strata, or ambient air…”

Release of Mixtures
The following is taken from U.S. Environmental Protection Agency, Emergency Management, Substances Covered under Reporting Requirements: The Mixture Rule.

EPA issued the “mixture rule” (40 CFR 302.6[b]), developed in connection with CWA section 311 regulations, as a method for determining when to report releases of mixtures or solutions. Under the mixture rule, if the quantities (or concentrations) of all the hazardous
constituents of the waste stream are known, notification is required only where an RQ or more of any hazardous constituent is released. However, if the quantity of one or more of the hazardous constituents of the waste is not known, notification is required where the total amount of the waste released equals or exceeds the RQ for the hazardous constituent with the lowest RQ (i.e., the RQ for the waste stream).

**Exemptions**

The following is taken from DOE/EH-231-019/1093.

The regulations in 40 CFR 302.3, “Definitions,” specifically exempt the following releases from the CERCLA reporting requirements:

- Release of source, byproduct, or SNM from a nuclear incident subject to requirements of the National Response Center for financial protection under section 170 of the AEA
- Releases resulting in exposure to persons solely within a workplace (releases occurring in a closed space with no emissions to the ambient environment)
- Federally permitted releases (i.e., releases of source, SNM, or byproduct material, as those terms are defined in the AEA, in compliance with a legally enforceable license, permit, regulation, or order issued pursuant to the AEA; and discharges covered by a NPDES permit, permit application, or permit administrative record)
- Emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel, or pipeline pumping station engine
- Continuous releases, stable in quantity and rate, for which notice was given and there was a period sufficient to establish the continuity, quantity, and regularity of such release

**f. Discuss how releases of hazardous substances are identified and the reporting requirements including time, to whom and by whom, definition of facility, and definition of environment.**

**Identifying Hazardous Substance Releases**

The following is taken from CERCLA Laws and Regulations.

CERCLA response authority is triggered by a “release” or a “substantial threat of a release” of hazardous substances into the environment. CERCLA defines “release” as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous substances into the environment. The definition of a release includes the abandonment or discarding of barrels, containers, and other closed receptacles containing a hazardous substance, pollutant, or contaminant. CERCLA excludes from the definition of release any federally permitted release; releases solely within a workplace; emissions from motor vehicles; and releases of source, byproduct, or SNM from a “nuclear incident” that is subject to financial protection requirements established under section 170 of the AEA, or releases of such materials from a mill processing site.

**Reporting Requirements**

The following is taken from CERCLA Laws and Regulations.
As soon as any person in charge of a facility has knowledge of a release of hazardous substances exceeding reportable quantities, CERCLA requires that such release be reported. Specifically, CERCLA section 103(b)(3) requires that the person in charge of a facility from which a hazardous substance exceeding reportable quantities has been released must immediately notify the National Response Center. Reportable quantities have been developed for all CERCLA hazardous substances and are listed in 40 CFR 302, “Designation, Reportable Quantities, and Notification.” Any responsible official who fails to provide proper notice of a release can be fined and imprisoned for up to three years.

Upon receiving notification, the National Response Center will in turn notify other appropriate government authorities. In addition, it may be necessary to satisfy state reporting requirements. The National Response Center needs the following information to properly characterize the release:

- Location of release
- Type(s) of material(s) released
- Estimate of quantity involved
- Possible source of release
- Date and time of release
- Danger to public health and safety and the environment

The report of the release or potential release is entered into the EPA’s Office of Solid Waste and Emergency Response CERCLA information system database, the Federal facilities docket database, and the emergency response notification system database. These databases are used by the EPA to track the progress of potential sites through the CERCLA process.

Definition of Facility
The following is taken from 40 CFR 307.14.

CERCLA section 101(9) defines facility broadly to include any site or area where a hazardous substance is located, but the definition specifically excludes consumer products in consumer use. Vessel is defined in CERCLA section 101(28) as any watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.

Definition of Environment
The following is taken from U.S. Environmental Protection Agency, Emergency Management, Releases Under the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA).

CERCLA section 101(8) defines “environment” as “(A) the navigable waters, the waters of the contiguous zone, and the ocean waters of which the natural resources are under the exclusive management authority of the United States under the Fishery Conservation and Management Act of 1976, and (B) any other surface water, groundwater, drinking water supply, land surface or subsurface strata, or ambient air within the United States or under the jurisdiction of the United States.”
g. Discuss the purpose of the Emergency Planning and Community Right-To-Know Act and DOE's role in its implementation within a community.

The following is taken from U.S. DOE, Office of Health, Safety and Security, Emergency Planning and Community Right-to-Know Act.

*Purpose and Organization*

The Emergency Planning and Community Right-to-Know Act (EPCRA), enacted on October 17, 1986, represents a significant first step toward a major Federal role in areas previously regulated by state and local governments. EPCRA was enacted by Congress as a stand-alone provision, Title III, of the Superfund Amendments and Reauthorization Act of 1986 (SARA).

Title III was passed in response to concerns regarding the environmental and safety hazards posed by the storage and handling of toxic chemicals. These concerns were triggered by the disaster in Bhopal, India, in which more than 2,000 people suffered death or serious injury from the accidental release of methyl isocyanate. To reduce the likelihood of such a disaster in the United States, Congress imposed requirements on both states and regulated facilities. Facilities must notify the local emergency planning districts regarding materials stored at and released from sites.

The emergency planning aspect requires local communities to prepare plans to deal with emergencies relating to hazardous substances. The community right-to-know aspect creates new rights for members of the public and local governments to obtain information concerning potential threats in their neighborhoods involving hazardous substances. Thus, EPCRA provides the tools for local governments and members of the community to make their own decisions regarding hazardous materials in their communities.

*Requirements for Affected DOE Facilities*

Appendix A of 40 CFR 355, “Emergency Planning and Notification,” defines EHSs. 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 appropriate SERC that they are subject to these requirements. The facilities must notify the LEPC of releases exceeding an RQ of EHSs, as defined under Title III, and Hazardous Substances, as defined under CERCLA. In addition, the facilities must report their chemical inventories and provide MSDSs to the local emergency planning organizations as outlined in 40 CFR 370. DOE voluntarily complies with these provisions.

h. Define Threshold Planning Quantities (TPQs).

The following is taken from U.S. Environmental Protection Agency, EPCRA Frequent Questions—Sections 301 and 302.

The EPA assigned chemicals to TPQ categories based on an index that accounts for the toxicity and the potential of each chemical, in an accidental release, to become airborne. This
approach does not give a measure of absolute risk, but provides a basis for relative measures of concern. Under this approach, the level of concern for each chemical is used as an index of toxicity, and physical state and volatility are used to assess its ability to become airborne. The two indices are combined to produce a ranking factor. Chemicals with a low ranking factor (highest concern), based on the agency’s technical review, are assigned a TPQ of one pound. It is believed that the one pound TPQ represents a reasonable lower limit for the most EHS on the list. Chemicals with the highest ranking factors, indicating lower concern, were assigned a TPQ of 10,000 pounds. This ensures that any facility handling bulk quantities of any EHS would be required to notify the state commission. Between the limits of one pound and 10,000 pounds, chemicals were assigned to intermediate categories of 10, 100, 500, or 1,000 pounds based on order of magnitude ranges in the ranking factors. The selection of the intermediate categories was based on standard industrial container sizes between one and 10,000 pounds. The agency believes that limited state and local resources should be focused on those substances that could cause the greatest harm in an accidental release. The TPQs developed in this approach meet the objective such that substances that are most likely to cause serious problems (extremely toxic gases, solids likely to be readily dispersed, or highly volatile liquids) have lower TPQs than those that might be toxic but are not likely to be released to the air (non-reactive, non-powered solids).

i. Discuss DOE’s responsibilities for facilities which contain greater than TPQs.

The following is taken from U.S. Environmental Protection Agency EPA, 550-F-00-004.

Any facility that has any of the listed chemicals (40 CFR 355, appendices A & B) at or above its TPQ must notify the SERC and LEPC within 60 days after they first receive a shipment or produce the substance onsite.

j. Identify the four characteristics of a sound EPCRA program at a DOE site.

The following is taken from U.S. Environmental Protection Agency, EPA 550-F-00-004.

The Emergency Planning and Community Right-to-Know Act has four major provisions:

- Emergency planning (Section 301-303)
- Emergency release notification (Section 304)
- Hazardous chemical storage reporting requirements (Sections 311-312)
- Toxic chemical release inventory (Section 313)

Regulations implementing EPCRA are codified in Title 40 of the Code of Federal Regulations, parts 350 to 372. The chemicals covered by each of the sections are different, as are the quantities that trigger reporting.

Emergency Planning

Emergency response plans contain information that community officials can use at the time of a chemical accident. Community emergency response plans for chemical accidents are developed under section 303. The plans must

- identify facilities and transportation routes of EHSs
• describe emergency response procedures, on and offsite
• designate a community coordinator and facility coordinator(s) to implement the plan
• outline emergency notification procedures
• describe how to determine the probable affected area and population by releases
• describe local emergency equipment and facilities and the persons responsible for them
• outline evacuation plans
• provide a training program for emergency responders (including schedules)
• provide methods and schedules for exercising emergency response plans

Planning activities of LEPCs and facilities initially focused on, but were not limited to, the 356 EHSs listed by EPA. The list includes the TPQ (minimum limits) for each substance. Any facility that has any of the listed chemicals at or above its TPQ must notify the SERC and LEPC within 60 days after they first receive a shipment or produce the substance onsite.

**Emergency Release Notification**

Facilities must immediately notify the LEPC and the SERC if there is a release into the environment of a hazardous substance that is equal to or exceeds the minimum RQ set in the regulations. This requirement covers the 356 EHSs as well as the more than 700 hazardous substances subject to the emergency notification requirements under CERCLA Section 103(a)(40 CFR 302.4). Some chemicals are common to both lists. Initial notification can be made by telephone, radio, or in person. Emergency notification requirements involving transportation incidents can be met by dialing 911, or in the absence of a 911 emergency number, calling the operator. This emergency notification needs to include:

- the chemical name
- an indication of whether the substance is extremely hazardous
- an estimate of the quantity released into the environment
- the time and duration of the release
- whether the release occurred into air, water, and/or land
- any known or anticipated acute or chronic health risks associated with the emergency, and where necessary, advice regarding medical attention for exposed individuals
- proper precautions, such as evacuation or sheltering in place
- the name and telephone number of contact person

A written follow-up notice must be submitted to the SERC and LEPC as soon as practicable after the release. The follow-up notice must update information included in the initial notice and provide information on actual response actions taken and advice regarding medical attention necessary for citizens exposed.

**Hazardous Chemical Storage Reporting Requirements**

Under OSHA regulations, employers must maintain a MSDS for any hazardous chemicals stored or used in the workplace. Approximately 500,000 products have MSDSs.

Section 311 requires facilities that have MSDSs for chemicals held above certain quantities to submit either copies of their MSDSs or a list of MSDS chemicals to the SERC, LEPC, and
local fire department. If the facility owner or operator chooses to submit a list of MSDS chemicals, the list must include the chemical or common name of each substance and must identify the applicable hazard categories. These hazard categories are

- immediate (acute) health hazard
- delayed (chronic) health hazard
- fire hazard
- sudden release of pressure hazard
- reactive hazard

If a list is submitted, the facility must submit a copy of the MSDSs for any chemical on the list upon the request of the LEPC or SERC.

Facilities that start using a chemical or increase the quantity to exceed the thresholds must submit MSDSs or a list of MSDSs chemicals within three months after they become covered. Facilities must provide a revised MSDS to update the original MSDS if significant new information is discovered about the hazardous chemical.

Facilities covered by section 311 must, under section 312, submit annually an emergency and hazardous chemical inventory form to the LEPC, the SERC, and the local fire department. Facilities provide either a tier I or tier II form. Tier I forms include the following aggregate information for each applicable hazard category:

- An estimate (in ranges) of the maximum amount of chemicals for each category present at the facility at any time during the preceding calendar year
- An estimate (in ranges) of the average daily amount of chemicals in each category
- The general location of hazardous chemicals in each category

The tier II report contains basically the same information as the tier I, but it must name the specific chemicals. Many states require tier II information under state law. Tier II forms provide the following information for each substance:

- The chemical name or the common name as indicated on the MSDS
- An estimate (in ranges) of the maximum amount of the chemical present at any time during the preceding calendar year and the average daily amount
- A brief description of the manner of storage of the chemical
- The location of the chemical at the facility
- An indication of whether the owner elects to withhold location information from disclosure to the public

Because many SERCs have added requirements or incorporated the Federal contents in their own forms, tier I/II forms should be obtained from the SERC. Section 312 information must be submitted on or before March 1 each year. The information submitted under sections 311 and 312 is available to the public from LEPCs and SERCs.

Toxic Chemical Release Inventory

EPCRA section 313 (commonly referred to as the Toxics Release Inventory, or TRI) requires certain facilities to complete a Toxic Chemical Release Inventory Form annually for specified chemicals. The form must be submitted to EPA and the state on July 1 and cover
releases and other waste management of toxic chemicals that occurred during the preceding calendar year. One purpose of this reporting requirement is to inform the public and government officials about releases and other waste management of toxic chemicals. The following information is required on the form:

- The name, location and type of business
- Whether the chemical is manufactured (including importation), processed, or otherwise used and the general categories of use of the chemical
- An estimate (in ranges) of the maximum amounts of the toxic chemical present at the facility at any time during the preceding year
- Quantity of the chemical entering the air, land, and water annually
- Offsite locations to which the facility transfers toxic chemicals in waste for recycling, energy recovery, treatment or disposal
- Waste treatment/disposal methods and efficiency of methods for each waste stream

In addition, the Pollution Prevention Act of 1990 requires collection of information on source reduction, recycling, and treatment.


a. Discuss the major requirements of the FFCA including:
   - Waiver of sovereign immunity for DOE
   - Mixed waste inventory report
   - Mixed waste treatment capacities and technologies report
   - Chief financial officer’s report
   - Site treatment plan
   - State agreement (consent order)

Waiver of Sovereign Immunity for DOE


Congress enacted the Federal Facility Compliance Act (FFCA) on October 6, 1992, which specifically waived DOE’s sovereign immunity with respect to RCRA for Federal facilities. The FFCA amends 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.” These penalties and fines can be levied by EPA or by authorized states. In addition, the FFCA states that “the United States hereby expressly waives any immunity otherwise applicable to the United States.” It should be noted that Federal agents, employees, and officers are not liable for civil penalties; however, they are subject to criminal sanctions. No departments, agencies, or instrumentalities are subject to criminal sanctions.
Mixed Waste Inventory Report and Mixed Waste Treatment Capacities and Technologies Report


Section 105 of the FFCA further amends RCRA by adding the new section 3021. This section provides the mechanism for fulfilling the requirements cited above by imposing several new reporting requirements on DOE related to mixed waste.

Not later than 180 days after the date of enactment, the Secretary of Energy had to submit reports containing a national inventory of mixed wastes on a state-by-state basis and 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. The mixed waste inventory was to, among other things, describe each mixed waste type, list the amount currently stored, and estimate the amount of each type of mixed waste expected to be generated in the next five years at each DOE facility. Wastes that had not been characterized by sampling and analysis also had to be described. The inventory of treatment capacities and technologies was to contain an estimate of available treatment capacity for each waste described in the waste inventory, and provide information to support determinations that no treatment technology exists. DOE submitted its initial draft mixed waste inventory report to EPA and affected states for comment in April 1993.

Chief Financial Officer’s Report

The following is taken from DOE, Federal Facility Compliance Act, Chief Financial Officer Report.

The chief financial officer of each affected agency shall submit to Congress an annual report containing, to the extent practicable, a detailed description of the compliance activities undertaken by the agency for mixed waste streams, and an accounting of the fines and penalties imposed on the agency for violations involving mixed waste.

Site Treatment Plan


The Secretary of Energy was directed to prepare and submit plans 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. Plans were not required where agreements and orders were already in place.
State Agreement (Consent Order)
The following is taken from DOE G 435.1-1, appendix A.

In 1992, Congress passed amendments to the SWDA, entitled the Federal Facility Compliance Act, which required DOE to prepare plans for the developing treatment capacities and technologies for mixed waste. Pursuant to this Act, DOE prepared site-specific treatment plans, and consent orders or agreements that were reached with the affected states and EPA. These consent orders and agreements typically specify how and when high-level wastes (HLWs), which also exhibit hazardous characteristics or contain RCRA-regulated hazardous components, are to be retrieved, characterized, treated, and stored for shipment to the geologic repository.

b. Discuss the content of the Site Treatment Plan at the site including the identification of mixed waste streams, the development of treatment capacities, technology development needs, and schedules. Explain how the Site Treatment Plan is maintained (e.g., updated).

The following is taken from DOE, Federal Facility Compliance Act, Plan for Development of Treatment Capacities and Technologies.

For each facility at which DOE generates or stores mixed wastes, except any facility subject to a permit, agreement, or order, the Secretary of Energy shall develop and submit a plan for developing treatment capacities and technologies to treat all of the facility’s mixed wastes, regardless of the time they were generated.

Each plan shall contain the following:

- For mixed wastes for which treatment technologies exist, a schedule for submitting all applicable permit applications, entering into contracts, initiating construction, conducting systems testing, commencing operations, and processing backlogged and currently generated mixed wastes
- For mixed wastes for which no treatment technologies exist, a schedule for identifying and developing such technologies, identifying the funding requirements for the identification and development of such technologies, submitting treatability study exemptions, and submitting research and development permit applications
- For all cases where the Department proposes radionuclide separation of mixed wastes, or materials derived from mixed wastes, provide an estimate of the volume of waste generated by each case of radionuclide separation, the volume of waste that would exist or be generated without radionuclide separation, the estimated costs of waste treatment and disposal if radionuclide separation is used compared to the estimated costs if it is not used, and the assumptions underlying such waste volume and cost estimates

A plan required under this subsection may provide for centralized, regional, or onsite treatment of mixed wastes, or any combination thereof.
c. Discuss the content of the Consent Order at the site including the requirements for identification of new waste streams, treatment of mixed waste from off-site, adherence to schedules, changes to treatment strategy, updates and revisions, and penalties for non-compliance.

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

35. Waste management personnel must demonstrate a familiarity level knowledge of the supporting environmental laws and regulations including:
   - Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)
   - Endangered Species Act (ESA)
   - National Historic Preservation Act
   - American Indian Religious Freedom Act
   - DOE American Indian Policy

   a. Describe the process for licensing applicators as defined in the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

   The following is taken from DOE, Environmental Guidance, *Federal Environmental Notification & Reporting Requirements Handbook*.

   FIFRA governs the sale and use of pesticides. All pesticides sold in the United States must be registered with the EPA (authority for the implementation of FIFRA was originally placed with the U.S. Department of Agriculture, but was transferred to the EPA in 1970).

   Each applicant for registration of a pesticide must file a statement with the EPA which includes the following information: name and address of applicant; name of the pesticide; a complete copy of the pesticide label; the complete pesticide formula; and a request that the pesticide be classified for general use or for restricted use, or for both. Also, if requested, a full description of tests made and the results on which the claims are based must be provided.

   Pesticide registration is very specific and is for a limited five-year period. Unless an interested party petitions for renewal, the registration automatically expires after the five-year period.

   A conditional registration is authorized when certain data on a product’s safety have either not yet been supplied to EPA or have not yet been analyzed to ensure “it will perform its intended function without unreasonable adverse effects on the environment.”

   b. Discuss the Endangered Species Act consultation requirements.

   The following is taken from DOE/EH-412/0012/0699.

   Section 7 (Interagency Cooperation) requires consultation with the Fish and Wildlife Service and the National Marine Fisheries Service by all Federal agencies when any activity they authorize, fund, or carry out (i.e., when they are “action agencies”) may affect a listed species or designated critical habitat. In addition, action agencies must confer with the services when any proposed action is likely to jeopardize proposed species or adversely modify proposed
critical habitat. Compliance with section 7 can take various paths as discussed below. Which procedure applies and whether one or both services will be involved depend upon the nature of the proposed action and the species or critical habitat that might be impacted by it.

Consultations are of several types: informal (the most common ones), formal, early, or emergency.

**Informal**
Except in those cases where the need for formal consultation is obvious from the start, the services encourage all action agencies to start section 7 compliance with informal consultation. If the action agency determines that a proposed action is not likely to adversely affect listed species or their critical habitat (i.e., the effects are completely beneficial, insignificant, or discountable) and if the services concur in writing with that determination, then formal consultation is not necessary, and section 7 consultation has been completed.

**Formal**
Formal consultation is necessary when a Federal agency determines that an action may affect a listed species or its designated critical habitat, or when the services, through informal consultation, do not concur with an action agency’s finding of “not likely to adversely affect” a listed species or “not likely to adversely modify” designated critical habitat. Formal consultation results in a biological opinion written by the services and sent to the action agency. Based on that opinion, the action agency determines whether and in what manner to proceed with the proposed action. An exemption process is available if the action agency determines that it must proceed with the action in spite of a jeopardy or adverse modification finding.

**Early**
Early consultation is an optional process an action agency may undertake on behalf of an applicant for a Federal permit or license. It is intended to reduce the potential for conflicts between listed species or designated critical habitat and proposed actions.

**Emergency**
Emergency consultations are held when an agency must respond quickly to a natural disaster or other calamity. These consultations are followed by a written formal consultation if listed species or critical habitats have been adversely affected.

Formal consultations need to be reinitiated when the proposed action or available information changes in ways not considered in the original consultation. Reinitiations involving major changes in analyses of effects or changes in the services’ biological opinion are addressed fully in a new formal consultation.

A conference considers the effect of an action on proposed species or proposed critical habitat. If a proposed species or critical habitat considered in a conference is listed or designated during the life of a project that retains Federal involvement, then a consultation with the services may be needed. Often the result of the conference can, however, be used as
though it had been a consultation on a listed species or designated critical habitat, thus eliminating the need for an involved second interaction with the services.

c. Discuss the requirements of the National Historic Preservation Act and the American Indian Religious Freedom Act.

National Historic Preservation Act (NHPA)
The following is taken from DOE/EH-412-0002r.

The National Historic Preservation Act was enacted in 1966 to protect the Nation’s historical resources from increasing development and expansion pressures by establishing a comprehensive national historic preservation policy. It defines historic properties to encompass a broad interpretation of American history and acknowledges significance at all levels, not just nationally. Furthermore, historic properties are now understood and appreciated as part of—not isolated from—the landscape in which they belong.

Implementation of this act is mainly through 36 CFR 63, Determinations of Eligibility for Inclusion in the National Register of Historic Places, and 36 CFR 800, Protection of Historic Properties. The regulations that implement this act and their accompanying guidance documents formulate a proactive national policy on historic preservation. It specifically directs Federal government agencies to take historic preservation into account in planning their initiatives and actions. Thus, the Federal government is now a full partner and a leader in historic preservation.

American Indian Religious Freedom Act
The following is taken from A Guide for DOE Employees, Working with Indian Tribal Nations.

In 1978 Congress passed the American Indian Religious Freedom Act that states that it is the policy of the United States to protect and preserve American Indians’ rights to believe, express, and practice their traditional religions. In the past other Federal laws, such as laws intended to protect wilderness areas and endangered species, have at times conflicted with access to sacred sites and possession of animal-derived sacred objects. This act clarified that Federal laws passed for other purposes were not intended to conflict with Indian rights to practice their traditional religions.

d. Discuss the Department’s policy on American Indians.

The following is taken from A Guide for DOE Employees, Working with Indian Tribal Nations, Appendix 3.

The Department recognizes and commits to a government-to-government relationship with American Indian tribal governments.

- DOE recognizes tribal governments as sovereign entities with, in most cases, primary authority and responsibility for Indian country. In keeping with the principle of American Indian self-government, the Department will view tribal governments as
the appropriate non-Federal parties for making decisions affecting Indian country, its energy resources and environments, and the health and welfare of its populace. The Department will recognize the right of each tribe to set its own priorities and goals in developing and managing its energy resources. The Department recognizes that some tribes have treaty-protected interests in resources outside reservation boundaries.

DOE recognizes that a trust relationship derives from the historical relationship between the Federal government and American Indian tribes as expressed in certain treaties and Federal Indian law.

- In keeping with the trust relationship, the DOE will consult with tribal governments regarding the impact of DOE activities on the energy, environmental and natural resources of American Indian tribes when carrying out its responsibilities.

The Department will consult with tribal governments to ensure that tribal rights and concerns are considered prior to DOE taking actions, making decisions or implementing programs that may affect tribes.

- The DOE will take a proactive approach to solicit input from tribal governments on departmental policies and issues. The Department will encourage tribal governments and their members to participate fully in the national and regional dialogues concerning departmental programs and issues.

Consistent with Federal cultural resource laws and the American Indian Religious Freedom Act, each field office or DOE installation with areas of cultural or religious concern to American Indians will consult with them about the potential impacts of proposed DOE actions on those resources and will avoid unnecessary interference with traditional religious practices.

- DOE will comply with all cultural resource legislation and implementing regulations in the management and operation of its programs and facilities. Consultation with appropriate American Indian tribal governments is part of the compliance process involving Federal cultural resource laws and the American Indian Religious Freedom Act. Consultation may include, but is not limited to 1) the exchange of information concerning the location and management of cultural resources, 2) repatriation or other disposition of objects and human remains, 3) access to sacred areas and traditional resources located on DOE lands in accordance with safety, health and national security considerations, and 4) assessment of potential community impacts.

The Department will identify and seek to remove impediments to working directly and effectively with tribal governments on DOE programs.

- DOE recognizes that there may be regulatory, statutory and/or procedural impediments which limit or restrict its ability to work effectively and consistently with tribes. In keeping with this policy, the Department will seek to remove any such impediments. Additionally, Department will, to the maximum extent permitted by law, apply existing statutory, regulatory and procedural requirements in a manner that furthers the goals of this policy.
The Department will work with other Federal and state agencies that have related responsibilities to clarify the roles, responsibilities and relationships of our respective organizations as they relate to tribal matters.

- DOE will seek and promote cooperation with other agencies that have related responsibilities. In many areas of concern to DOE, cooperation and mutual consideration among neighboring governments (Federal, state, tribal and local) is essential. Accordingly, DOE will encourage early communication and cooperation among all governmental parties. This recognizes that the principle of comity among equals and neighbors often serves the best interests of all parties.

The Department will incorporate this policy into its ongoing and long-term planning and management processes.

- It is key to this effort to ensure that the principles of this policy are effectively institutionalized by incorporating them into the Department’s ongoing and long-term planning and management processes. Department managers will include specific programmatic actions designed to facilitate tribal participation in departmental program planning and activities.

36. Waste management personnel must demonstrate a working level knowledge of the management and negotiation of regulatory requirements.

a. Describe the responsibilities involved with the management of documents such as:

- National pollutant discharge elimination system permit
- Federal facility agreement
- Consent orders & settlement agreements
- Record of decision
- Resource Conservation and Recovery Act Part B permit
- Grant conditions
- Monitoring requirements

_National Pollutant Discharge Elimination System Permit_

The following is taken from DOE, Office of Nuclear Safety, Quality Assurance, and Environment, National Pollutant Discharge Elimination System, General Permit for Stormwater Discharges from Construction Activities.

On July 1, 2008, the EPA re-issued the general permit that authorizes the discharge of sediment-laden stormwater associated with construction activities, also known as the construction general permit (CGP). Construction activities that disturb land, potentially introducing pollutants into stormwater discharges, are regulated under the NPDES stormwater program, pursuant to the CWA. Most states are authorized to implement the NPDES stormwater program; however, in those areas where EPA is the permitting authority, the CGP sets those provisions that construction operators must comply under the NPDES stormwater program. Areas eligible for coverage under the CGP are identified in appendix B of the permit.
The CGP regulates the discharge of stormwater from construction sites that disturb one acre or more of land, and from smaller sites that are part of a larger, common plan of development. Operators of regulated construction sites are required to apply for coverage under the CGP through EPA’s Electronic Stormwater Notice of Intent (eNOI) system, and develop and implement pollution prevention plans to minimize the discharge of sediment and other pollutants in stormwater runoff.

The 2008 CGP has been issued for a two-year time period and applies only to new discharges sites that start construction on or after the effective date of this permit, and sites that have already started construction but do not have permit coverage under the previous CGP. Construction site operators with permit coverage under the previous CGP may continue to operate under the provisions of the permit and do not need to file a new eNOI.

*Federal Facility Agreement*

The following is taken from DOE/EH 413/9713.

A Federal facility agreement is an administrative tool used by EPA (or authorized state) to dictate Federal requirements (such as CERCLA or RCRA). One example would be an agreement to conduct a RI/FS via a CERCLA section 120, interagency agreement/Federal facility agreement.

*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 (PRPs). These agreements are in the form of administrative orders on consent (AOCs), 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 PRPs to address some or all of the parties’ responsibility for a site. EPA uses AOCs for removal activity (short-term cleanup), investigation, and remedy design work. EPA also uses AOCs for cost recovery when the payments are made as part of an agreement for work and for de minimis cash-out payments. AOCs do not require approval by the court.

Administrative agreements are legal documents that formalize an agreement between EPA and one or more PRPs 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 PRPs 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/FSs. A consent decree is final when it is approved and entered by a U.S. District Court.

The EPA prefers that PRPs do the work of investigating, cleaning up, and maintaining the cleanup of Superfund sites. EPA negotiates an agreement (in the form of an AOC or consent decree) with the PRPs 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, short-term cleanup (removal action), and long-term cleanup.

When EPA performs investigations or cleanup work, it can recover these costs from PRPs 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. AOCs for work may include a provision for the PRPs to reimburse EPA for past work costs and will include a provision for the PRP to pay EPA’s future costs in overseeing the PRP’s work (considered “cost recovery” because such costs are billed to PRPs after they are incurred).

There are a few situations when it is more appropriate for PRPs not to be involved in performing work at a site. In such cases, EPA may negotiate a cash-out agreement with the PRP, where the PRP 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 cleanup. Agreements to cash out de minimis PRPs 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.

*Record of Decision*

The following is taken from U.S Environmental Protection Agency, Superfund, Record of Decision.

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.

*Resource Conservation and Recovery Act Part B Permit*

The following is taken from U.S. Environmental Protection Agency, EPA 530-K-05-016.

Owners/operators of facilities that fall under the permitting regulations are required to submit a comprehensive permit application covering all aspects of the design, operation, and maintenance of the facility. The application provides EPA valuable information that will ensure compliance with subtitle C regulations through the development of a facility-specific
permit. Permits are written to address the specific geography of the facility, the types of hazardous waste management units, and the specific waste streams that will be managed at the facility. The permit application consists of two parts, part A and part B.

Part B information is submitted in narrative form. It includes general information requirements for all hazardous waste management facilities, as well as unit-specific information. The part B information requirements presented in 40 CFR 270, “EPA-Administered Permit Programs: The Hazardous Waste Permit Program,” reflect the standards promulgated in parts 264 and 266. 40 CFR 270.14, “Contents of Part B: General Requirements,” lists the general information requirements that all hazardous waste management facilities must submit in part B of the permit application, including:

- general description of the facility
- chemical and physical analyses of the wastes to be handled at the facility
- copy of the waste analysis plan
- description of the security procedures and copy of the inspection schedule
- copy of the contingency plan
- description of procedures, structures, or equipment used at the facility to prevent releases to the environment
- description of precautions to prevent accidental ignition or reaction of ignitable, reactive, or incompatible waste
- facility location information such as proximity to a seismic area or a 100-year floodplain

Owners/operators are required to provide information regarding the placement of hazardous waste and any resultant releases. These regulations are designed to prevent or remediate releases into the environment from land-based hazardous waste management units and solid waste management units. This information is then used as part of the corrective action process.

Grant Conditions

The following is taken from U.S. Environmental Protection Agency, State and Local Government Information: Performance Partnership Agreements.

One of the main ways that EPA and individual states implement the principles of performance partnerships on the ground is by negotiating performance partnership agreements.

Some performance partnership agreements meet relevant statutory and regulatory requirements and also serve as the work plans for performance partnership grants or other EPA grants.

Monitoring Requirements

The following is taken from EH-231-039/1193.

Owners/operators of interim status facilities may obtain a waiver from all or part of the groundwater monitoring requirements by demonstrating that there is a low potential for
migration of hazardous waste or hazardous constituents from the facility via the uppermost aquifer to water supply wells or to surface water. This demonstration must be in writing, kept at the facility, and certified by a qualified geologist or geotechnical engineer. The demonstration must establish that there is a low potential for hazardous waste or hazardous constituents

- to migrate from the facility to the uppermost aquifer and enter the uppermost aquifer
- to migrate to a water supply well or to surface water

In addition, groundwater monitoring requirements may be waived for interim status surface impoundments where the owner or operator can demonstrate that there is no potential for migration of hazardous wastes if the impoundments

- are only used to neutralize wastes that are hazardous because they exhibit the characteristic of corrosivity or were listed for exhibiting this characteristic
- contain no other hazardous wastes

A regulator may waive groundwater monitoring requirements for the following types of permitted units:

- Engineered structures that do not receive liquid wastes and have inner and outer containment layers with a liquid detection system in each containment layer
- Units in which the regulator finds no potential for migration of liquids to the uppermost aquifer
- During the post-closure care period only, land treatment units with unsaturated (vadose) zone monitoring programs meeting the requirements

b. Discuss the requirements and methods of negotiation for documents such as:

- National pollutant discharge elimination system permit
- Federal facility agreement
- Consent order & settlement agreements
- Record of decision
- Resource Conservation and Recovery Act Part B permit
- Grant conditions
- Monitoring requirements

National Pollution Discharge Elimination System Permit

The following is taken from U.S. Environmental Protection Agency, EPA 833-B-96-003.

In the process of developing a draft permit and during the public notice period, the permit writer should carefully consider the legitimate concerns of the permittee as well as the concerns of any third party who may have an interest in the permit terms and conditions. However, there will inevitably be situations in which a permit is issued in spite of the objections of the permittee or a third party. In such instances, the permittee or an interested party may choose to legally contest or appeal the NPDES permit.

Various mechanisms are available to resolve legal challenges to NPDES permits. In the case of EPA-issued permits, the administrative procedure involved is called an evidentiary hearing. Many NPDES states and tribes have similar administrative procedures designed to
resolve challenges to the conditions of a permit. These procedures involve hearings presided over by an ALJ.

Where the permittee is granted relief at the evidentiary hearing, the ALJ generally will order appropriate relief. Where a request for an evidentiary hearing is denied, the permittee may file a notice of appeal and petition for review with the environmental appeals board (EAB), which may or may not grant an evidentiary hearing based on the factual and legal issues alleged. Similarly, where a permittee is denied relief at an evidentiary hearing, the permittee may appeal to the EAB to overturn the hearing decision. Finally, under certain circumstances decisions of the EAB against the permittee may be appealed in Federal court.

**Federal Facility Agreement**

The following is taken from DOE, Environmental Management, Background: Section 120 of CERCLA.

The Superfund Amendments and Reauthorization Act amendments to CERCLA enacted a section devoted to the cleanup of Federal facilities. 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 and site inspections are required. The facility is then scored under the hazardous ranking system 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 remedial action at the facility. The contents of IAGs must include

- a review of alternative remedial actions and selection of a remedial action
- a schedule for the completion of the remedial action
- 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.

The EPA negotiates cleanup agreements with PRPs. These agreements are in the form of AOCs, administrative agreements, or judicial consent decrees. Negotiations are based on model settlement documents, which can be modified to fit site circumstances.
Administrative agreements on consents are legal documents that formalize an agreement between EPA and one or more PRPs to address some or all of the parties’ responsibility for a site. EPA uses AOCs for removal activity (short-term cleanup), investigation, and remedy design work. EPA also uses AOCs for cost recovery when the payments are made as part of an agreement for work and for de minimis cash-out payments. AOCs do not require approval by the court.

Administrative agreements are legal documents that formalize an agreement between EPA and one or more PRPs 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 PRPs 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/FSs. A consent decree is final when it is approved and entered by a U.S. district court.

The EPA prefers that PRPs do the work of investigating, cleaning up, and maintaining the cleanup of Superfund sites. EPA negotiates an agreement (in the form of an AOC or consent decree) with the PRPs 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 cleanup (removal action), and long-term cleanup.

When EPA performs investigations or cleanup work, it can recover these costs from PRPs 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. AOC for work may include a provision for the PRPs to reimburse EPA for past work costs and will include a provision for the PRP to pay EPA’s future costs in overseeing the PRPs’ work (considered “cost recovery” because such costs are billed to PRPs after they are incurred).

There are a few situations when it is more appropriate for PRPs not to be involved in performing work at a site. In such cases, EPA may negotiate a cash-out agreement with the PRP, where the PRP 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 cleanup. Agreements to cash out de minimis PRPs 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.

Record of Decision
The following is taken from U.S. Environmental Protection Agency, EPA 540-R-98-031.
If a dispute occurs between the lead and support agencies during any phase of the remedial process, the staffs of the agencies should attempt a timely resolution of the disputed issue. If staff resolution is not possible, the issue should be brought promptly to management’s attention for resolution.

The lead and support agencies should use the dispute resolution process specified in the Superfund memorandum of agreement or cooperative agreement when appropriate. If other Federal agencies besides EPA are involved, the dispute resolution process specified in the IAG should be followed. Alternatively, the lead and support agencies could consider using the dispute resolution process recommended in the NCP Preamble to subpart F. The section entitled “State Involvement in Hazardous Substance Response” outlines a process that EPA regional offices and states should use to resolve disputes that arise during the RI/FS and remedy selection process. This approach encourages the lead and support agencies’ remedial project managers to resolve any disputes promptly. If this cannot be accomplished, the dispute could be referred to their supervisors for further EPA/state consultation. This supervisory referral and resolution process should continue, if necessary, to the level of director of the state agency and the regional administrator, respectively. If agreement still cannot be reached, the dispute should be referred to the assistant administrator of Office of Solid Waste and Emergency Response, who serves as final arbiter on remedy selection issues.

Regardless of the process used, the result should be an equitable resolution of outstanding issues. There may be instances, however, in which a final resolution cannot be achieved. If this should occur, two alternatives exist for continuing effective action. First, if EPA is the lead agency, the region should use its discretion as to whether to proceed with publication of the proposed plan.

Second, if the state or another Federal agency such as DOE is the lead agency EPA must approve the proposed plan before it may be issued. In some cases, EPA could elect to become the lead agency for the proposed plan, public participation activities, and the ROD. (This applies only to fund-financed, state-lead projects.)

However, mutual acceptance of the preferred alternative (and, ultimately, of the selected remedy) by both EPA and the state is an important goal in order to effect timely cleanup at the site. In addition, state involvement during the RI/FS and proposed plan process is important to the successful selection of the remedy and completion of the remedial action.

Resource Conservation and Recovery Act Part B Permit
The following is taken from Negotiating a Part B Permit by Daniel M Darragh.

The corrective action process generally involves three major stages. The first phase is the RCRA facility investigation (RFI), the purpose of which is to characterize both the nature and extent of any releases from the solid waste management units at the facility. The RFI is followed by a corrective measures study (CMS) to evaluate potential remedial approaches. Based on the RFI and CMS, the permitting agency selects the remedial measures it deems appropriate and modifies the permit to require implementation of the selected remedy. In
addition, the permit includes a mechanism to address, via interim measures, those releases that the permitting authority concludes pose an imminent threat to human health or the environment, without awaiting the completion of the RFI and CMS process.

Corrective action at a facility is carried out according to a schedule of compliance, set forth in the permit, which prescribes those tasks that must be accomplished within specified time periods. However, because the full nature and extent of the contamination at a facility typically is unknown at the time the permit is issued, the issuing agency will have insufficient information to set forth, with any degree of particularity, those tasks which must be undertaken to fully characterize a release and to evaluate the most effective remedial measures. Consequently, the permit’s schedule of compliance will contain merely an outline of the RFI and CMS procedures. The details of the process and the permittee’s obligations under the permit then emerge through a series of interim submissions in which the permittee proposes plans for carrying out the various steps of the RFI and CMS and reports on the individual tasks as they are completed. Each of the plans and reports is subject to review and revision by the agency. Upon approval, the interim submissions, as revised by the agency, are incorporated into the permit and thus become enforceable permit obligations. By this process, the general obligations set forth in the original permit are infused with substance through the permittee’s interim submissions, as modified by the agency.

Since the details of the permittee’s corrective action obligations are typically not included in the permit as originally issued, some permit holders have challenged their permits on the ground that the agency’s revision of its interim submissions constitutes a permit modification and should be subject to the formal modification procedures prescribed by 40 CFR 270.41, “Modification or Revocation and Reissuance of Permits,” and 40 CFR 124.5, “Modification, Revocation and Reissuance, or Termination of Permits.” While this position has been uniformly rejected, the EAB has acknowledged that, because they can materially and substantially affect the scope of the permittee’s obligations under the permit, such revisions constitute a deprivation of property within the meaning of the due process clause of the United States Constitution. Therefore, the permittee must be given adequate notice and an opportunity for a hearing before the agency’s revisions become an enforceable part of the permit. In other words, there must be some sort of dispute resolution mechanism which the permittee may invoke in the event the permittee disagrees with the revisions the agency seeks to impose. Exactly what this dispute resolution mechanism must entail to protect the permittee’s due process rights has been the subject of numerous permit challenges before the EAB.

Consideration of the parameters of the dispute resolution mechanism has focused on three issues, the first being who should be the final arbiter of the dispute between the permittee and the agency. In this regard, the EAB has concluded that, since revisions to the interim submissions can have significant financial consequences for the permittee (perhaps commensurate with those flowing from the terms of the original permit), the person who has final authority to issue the permit in the first instance must also be the person who resolves disputes over the proposed revisions. Generally, this person is either the regional administrator or a division director to whom permit issuance authority has been delegated.
The second issue is whether the conclusion of the decision-maker must be deemed final agency action, such that the administrative determination will be subject to immediate judicial review. On this point, the EAB has taken the position that due process does not require immediate recourse to the courts; it is sufficient that the disputed revision could be challenged in an enforcement proceeding, despite the fact that daily penalties would accrue during the pendency of that proceeding.

The final point of contention is whether the permittee must be afforded an opportunity to make an oral presentation of its arguments to the final decision-maker. Noting that corrective action determinations are based on technical considerations and therefore amenable to effective written presentation, the EAB concluded that oral argument is not required to protect the permittee’s due process rights. It strongly urged the agency, however, to include in its dispute resolution procedures an opportunity for the permittee to make an oral presentation of its position to the regional staff prior to submission of the dispute to the final decision-maker.

While EPA has not yet formally promulgated a hearing procedure to address disputes over agency revisions to interim submissions, the regions have developed dispute resolution provisions that are routinely included as a condition to the permit. The elements of the dispute resolution provision typically include the following: 1) the right of the permittee to submit written statements to, and meet with, regional staff members responsible for making the disputed revisions; 2) the right to meet with the final decision-maker; and 3) the issuance of a written decision by the agency responding to the evidence and arguments presented by the permittee.

Grant Conditions
The following is taken from U.S. Environmental Protection Agency, State and Local Government Information: Performance Partnership Agreements.

One of the main ways that EPA and individual states implement the principles of performance partnerships on the ground is by negotiating performance partnership agreements.

Some performance partnership agreements meet relevant statutory and regulatory requirements and also serve as the work plans for performance partnership grants or other EPA grants.

Monitoring Requirements
The following is taken from DOE EH-231-039/1193.

Owners/operators of interim status facilities may obtain a waiver from all or part of the groundwater monitoring requirements by demonstrating that there is a low potential for migration of hazardous waste or hazardous constituents from the facility via the uppermost aquifer to water supply wells or to surface water. This demonstration must be in writing, kept at the facility, and certified by a qualified geologist or geotechnical engineer. The
demonstration must establish that there is a low potential for hazardous waste or hazardous constituents
  - to migrate from the facility to the uppermost aquifer and enter the uppermost aquifer
  - to migrate to a water supply well or to surface water

In addition, groundwater monitoring requirements may be waived for interim status surface impoundments where the owner/operator can demonstrate that there is no potential for migration of hazardous wastes if the impoundments
  - are only used to neutralize wastes that are hazardous because they exhibit the characteristic of corrosivity or were listed for exhibiting this characteristic
  - contain no other hazardous wastes

A regulator may waive groundwater monitoring requirements for the following types of permitted units:
  - Engineered structures that do not receive liquid wastes and have inner and outer containment layers with a liquid detection system in each containment layer
  - Units in which the regulator finds no potential for migration of liquids to the uppermost aquifer
  - During the post-closure care period only, land treatment units with unsaturated (vadose) zone monitoring programs meeting the requirements

37. Waste management personnel must demonstrate a familiarity level knowledge of how environmental laws and regulations are enforced.

a. Discuss the interrelationship between the following:
  - Environmental law
  - The United States Code
  - The Code of Federal Regulations
  - State laws and regulations

The following is taken from LLRX.com, Features—Update to a Guide to the U.S. Federal Legal System.

The legal system in the United States is an often uneasy balance of national government and the governments of the fifty states. There are parallel systems of executive, legislative and judicial branches of government, and shared powers among the states and the Federal governments. The interrelationship between the state and Federal systems can be quite complex. Simply stated, the powers of the Federal government are specifically defined in the Constitution. Those powers not expressly prescribed therein are left to the jurisdiction of the fifty sovereign states. Conflicts between state and Federal laws are governed by the Supremacy Clause of the United States Constitution, which declares that all laws enacted in the furtherance of the Constitution are the “supreme law of the land,” and that Federal laws have legal superiority over a state constitution or law.
b. Describe the organization, mission, and enforcement authorities of the Environmental Protection Agency (EPA) and applicable state regulatory agencies.

Organization of the EPA
The following is taken from U.S. Environmental Protection Agency, Office of the Administrator.

The Office of the Administrator provides executive and logistical support for the EPA administrator and the staff offices that directly support the administrator. The administrator is responsible to the President, and is assisted by the deputy administrator and staff offices. The Office of the Administrator supports the leadership of EPA’s programs and activities to protect human health and safeguard the air, water, and land upon which life depends.

The following offices within the Office of the Administrator help support the mission of EPA and day-to-day operations:

- Administrative law judges conduct hearings and render decisions in proceedings brought by the EPA.
- Civil rights enforce Federal non-discrimination laws in all of the agency’s internal and external programs and policies.
- Congressional and intergovernmental relations coordinate interactions between Congress, states, and local governments.
- Cooperative environmental management provided through management of the Federal advisory committee process. EPA’s advisory committees bring the concerned public into a productive, information-gathering process to assist in the development of national and international environmental policies.
- The EAB acts as the final agency decision-maker on administrative appeals under all major environmental statutes that EPA administers.
- Environmental Education and Children’s Health Protection supports and facilitates EPA efforts to protect children’s health by working with Federal agencies, states, and private sector entities; and advances and supports education efforts that develop an environmentally conscious and responsible public.
- The Aging Initiative strives to protect the health of older adults through research and education and encourages civic involvement among older persons to reduce hazards.
- Executive secretariat tracks executive correspondence and Freedom of Information Act requests, and maintains the official records for the administrator and deputy administrator.
- Executive Services provides administrative and financial management services to all of the component offices of the Office of the Administrator.
- Homeland Security focuses on leading and coordinating homeland security activities and policy development across all EPA program areas; and on ensuring consistent direction, efficient use of resources, and effective communication of homeland security efforts both within and outside the agency.
- Policy, Economics, and Innovation serves as the agency’s focal point for regulatory analysis, economic analysis, and innovative policy development to achieve greater and more cost effective public health and environmental protection.
- Public Affairs serves as the agency’s primary policy office on all agency communications, environmental education and media relations activities.
- Science Advisory Board assures the scientific and technical basis for EPA rules and regulations, and integrates policies that guide agency decision-makers in their use of scientific and technical information.
- Small and Disadvantaged Business Utilization ensures the development of policies and the oversight relating to preference programs for small, small disadvantaged, women-owned businesses and hub zones.

**EPA Mission**
The following is taken from U.S. Environmental Protection Agency, History, EPA Goals.

Goal 1: Clean Air and Global Climate Change
Protect and improve the air so it is healthy to breathe and risks to human health and the environment are reduced. Reduce greenhouse gas intensity by enhancing partnerships with businesses and other sectors.

Goal 2: Clean and Safe Water
Ensure drinking water is safe. Restore and maintain oceans, watersheds, and their aquatic ecosystems to protect human health, support economic and recreational activities, and provide healthy habitat for fish, plants, and wildlife.

Goal 3: Land Preservation and Restoration
Preserve and restore the land by using innovative waste management practices and cleaning up contaminated properties to reduce risks posed by releases of harmful substances.

Goal 4: Healthy Communities and Ecosystems
Protect, sustain, or restore the health of people, communities, and ecosystems using integrated and comprehensive approaches and partnerships.

Goal 5: Compliance and Environmental Stewardship
Improve environmental performance through compliance with environmental requirements, preventing pollution, and promoting environmental stewardship. Protect human health and the environment by encouraging innovation and providing incentives for governments, businesses, and the public that promote environmental stewardship.

*Enforcement Authorities of the EPA and Applicable State Regulatory Agencies*
The following is taken from the Congressional Research Service, CRS Report for Congress, Environmental Laws: Summaries of Statutes Administered by the Environmental Protection Agency.

A dozen major statutes form the legal basis for the programs of the EPA.
- The Pollution Prevention Act seeks to prevent pollution through the reduced generation of pollutants at their point of origin.
The CAA requires EPA to set mobile source limits, ambient air quality standards, hazardous air pollutant emission standards, standards for new pollution sources, and significant deterioration requirements, and to focus on areas that do not attain standards.

The CWA establishes a sewage treatment construction grants program, and a regulatory and enforcement program for discharges of wastes into U.S. waters. Focusing on the regulation of the intentional disposal of materials into ocean waters and authorizing related research is the Ocean Dumping Act. The SDWA establishes primary drinking water standards, regulates underground injection disposal practices, and establishes a groundwater control program.

The SWDA and RCRA provide regulation of solid and hazardous waste, while the CERCLA, or Superfund, establishes a fee-maintained fund to clean up abandoned hazardous waste sites.

The EPCRA requires industrial reporting of toxic releases and encourages planning to respond to chemical emergencies.

The TSCA regulates the testing of chemicals and their use, and the FIFRA governs pesticide products and their use.

The Environmental Research and Development Demonstration Act authorizes all EPA research programs.

The NEPA requires, in part, EPA to review EISs.

Parts of some statutes preexisted the EPA’s formation in 1970, but contemporary environmental law was established by Congress during the 1970s, and has been expanded by major amendments. Over these years, Congress has assigned EPA the administration of a considerable body of law and associated programs.

The following is taken from U.S. Environmental Protection Agency, Pollution Prevention, Technical Services.

Technical assistance programs benefit state officials responsible for implementing state regulatory programs. By taking advantage of the services that state technical assistance programs offer, states can enhance the effectiveness of the regulatory activities they perform on a daily basis and see greater compliance in the businesses they regulate. Informing businesses about more efficient production technologies can help businesses comply with environmental regulations, which, in turn, helps make the state’s job easier.

c. Discuss the role of the Department’s legal counsel in waste management activities.

The following is taken from U.S. DOE, Office of General Counsel, Deputy General Counsel for Environment and Nuclear Programs, Assistant General Counsel for Environment.

The Assistant General Counsel for Environment provides legal review, support and advice to DOE in regard to environmental protection and compliance with the NEPA and other applicable environmental protection laws, regulations and other requirements. In addition, this individual provides legal review, support, and advice to DOE and DOE contractors, in
regard to labor, labor relations, pension, retiree benefit, anti-discrimination, and work force restructuring laws, regulations, and policies.

d. Discuss the enforcement of environmental statutes under civil and criminal authorities.

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

The Federal laws regulate a wide variety of sources, including businesses, individuals, organizations, and public entities (such as water authorities). Other EPA enforcement programs specialize in particular aspects of these laws. Where violations are committed by federally-owned facilities or businesses, the Federal facility enforcement program has primary responsibility. When the remediation or cleanup of abandoned waste sites, private facilities or Federal facilities is required, cleanup enforcement takes over. If intentional or deliberate violations are found, they are referred to the criminal enforcement program for enforcement action.

Alternative dispute resolution is any procedure that is used to resolve issues in controversy, including but not limited to, conciliation, facilitation, mediation, fact finding, mini-trials, arbitration, and use of ombudsmen, or any combination thereof. All of these procedures involve a neutral third party, a person who assists others in designing and conducting a neutral process. The neutral third party has no stake in the substantive outcome of the process. Neutral third parties may be agency employees or may come from outside EPA, depending on the nature of a specific dispute or need.

EPA utilizes a series of computer models to address three economic issues that commonly arise in the assessment of civil penalties. Those three issues are: 1) what economic benefit did the violator obtain in violating the law? 2) how do we evaluate claims that the violator cannot afford to pay for compliance, cleanup and/or civil penalties? and 3) what is the real out of pocket expense for a supplemental environmental project (SEP) (i.e. a project whereby the violator goes beyond legal compliance in mitigation of its penalty liability).

The SEP’s policy is one of many tools that the enforcement program uses when settling a civil judicial or administrative enforcement action. The SEP policy provides for the inclusion in settlements of environmentally beneficial projects which the defendant/respondent is not otherwise legally required to perform. A violator’s willingness to implement an SEP is one of several factors taken into consideration by EPA when determining an appropriate settlement penalty.

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

EPA’s criminal enforcement program uses stringent sanctions, including jail sentences, to promote deterrence and help ensure compliance in order to protect human health and the environment. Criminal enforcement is often used against the most serious environmental violations as well as those which involve egregious negligence or conduct involving intentional, willful or knowing disregard of the law.
e. 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 information for this KSA is covered under KSA 28d and will not be repeated here.

38. Waste management personnel must demonstrate a familiarity level knowledge of the development, review, and assessment of the following Comprehensive Environmental Response, Compensation, and Liability Act documentation.
   - Remedial investigation/feasibility study
   - Investigative work plan report
   - Permits
   - National pollution discharge elimination system
   - Record of decision
   - Remedial design
   - Remedial investigation work plan
   - Consent order & settlement agreement

a. Describe the process for developing the listed documents.

Remedial Investigation/Feasibility Study
The following is taken from EPA 540/G-89/004.

Although the new provisions of CERCLA have resulted in some modifications to the RI/FS process, the basic components of the process remain intact. The RI continues to serve 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 as necessary to evaluate the potential performance and cost of the treatment technologies that are being considered. The latter also supports the design of selected remedies. The FS continues to serve as the mechanism for the development, screening, and detailed evaluation of alternative remedial actions.

The various steps, or phases, of the RI/FS process and how they have been modified to comply with the new provisions in CERCLA are summarized below. It is important to note that the RI and FS are to be conducted concurrently and that data collected in the RI influence the development of remedial alternatives in the FS, which in turn affects the data needs and scope of treatability studies and additional field investigations. Two concepts are essential to the phased RI/FS approach. First, data should generally be collected in several stages, with initial data collection efforts usually limited to developing a general understanding of the site. As a basic understanding of site characteristics is achieved, subsequent data collection efforts focus on filling identified gaps in the understanding of site characteristics and gathering information necessary to evaluate remedial alternatives. Second, this phased sampling approach encourages identification of key data needs as early in the process as possible to ensure that data collection is always directed toward providing information relevant to selection of a remedial action. In this way the overall site characterization effort can be continually scoped to minimize the collection of unnecessary data and maximize data quality.
Because of the interactive and iterative nature of this phase of the RI/FS process, the sequence of the various phases and associated activities, as described below and presented in figure 40, will frequently be less distinct in practice. The actual timing of individual activities will depend on specific site situations.

Scoping
Scoping is the initial planning phase of the RI/FS process, and many of the planning steps begun here are continued and refined in later phases of the RI/FS. Scoping activities typically begin with the collection of existing site data, including data from previous investigations such as the preliminary assessment and site investigation. On the basis of this information, site management planning is undertaken to preliminarily identify boundaries of the study area, identify likely remedial action objectives and whether interim actions may be necessary or appropriate, and to establish whether the site may best be remedied as one or several separate operable units. Once an overall management strategy is agreed upon, the RI/FS for a specific project or the site as a whole is planned.

Source: EPA 540/G-89/004

**Figure 40.** Phased RI/FS process

Site Characterization
During site characterization, field sampling and laboratory analyses are initiated. Field sampling should be phased so that the results of the initial sampling efforts can be used to
refine plans developed during scoping to better focus subsequent sampling efforts. Data quality objectives are revised as appropriate based on an improved understanding of the site to facilitate a more efficient and accurate characterization of the site and, therefore, achieve reductions in time and cost.

A preliminary site characterization summary is prepared to provide the lead agency with information on the site early in the process before preparation of the full RI report. This summary will be useful in determining the feasibility of potential technologies and in assisting both the lead and support agencies with the initial identification of ARARs. It can also be sent to Agency for Toxic Substances and Disease Registry to assist them in performing their health assessment of the site.

A baseline RA is developed to identify the existing or potential risks that may be posed to human health and the environment by the site. This assessment also serves to support the evaluation of the no-action alternative by documenting the threats posed by the site based on expected exposure scenarios. Because this assessment identifies the primary health and environmental threats at the site, it also provides valuable input to the development and evaluation of alternatives during the FS.

**Development and Screening of Alternatives**

The development of alternatives usually begins during or soon after scoping, when likely response scenarios may first be identified. The development of alternatives requires 1) identifying remedial action objectives; 2) identifying potential treatment, resource recovery, and containment technologies that will satisfy these objectives; 3) screening the implementability, and cost; and 4) assembling technologies and their associated containment or disposal requirements into alternatives for the contaminated media at the site or for the operable unit. Alternatives can be developed to address contaminated medium (e.g., groundwater), a specific area of the site (e.g., a waste lagoon or contaminated hot spots), or the entire site. Alternatives for specific media and site areas either can be carried through the FS process separately or combined into comprehensive alternatives for the entire site. The approach is flexible to allow alternatives to be combined at various points in the process.

**Treatability Investigations**

Should existing site and/or treatment data be insufficient to adequately evaluate alternatives, treatability tests may be necessary to evaluate a particular technology on specific site wastes. Generally, treatability tests involve bench-scale testing to gather information to assess the feasibility of a technology. In a few situations, a pilot-scale study may be necessary to furnish performance data and develop better cost estimates so that a detailed analysis can be performed and a remedial action can be selected. To conduct a pilot-scale test and keep the RI/FS on schedule, it will usually be necessary to identify and initiate the test at an early point in the process.

**Detailed Analysis**

Once sufficient data are available, alternatives are evaluated in detail with respect to nine evaluation criteria that the agency has developed to address the statutory requirements and
preferences of CERCLA. The alternatives are analyzed individually against each criterion and then compared against one another to determine their respective strengths and weaknesses and to identify the key tradeoffs that must be balanced for that site. The results of the detailed analysis are summarized and presented to the decision-maker so that an appropriate remedy consistent with CERCLA can be selected.

Investigative Work Plan Report
The following is taken from DOE/EH-0505.

The investigative work plan (or proposed plan), the first step in the CERCLA remedy selection process, is made available with the RI/FS to the public for comment. A proposed plan employs one of two basic formats—a fact sheet format or an expanded, more detailed format that is more a stand-alone document. It highlights key aspects of the RI/FS, provides a brief analysis of remedial alternatives under consideration, and identifies the preferred alternative. The proposed plan also highlights the key factors that led to identification of the preferred alternative. It should make clear that although DOE has “identified” a preferred alternative based on available information, a remedy has not been “selected.”

The proposed plan should request comments on all the alternatives described and clearly state that changes to the preferred alternative, or a change from the preferred alternative to another alternative, may be made if public comments or additional data indicate that such a change would result in a more appropriate solution. Finally, the proposed plan should provide information on how the public can be involved in the remedy selection process (including referring readers to the RI/FS report and administrative record as more complete sources of information). The proposed plan should contain, at a minimum, the following elements:

- Introduction
- Site background
- Scope and role of operable unit or response action
- Summary of site risks
- Summary of alternatives
- Evaluation of alternatives and the preferred alternative
- Community participation

Proposed plans that are prepared to support the selection of interim remedial actions (“early actions”) should be tailored to the limited scope and purpose of the interim action (i.e., areas/media affected by the interim action). These plans will be followed by a final operable unit ROD. They are generally more streamlined than proposed plans for comprehensive response actions. In particular, the “site description” should focus on site characteristics addressed by the limited action. The “scope and role of operable unit” section should illustrate how the early action fits into and is consistent with any planned future actions. The “summary of site risks” discussion may be very brief, providing information to support the need to take early action, but usually not specifying final acceptable exposure levels for the site. If presumptive remedies are employed, the proposed plan may be streamlined by focusing primarily on the presumptive remedies being considered. When program managers
invoke a technical impracticability ARAR waiver (i.e., a front-end decision), they must provide notice of this intent in the proposed plan and respond to regulator or public comments concerning the waiver to support ROD approval.

EPA recommends that, in addition to identifying interim remedial actions, provisions in the proposed plan should allow for modification of the remedy during the remedial design/remedial action phase, either by specifying a contingent remedy or by selecting an interim remedy and goals.

Permits

The following is taken from U.S. Environmental Protection Agency, Hazardous Waste Permitting Process, A Citizen’s Guide.

An RCRA permit is a legally binding document that establishes the waste management activities that a facility can conduct and the conditions under which it can conduct them.

Step 1. Starting the Process

Before a business even submits a permit application, it must hold an informal meeting with the public. The business must announce the preapplication meeting by putting up a sign on or near the proposed facility property, running an advertisement on radio or television, and placing a display advertisement in a newspaper. At the meeting, the business explains the plans for the facility, including information about the proposed processes it will use and wastes it will handle. The public has the opportunity to ask questions and make suggestions. The business may choose to incorporate the public’s suggestions into its application. The permitting agency uses the attendance list from the meeting to help set up a mailing list for the facility.

Step 2. Applying for a Permit

After considering input from the preapplication meeting, the business may decide to submit a permit application. Permit applications are often lengthy. They must include a description of the facility and address the following:

- How the facility will be designed, constructed, maintained, and operated to be protective of public health and the environment
- How any emergencies and spills will be handled, should they occur
- How the facility will clean up and finance any environmental contamination that occurs
- How the facility will close and clean up once it is no longer operating

Step 3. Receipt and Review of the Application

When the permitting agency receives a permit application, it sends a notice to everyone on the mailing list. The notice indicates that the agency has received the application and will make it available for public review. The permitting agency must then place a copy of the application in a public area for review.
Simultaneously, the permitting agency begins to review the application to make sure it contains all the information required by the regulations. The proposed design and operation of the facility are also evaluated by the permitting agency to determine if the facility can be built and operated safely.

Step 4. Revisions
After reviewing the application, the permitting agency may issue a notice of deficiency (NOD) to the applicant. NODs identify and request that the applicant provide any missing information. During the application review and revision process, the permitting agency may issue several NODs. Each time the permitting agency receives a response from the applicant, it reviews the information and, if necessary, issues another NOD until the application is complete. Given the complex and technical nature of the information, the review and revision process may take several years.

Step 5. Drafting the Permit for Public Review
When the revisions are complete, the agency makes a preliminary decision about whether to issue or deny the permit. If the agency decides that the application is complete and meets appropriate standards, the agency issues a draft permit containing the conditions under which the facility can operate if the permit receives final approval. If the permitting agency determines that an applicant cannot provide an application that meets the standards, the agency tentatively denies the permit and prepares a notice of intent to deny.

The permitting agency announces its decision by sending a letter to everyone on the mailing list, placing a notice in a local paper, and broadcasting it over the radio. It also issues a fact sheet to explain the decision. Once the notice is issued, the public has 45 days to comment on the decision. Citizens also may request a public hearing by contacting the permitting agency. The permitting agency may also hold a hearing at its own discretion. The agency must give 30-day public notice before the hearing.

Step 6. The End Result: A Final Permit Decision
After carefully considering public comments, the permitting agency reconsiders the draft permit or the notice of intent to deny the permit. The agency must issue a response to public comments, specifying any changes made to the draft permit. The agency then issues the final permit or denies the permit.

Even after issuing a permit, the permitting agency continues to monitor the construction and operation of the facility to make sure they are consistent with state and Federal rules and with the application.

Several additional steps can also take place after the original permit is issued:
- Permit appeals. Facility owners and the public both have a right to appeal the final permit decision. The appeal is usually decided upon by ALJs.
- Permit modifications. If a facility changes its management procedures, mechanical operations, or the wastes it handles, then it must secure a permit modification. For modifications that significantly change facility operations, the public must receive
early notice and have a chance to participate and comment. For minor modifications, the facility must notify the public within a week of making the change.

- Permit renewals. The permitting agency can renew permits that are due to expire. Permit holders that are seeking a permit renewal must follow the same procedures as a facility seeking a new permit.
- Permit terminations. If a facility violates the terms of its permit, the permitting agency can terminate the permit.

**National Pollutant Discharge Elimination System**

The following is taken from U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System, Overview of the Water Quality Standards-to-Permits Process.

The process begins when a state or Indian tribe establishes water quality standards for a water body within its jurisdiction, as required by the CWA. Water quality standards include designated uses for a water body (e.g., public water supply, propagation of fish and wildlife, recreation); water quality criteria necessary to support the designated uses; and a policy for preventing degradation of the quality of water bodies. Water quality criteria include numeric criteria for specific parameters (e.g., copper, chlorine, temperature, pH); toxicity criteria to protect against the aggregate effects of toxic pollutants; and narrative criteria that describe the desired condition of the water body (e.g., free from visible oil sheen).

States and tribes assess water bodies to determine whether they are attaining the established standards.

After identifying potential water quality problems, the state or tribe sets priorities for which water bodies to target first for further evaluation.

The state or tribe may then evaluate the appropriateness of the established water quality standards for specific waters and reaffirm or refine the standards as appropriate.

Next, the state or tribe defines what controls on point and nonpoint sources are necessary either through an analysis of the entire water body or by assessing the impact of individual sources of pollution (e.g., a single industrial process wastewater discharge). When assessing point source discharges to determine whether controls based on water quality standards are necessary, an NPDES permitting authority should conduct an analysis to determine whether the discharge causes, has the reasonable potential to cause, or contributes to an excursion of any water quality criteria in the receiving water. Where effluent limits based on water quality standards are necessary, the permitting authority allocates responsibility for controls through wasteload allocations and then effluent limits in NPDES permits consistent with those wasteload allocations.

Controls on individual sources are established through nonpoint source programs or NPDES permits.

Point source effluent monitoring allows the NPDES authority to assess compliance with the required controls and take enforcement actions where necessary.
Finally, the state or tribe uses the information gathered from monitoring sources of pollution and the quality of the water body itself to measure progress in attaining water quality standards.

**Record of Decision**

The following is taken from U.S. Environmental Protection Agency, Superfund, Record of Decision.

A ROD provides the justification for the remedial action (treatment) chosen at a Superfund site. It also 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, EPA 540/G-90-006.

The remedial management strategy (RMS) is a planning tool for expediting the remedial design (RD) and remedial action (It contains an analysis of the major management considerations required to achieve the goals of the ROD in a timely manner.) Preparation of the strategy by the lead agency remedial project manager (RPM) is essential for the smooth progression of a project through RD and remedial action.

**Pre-Design Planning**

Pre-design planning moves a project from the ROD into the RD. During this phase, a pre-design technical summary is developed prior to negotiations with the PRPs to express EPA’s technical requirements in design terms. If the response action will be financed by the Superfund, a decision must be made as to whether EPA or the state will be the lead agency.

Once the lead agency has been determined, an RMS should be prepared to establish a strategy for managing the RD and remedial action. The RMS is a working document for internal use. It is not intended to be cumbersome or difficult to prepare. The RMS’s length and complexity should be tailored to the nature of the project and kept as brief as possible. The lead agency RPM, with technical assistance from various resources, such as contractors and other agencies, should develop an RMS using the following general guidelines:

- Identify project goals in the ROD
- Evaluate the project site, including geography, geology, climate, access, local population, utilities, evacuation routes, and proximity of hospital and fire department facilities
- Review the remedial technology to determine the need for new or innovative equipment, items requiring long lead-time for procurement, operable units, and specialty contractor requirements
- Develop schedules and budget projections
- Evaluate funding requirements (such as mixed or incremental funding)
- Review health and safety requirements
- Develop a RMS that is consistent with the project’s goals and constraints
**Remedial Investigation Work Plan**

The following is taken from 40 CFR 300.430.

The lead and support agencies shall confer to identify the optimal set and sequence of actions necessary to address site problems. Specifically, the lead agency shall do the following:

- Assemble and evaluate existing data on the site, including the results of any removal actions, remedial preliminary assessment and site inspections, and the NPL listing process.
- Develop a conceptual understanding of the site based on the evaluation of existing data.
- Identify likely response scenarios and potentially applicable technologies and operable units that may address site problems.
- Undertake limited data collection efforts or studies where this information will assist in scoping the RI/FS or accelerate response actions, and begin to identify the need for treatability studies, as appropriate.
- Identify the type, quality, and quantity of the data that will be collected during the RI/FS to support decisions regarding remedial response activities.
- Prepare site-specific health and safety plans that shall specify, at a minimum, employee training and protective equipment, medical surveillance requirements, standard operating procedures, and a contingency plan.
- If natural resources are or may be injured by the release, ensure that state and Federal trustees of the affected natural resources have been notified in order that the trustees may initiate appropriate actions. The lead agency shall seek to coordinate necessary assessments, evaluations, investigations, and planning with such state and Federal trustees.
- Develop sampling and analysis plans that shall provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. Sampling and analysis plans shall be reviewed and approved by EPA. The sampling and analysis plans shall consist of two parts:
  - The field sampling plan, which describes the number, type, and location of samples and the type of analyses
  - The QA project plan, which describes policy, organization, and functional activities and the data quality objectives and measures necessary to achieve adequate data for use in selecting the appropriate remedy.
- Initiate the identification of potential Federal and state ARARs and, as appropriate, other criteria, advisories, or guidance to be considered.

**Consent Order and Settlement Agreement**

The following is taken from U.S. Environmental Protection Agency, Cleanup Enforcement, Types of Superfund Settlements.

Administrative orders on consent are legal documents that formalize an agreement between EPA and one or more PRPs to address some or all of the parties’ responsibility for a site.
EPA uses AOCs for removal activity (short-term cleanup), investigation, and remedy design work.

EPA also uses AOCs 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

Administrative agreements are legal documents that formalize an agreement between EPA and one or more PRPs to reimburse EPA for costs already incurred (cost recovery) or for costs to be incurred (cash-out) at a Superfund site. (Cash-out settlements generally include payments for both past and future costs, but always include a future cost component.)

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.

b. Discuss the requirements for each document and describe the process for reviewing the listed documents.

Remedial Investigation/Feasibility Study
The following is taken from EPA 540/G-89-004.

EPA will review all RI/FS products which are submitted to the agency as specified in the work plan or administrative order. PRPs should ensure that all plans, reports, and records are comprehensive, accurate, and consistent in content and format with the NCP and relevant EPA guidance. After this review process, EPA will either approve or disapprove the product. If the product is found to be unsatisfactory, EPA will notify the PRPs of the discrepancies or deficiencies and will require corrections within a specified time period.

Project Plans
EPA will review all project plans that are submitted as deliverables in fulfillment of the agreement. These plans include the work plan, the sampling and analysis plan, and the health and safety plan. If the initial submittals are not sufficient in content or scope, the RPM will request that the PRPs submit revised document(s) for review. EPA does not approve the PRP’s health and safety plan but rather, it is reviewed to ensure the protection of public health and the environment. The PRP’s work plan and sampling and analysis plan, on the other hand, must be reviewed and approved prior to the initiation of field activities. Conditional approval to these plans may be provided to initiate field activities in a timelier manner.

The PRPs may be required to develop additional work plans or modify the initial work plan contained in or created pursuant to the agreement. These changes may result from the need to: 1) re-evaluate the RI/FS activities due either to changes in or unexpected site conditions;
2) expand the initial work plan when additional detail is necessary; or 3) modify or add products to the work plan based on new information. EPA will review and approve all work plans and/or modifications to work plans once they are submitted for review.

Reports
PRPs will, at a minimum, submit monthly progress reports, technical memorandums or reports, and the draft and final RI/FS reports as required in the agreement. To assist in the development of the RI/FS and review of documents, additional deliverables may be specified by the region and included in the agreement. These reports and deliverables will be reviewed by EPA to ensure that the activities specified in the order and approved work plan are being properly implemented. These reports will generally be submitted according to the conditions and schedule set forth in the agreement.

Technical Summary of Work
The monthly report will describe the activities and accomplishments performed to date. This will generally include a description of all field work completed, such as sampling events and installation of wells; a discussion of analytical results received; a discussion of data review activities; and a discussion of the development, screening, and detailed analysis of alternatives. The report will also describe the activities to be performed during the upcoming month.

Schedule
EPA will oversee PRP compliance with respect to those schedules specified in the order. Delays, with the exception of those specified under the force majeure clause of the agreement, may result in penalties, if warranted. The RPM should be immediately notified if PRPs cannot perform required activities or cannot provide the required deliverables in accordance with the schedule specified in the work plan. In addition, PRPs should notify the RPM when circumstances may delay the completion of any phase of the work or when circumstances may delay access to the site. PRPs should also provide to the RPM, in writing, the reasons for, and the anticipated duration of, such delays. Any measures taken or to be taken by the PRPs to prevent or minimize the delay should be described, including the timetables for implementing such measures.

Budget
The relationship of budgets to expenditures should be tracked where the RI/FS is funded with a financial mechanism established by the PRPs. If site activities require more funds than originally estimated, EPA must be assured that the PRPs are financially able to undertake additional expenditures. While EPA does not have the authority to review or approve a PRP budget, evaluating costs during the course of the RI/FS allows EPA to effectively monitor activity to ensure timely completion of RI/FS activities. If the PRPs run over budget, EPA must be assured that they can continue the RI/FS activities as scheduled. Therefore, if specified in the agreement, PRPs should submit budget expenditures and cost overrun information to EPA. Budget reports need not present dollar amounts, but should indicate the relationship between remaining available funds and the estimate of the costs of remaining activities.
Problems

Any problems that the PRPs encounter that could affect the satisfactory performance of the RI/FS should be brought to the immediate attention of EPA. Such problems may or may not be a force majeure event, or caused by a force majeure event. EPA will review problems and advise the PRPs accordingly. Problems which may arise include, but are not limited to:

- delays in mobilization or access to necessary equipment
- unanticipated laboratory/analytical time requirements
- unsatisfactory QA/QC performance
- requirements for additional or more complex sampling
- prolonged unsatisfactory weather conditions
- unanticipated site conditions
- unexpected, complex community relations activities

Records

PRPs should preserve all records, documents, and information of any kind relating to the performance of work at the site for a minimum of six years after completion of the work and termination of the administrative order. After the six-year period, the PRPs should offer the records to EPA before their destruction.

Document control should be a key element of all recordkeeping. The following activities require careful recordkeeping and will be subject to EPA oversight.

Administration— PRP administrative activities should be accurately documented and recorded. Necessary precautions to prevent errors or the loss or misinterpretation of data should be taken. At a minimum, the following administrative actions should be documented and recorded:

- contractor work plans, contracts, and change orders
- personnel changes
- communications between and among PRPs, the state, and EPA officials regarding technical aspects of the RI/FS
- permit application and award (if applicable)
- cost overruns

Technical Analysis— Samples and data should be handled according to procedures set forth in the sampling and analysis plan. Documentation establishing adherence to these procedures should include:

- sample labels
- shipping forms
- chain-of-custody forms
- field log books

All analytical data in the RI/FS process should be managed as set forth in the sampling and analysis plan. Such analytical data may be the product of:

- contractor laboratories
- environmental and public health studies
Decision-making— Actions or communications among PRPs that involve decisions affecting technical aspects of the RI/FS should be documented. Such actions and communications include those of the project manager, steering committees, or contractors.

Administrative Record Requirements

Section 113(k) of CERCLA requires that the agency establish an administrative record upon which the selection of a response action is based. A suggested list of documents that are most likely to be included in any adequate administrative record is provided in the memorandum entitled “Draft Interim Guidance on Administrative Records for Selection of CERCLA Response Actions” (June 23, 1988–OSWER Directive No. 9833.3A). More detailed guidance will be forthcoming, including guidance provided in the revisions to the NCP. There are, however, certain details associated with compiling and maintaining an administrative record that are unique to PRP RI/FS activities.

EPA is responsible for compiling and maintaining the administrative record, and generating and updating an index. If EPA and the PRPs mutually agree, the PRPs may be allowed to house and maintain the administrative record file at or near the site; they may not, however, be responsible for the actual compilation of the record. Housing and maintaining the administrative record would include setting up a publicly accessible area at or near the site and ensuring that documents remain and are updated as necessary. EPA must always be responsible for deciding whether documents are included in the administrative record; transmitting records to the PRPs; and maintaining the index to the repository.

Investigative Work Plan Report

The following is taken from U.S. Environmental Protection Agency, EPA 540/G-89-004.

The investigative work plan 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 RA (human health evaluation, environmental evaluation)
- Summary and conclusions
Permits
The following is taken from U.S. Code Title 42, subpart 7503.

The permit program required shall provide that permits to construct and operate may be issued if

- in accordance with regulations issued by the Administrator for the determination of baseline emissions in a manner consistent with the assumptions underlying the applicable implementation plan approved, the permitting agency determines that
  - by the time the source is to commence operation, sufficient offsetting emissions reductions have been obtained, such that total allowable emissions from existing sources in the region, from new or modified sources which are not major emitting facilities, and from the proposed source will be sufficiently less than total emissions from existing sources prior to the application for such permit to construct or modify so as to represent reasonable further progress; or
  - in the case of a new or modified major stationary source which is located in a zone identified by the Administrator, in consultation with the Secretary of Housing and Urban Development, as a zone to which economic development should be targeted, that emissions of such pollutant resulting from the proposed new or modified major stationary source will not cause or contribute to emissions levels which exceed the allowance permitted for such pollutant for such area from new or modified major stationary sources;
- the proposed source is required to comply with the lowest achievable emission rate;
- the owner or operator of the proposed new or modified source has demonstrated that all major stationary sources owned or operated by such person in such state are subject to emission limitations and are in compliance, or on a schedule for compliance, with all applicable emission limitations and standards;
- the Administrator has not determined that the applicable implementation plan is not being adequately implemented for the nonattainment area in which the proposed source is to be constructed or modified; and
- an analysis of alternative sites, sizes, production processes, and environmental control techniques for such proposed source demonstrates that benefits of the proposed source significantly outweigh the environmental and social costs imposed as a result of its location, construction, or modification.

Any emission reductions required as a precondition of the issuance of a permit shall be federally enforceable before such permit may be issued.

National Pollutant Discharge Elimination System
The following is taken from U.S. Environmental Protection Agency, EPA 833-B-96-003.

Compliance monitoring is a generic term that includes all activities undertaken by Federal or state regulatory agencies to ascertain a permittee’s adherence to a NPDES permit. Compliance monitoring data collected as part of the NPDES Program are used in compliance evaluation and in support of enforcement. The process includes receiving data, reviewing
data, entering data into the permit compliance system (PCS) database, identifying violators, and determining an appropriate response.

A primary function of the compliance monitoring program is the verification of compliance with permit conditions, including effluent limitations and compliance schedules. Compliance monitoring may be described as comprising two elements:

- Compliance review—the review of all written reports and other material relating to the status of a permittee’s compliance.
- Compliance inspections—field-related regulatory activities, including sampling, conducted to determine compliance.

Compliance Review
Compliance and enforcement personnel use two primary sources of information to carry out their compliance review responsibilities:

- Permit/compliance files—these files include compliance schedule reports, compliance inspection reports, discharge monitoring reports, enforcement actions, and any other correspondence. Compliance personnel periodically review this information and use it to determine if enforcement is necessary and what level of enforcement is appropriate.
- PCS—PCS is a data management system used to compile all relevant facts about a facility’s permit conditions, self-monitoring data, the inspections performed, and any enforcement actions taken. PCS is the national database for the NPDES Program. As such, PCS promotes national consistency and uniformity in permit and compliance evaluations. To accomplish this goal, all required data are entered into and maintained regularly in PCS.

NPDES permits must be written so that compliance data are capable of being tracked by PCS. There may be situations where permit limits and monitoring conditions are not initially compatible with PCS entry and tracking. In these cases, states should ensure that appropriate steps are taken by the permit writer to identify difficult permits to the person responsible for entering PCS codes and to mutually resolve any coding issues. To assist PCS coders in accurately interpreting and coding the permit into PCS and to assist enforcement personnel in reviewing permittee self-monitoring data and reports in a timely manner, permit writers should apply the compliance inspection procedures discussed in section 12.2.2 of the NPDES Permit Writer’s Manual.

Compliance Inspections
Compliance inspections refer to all field-related regulatory activities conducted to determine permit compliance. Such field activities may include evaluation inspections (nonsampling), sampling inspections, other specialized inspections, and remote sensing. Certain inspections, such as diagnostic inspections and performance audit inspections, aid the regulatory agency in evaluating the facility’s problems in addition to providing information to support enforcement action. Biomonitoring inspections are specifically targeted at facilities with effluent suspected or identified as causing toxicity problems that threaten the ecological balance of the receiving waters.
Record of Decision
The following is taken from 40 CFR 1505.3, “Implementing the Decision.”

Agencies may provide for monitoring to ensure that their decisions are carried out and should do so in important cases. Mitigation and other conditions established in the EIS or during its review and committed as part of the decision shall be implemented by the lead agency or other appropriate consenting agency. The lead agency shall

- include appropriate conditions in grants, permits or other approvals
- condition funding of actions on mitigation
- upon request, inform cooperating or commenting agencies on progress in carrying out mitigation measures that they have proposed and that were adopted by the agency making the decision
- upon request, make available to the public the results of relevant monitoring

Remedial Design
The following is taken from U.S. Environmental Protection Agency, Office of Site Remediation, Model Remedial Design/Remedial Action Unilateral Administrative Order.

Within 30 days after the respondent selects an approved project manager, the respondent shall submit a work plan for the RD at the site to EPA for review and approval. The RD work plan shall include a step-by-step plan for completing the RD for the remedy described in the ROD and for attaining and maintaining all requirements, including performance standards, identified in the ROD. The RD work plan must describe in detail the tasks and deliverables the respondent will complete during the RD phase, and a schedule for completing the tasks and deliverables in the RD work plan. The major tasks and deliverables described in the RD work plan shall include, but not be limited to, the following: 1) a preliminary design; 2) an intermediate design; 3) a pre-final design; 4) a final design; 5) a design sampling and analysis plan (including, but not limited to, a RD QA project plan); 6) a contingency plan; 7) a construction QA plan; 8) treatability studies; 9) a plan for gathering additional data or information, or performing additional feasibility studies; and 10) any other appropriate components.

Within 30 days after EPA approves the intermediate design, the respondent shall submit a final design to EPA for review and approval. The final design submittal shall include, at a minimum, the following: 1) final plans and specifications; 2) an operation and maintenance plan; 3) the construction QA plan; 4) the field sampling plan; and 5) a contingency plan.

Within 30 days after EPA approves the remedial action work plan the respondent shall notify EPA in writing of the name, title, and qualifications of any construction contractor proposed to be used in carrying out work. EPA shall thereafter provide written notice of the name(s) of the contractor(s) it approves, if any. The respondent may select any approved contractor from that list and shall notify EPA of the name of the contractor selected within 21 days of EPA’s designation of approved contractors.
Remedial Investigation Work Plan

Five elements (introduction, site background and physical setting, initial evaluation, work plan rationale, and RI/FS tasks) typically are included in a work plan.

Among the elements to be included is the specification of RI/FS tasks. For Federal-lead sites, 14 standard tasks have been defined to provide consistent reporting and allow more effective monitoring of RI/FS projects. Figure 41 shows these tasks and their relationship to the phases of an RI/FS. Although RI/FSs that are not Federal-lead projects are not required to use these standard tasks, their use provides a valuable project management tool that allows for compilation of historical cost and schedule data to help estimate these tasks during project planning and management.

Source: EPA 540/G-89-004

Figure 41. Relationship of RI/FS tasks to RI/FS approach
Consent Order and Settlement Agreement

The following is taken from the Environmental Appeals Board Consent Order Review Procedures.

The EAB is delegated the authority to sign for the EPA consent orders memorializing settlements between the agency and respondents resulting from various administrative enforcement actions. This authority encompasses orders under the TSCA, the FIFRA, the Solid Waste Disposal Act, and other statutes. Under the terms of the delegations, these orders may assess penalties and, in some circumstances, require compliance. To ensure that the Board may properly perform its approval function, starting January 1, 1993, any proposed order shall be transmitted to the Board by an action memorandum signed by the Assistant Administrator for Enforcement or the Deputy Assistant Administrator for Enforcement, which includes the following:

- A copy of the complaint
- A detailed explanation of how the proposed agreement is consistent with the applicable penalty guidelines or, if not, why not; with a brief statement of the facts describing both the allegations of the complaint and how the settlement addresses each of the violations identified
- A summary of any human health or environmental concerns presented by the respondent’s actions or why there are no concerns
- An explanation of how the order addresses the disposition of any substances or wastes identified in the complaint, including any additional steps, if required, to address any past exposure to the environment
- A brief explanation of any past or pending actions involving this same respondent arising out of the same facts
- A statement of how the public interest is served by the agreement

c. Discuss the use of the non-time critical removal action process as it applies to conducting decommissioning activities.

The following is taken from U.S. Environmental Protection Agency, EPA 540/F-94/009.

Non-time-critical removal actions are conducted at Superfund sites when the lead agency determines, based on the site evaluation, that a removal action is appropriate, and a planning period of at least six months is available before onsite activities must begin. Because non-time-critical removal actions can address priority risks, they provide an important method of moving sites more quickly through the Superfund process. Thus, conducting non-time-critical removal actions advances the goals of the Superfund accelerated cleanup model to include substantial, prioritized risk reduction in shorter time frames and to communicate program accomplishments to the public more effectively.

   a. Define the term “hazardous waste.”

The following is taken from DOE G 430.1-1, appendix A.

Hazardous waste, as defined in RCRA, is a solid waste, or combination of solid wastes, that because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

   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 KSA is site-specific. The local Qualifying Official will evaluate its completion.

   d. Describe the combination of treatment, storage, and disposal facilities used to manage hazardous wastes.

The following is taken from U.S. Environmental Protection Agency, EPA 530-K-05-017.

The terms “facility,” “treat,” “store,” and “dispose” all have specific definitions. A facility includes all contiguous land, structures, and appurtenances on or in the land used for treating, storing, or disposing of hazardous waste. A single facility may consist of several types or combinations of operational units. Treatment is defined as any method, technique, or process designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to: neutralize such waste, or recover energy or material resources from the waste, or render such waste nonhazardous or less hazardous; make such waste safer to transport, store, or dispose of; make it amenable for recovery or storage; or reduce its volume. Storage is defined as holding hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere. Disposal is the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid or hazardous waste on or in the land or water. A disposal facility is any site where hazardous waste is intentionally placed and where the waste will remain after closure.

   e. Discuss the current methods of disposing of hazardous wastes.

The following is taken from U.S. Environmental Protection Agency, Wastes: Hazardous waste: 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.

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.

f. Discuss regulatory requirements imposed on generators of hazardous wastes required by 40 CFR 262 related to the following:
   - Accumulating waste
   - Preparing hazardous waste for shipment
   - Preparing a uniform hazardous waste manifest

The following descriptions are taken from U.S. Environmental Protection Agency, EPA 530-K-05-011.

Accumulating Waste
Storage of hazardous waste generally requires a permit under the RCRA regulations. There are, however, provisions under RCRA that allow generators to “accumulate” hazardous waste onsite without a permit as long as they comply with certain management standards for their accumulation unit(s) and for their facility, such as a contingency plan and personnel training requirements. The length of time a generator is allowed to accumulate waste will vary depending on the generator’s classification, as illustrated in table 10. The regulations pertaining to accumulation of hazardous waste onsite are found in 40 CFR 262.34, “Accumulation Time,” for large quantity generators (LQGs) and small quantity generators (SQGs), and in 40 CFR 261.5, “Special Requirements for Hazardous Waste Generated by Conditionally Exempt Small Quantity Generators.”

**Table 10.** Accumulation time limits by hazardous waste generator type

<table>
<thead>
<tr>
<th>Generator Type</th>
<th>Onsite Accumulation Time</th>
<th>Onsite Quantity Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Quantity</td>
<td>≤90 days onsite</td>
<td>No Limit</td>
</tr>
<tr>
<td>Small Quantity</td>
<td>≤180 days onsite or ≤270 days if shipped 200 miles or more</td>
<td>6,000 kg</td>
</tr>
<tr>
<td>Conditionally Exempt Small Quantity</td>
<td>N/A</td>
<td>1,000 kg (1 kg acute) 100 kg residue of contaminated soil from cleanup of an acute hazardous waste spill</td>
</tr>
</tbody>
</table>

*Source: EPA530-K-05-011*
Accumulation units. LQGs accumulating hazardous wastes pursuant to 40 CFR 262.34 may only do so in containers, tanks, containment buildings, or on drip pads. SQGs may only accumulate waste in tanks or containers. If SQGs wish to accumulate waste in containment buildings or on drip pads, then they must meet the LQG standards. While these units do not need RCRA storage permits when used for generator accumulation, they must comply with certain standards found in the 40 CFR 265 requirements for interim status units, such as release detection and prevention requirements.

Generators who accumulate hazardous waste in containers must comply with certain sections in 40 CFR 265, subpart I. Generators who accumulate hazardous waste in tanks must comply with certain sections in 40 CFR 265, subpart J, potentially including secondary containment and release detection. Generators who accumulate hazardous waste in containment buildings must comply with 40 CFR 265, subpart DD. Generators who accumulate hazardous waste on drip pads must comply with 40 CFR 265, subpart W; only generators managing wood preserving wastes may use drip pads for hazardous waste accumulation. All accumulation containers and tanks must be labeled or marked “Hazardous Waste.” Finally, LQGs must comply with the air emission control requirements in 40 CFR 265, subparts AA, BB, and CC, for accumulation tanks and containers. The modules entitled “Tanks,” “Containers,” “Drip Pads,” “Containment Buildings,” and “Air Emissions” provide additional information on the hazardous waste unit standards.

The time period for generator waste accumulation starts when waste is first placed in or on the empty accumulation unit. Tanks and containers must be marked with the date accumulation begins. In order to avoid exceeding the time limits when accumulating in a tank, the generator should fully empty the tank every 90, 180, or 270 days, as appropriate. All wastes must be removed from drip pads and their associated collection systems at least once every 90 days.

Satellite accumulation. Prior to consolidation in the generator’s waste accumulation area, 40 CFR 262.34(c) allows generators to accumulate hazardous waste at or near the point where it is initially generated and collected during daily operations. A person may accumulate up to 55 gallons of hazardous waste or 1 quart of acute hazardous waste at each satellite accumulation area, if it is under the control of the person operating the process that generates the waste. Limited standards, such as labeling and maintaining the container in good condition, apply to satellite areas. Once the 55-gallon or 1 quart limit is exceeded at the satellite area, the excess waste must be dated and moved within three days to the central accumulation area where 40 CFR 262.34 standards apply. The accumulation limit is 55 gallons, regardless of the size of the container used.

Accumulation time limits. Pursuant to 40 CFR 262.34(a), an LQG is allowed to accumulate hazardous waste onsite for up to 90 days in specified units without obtaining a storage permit or interim status, provided he or she complies with part 265 management standards for specific units as specified in 40 CFR 262.34. (It is important to note, however, that generators that accept waste from other generators or from offsite locations are owners/operators of storage facilities subject to 40 CFR 264 and 265.) An SQG may accumulate up to 6,000 kg of hazardous waste for 180 days or less without a storage permit.
or interim status if he or she complies with the modified standards in 40 CFR 262.34(d). If the TSDF is 200 miles or more away, the generator may accumulate hazardous waste for 270 days or less. Note that these extended time limits only apply to SQGs accumulating waste in tanks or containers. SQGs that accumulate waste in containment buildings or on drip pads are subject to the accumulation standards for LQGs.

Generators may receive a 30-day extension to their 90-day, 180-day, or 270-day accumulation period if uncontrollable and unforeseen circumstances cause them to accumulate waste onsite for longer than the allowed time period. Such an extension may be granted by a regional administrator or authorized state on a case-by-case basis. An example of an uncontrolled or unforeseen circumstance is a truckers’ strike preventing the shipment of waste offsite.

Preparing Hazardous Waste for Shipment
Before shipping hazardous waste offsite to an RCRA facility for treatment, storage, or disposal, a generator must comply with numerous pre-transport requirements. These requirements include obtaining an EPA identification number, preparing a Uniform Hazardous Waste Manifest, and complying with several DOT requirements.

EPA Identification Numbers
A generator must obtain an EPA identification (ID) number before treating, storing, disposing, or transporting (or offering for transport) hazardous waste. EPA ID numbers are site-specific numbers assigned to generators, transporters, and TSDFs, and need only be obtained once, although the generator should update the state or region if his or her waste activities change. Conditionally exempt small quantity generators (CESQG), however, are not required to obtain EPA ID numbers.

Each EPA ID number consists of twelve alphanumeric characters. The first two letters are simply the two-letter abbreviation for the state in which the facility is located; whereas, the third character is either a number or letter indicating the “type” of ID number (e.g., automatically generated by RCRA Info). A nine-digit number uniquely associated with the site follows these first three characters. Emergency EPA ID numbers are also available in certain situations.

EPA ID numbers are obtained by filing Form 8700-12, “Notification of Regulated Waste Activity,” with the appropriate EPA regional or authorized state RCRA office. The notification forms are obtained from state or regional offices or via the Internet.

DOT requires that generators of hazardous waste subject to manifesting meet several requirements before transporting or offering hazardous waste for transport offsite, including packaging, labeling, marking, and placarding.

Preparing a Uniform Hazardous Waste Manifest
Generally, a generator who transports, or offers for transportation, hazardous waste for offsite treatment, storage, or disposal must prepare a uniform hazardous waste manifest. The
manifest is a multiple-copy tracking document for hazardous waste shipments that is required by DOT and EPA. The manifest tracks the chain of custody for the waste from the point it leaves the generator to final disposition at a hazardous waste TSDF or a recycling facility. Each party that manages the waste signs the manifest and retains a copy, providing critical continuity between the generator and the receiving facility. Once the chain is complete, the receiving facility returns a signed copy of the manifest to the generator. If a generator does not receive a copy of the manifest signed by the designated facility owner or operator within 45 days of the date the waste was accepted by the initial transporter (60 days for a SQG), he or she must file an exception report. SQGs that have tolling agreements with recycling facilities and CESQGs are not required to use a manifest when shipping their waste offsite. Additionally, the manifest requirements do not apply to the transportation of hazardous wastes on rights-of-way on or between contiguous properties, and along the perimeter of contiguous properties controlled by the same person.

A copy of the manifest form and instructions for completing it are found in the appendix to 40 CFR 262, “Standards Applicable to Generators of Hazardous Waste.” All numbered sections on the manifest must be completed to meet Federal requirements. The lettered sections are options that may be required by the generator’s or receiving facility’s state. Since states may customize the manifest, 40 CFR 262.21, “Manifest Tracking Numbers, Manifest Printing, and Obtaining Manifests,” explains which state’s manifest must be used when waste transportation is interstate. Federal EPA does not require hazardous waste codes to be included on the manifest; however state law may require waste codes.

g. For Resource Conservation and Recovery Act-permitted facilities and interim status facilities, discuss the following as required by 40 CFR 264 and 40 CFR 265:
   - General facility standards
   - Preparedness and prevention requirements
   - Contingency plan and emergency procedures
   - Manifest and record keeping requirements
   - Releases from solid waste management units
   - Closure requirements
   - Use and management of containers
   - Tank systems
   - Landfills

The following descriptions are taken from U. S. Environmental Protection Agency, *RCRA Orientation Manual*.

*General Facility Standards*
If a TSDF is not exempt, then it must comply with the standards for fully regulated TSDFs. These standards cover good management practices, including keeping track of the amount and type of wastes entering the facility, training employees to safely manage hazardous waste, and preparing to avoid hazardous waste emergencies.
Preparedness and Prevention Requirements

The preparedness and prevention standards are intended to minimize and prevent emergency situations at TSDFs, such as a fire, an explosion, or any unplanned release of hazardous waste or hazardous waste constituents to the air, soil, or surface water. These regulations require maintenance and routine testing of emergency equipment, alarms, minimum aisle space, and provisions for contacting local authorities involved in emergency responses at the facility.

Contingency Plan and Emergency Procedures

A TSDF must be prepared to respond to unavoidable emergencies. Contingency plans and emergency procedures provide the owner/operator with mechanisms to respond effectively to emergencies. The goal of these requirements is to minimize hazards resulting from fires, explosions, or any unplanned release of hazardous waste or constituents to air, soil, or surface water. To help guide these activities, the owner/operator must maintain a written contingency plan at the facility, and must carry out that plan immediately in the event of an emergency.

Contingency Plan

The contingency plan describes emergency response arrangements with local authorities and lists the names, addresses, and telephone numbers of all facility personnel qualified to work with local authorities as emergency coordinators. Where applicable, the plan might also include a list of emergency equipment and evacuation plans. If the owner or operator has already prepared an emergency or contingency plan in accordance with other regulations, he or she can amend the existing plan to incorporate hazardous waste management provisions.

The contingency plan must be reviewed and amended when the applicable regulations or facility permits are revised, if the plan fails in an emergency, or when there are changes to the facility, the list of emergency coordinators, or the list of emergency equipment. A copy of the contingency plan must be maintained at the facility and provided to all local authorities who may have to respond to emergencies.

Manifest and Record Keeping Requirements

Refer to element f of this competency for a discussion of manifest and record-keeping requirements.

Releases from Solid Waste Management Units (SWMU)

EPA requires corrective action for releases of hazardous waste or hazardous constituents from SWMUs in a facility’s permit. A SWMU is any discernible unit where solid or hazardous wastes have been placed at any time, or any area where solid wastes have been routinely and systematically released.

Closure Requirements

Closure is the period directly after a TSDF stops its normal operations. During this period, a TSDF stops accepting hazardous waste; completes treatment, storage and disposal of any wastes left onsite; and disposes or decontaminates equipment, structures, and soils. Some
owners/operators will completely remove all waste that was treated, stored, or disposed in their unit. This operation is known as clean closure. In order to demonstrate clean closure, an owner/operator must show that levels of hazardous contaminants at the facility do not exceed EPA-recommended exposure levels.

Closure Plan
To ensure that a TSDF is closed properly, the owner/operator must prepare a closure plan that details exactly how and when facility closure will take place, and must submit the plan to their implementing agency for approval. Permitted facilities are required to submit a closure plan to their implementing agency at the time of permit application. The approved closure plan then becomes an enforceable component of their permit. Interim status facilities must have a written closure plan on the premises six months after they become subject to RCRA. The closure plan must contain

- a description of how the owner or operator will close each hazardous waste management unit
- a description of how and when the owner or operator will achieve final closure of the whole facility
- an estimate of the maximum amount of hazardous waste kept onsite over the life of the facility
- a detailed description of closure methods, including the actions necessary to remove and manage waste and decontaminate the site
- a description of any other steps necessary to comply with the closure standards, such as groundwater monitoring or leachate collection (depending on the type of unit)

When there is a change in the design or operation of the facility, a change in the expected closure date, or an unexpected event, the owner or operator or the implementing agency must amend the closure plan to address the additional steps necessary to safely close the facility. In such instances, permitted facilities must submit an application to modify their permit, while interim status facilities must submit the proposed modification to the implementing agency for approval.

Use and Management of Containers
TSDF owners/operators are subject to one of three different sets of requirements for containers depending on the size of the container, the organic content of hazardous waste placed in the container, and whether or not waste stabilization occurs in the container. Small containers (between 0.1 m$^3$ and 0.46 m$^3$) and large containers (greater than 0.46 m$^3$) storing waste with a low vapor pressure (known as level 1 containers) must either comply with DOT requirements, be equipped with a closed cover, or be fitted with a vapor suppressing barrier. Large containers storing waste with a high vapor pressure (known as level 2 containers) may either meet DOT specifications, operate with no detectable emissions, or be vapor tight (i.e., no vapors can escape the unit). The last category of containers (level 3 containers) are those units conducting waste stabilization. These containers must be vented through a closed-vent system to a control device.
**Tank Systems**

TSDF tank owners/operators are subject to one of two different sets of requirements depending on the vapor pressure of the waste being managed in the unit. Tanks that store hazardous waste below certain vapor pressures (known as level 1 tanks), must be equipped with, at a minimum, a fixed roof. Those tanks that store waste with higher vapor pressures (known as level 2 tanks), have five compliance options that range from putting the tank in an enclosure vented to a control device to using a closed-vent system that vents emissions from the unit to a control device.

**Landfills**

A landfill is a disposal unit where non-liquid hazardous waste is placed in or on the land. Landfills are the final disposal site, the ultimate grave, for a significant portion of the hazardous waste that is generated in the United States.

To minimize the potential for leachate to leak from a landfill, EPA developed the following design standards:

- Double liner
- Double leachate collection and removal system
- Leak detection system
- Run-on, run-off, and wind dispersal controls
- Construction QA

**Double Liner**

The double liner system has two components: a top liner and a composite bottom liner. The top liner, usually a synthetic material, keeps the liquid waste in the unit and prevents migration of hazardous leachate and waste into the liner. The composite bottom liner, consisting of a synthetic liner on top of three feet of compacted soil material, is designed to prevent any liquids that have leaked through the top liner from reaching underlying soils and groundwater.

**Double Leachate Collection and Removal System**

Landfills must also be equipped with two leachate collection and removal systems. The first rests on the top liner, and the second between the top liner and the bottom composite liner. The top system collects any leachate that has filtered down through the waste in the unit and pumps it out to a collection tank, where it may be collected and disposed. The bottom system collects any leachate that has leaked through the top liner and similarly pumps it out to a collection tank, where it may similarly be collected and disposed.

**Leak Detection System**

While the lower leachate collection and removal system (LCRS) will continually remove the small amounts of liquid that might seep through the top liner, it may not be capable of handling a larger leak. Larger leaks can apply strong pressure on the bottom liner, potentially causing it to fail. To avoid this problem, RCRA requires that a leak detection system be installed within the leachate collection and removal system. This system must be able to
detect when the flow rate into the LCRS is above a normal operating range, and warn the owner or operator that the top liner may be leaking.

Run-On, Run-Off, and Wind Dispersal Controls
The run-on, run-off, and wind dispersal requirements are identical to those for land treatment units.

Construction QA
None of these technologies are effective if the landfill is installed improperly or constructed of inferior materials. To ensure that a landfill meets all the technological requirements, EPA requires a construction QAP. The program mandates a construction QAP that identifies how construction materials and their installation will be monitored and tested and how the results will be documented. The program must be developed and implemented under the direction of a registered professional engineer, who must also certify that the construction QAP has been successfully carried out and that the unit meets all specifications before any waste is placed into the unit.

h. Discuss the Resource Conservation and Recovery Act regulatory requirements for:
   ▪ Recyclable materials
   ▪ Incinerators
   ▪ Disposal facilities

The following descriptions are taken from U.S. Environmental Protection Agency, RCRA Orientation Manual.

Recyclable Materials
RCRA provides separate, reduced regulations for TSDFs recycling certain materials. These recycling facilities are generally exempt from the TSDF standards, but may be required to comply with streamlined hazardous waste management requirements. These reduced provisions apply to facilities recycling these materials:
   ▪ Precious metals
   ▪ Lead-acid batteries
   ▪ Used oil
   ▪ Hazardous waste burned in boilers and industrial furnaces

For other recyclable materials, there are no special requirements. For example, facilities recycling the following materials are exempt from all TSDF standards:
   ▪ Industrial ethyl alcohol
   ▪ Used batteries returned to the manufacturer for regeneration
   ▪ Scrap metal
   ▪ Fuels produced from refining oil-bearing hazardous wastes
   ▪ Oil reclaimed from hazardous waste
**Incinerators**

The first class of combustion units is hazardous waste incinerators. Incineration is the combustion of hazardous waste primarily for destruction. Incineration is a method of thermal destruction of primarily organic hazardous waste using controlled flame combustion. This process can reduce large volumes of waste materials to ash and lessen toxic gaseous emissions. An incinerator is an enclosed device that uses controlled flame combustion and does not meet the more specific criteria for classification as a boiler, industrial furnace, sludge dryer, or carbon regeneration unit. Incinerators also include infrared incinerators and plasma arc incinerators.

Hazardous waste burning incinerators, cement kilns, and light-weight aggregate kilns, hereafter referred to as MACT combustion units, must also comply with emission limitations. The MACT emission standards are found under the CAA regulations. The compliance framework for these MACT combustion units is similar to that used to comply with the RCRA emission standards. Sources are required to demonstrate compliance with emission standards via a comprehensive performance test and establish operating limits to ensure compliance on a daily basis. Generally speaking, sources can use any combination of control technologies to achieve the emission standards.

**Disposal Facilities (Land Disposal Units)**

The following is taken from U.S. Environmental Protection Agency, Wastes: Hazardous Waste Land Disposal Units.

Specific regulations have been developed for four types of land disposal units under subtitle C of RCRA: landfills, surface impoundments, waste piles, and land treatment units. These units are addressed below:

- **Landfills** are excavated or engineered sites where non-liquid hazardous waste is deposited for final disposal and then covered. These units are selected and designed to minimize the chance of release of hazardous waste into the environment. Design standards for hazardous waste landfills require a double liner; double leachate collection and removal systems; a leak detection system; run-on, run-off, and wind dispersal controls; and a construction QAP. Liquid wastes may not be placed in a hazardous waste landfill. Operators must also comply with inspection, monitoring, and release response requirements. Since landfills are permanent disposal sites and are closed with waste in place, closure and post-closure care requirements include installing and maintaining a final cover, continuing operation of the LCRS until leachate is no longer detected, maintaining and monitoring the leak detection system, maintaining groundwater monitoring, preventing stormwater run on and runoff, and installing and protecting surveyed benchmarks.

- **Surface impoundments** are natural topographic depressions, man-made excavations, or diked areas formed primarily of earthen materials used for temporary storage or treatment of liquid hazardous waste. Examples include holding, storage, settling, aeration pits, ponds, and lagoons. Hazardous waste surface impoundments are required to be constructed with a double liner system, an LCRS, and a leak detection system. To ensure proper installation and construction, regulations require the unit to
have and follow a construction QAP. The regulations also outline monitoring, inspection, response action, and closure requirements.

- Waste piles are non-containerized piles of solid, non-liquid hazardous waste that are used for temporary storage or treatment. In addition to the standard double liner and LCRS, waste piles are required to have a second LCRS above the top liner. Waste piles must have run-on and run-off controls, must be managed to prevent wind dispersal of waste, and are subject to inspection, monitoring, and release response requirements. When closing a waste pile, all waste residue and contaminated soils and equipment must be removed or decontaminated.

- Land treatment units use naturally occurring soil microbes and sunlight to treat hazardous waste. This is accomplished by applying the hazardous waste directly on the soil surface or incorporating it into the upper layers of the soil in order to degrade, transform, or immobilize the hazardous constituents. Land treatment units rely upon the physical, chemical, and biological processes occurring in the topsoil layers to contain the waste. Because of this, the units are not required to have liner systems or an LCRS. Before hazardous waste can be placed in a land treatment unit, operators must complete a treatment demonstration to demonstrate the unit’s effectiveness and ability to treat the hazardous waste. Once operational, operators must monitor the unit (unsaturated zone monitoring) to ensure that all hazardous constituents are being treated adequately. Unit closure consists primarily of placing a vegetative cover over the unit and certifying that hazardous constituent levels in the treatment zone do not exceed background levels.

The remaining types of land disposal units are categorized as miscellaneous units:

- Injection wells are regulated primarily under the SDWA and the UIC Program.
- Salt dome formations, salt bed formations, underground mines, and underground caves are geologic repositories. Because these units vary greatly, they are subject to environmental performance standards, and not prescribed technology-based standards (e.g., liners, leachate collection systems, leak detection systems). The standards require that these miscellaneous units must be located, designed, constructed, operated, maintained, and closed in a manner that ensures the protection of human health and the environment.

i. Describe the treatment standards required under the Land Disposal Restrictions (LDRs), and describe the prohibition on storage as required by 40 CFR 268.

The following is taken from U.S. Environmental Protection Agency, EPA 530-F-99-043.

The LDR program ensures that land disposed hazardous waste does not pose a threat to human health and the environment. EPA accomplishes this by setting treatment standards for all hazardous waste bound for land disposal. These treatment standards ensure hazardous waste is properly treated to destroy or immobilize hazardous chemical components before it is land disposed.

The LDR program has three major components that address hazardous waste disposal, dilution, and storage. The disposal prohibition states that, before a hazardous waste can be
land disposed, treatment standards specific to that waste material must be met. A facility may meet such standards by either
- treating hazardous chemical constituents in the waste to meet required treatment levels. Any method of treatment can be used to bring concentrations to the appropriate level except dilution.
- treating hazardous waste using a treatment technology specified by EPA. Once the waste is treated with the technology required under LDR, it can be land disposed.

The dilution prohibition states that waste must be properly treated and not simply diluted in concentration by adding large amounts of water, soil, or nonhazardous waste. Dilution does not reduce the toxicity of the hazardous constituents.

The storage prohibition states that waste must be treated and cannot be stored indefinitely. This prevents generators and TSDFs from storing hazardous waste for long periods to avoid treatment. Waste may be stored, subject to the LDR, in tanks, containers, or containment buildings—but only for the purpose of accumulating quantities necessary to facilitate proper recovery, treatment, or disposal.

j. Discuss Resource Conservation and Recovery Act permitting requirements and requirements associated with modifying permits, as defined in 40 CFR 270.

The following is taken from U.S. Environmental Protection Agency, EPA 530-K-05-016.

A permit establishes the site-specific administrative and technical standards to which a TSDF must adhere in order to legally manage hazardous waste. A lengthy permit application and review process ensures that each site receives specific analysis concerning hazardous waste management at that location.

Owners/operators of facilities that fall under the permitting regulations are required to submit a comprehensive permit application covering all aspects of the design, operation, and maintenance of the facility. The application provides EPA valuable information that will ensure compliance with subtitle C regulations through the development of a facility-specific permit. Permits are written to address the specific geography of the facility, the types of hazardous waste management units, and the specific waste streams that will be managed at the facility. The permit application consists of two parts, part A and part B.

Part A
Part A of the permit application is submitted on a designated form, Form 8700-23. The basic part A information requirements include
- activities conducted by the applicant that require the owner/operator to obtain a permit under RCRA
- name, mailing address, and location of the facility
- up to four North American Industry Classification System codes that best describe facility activities
- descriptions of the processes to be used for treating, storing, and/or disposing of hazardous waste and the design capacity of these items or units
• identification of the hazardous wastes to be managed at the facility
• list of all permits received or applied for under other regulatory programs
• topographic map of the facility

Part B
Part B information is submitted in narrative form. It includes general information requirements for all hazardous waste management facilities, as well as unit-specific information. 40 CFR 270.14, lists the general information requirements that all hazardous waste management facilities must submit in part B of the permit application, including:

• general description of the facility
• chemical and physical analyses of the wastes to be handled at the facility
• copy of the waste analysis plan
• description of the security procedures and copy of the inspection schedule
• copy of the contingency plan
• description of procedures, structures, or equipment used at the facility to prevent releases to the environment
• description of precautions to prevent accidental ignition or reaction of ignitable, reactive, or incompatible waste
• facility location information such as proximity to a seismic area or a 100-year floodplain

Owners/operators are required to provide information regarding the placement of hazardous waste and any resultant releases. These regulations are designed to prevent or remediate releases into the environment from land-based hazardous waste management units and SWMUs. This information is then used as part of the corrective action process.

Changes to Permits
40 CFR 270, subpart D, establishes the steps necessary to make changes to a permit. The procedures for making changes to a permit will vary depending on whether EPA or the owner/operator is initiating the change. The three basic situations for changing a permit after issuance are:

• permit modification at the request of the permittee
• permit modification at the request of EPA
  • modification of the permit
  • revocation and reissuance of the permit
• termination of the permit

The procedures for each of these actions are discussed below.

Facility-Initiated Permit Modifications
40 CFR 270.42, “Permit Modification at the Request of the Permittee,” contains the regulations that apply to the modification of a permit at the request of the permittee. There are three classifications of permit modifications—classes 1, 2, and 3—that correspond to the degree the permit will be modified. Appendix I to 40 CFR 270.42, describes the type of permit modification necessary to change a permit provision when there is a transfer of a
permit or the permittee requests a permit modification. For all modifications, the permittee submits information to EPA that describes the exact change to be made to the permit conditions, identifies whether the modification is class 1, 2, or 3, and provides the applicable permit application information. Class 1 and 2 modifications do not substantially alter existing permit conditions or significantly affect the overall operation of a facility. Class 1 covers routine changes, such as changing typographical errors, upgrading plans and records maintained by the facility, or replacing equipment. Class 2 modifications address common operating changes needed to maintain a facility’s ability to manage a waste safely or to conform with new regulatory requirements. Class 3 changes cover major modifications that substantially alter the facility or its operations, such as significantly increasing the facility’s capacity to treat, store, or dispose of hazardous waste.

Prior approval of the agency is not required for most class 1 modifications. For class 2 and class 3 modifications, prior agency approval is required, and a procedure similar to the permitting process is followed.

For a modification not explicitly listed in appendix I, the permittee may submit a class 3 modification or request a determination by EPA that the modification be reviewed and approved as a class 1 or 2 modification.

Fully permitted facilities managing newly regulated hazardous wastes or hazardous wastes in newly regulated units must submit a class 1 modification by the date on which the waste or unit becomes subject to the new requirements. The permittee must also be in compliance with the applicable standards of 40 CFR 265 and 266. If a class 2 or 3 modification is required, the permittee must also submit a complete permit modification request within 180 days after the effective date of the rule that subjected the waste or unit to the subtitle C regulation.

Finally, for all land disposal units that are newly regulated, the permittee must certify that the unit is in compliance with all applicable requirements of 40 CFR 265 for groundwater monitoring and financial responsibility 12 months after the effective date of the rule.

As with the initial permit process, permit modifications can raise public concerns that must be addressed through public participation. Public participation responsibilities and activities vary depending on who initiated the modification and the degree to which the modification changes the facility permit. When a modification is proposed, only the permit conditions subject to modification are reopened for public comment.

Agency-Initiated Permit Modifications
There are two types of EPA-initiated changes to permits: permit modification or revocation and reissuance of a permit. When a permit is modified, only the conditions subject to modification are reopened. If a permit is revoked and reissued, the entire permit is reopened and can be revised, and the permit is reissued for a new term. The agency may modify a permit, or revoke and reissue if the permittee agrees, for the following reasons: if there have been alterations or additions to the facility; there is new information that was not available at the time of permit issuance; new statutory or regulatory requirements were promulgated; or
the agency has cause to initiate a compliance schedule. The agency may also modify a land disposal facility’s permit during the permit’s five-year review. EPA may either modify a permit or revoke and reissue a permit if cause for termination of the permit exists or if the permit is transferred.

Termination of Permits
EPA can terminate a permit during its term or deny a permit renewal application if any of the following causes occur:

- Noncompliance by the permittee with any condition of the permit
- Failure to disclose all relevant facts or misrepresentation of any relevant facts
- Determination that a permitted activity endangers human health and the environment


The following is taken from DOE, Office of Health, Safety, and Security, Federal Facilities Compliance Act.

Under RCRA, the Federal government maintained that it was not subject to administrative and civil fines and penalties because of the doctrine of “sovereign immunity.” The FFCA, when enacted on October 6, 1992, specifically waived sovereign immunity with respect to RCRA for Federal facilities.

Section 104 (1) and (2) of the FFCA required EPA to conduct annual RCRA inspections of all Federal facilities. As part of the first inspection conducted under this authority, EPA is required to conduct a comprehensive groundwater monitoring evaluation, unless such an evaluation was conducted in the preceding 12 months. Authorized states are also given authority to conduct inspection of Federal facilities for the purpose of enforcing compliance with the state hazardous waste program.

Section 105 of the FFCA further amends RCRA by adding the new section 3021. This section, “Mixed Waste Inventory Reports and Plan[s],” provides the mechanism for fulfilling the requirements by imposing several new reporting requirements on DOE related to mixed waste.

First, 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. The mixed waste inventory was to, among other things, describe each mixed waste type, list the amount currently stored, and estimate the amount of each type of mixed waste expected to be generated in the next five years at each DOE facility. Wastes that had not been characterized by sampling and analysis also had to be described. The inventory of treatment capacities and technologies [Note: this inventory is known as the site treatment plan] was
to contain an estimate of available treatment capacity for each waste described in the waste inventory, and provide information to support determinations that no treatment technology exists. DOE submitted its initial draft mixed waste inventory report to EPA and affected states for comment in April 1993.

Second, the Secretary was directed to prepare and submit plans 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. Plans were not required where agreements and orders were already in place.

I. Describe the types of facilities that need Resource Conservation and Recovery Act 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.

The following is taken from DOE/EH [RCRA] 9705.

Unless excluded by the implementing regulations, owners/operators of facilities that treat, store, or dispose of hazardous or radioactive mixed waste regulated under RCRA Subtitle C, “Hazardous Waste Management,” must have permits. Facilities in existence on the effective date of statutory or regulatory changes subjecting them to RCRA permitting requirements may operate under “interim status” until permits are issued or denied. New facilities (or new units at existing facilities) that manage hazardous or radioactive mixed waste, however, must apply for and obtain RCRA permits before construction begins [40 CFR 270.10(f)(1)].

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. Part A information is shown in table 11. The 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 while other information items are specific to the types of units included in the application. Table 12 lists both types of part B information.
Table 11. Overview of part A RCRA permits application information

| Part A  
<table>
<thead>
<tr>
<th>(40 CFR 270.13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation EPA ID #</td>
</tr>
<tr>
<td>Name of Facility</td>
</tr>
<tr>
<td>Facility Location</td>
</tr>
<tr>
<td>Facility Mailing Address</td>
</tr>
<tr>
<td>Facility Contact</td>
</tr>
<tr>
<td>Facility Contact Address</td>
</tr>
<tr>
<td>Operator Information</td>
</tr>
<tr>
<td>Facility Owner</td>
</tr>
<tr>
<td>SIC Codes</td>
</tr>
<tr>
<td>Existing Environmental Permits</td>
</tr>
<tr>
<td>Nature of Business</td>
</tr>
<tr>
<td>Process Codes and Design Capacities</td>
</tr>
<tr>
<td>Additional Treatment Processes</td>
</tr>
<tr>
<td>Description of Hazardous Wastes</td>
</tr>
<tr>
<td>Map</td>
</tr>
<tr>
<td>Facility Drawing</td>
</tr>
<tr>
<td>Photographs</td>
</tr>
<tr>
<td>Certification(s)</td>
</tr>
<tr>
<td>Comments</td>
</tr>
</tbody>
</table>

Source: DOE/EH (RCRA) 9705
Table 12. Overview of part B RCRA permits application information

<table>
<thead>
<tr>
<th>Part B</th>
<th>Information Addressing General Requirements (40 CFR 270.14)</th>
<th>Information Addressing Specific Requirements Applicable to the Units Listed (40 CFR 270.15-270.26)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Facility Description</td>
<td>Containers</td>
</tr>
<tr>
<td></td>
<td>Waste Characterization</td>
<td>Tank Systems</td>
</tr>
<tr>
<td></td>
<td>Process Information</td>
<td>Surface Impoundments</td>
</tr>
<tr>
<td></td>
<td>Groundwater Monitoring</td>
<td>Waste Piles</td>
</tr>
<tr>
<td></td>
<td>Procedures to Prevent Hazards</td>
<td>Incinerators</td>
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<tr>
<td></td>
<td>Contingency Plan</td>
<td>Land Treatment Facilities</td>
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<tr>
<td></td>
<td>Personnel Training</td>
<td>Landfills</td>
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<tr>
<td></td>
<td>Closure Plans</td>
<td>Boilers and Industrial Furnaces</td>
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<tr>
<td></td>
<td>Post-Closure Plans</td>
<td>Miscellaneous Units</td>
</tr>
<tr>
<td></td>
<td>Financial Assurance for Closure, Post Closure, and Third</td>
<td>Process Vents</td>
</tr>
<tr>
<td></td>
<td>Party Liability*</td>
<td>Equipment Subject to Standards for Equipment Leaks</td>
</tr>
<tr>
<td></td>
<td>Corrective Action for Solid Waste Management Units</td>
<td>Drip Pads</td>
</tr>
<tr>
<td></td>
<td>Public Participation</td>
<td>Air Emission Standards for Containers, Tanks, and Surface Impoundments</td>
</tr>
<tr>
<td></td>
<td>Part B Certification</td>
<td>Containment Buildings</td>
</tr>
<tr>
<td></td>
<td>Other Federal Laws</td>
<td></td>
</tr>
</tbody>
</table>

Source: DOE/EH (RCRA) 9705

m. 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 the Federal Facilities Environmental Stewardship and Compliance Assistance Center, Hazardous Identification Flow Chart.

The first step is to determine if the material in question is classified as a solid waste. If the material is not a solid waste, it cannot be a hazardous waste.

The statutory definition of a solid waste is completely irrespective of the physical form of the waste. A solid waste can be just as easily liquid or gas. A material is considered a solid waste if it meets any of the provisions below:

- Is a solid, semi-solid, liquid, or contained gaseous material which is discarded or has served its intended purpose
• Is abandoned
• Is being recycled by being placed on the ground, burned for energy recovery, reclaimed, or accumulated more than one year
• Is inherently waste-like (e.g., dioxin wastes)

The next step is to see if the waste is a characteristic hazardous waste.

Solid wastes that are not directly listed in 40 CFR 261, “Identification and listing of Hazardous Waste” may still be hazardous. EPA uses a classification system based on the four properties of solid wastes. If a material exhibits at least one of these characteristics, it is classified as a hazardous waste. The four properties are listed below:

Ignitability
A substance is ignitable if it displays any of the following properties:
- A liquid with a flashpoint of less than 60°C (140°F)
- A non-liquid that is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and when ignited, burns so vigorously and persistently that it creates a hazard
- An ignitable compressed gas
- An oxidizer (such as a chlorate or peroxide)

Corrosivity
A substance is corrosive if it displays either of the following properties:
- An aqueous material with a pH less than or equal to 2 or greater than or equal to 12.5
- A liquid that corrodes steel at a rate of at least 0.25 inches per year at 55°C (130°F).

NOTE: A waste that is not aqueous and contains no liquid falls outside the definition of EPA corrosivity.

Reactivity
A substance is reactive if it displays any of the following properties:
- Normally unstable and readily undergoes violent change without detonating
- Reacts violently with water
- Forms potentially explosive mixtures with water
- A cyanide or sulfide bearing waste which can generate fumes in a quantity sufficient to present a danger to human health
- Capable of detonation
- A forbidden explosive, or a class A or class B explosive, as defined in DOT regulations

Toxicity
A substance is toxic if it exceeds the concentrations for contaminants listed in the “Maximum Concentration of Contaminants for the Toxicity Characteristic” table, presented in 40 CFR 261.24, “Toxicity Characteristic.” A specific test, the toxicity characteristic leaching procedure must be conducted to determine if the waste is classified as toxic.
Even though the solid waste is not a listed or hazardous waste, it could become a hazardous waste if mixed with materials classified as hazardous. The next step is to determine if the waste is a mixture of a solid waste and a hazardous waste.

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

- If the material is a mixture of a solid waste and a hazardous waste, and the mixture exhibits one or more of the characteristics of hazardous waste.
- If the material is a mixture of a solid waste and a listed waste. The mixture rule is intended to discourage generators from mixing waste streams.

n. Discuss the Land Disposal Restrictions, 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, EPA 530-F-99-043.

The LDR program ensures that land disposed hazardous waste does not pose a threat to human health and the environment. EPA accomplishes this by setting treatment standards for all hazardous waste bound for land disposal. These treatment standards ensure hazardous waste is properly treated to destroy or immobilize hazardous chemical components before it is land disposed.

The LDR program has three major components that address hazardous waste disposal, dilution, and storage. The disposal prohibition states that, before a hazardous waste can be land disposed, treatment standards specific to that waste material must be met. A facility may meet such standards by either

- treating hazardous chemical constituents in the waste to meet required treatment levels. Any method of treatment can be used to bring concentrations to the appropriate level except dilution.
- treating hazardous waste using a treatment technology specified by EPA. Once the waste is treated with the technology required under LDR, it can be land disposed.

The dilution prohibition states that waste must be properly treated and not simply diluted in concentration by adding large amounts of water, soil, or nonhazardous waste. Dilution does not reduce the toxicity of the hazardous constituents.

The storage prohibition states that waste must be treated and cannot be stored indefinitely. This prevents generators and TSDFs from storing hazardous waste for long periods to avoid treatment. Waste may be stored, subject to the LDR, in tanks, containers, or containment buildings—but only for the purpose of accumulating quantities necessary to facilitate proper recovery, treatment, or disposal.
The following is taken from DOE/EH-231/005/0293.

The LDR regulations provide certain compliance alternatives that delay the effective date of prohibitions or allow a variance from the prohibitions. Under certain conditions, EPA may grant a variance from the treatment standard, an extension to the LDR effective date based on capacity determinations, or an exemption from the prohibition for a specific waste at a specific site. EPA has established six types of variances, extensions and exemptions:

National Capacity Variance
A national capacity variance is provided when EPA determines that sufficient treatment capacity for specific RCRA hazardous waste codes is not available on a nationwide basis. The variance extends the LDR effective date of the waste until the earliest date treatment capacity becomes available, but by law this variance cannot be longer than two years. When the LDR effective date for a waste is extended, the new effective date is listed in appendix VII of 40 CFR 268.

During the period of a national capacity variance, the generator may continue to land dispose the waste without treatment. If wastes that are granted such a capacity variance are to be placed in a landfill or surface impoundment, then such disposal may only be in a unit meeting the minimum technological requirements of RCRA.

Case-by-Case Extension
A case-by-case extension may be granted if the petitioner can demonstrate a binding contractual commitment exists to provide alternate treatment for the waste, but through no fault of their own, the petitioner cannot bring this new capacity online by the effective date of the LDR treatment standards. EPA may grant a case-by-case extension of up to one year, renewable only once, for a total of two years.

Treatability Variance
Generators whose wastes cannot be treated to the established treatment standards may petition EPA for a treatability variance. For EPA to grant a variance, the petitioner must successfully demonstrate that the waste differs significantly from the wastes evaluated by EPA in developing the treatment standards. The petitioner must also demonstrate that the waste cannot be treated to the level or by the method specified as the treatment standard, or that the existing level or method is inappropriate for the waste. In granting a variance, EPA will establish a new treatability group for that waste, and set a new treatment standard.

Equivalent Method Variance
If EPA has specified a method of treatment as the treatment standard for a waste, a generator or facility may submit an application to the EPA administrator demonstrating that an alternative treatment method can achieve performance equivalent to that of the method specified as the treatment standard. If approved, wastes treated by this alternative treatment method comply with the treatment standard and thus can be land disposed.
No-Migration Petition
EPA will consider allowing land disposal of restricted wastes if a petitioner can demonstrate, to a reasonable degree of certainty, that such disposal will not allow migration of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous. A successful no-migration petition will allow land disposal of specific restricted wastes at a specific site.

Treatment in Surface Impoundment Exemption
Owners/operators of surface impoundments seeking an exemption for treatment of restricted wastes must certify to the EPA Regional Administrator that the impoundment meets minimum technological requirements and must submit a copy of the facility’s revised waste analysis plan that outlines methods for representative sampling and proper testing, frequency of removal, and methods for removal of restricted residuals.

o. 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, Municipal Solid Wastes: Landfills.

Modern landfills are well-engineered facilities that are located, designed, operated, and monitored to ensure compliance with Federal regulations. Solid waste landfills must be designed to protect the environment from contaminants which may be present in the solid waste stream. The landfill siting plan—which prevents the siting of landfills in environmentally-sensitive areas—as well as onsite environmental monitoring systems—which monitor for any sign of groundwater contamination and for landfill gas—provide additional safeguards. In addition, many new landfills collect potentially harmful landfill gas emissions and convert the gas into energy.

Municipal solid waste landfills (MSWLFs) receive household waste. MSWLFs can also receive non-hazardous sludge, industrial solid waste, and construction and demolition debris. All MSWLFs must comply with the Federal regulations in 40 CFR 258, “Criteria for Municipal Solid Waste Landfills,” (subtitle D of RCRA), or equivalent state regulations. Federal MSWLF standards include the following:

- Location restrictions—ensure that landfills are built in suitable geological areas away from faults, wetlands, flood plains, or other restricted areas.
- Composite liners requirements—include a flexible membrane (geomembrane) overlaying two feet of compacted clay soil lining the bottom and sides of the landfill, protect groundwater and the underlying soil from leachate releases.
- LCRSs—sit on top of the composite liner and removes leachate from the landfill for treatment and disposal.
- Operating practices—include compacting and covering waste frequently with several inches of soil to help reduce odor; control litter, insects, and rodents; and protect public health.
- Groundwater monitoring requirements—require testing groundwater wells to determine whether waste materials have escaped from the landfill.
- Closure and post-closure care requirements—include covering landfills and providing long-term care of closed landfills.
- Corrective action provisions—control and clean up landfill releases and achieves groundwater protection standards.
- Financial assurance—provides funding for environmental protection during and after landfill closure (i.e., closure and post-closure care).

Some materials may be banned from disposal in MSWLFs, including common household items such as paints, cleaners/chemicals, motor oil, batteries, and pesticides. Leftover portions of these products are called household hazardous waste. These products, if mishandled, can be dangerous to health and the environment. Many municipal landfills have a household hazardous waste drop-off station for these materials.

p. Discuss the personal protective equipment (PPE) requirements for work activities in hazardous areas.

The following is taken from DOE-EM-STD-5503-94.

The purpose of PPE is to shield or isolate individuals from the chemical, physical, radiological, and biological hazards that may be encountered at a hazardous waste site when engineering and other controls are not feasible or cannot provide adequate protection. Careful selection and use of adequate PPE should protect the health of employees.

No single combination of PPE is capable of protecting against all hazards. Therefore, PPE should be used in conjunction with, not in place of, other protective methods, such as engineering controls and safe work practices. A written PPE program should be in place at all hazardous waste sites. The effectiveness of the PPE program should be evaluated regularly. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, impaired vision, reduced mobility, and distorted communication. In general, the higher the level of PPE protection, the greater the risks associated with use of PPE. For any given situation, PPE should be selected to provide an adequate level of protection. Over-protection as well as under-protection can be hazardous and should be avoided.

Personal protective equipment should be used when
- it is not possible and/or feasible to implement engineering controls and work practices that will ensure the safety and health of workers;
- it is necessary to reduce and maintain employee exposure to below the permissible exposure limits, and/or below the threshold limit values established by the American Conference of Governmental Industrial Hygienists; or below the recommended exposure limits published in the National Institute for Occupational Safety and Health publication, *NIOSH Recommendations for Occupational Health Standards*;
- handling radiological materials with removable contamination in excess of levels established in the DOE Radiological Control Manual, or manuals implementing these requirements, or when working in radiologically controlled areas in which PPE requirements have been established; or
existing or potential physical and/or biological hazards pose a threat to worker safety and health.

Required PPE should be discussed with site workers prior to the start of work. Employees should be trained and have passed a baseline medical examination for the use of prescribed PPE. The health and safety plan should implement a written PPE program containing operating procedures.

q. 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 information for this KSA is covered under KSA 28d and will not be repeated here.

r. Discuss the Resource Conservation and Recovery Act underground storage tank regulations (Subtitle I).


Subtitle I was added by Hazardous and Solid Waste Amendments. It established a program to regulate the three to five million underground storage tanks (USTs) in the United States to prevent their leaking. Under this subtitle, RCRA regulates the storage of a product rather than hazardous waste. Hazardous substances regulated under subtitle I include all the hazardous substances defined under CERCLA. Hazardous substances under CERCLA section 101(14) encompass a wide variety of pollutants regulated under other Federal statutes, including the CWA, the CAA, and TSCA. Radionuclides, which are specifically excluded under RCRA’s definition of solid waste, are regulated under CERCLA because they are defined as HAPs under the CAA. Thus, radioactive materials and waste stored in USTs are within the scope of RCRA subtitle I authority. However, within the scope of subtitle I, tanks containing radioactive materials and wastes subject to the AEA requirements are deferred from having to comply with UST regulations. 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.

Federal agencies and departments, including DOE, that own or operate USTs are subject to, and must comply with, all applicable Federal, state, interstate, and local requirements, except when the President determines that exemption of specific tanks from these requirements is in the “paramount” interest of the United States.


The following is taken from DOE/EH-231-013/0394.
The RCRA and the Hazardous Materials Transportation Act (HMTA) regulate the transport of hazardous wastes. Under these statutes, specific pre-transport regulatory requirements must be met by DOE before the shipment of hazardous wastes, including radioactive mixed wastes. The pre-transport requirements are designed to help reduce the risk of loss, leakage, or exposure during shipment of hazardous materials and to communicate information on potential hazards posed by the hazardous material in transport. These goals are accomplished through the tracking of shipments, correctly packaging and labeling containers, and communicating potential hazards. Specific requirements include manifesting, packaging, marking and labeling waste packages; placarding transport vehicles; choosing appropriate waste transporters and shipment destinations; and recordkeeping and reporting. Finally, RCRA Subpart CC standards (e.g., control, visual inspection, and waste transfer requirements) designed to reduce organic air emissions from containers (e.g., tanker trucks) must be met when applicable.

40 CFR 263, “Transportation of Hazardous Waste Requirements,” of RCRA contains regulations governing the transportation of hazardous waste. In developing its regulations, EPA adopted most of the DOT’s HMTA implementing regulations for the safe transportation of hazardous wastes. EPA’s regulations are not completely inclusive; thus, a transporter must ensure that their operations are in compliance with all applicable RCRA and DOT regulations. Anyone who transports a hazardous waste offsite via air, rail, highway, or water is subject to the RCRA transporter requirements, unless their shipment does not require a hazardous waste manifest.

**t. Identify the types of data and records required to be retained as permanent records.**

The following is taken from 40 CFR 262.40.

A generator must keep a copy of each manifest signed in accordance with 40 CFR 262.23, “Use of the Manifest,” for three years or until he or she receives a signed copy from the designated facility which received the waste. This signed copy must be retained as a record for at least three years from the date the waste was accepted by the initial transporter.

A generator must keep a copy of each biennial report and exception report for a period of at least three years from the due date of the report.

A generator must keep records of any test results, waste analyses, or other determinations made in accordance with 40 CFR 262.11, “Hazardous Waste Determination,” for at least three years from the date that the waste was last sent to onsite or offsite treatment, storage, or disposal.

The periods of retention are extended automatically during the course of any unresolved enforcement action regarding the regulated activity or as requested by the administrator.
40. Waste management personnel must demonstrate a working level knowledge of the management of low-level radioactive waste as described in DOE O 435.1, Radioactive Waste Management, and any accompanying office or site-specific implementation plan.

The information for the KSAs in this competency statement is taken from DOE M 435.1-1, chg 1.

a. Define low-level waste.

Low-level radioactive waste is radioactive waste that is not high-level radioactive waste, SNF, TRU waste, byproduct material, or naturally occurring radioactive material.

b. State the requirements for LLW management including mixed low-level, TSCA regulated, accelerator-produced, 11e.(2), and naturally occurring radioactive material waste.

The following provide for management of specific wastes as LLW:

- Mixed LLW. Low-level waste determined to contain source, SNM, or byproduct material subject to the AEA of 1954, as amended, and a hazardous component subject to RCRA, as amended, shall be managed in accordance with the requirements of RCRA and DOE O 435.1, Radioactive Waste Management, and DOE M 435.1-1.
- Toxic Substances Control Act regulated waste. Low-level waste containing PCBs, asbestos, or other such regulated toxic components shall be managed in accordance with requirements derived from the TSCA, as amended, DOE O 435.1, and DOE M 435.1-1.
- Accelerator-produced waste. Radioactive waste produced as a result of operations of DOE accelerators is LLW and shall be managed in accordance with DOE O 435.1, DOE M 435.1-1, and all applicable Federal or state requirements.
- 11e.(2) and naturally occurring radioactive material. Small quantities of 11e.(2) byproduct material and naturally occurring radioactive material may be managed as LLW provided they can be managed to meet the requirements for LLW disposal in section IV.P of DOE M 435.1-1.

c. State the requirements for treatment, storage and disposal facility operations.

Low-Level Waste Treatment and Storage Facility Design

The following facility requirements and general design criteria, at a minimum, apply:

- Confinement. Low-level waste systems and components shall be designed to maintain waste confinement.
- Ventilation. Design of LLW treatment and storage facilities shall include ventilation, if applicable, through an appropriate filtration system to maintain the release of radioactive material in airborne effluents within the requirements and guidelines specified in applicable requirements.

When conditions exist for generating gases in flammable or explosive concentrations, ventilation systems or other measures shall be provided to keep the gases in a non-flammable and non-explosive condition. Where concentrations of explosive or
flammable gases are expected to approach the lower flammability limit, measures shall be taken to prevent deflagration or detonation.

- Consideration of D&D. Areas in new and modifications to existing LLW management facilities that are subject to contamination with radioactive or other hazardous materials shall be designed to facilitate decontamination. For such facilities a proposed decommissioning method or a conversion method leading to reuse shall be described.

- Instrumentation and Control Systems. Engineering controls shall be incorporated in the design and engineering of LLW treatment and storage facilities to provide volume inventory data and to prevent spills, leaks, and overflows from tanks or confinement systems.

- Monitoring. Monitoring and/or leak detection capabilities shall be incorporated in the design and engineering of LLW treatment and storage facilities to provide rapid identification of failed confinement and/or other abnormal conditions.

**Low-Level Waste Disposal Facility Design**

The following facility requirements and general design criteria, at a minimum, apply:

- Confinement. Low-level waste systems and components shall be designed to maintain waste confinement.

- Ventilation. Design of LLW disposal facilities shall include ventilation, if applicable, through an appropriate filtration system to maintain the release of radioactive material in airborne effluents within the requirements and guidelines specified in applicable requirements.

  When conditions exist for generating gases in flammable or explosive concentrations, ventilation systems or other measures shall be provided to keep the gases in a nonflammable and non-explosive condition. Where concentrations of explosive or flammable gases are expected to approach the lower flammability limit, measures shall be taken to prevent deflagration or detonation.

- Stability. Low-level waste disposal facilities shall be designed to achieve long-term stability and to minimize to the extent practical, the need for active maintenance following final closure.

- Control of Water. Low-level waste disposal facilities shall be designed to minimize to the extent practical, the contact of waste with water during and after disposal.

**d. Discuss the complex-wide low-level waste management program.**

The Assistant Secretary for Environmental Management is responsible for establishing and maintaining integrated complex-wide radioactive waste management programs for HLW, TRU, LLW, and mixed LLW. These programs shall use a systematic approach to planning, execution, and evaluation to ensure that waste generation, storage, treatment, and disposal needs are met and coordinated across the DOE complex.
e. **Review and evaluate the specific management controls included in the radioactive waste management basis.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Low-level waste facilities, operations, and activities shall have a radioactive waste management basis consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. The following specific waste management controls shall be part of the radioactive waste management basis:

- Generators. The waste certification program.
- Treatment facilities. The waste acceptance requirements and waste certification program.
- Storage facilities. The waste acceptance requirements and the waste certification program.
- Disposal facilities. The performance assessment, composite analysis, disposal authorization statement, closure plan, waste acceptance requirements, and monitoring plan.

f. **Discuss contingency actions for storage and transfer equipment.**

*Contingency Storage*

For off-normal or emergency situations involving high activity or high hazard liquid LLW storage or treatment, spare capacity with adequate capabilities shall be maintained to receive the largest volume of liquid contained in any one storage tank or treatment facility. Tanks or other facilities that are designated LLW contingency storage shall be maintained in an operational condition when waste is present, and shall meet the requirements of DOE O 435.1 and DOE M 435.1-1, chg 1.

*Transfer Equipment*

Pipelines and auxiliary facilities necessary for the transfer of high activity or high hazard liquid LLW to contingency storage shall be maintained in an operational condition when waste is present, and shall meet the requirements of DOE O 435.1 and DOE M 435.1-1, chg 1.

g. **Discuss waste acceptance requirements for low-level waste.**

Waste acceptance requirements for all LLW 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 LLW 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 LLW or LLW 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 LLW 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°C.

The basis, procedures, and levels of authority required for granting exceptions to the waste acceptance requirements shall be contained in each facility’s waste acceptance documentation. Each exception request shall be documented, including its disposition as approved or not approved.

The receiving facility shall evaluate waste for acceptance, including confirmation that the technical and administrative requirements have been met. A process for the disposition of non-conforming wastes shall be established.

**h. Discuss life cycle planning and waste with no identified path to disposal as it relates to waste generation planning.**

Prior to waste generation, planning shall be performed to address the entire life cycle for all LLW streams.

Low-level waste streams with no identified path to disposal shall be generated only in accordance with approved conditions which, at a minimum, shall address the following:

- The programmatic need to generate the waste
- Characteristics and issues preventing the disposal of the waste
- Safe storage of the waste until disposal can be achieved
- Activities and plans for achieving final disposal of the waste
i. Discuss the minimum relevant information for characterizing low-level waste.

Low-level waste shall be characterized using direct or indirect methods, and the characterization shall be 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
- Any other information which may be needed to prepare and maintain the disposal facility performance assessment, or to demonstrate compliance with applicable performance objectives

j. Discuss the waste certification program for low-level waste.

A waste certification program shall be developed, documented, and implemented to ensure that the waste acceptance requirements of facilities receiving LLW for storage, treatment, and disposal are met.

Certification Program
The waste certification program shall designate the officials who have the authority to certify and release waste for shipment, and shall specify what documentation is required for waste generation, characterization, shipment, and certification. The program shall provide requirements for auditability, retrievability, and storage of required documentation, and shall specify the records retention period.

Certification before Transfer
Low-level waste shall be certified as meeting waste acceptance requirements before it is transferred to the facility receiving the waste.

Maintaining Certification
Low-level waste that has been certified as meeting the waste acceptance requirements for transfer to a storage, treatment, or disposal facility shall be managed in a manner that maintains its certification status.

k. Discuss the packaging and transportation requirements for low-level waste.

Packaging
If containers are used, the following requirements apply:
Low-level waste shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste has been removed from the container.

When waste is packaged, vents or other measures shall be provided if the potential exists for pressurizing or generating flammable or explosive concentrations of gases within the waste container.

Containers of LLW shall be marked such that their contents can be identified.

**Transportation**

To the extent practical, the volume of waste and number of LLW shipments shall be minimized.

l. **Discuss storage prohibitions for low-level waste.**

Low-level waste in storage shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water. Prior to storage, pyrophoric materials shall be treated, prepared, and packaged to be nonflammable.

m. **Evaluate the attainment of the performance objectives for disposal of low-level waste.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

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:

- A 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.
- A 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.
- A release of radon shall be less than an average flux of 20 pCi/m²/s (0.74 Bq/m²/s) at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/l (0.0185 Bq/l) of air may be applied at the boundary of the facility.

n. **Review and evaluate a performance assessment.**

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

o. **Review and evaluate a composite analysis.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion.
p. Discuss the maintenance requirements for performance assessments and composite analyses.

The performance assessment and composite analysis shall be maintained to evaluate changes that could affect the performance, design, and operating bases for the facility. Performance assessment and composite analysis maintenance shall include the conduct of research, field studies, and monitoring needed to address uncertainties or gaps in existing data. The performance assessment shall be updated to support the final facility closure. Additional iterations of the performance assessment and composite analysis shall be conducted as necessary during the post-closure period.

- Performance assessments and composite analyses shall be reviewed and revised when changes in waste forms or containers, radionuclide inventories, facility design and operations, closure concepts, or the improved understanding of the performance of the waste disposal facility in combination with the features of the site on which it is located alter the conclusions or the conceptual model(s) of the existing performance assessment or composite analysis.
- A determination of the continued adequacy of the performance assessment and composite analysis shall be made on an annual basis, and shall consider the results of data collection and analysis from research, field studies, and monitoring.
- Annual summaries of LLW disposal operations shall be prepared with respect to the conclusions and recommendations of the performance assessment and composite analysis and a determination of the need to revise the performance assessment or composite analysis.

q. Discuss the closure plan requirements for disposal facility operations.

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
- include the total expected inventory of wastes to be disposed of at the facility over the operational life of the facility

r. Discuss the monitoring requirements for low-level waste facilities.

*All Waste Facilities*

Parameters that shall be sampled or monitored, at a minimum, include: temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, and flammable or explosive mixtures of gases. Facility monitoring programs shall include verification that passive and active control systems have not failed.
**Liquid Waste Storage Facilities**

For facilities storing liquid LLW the following shall also be monitored: liquid level and/or waste volume, and significant waste chemistry parameters.

**Disposal Facilities**

A preliminary monitoring plan for an LLW disposal facility shall be prepared and submitted to headquarters for review with the performance assessment and composite analysis. The monitoring plan shall be updated within one year following issuance of the disposal authorization statement to incorporate and implement conditions specified in the disposal authorization statement.

- The site-specific performance assessment and composite analysis shall be used to determine the media, locations, radionuclides, and other substances to be monitored.
- The environmental monitoring program shall be designed to include measuring and evaluating releases, migration of radionuclides, disposal unit subsidence, and changes in disposal facility and disposal site parameters which may affect long-term performance.
- The environmental monitoring programs shall be capable of detecting changing trends in performance to allow application of any necessary corrective action prior to exceeding the performance objectives in this chapter.

s. Identify the types of data and records required to be retained as permanent records.

Radioactive waste management facilities, operations, and activities shall develop and maintain a record-keeping system, as required by DOE O 200.1A, and DOE O 414.1C. Records shall be established and maintained for radioactive waste generated, treated, stored, transported, or disposed. To the extent possible, records prepared in response to other requirements may be used to satisfy the documentation requirements of DOE M 435.1-1. Additional records may be required to satisfy the regulations applicable to the hazardous waste components of mixed waste.

**41. Waste management personnel must demonstrate a working level knowledge of the management of transuranic waste as described in DOE O 435.1, Radioactive Waste Management, and any accompanying office or site specific implementation plan.**

The information for the KSAs in this competency statement is taken from DOE M 435.1-1, chg 1.

a. Define the term “transuranic waste” (TRU) including the requirements for classification of transuranic waste and the lower concentration limit below which transuranic waste may be considered low-level waste.

Transuranic waste is radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years, except for the following:
- High-level radioactive waste
Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, 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.

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”

b. Evaluate and determine the requirements for management of transuranic, mixed transuranic and TSCA-regulated waste.

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

c. Review and evaluate the site radioactive waste management basis.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Transuranic waste facilities, operations, and activities shall have a radioactive waste management basis consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. The following specific waste management controls shall be part of the radioactive waste management basis:

- For generators, the waste certification program
- For treatment facilities, the waste acceptance requirements and the waste certification program
- For storage facilities, the waste acceptance requirements and the waste certification program
- For disposal facilities, the performance assessment, composite analysis, the disposal authorization statement, the closure plan, waste acceptance requirements, and the monitoring plan

d. Evaluate and determine the waste acceptance requirements for all transuranic waste storage, treatment, or disposal facilities.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Technical and Administrative Requirements

Waste acceptance requirements for all TRU waste storage, treatment, or disposal facilities, operations, and activities shall, at a minimum, specify 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 requirement to identify TRU waste as defense or non-defense, and limitations on acceptance.
- 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.

**Evaluation and Acceptance**

The receiving facility shall evaluate waste for acceptance, including confirmation that technical and administrative requirements have been met. A process for the disposition of nonconforming wastes shall be established.

e. **Discuss life-cycle planning and waste with no identified path to disposal as it relates to waste generation planning.**

**Life Cycle Planning**

Prior to waste generation, planning shall be performed to address the entire life cycle for all TRU waste streams.

**Waste with No Identified Path to Disposal**

Transuranic waste streams with no identified path to disposal shall be generated only in accordance with approved conditions which, at a minimum, shall address the following:

- The programmatic need to generate the waste
- Characteristics and issues preventing the disposal of the waste
- Safe storage of the waste until disposal can be achieved
- Activities and plans for achieving final disposal of the waste

f. **Evaluate and determine the minimum relevant information for characterizing transuranic waste.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Transuranic waste shall be characterized using direct or indirect methods, and the characterization shall be 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
- Packaging date
- Any other information which may be needed to prepare and maintain the disposal facility performance assessment, or to demonstrate compliance with applicable performance objectives

g. Discuss the waste certification program for transuranic waste.

A waste certification program shall be developed, documented, and implemented to ensure that the waste acceptance requirements of facilities receiving TRU waste for storage, treatment, or disposal are met.

Certification Program
The waste certification program shall designate the officials who have the authority to certify and release waste for shipment, and shall specify what documentation is required for waste generation, characterization, shipment, and certification. The program shall provide requirements for auditability, retrievability, and storage of required documentation, and shall specify the records retention period.

Certification before Transfer
Transuranic waste shall be certified as meeting waste acceptance requirements before it is transferred to the facility receiving the waste.

Maintaining Certification
Transuranic waste that has been certified as meeting the waste acceptance requirements for transfer to a storage, treatment, or disposal facility shall be managed in a manner that maintains its certification status.

h. Discuss the packaging and transportation requirements for transuranic waste.

Packaging
- Transuranic waste shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until disposal is achieved or until the waste is removed from the container.
- Vents or other mechanisms to prevent pressurization of containers or generation of flammable or explosive concentrations of gases shall be installed on containers of newly-generated waste at the time the waste is packaged. Containers of currently stored waste shall meet this requirement as soon as practical unless analyses demonstrate that the waste can otherwise be managed safely.
- When TRU waste is packaged, defense waste shall be packaged separately from non-defense waste, if feasible.
- Containers of TRU waste shall be marked such that their contents can be identified.

Transportation
To the extent practical, the volume of waste and number of TRU waste shipments shall be minimized.
i. **Evaluate and determine the storage prohibitions for transuranic waste.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

DOE shall ensure that all radioactive waste is stored in a manner that protects the public, workers, and the environment in accordance with a radioactive waste management basis, and that the integrity of waste storage is maintained for the expected time of storage and does not compromise meeting the disposal performance objectives for protection of the public and environment when the waste is disposed.

In meeting these objectives, TRU waste in storage shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water. Prior to storage, pyrophoric materials shall be treated, prepared, and packaged to be nonflammable.

j. **Evaluate and determine the monitoring requirements for transuranic waste facilities.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

For all TRU waste facilities, parameters that shall be sampled or monitored, at a minimum, include: temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, and flammable or explosive mixtures of gases. Facility monitoring programs shall include verification that passive and active control systems have not failed.

All TRU wastes in storage shall be monitored, as prescribed by the appropriate facility safety analysis, to ensure the wastes are maintained in safe condition.

*Liquid Waste Storage Facilities*

For facilities storing liquid TRU waste, the following shall also be monitored: liquid level and/or waste volume, and significant waste chemistry parameters.

k. **Identify the types of data and records required to be retained as permanent records.**

Radioactive waste management facilities, operations, and activities shall develop and maintain a record-keeping system, as required by DOE O 200.1A, and DOE O 414.1C. Records shall be established and maintained for radioactive waste generated, treated, stored, transported, or disposed. To the extent possible, records prepared in response to other requirements may be used to satisfy the documentation requirements of DOE M 435.1-1. Additional records may be required to satisfy the regulations applicable to the hazardous waste components of mixed waste.
42. Waste management personnel must demonstrate a working level knowledge of the management of high-level waste and/or other materials which, because of their highly radioactive nature, require similar handling as described in DOE O 435.1, Radioactive Waste Management, and any accompanying office or site specific implementation plan.

The information for the KSAs in this competency statement is taken from DOE M 435.1-1.

a. Define the term “high-level waste,” and list potential sources of high-level waste from operations within the complex.

High-level waste is the highly radioactive waste material resulting from the reprocessing of SNF, 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.

b. Define “waste incidental to reprocessing” and explain how it is managed.

Waste resulting from reprocessing SNF that is determined to be incidental to reprocessing is not HLW, and shall be managed under DOE’s regulatory authority in accordance with the requirements for TRU waste or LLW, as appropriate. When determining whether SNF reprocessing plant wastes shall be managed as another waste type or as HLW, either the citation process or the evaluation process, described below, shall be used.

Citation
Waste incidental to reprocessing by citation includes SNF reprocessing plant wastes that meet the description included in the notice of proposed rulemaking for proposed appendix D, 10 CFR 50, “Domestic Licensing of Production and Utilization Facilities,” paragraphs 6 and 7. These radioactive wastes are the result of reprocessing plant operations, such as, but not limited to, contaminated job wastes including laboratory items such as clothing, tools, and equipment.

Evaluation
Determinations that any waste is incidental to reprocessing by the evaluation process shall be developed under good record-keeping practices, with an adequate QA process, and shall be documented to support the determinations. Such wastes may include, but are not limited to, SNF reprocessing plant wastes that

- will be managed as LLW and
  - have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical;
  - will be managed to meet safety requirements comparable to the performance objectives set out in 10 CFR 61, subpart C, “Performance Objectives;”
  - are to be managed, pursuant to DOE’s authority under the AEA of 1954, as amended, and in accordance with the provisions of chapter IV of DOE M 435.1-1, provided the waste will be incorporated in a solid physical form at a
concentration that does not exceed the applicable concentration limits for class C LLW as set out in 10 CFR 61.55, “Waste Classification,” or will meet alternative requirements for waste classification and characterization as DOE may authorize.

- will be managed as TRU waste and
  - have been processed, or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical;
  - will be incorporated in a solid physical form and meet alternative requirements for waste classification and characteristics, as DOE may authorize;
  - are managed pursuant to DOE’s authority under the AEA of 1954, as amended, in accordance with the provisions of chapter III of DOE M 435.1-1, as appropriate.

c. Evaluate and determine the requirements for treatment, storage, and disposal facility operations.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Waste acceptance requirements for all HLW storage, pretreatment, or treatment facilities, operations, and activities shall specify, at a minimum, the following:

- Allowable activities and/or concentrations of specific radionuclides.
- Acceptable waste form that ensures the chemical and physical stability of the waste under conditions that might be encountered during transfer, storage, pretreatment, or treatment.
- 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.
- Pretreatment, treatment, storage, packaging, and other operations shall be designed and implemented in a manner that will ultimately comply with DOE/EM-0093, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*, or DOE/RW-0351P, *Waste Acceptance System Requirements Document*, for non-vitrified, immobilized HLW.

d. Evaluate and determine the requirements for management of high-level waste including mixed high-level and TSCA-regulated waste.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

*Mixed High-Level Waste*

Unless demonstrated otherwise, all HLW shall be considered mixed waste and is subject to the requirements of the AEA of 1954, as amended, RCRA, as amended, DOE O 435.1, and DOE M 435.1-1.
TSCA-Regulated Waste

High-level waste containing PCBs, asbestos, or other such regulated toxic components shall be managed in accordance with requirements derived from the TSCA, as amended, DOE O 435.1 and DOE M 435.1-1.

e. Review and evaluate the site radioactive waste management basis.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

High-level waste facilities, operations, and activities shall have a radioactive waste management basis consisting of physical and administrative controls to ensure the protection of workers, the public, and the environment. The following specific waste management controls shall be part of the radioactive waste management basis:

- For generators, the waste certification program
- For treatment facilities, the waste acceptance requirements and the waste certification program
- For storage facilities, the waste acceptance requirements and the waste certification program
- For disposal facilities, the performance assessment, composite analysis, the disposal authorization statement, the closure plan, waste acceptance requirements, and the monitoring plan

f. Evaluate and determine the contingency actions for storage and transfer equipment.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Storage

For off-normal or emergency situations involving HLW storage or treatment, spare capacity with adequate capabilities shall be maintained to receive the largest volume of waste contained in any one storage vessel, pretreatment facility, or treatment facility. Tanks or other facilities that are designated for HLW contingency storage shall be maintained in an operational condition when waste is present and shall meet all the requirements of DOE O 435.1 and DOE M 435.1-1.

Transfer Equipment

Pipelines and auxiliary facilities necessary for the transfer of waste to contingency storage shall be maintained in an operational condition when waste is present and shall meet the requirements of DOE O 435.1, and DOE M 435.1-1.

g. Identify when operations must be curtailed.

DOE facility management is responsible for ensuring a process exists for proposing, reviewing, approving, and implementing corrective actions when necessary to ensure that the
requirements of DOE O 435.1 and DOE M 435.1-1 are met, and to address conditions that are not protective of the public, workers, or the environment. The process shall allow workers, through the appropriate level of management, to stop or curtail work when they discover conditions that pose an imminent danger or other serious hazard to workers or the public or that are not protective of the environment.

Operations shall be curtailed or facilities shut down for failure to establish, maintain, or operate consistent with an approved radioactive waste management basis.

h. **Evaluate and determine the minimum waste acceptance requirements for all high-level waste storage, pretreatment, or treatment facilities, operations, and activities.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

*Technical and Administrative Requirements*

Waste acceptance requirements for all HLW storage, pretreatment, or treatment facilities, operations, and activities shall specify, at a minimum, the following:

- Allowable activities and/or concentrations of specific radionuclides
- An acceptable waste form that ensures the chemical and physical stability of the waste under conditions that might be encountered during transfer, storage, pretreatment, or treatment
- 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)
- Design and implementation requirements for pretreatment, treatment, storage, packaging, and other operations that will ultimately comply with DOE/EM-0093, or DOE/RW-0351P, for non-vitrified, immobilized high-level waste

*Evaluation and Acceptance*

The receiving facility shall evaluate waste for acceptance, including confirmation that the technical and administrative requirements have been met. A process for the disposition of nonconforming wastes shall be established.

i. **Discuss in the waste generation planning, life-cycle planning and waste with no identified path to disposal.**

Planning, acquisition, operation, maintenance, and disposition of radioactive waste management facilities shall be in accordance with DOE O 430.1B, and DOE O 433.1, and shall include a configuration management process to ensure the integrity of physical assets and systems. Corporate physical asset databases shall be maintained as complete, current inventories of physical assets and systems to allow reliable analysis of existing and potential hazards to the public and workers.
Prior to waste generation, planning shall be performed to address the entire life cycle for all HLW streams.

High-level waste streams with no identified path to disposal shall be generated only in accordance with approved conditions which, at a minimum, shall address the following:

- The programmatic need to generate the waste
- Characteristics and issues preventing the disposal of the waste
- Safe storage of the waste until disposal can be achieved
- Activities and plans for achieving final disposal of the waste

j. **Discuss the waste certification program.**

A waste certification program shall be developed, documented, and implemented to ensure that the waste acceptance requirements of facilities receiving HLW for storage, pretreatment, treatment, and disposal are met.

**Certification Program**

The waste certification program shall designate the officials who have the authority to certify and release waste for shipment, and shall specify what documentation is required for waste generation, characterization, shipment, and certification. The program shall provide requirements for auditability, retrievability, and storage of required documentation, and shall specify the records retention period.

**Certification before Transfer**

High-level waste shall be certified as meeting the waste acceptance requirements before it is transferred to the facility receiving the waste.

**Maintaining Certification**

High-level waste that has been certified as meeting the waste acceptance requirements for transfer to a storage, pretreatment, treatment, or disposal facility shall be managed in a manner that maintains its certification status.

k. **Review and evaluate the structural integrity program for tanks.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

A structural integrity program shall be developed for each HLW storage tank site to verify the structural integrity and service life of each tank to meet operational requirements for storage capacity. The program shall be capable of the following:

- Verifying the current leak-tightness and structural strength of each tank in service
- Identifying corrosion, fatigue, and other critical degradation modes
- Adjusting the chemistry of tank waste, calibrating cathodic protection systems, wherever employed, and implementing other necessary corrosion protection measures
- Providing credible projections as to when structural integrity of each tank can no longer be ensured
- Identifying the additional controls necessary to maintain an acceptable operating envelope

I. **Evaluate and determine the areas to be monitored for high-level waste pretreatment, treatment, storage, and transportation facilities.**

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

High-level waste pretreatment, treatment, storage, and transportation facilities shall be monitored for chemical, physical, radiological, structural, and other changes that could indicate failure of system confinement, integrity, or safety, and which could lead to abnormal events or accidents. Parameters that shall be sampled or monitored, at a minimum, include: temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, flammable or explosive mixtures of gases, level and/or waste volume, and significant waste chemistry parameters for non-immobilized HLW. Facility monitoring programs shall also include physical inspections to verify that control systems have not failed.

m. **Identify the types of data and records required to be retained as permanent records.**

Radioactive waste management facilities, operations, and activities shall develop and maintain a record-keeping system, as required by DOE O 200.1 and DOE O 414.1C. Records shall be established and maintained for radioactive waste generated, treated, stored, transported, or disposed. To the extent possible, records prepared in response to other requirements may be used to satisfy the documentation requirements of DOE M 435.1-1. Additional records may be required to satisfy the regulations applicable to the hazardous waste components of mixed waste.

43. **Waste management personnel must demonstrate a working level knowledge of the packaging and transportation of waste as described in DOE O 460.1A, Packaging and Transportation Safety, and DOE O 460.2, Departmental Materials Transportation and Package Management.**

[Note: DOE O 460.1A has been superseded by DOE O 460.1C.]

a. Discuss the requirements of the Hazardous Materials Transportation Act as they relate to the packaging and transportation of waste.

The following is taken from 49 CFR 171.1.

The HMTA directs the Secretary of Transportation to establish regulations for the safe and secure transportation of hazardous materials in commerce, as the Secretary considers appropriate. The Secretary is authorized to apply these regulations to persons who transport hazardous materials in commerce. In addition, the law authorizes the Secretary to apply these regulations to persons who cause hazardous materials to be transported in commerce. The
law also authorizes the Secretary to apply these regulations to persons who manufacture or maintain a packaging or a component of a packaging that is represented, marked, certified, or sold as qualified for use in the transportation of a hazardous material in commerce. Federal hazardous material transportation law also applies to anyone who indicates by marking or other means that a hazardous material being transported in commerce is present in a package or transport conveyance when it is not, and to anyone who tampers with a package or transport conveyance used to transport hazardous materials in commerce or a required marking, label, placard, or shipping description.

Regulations prescribed in accordance with Federal hazardous materials transportation law shall govern safety aspects, including security, of the transportation of hazardous materials that the Secretary considers appropriate. In 49 CFR 1.53, “Delegations to the Administrator of the Pipeline and Hazardous Materials Safety Administration,” the Secretary delegated authority to issue regulations for the safe and secure transportation of hazardous materials in commerce to the Pipeline and Hazardous Materials Safety Administrator. The Administrator issues the HMR under that delegated authority.

Packagings
Requirements in the HMR apply to each person who manufactures, fabricates, marks, maintains, reconditions, repairs, or tests a packaging or a component of a packaging that is represented, marked, certified, or sold as qualified for use in the transportation of a hazardous material in commerce, including each person under contract with any department, agency, or instrumentality of the executive, legislative, or judicial branch of the Federal government who manufactures, fabricates, marks, maintains, reconditions, repairs, or tests a packaging or a component of a packaging that is represented, marked, certified, or sold as qualified for use in the transportation of a hazardous material in commerce.

Pre-Transportation Functions. Requirements in the HMR apply to each person who offers a hazardous material for transportation in commerce, causes a hazardous material to be transported in commerce, or transports a hazardous material in commerce and who performs or is responsible for performing a pre-transportation function, including each person performing pre-transportation functions under contract with any department, agency, or instrumentality of the executive, legislative, or judicial branch of the Federal government. Pre-transportation functions include, but are not limited to, the following:

- Determining the hazard class of a hazardous material
- Selecting a hazardous materials packaging
- Filling a hazardous materials packaging, including a bulk packaging
- Securing a closure on a filled or partially filled hazardous materials package or container or on a package or container containing a residue of a hazardous material
- Marking a package to indicate that it contains a hazardous material
- Labeling a package to indicate that it contains a hazardous material
- Preparing a shipping paper
- Providing and maintaining emergency response information
- Reviewing a shipping paper to verify compliance with the HMR or international equivalents
For each person importing a hazardous material into the United States, providing the shipper with timely and complete information as to the HMR requirements that will apply to the transportation of the material within the United States

- Certifying that a hazardous material is in proper condition for transportation in conformance with the requirements of the HMR
- Loading, blocking, and bracing a hazardous materials package in a freight container or transport vehicle
- Segregating a hazardous materials package in a freight container or transport vehicle from incompatible cargo
- Selecting, providing, or affixing placards for a freight container or transport vehicle to indicate that it contains a hazardous material

Transportation Functions. Requirements in the HMR apply to transportation of a hazardous material in commerce and to each person who transports a hazardous material in commerce, including each person under contract with any department, agency, or instrumentality of the executive, legislative, or judicial branch of the Federal government who transports a hazardous material in commerce. Transportation of a hazardous material in commerce begins when a carrier takes physical possession of the hazardous material for the purpose of transporting it and continues until the package containing the hazardous material is delivered to the destination indicated on a shipping document, package marking, or other medium, or, in the case of a rail car, until the car is delivered to a private track or siding. For a private motor carrier, transportation of a hazardous material in commerce begins when a motor vehicle driver takes possession of a hazardous material for the purpose of transporting it and continues until the driver relinquishes possession of the package containing the hazardous material at its destination and is no longer responsible for performing functions subject to the HMR with respect to that particular package.

Transportation of a hazardous material in commerce includes the following:

- Movement. Movement of a hazardous material by rail car, aircraft, motor vehicle, or vessel (except as delegated by Department of Homeland Security Delegation No. 0170 at 2[103]).
- Loading Incidental to Movement of a Hazardous Material. Loading of packaged or containerized hazardous material onto a transport vehicle, aircraft, or vessel for the purpose of transporting it, including blocking and bracing a hazardous materials package in a freight container or transport vehicle, and segregating a hazardous materials package in a freight container or transport vehicle from incompatible cargo, when performed by carrier personnel or in the presence of carrier personnel. For a bulk packaging, filling the packaging with a hazardous material for the purpose of transporting it when performed by carrier personnel or in the presence of carrier personnel (except as delegated by Department of Homeland Security Delegation No. 0170 at 2[103]), including transloading.
- Unloading Incidental to Movement of a Hazardous Material. Removing a package or containerized hazardous material from a transport vehicle, aircraft, or vessel; or for a bulk packaging, emptying a hazardous material from the bulk packaging after the hazardous material has been delivered to the consignee when performed by carrier personnel.
personnel or in the presence of carrier personnel or, in the case of a private motor carrier, while the driver of the motor vehicle from which the hazardous material is being unloaded immediately after movement is completed is present during the unloading operation. (Emptying a hazardous material from a bulk packaging while the packaging is on board a vessel is subject to separate regulations as delegated by Department of Homeland Security Delegation No. 0170 at 2[103].)

- **Storage Incidental to Movement of a Hazardous Material.** Storage of a transport vehicle, freight container, or package containing a hazardous material by any person between the time that a carrier takes physical possession of the hazardous material for the purpose of transporting it until the package containing the hazardous material has been delivered to the destination indicated on a shipping document, package marking, or other medium, or, in the case of a private motor carrier, between the time that a motor vehicle driver takes physical possession of the hazardous material for the purpose of transporting it until the driver relinquishes possession of the package at its destination and is no longer responsible for performing functions subject to the HMR with respect to that particular package.

**b. Describe the requirements for selecting shipping containers.**

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

Packaging selection depends on the DOT material classification and the chemical and physical characteristics of the material. Packaging requirements may also be specified by statute. The Waste Isolation Pilot Plant Land Withdrawal Act (WIPP) and the Nuclear Waste Policy Act (NWPA) contain packaging certification requirements for WIPP and SNF/HLW repository shipments, respectively. The cognizant DOE organization is responsible for identifying the proper packaging and taking steps to ensure that the packagings are available when needed for shipment. For type B packagings, the appropriate certificate of compliance must be checked to ensure that it is current and that the proposed contents have been approved. Packaging selection is performed by the shipper’s or contractor’s technical staff that has been properly trained on DOT, NRC and/or international packaging regulations.

For repository shipments of SNF and HLW, section 180(a) of the NWPA requires that the Office of Civilian Radioactive Waste Management only use packages that have been certified by the NRC for such purposes.
c. Discuss the labeling, placarding, and shipping requirements specified in the requirements of 49 CFR (Placarding, Labeling, and Shipping).

The following is taken from DOE/EH-231-031-0793.

Labeling
Before transporting hazardous waste containers offsite, they must be labeled in accordance with the applicable DOT HMR requirements. The labeling requirements are set forth in subpart E of 49 CFR 172. The term “label” as used in the HMR refers to a prescribed hazard warning notice. Labels are applied to the outside of containers to identify the primary and subsidiary hazards specific to the contents. While the HMR include detailed and specific labeling standards for each type of hazardous material and for many kinds of containers and packages, the following requirements are generally applicable to all labels:

- When two or more labels are required, they must be displayed next to each other.
- Labels must be on a background of contrasting color or have a dotted or solid line outer border.
- Labels may not be obscured by markings or attachments.
- Labels must be durable, weather resistant, and able to withstand for 30 days deterioration or change from exposure to conditions incident to transportation.
- Labels must be at least 3.9 inches on each side.
- A label may be printed on or affixed to a tag or by other suitable means when the package contains no radioactive material and the label is larger than the package; or the package surface is such that a label cannot be affixed; or when the package is a cylinder.

Placarding
Before offsite transport, each bulk package, freight container, transport vehicle, or rail car used to transport hazardous waste containers must be placarded in accordance with the applicable DOT HMR requirements. The placarding requirements are set forth in subpart F of 49 CFR 172, “Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.” There are two placarding tables in 49 CFR 172.504, “General Placarding Requirements.” When determining which placards must be used and what options are available, both placarding tables must be considered. It is important to keep the two placarding tables separate when determining placarding requirements. Placards are placed to alert the public of the potential emergency responders in the event of an incident or accidental release. Placards must be displayed on each end and each side of a bulk packaging, freight container, unit load device, transport vehicle, and rail car containing any quantity of a hazardous waste unless the HMR says otherwise. Placards may be made of any plastic, metal, or other material capable of withstanding, without deterioration or a substantial reduction in effectiveness, a 30-day exposure to open weather conditions. In addition, 49 CFR 172.516, “Visibility and Display of Placards,” requires that placards

- be securely attached or affixed
- be located clear of appurtenances and devices
- be located away from any marking that could substantially reduce its effectiveness
be maintained in a condition so that format, legibility, color, and visibility will not be substantially reduced due to damage, deterioration, or obscuration by dirt or other matter
• be affixed to a background of contrasting color, or have a dotted- or solid-line outer border which contrasts with the background color
• have the words or ID number (when authorized) displayed horizontally, reading from left to right

Shipping
The following is derived from DOE/EH-231-031-0793.

Before transporting (shipping) hazardous waste containers offsite, they must be labeled in accordance with 40 CFR 262.31, marked in accordance with 40 CFR 262.32(a), and placarded in accordance with 40 CFR 262.33. The labeling and placarding requirements are discussed above in this KSA; the marking requirements are discussed below.

The following is taken from DOE/EH-231-031-0793.

Marking
Before transporting hazardous waste containers offsite, they must be marked in accordance with the applicable DOT HMR requirements. The marking requirements are set forth in Subpart D of 49 CFR Part 172. The term “marking” as used in the HMR refers to the required information on the outside of a hazardous waste container. This includes a proper shipping name, identification number, specifications, plus any required information, instructions and/or cautions. The HMR also include the following marking requirements in 49 CFR 172.304(a):

• All markings must be durable, in English, and printed on or affixed to the surface of the container or on an attached label, tag or sign.
• Markings must be displayed on a background of sharply contrasting color.
• Markings must be unobscured by labels or attachments.
• Markings must be located away from any other markings that could substantially reduce their effectiveness.

In addition, hazardous waste containers of 110 gallons or less must be marked in accordance with the requirements of 49 CFR 172.304 [40 CFR 262.32(b)].

The proper shipping name marked on a container of hazardous waste is not required to include the word “waste” if the container bears the hazardous waste marking noted in 49 CFR 172.304 [49 CFR 172.301(a)(2)].

44. Waste management personnel must demonstrate the ability to appraise the contractor’s program(s) and/or permits to assess compliance with the requirements for waste management.

All of the KSAs in this competency statement are performance-based. The Qualifying Official will evaluate their completion.
a. Assess the contractor's plans and procedures for low-level, transuranic, mixed, and high level waste to ensure compliance with the DOE O 435.1.

b. Given a proposed permit application for mixed waste, evaluate it for compliance with the Resource Conservation and Recovery Act requirements.

c. Assess the contractor's plans and procedures for waste generation to ensure compliance with DOE O 435.1.


The following is taken from Environment, Health and Safety Online, PSM: OSHA Process Safety Guidance and Information.

The OSHA Rule for Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119), hereafter referred to as the PSM Rule, is intended to prevent or minimize the consequences of a catastrophic release of toxic, reactive, flammable, or explosive highly hazardous chemicals (HHCs) from a process. A process is any activity or combination of activities, including any use, storage, manufacturing, handling, or onsite movement of HHCs. A process includes any group of vessels that are interconnected, and separate vessels that are located such that an HHC could be involved in a potential release. The PSM Rule intends to accomplish its goal by requiring a comprehensive management program integrating technologies, procedures, and management practices.

Applicability
The standard applies to a process which contains a threshold quantity or greater amount of a toxic or reactive HHC as specified in appendix A to the PSM Rule. Also, it applies to 10,000 pounds or greater amounts of flammable liquids and gases, and to the process activity of manufacturing explosives and pyrotechnics.

Exceptions
The standard does not apply to retail facilities, normally unoccupied remote facilities, and oil or gas well drilling or servicing activities. Hydrocarbon fuels used solely for workplace consumption as a fuel are not covered if such fuels are not part of a process containing another HHC covered by the standard. Atmospheric tank storage and associated transfer of flammable liquids which are kept below their normal boiling point without benefit of chilling or refrigeration are not covered by the PSM standard unless the atmospheric tank is connected to a process or is sited in proximity to a covered process such that an incident in a covered process could involve the atmospheric tank.

b. As contained in 29 CFR 1910.119, describe the role departmental waste management personnel play in

- the development and review of a contractor's operating procedures
- the evaluation of a contractor's training program
compliance audit requirements

The following is taken from 29 CFR 1910.119.

The Development and Review of a Contractor’s Operating Procedures

Employer Responsibilities

- The employer, when selecting a contractor, shall obtain and evaluate information regarding the contract employer’s safety performance and programs.
- The employer shall inform contract employers of the known potential fire, explosion, or toxic release hazards related to the contractor’s work and the process.
- The employer shall explain to contract employers the applicable provisions of the emergency action plan.
- The employer shall develop and implement safe work practices consistent with this section, to control the entrance, presence and exit of contract employers and contract employees in covered process areas.
- The employer shall periodically evaluate the performance of contract employers in fulfilling their obligations as specified below.
  - Contractor work methods and experiences should be evaluated. For example, does the contractor conducting demolition work swing loads over operating processes or does the contractor avoid such hazards?
  - The contract employer shall ensure that each contract employee follows the safety rules of the facility including the safe work practices required by this section.
  - The contract employer shall advise the employer of any unique hazards presented by the contract employer’s work, or of any hazards found by the contract employer’s work.
- The employer shall maintain a contract employee injury and illness log related to the contract’s work in process areas.

The Evaluation of a Contractor’s Training Program

The employer shall periodically evaluate the performance of contract employers in fulfilling their obligations as specified below:

- The contract employer shall ensure that each contract employee is trained in the work practices necessary to safely perform his/her job.
- The contract employer shall ensure that each contract employee is instructed in the known potential fire, explosion, or toxic release hazards related to his/her job and the process, and the applicable provisions of the emergency action plan.
- The contract employer shall document that each contract employee has received and understood the training required by this paragraph. The contract employer shall prepare a record which contains the identity of the contract employee, the date of training, and the means used to verify that the employee understood the training.

Compliance Audit Requirements

Employers need to select a trained individual or assemble a trained team of people to audit the PSM system and program. A small process or plant may need only one knowledgeable person to conduct an audit. The audit is to include an evaluation of the design and
effectiveness of the PSM system and a field inspection of the safety and health conditions and practices to verify that the employer’s systems are effectively implemented. The audit should be conducted or led by a person knowledgeable in audit techniques and who is impartial towards the facility or area being audited. The essential elements of an audit program include planning, staffing, conducting the audit, evaluation and corrective action, follow-up and documentation.

Planning in advance is essential to the success of the auditing process. Each employer needs to establish the format, staffing, scheduling and verification methods prior to conducting the audit. The format should be designed to provide the lead auditor with a procedure or checklist that details the requirements of each section of the standard. The names of the audit team members should be listed as part of the format as well. The checklist, if properly designed, could serve as the verification sheet that provides the auditor with the necessary information to expedite the review and ensure that no requirements of the standard are omitted. This verification sheet format could also identify those elements that will require evaluation or a response to correct deficiencies. This sheet could also be used for developing the follow-up and documentation requirements.

The selection of effective audit team members is critical to the success of the program. Team members should be chosen for their experience, knowledge, and training and should be familiar with the processes and with auditing techniques, practices and procedures. The size of the team will vary depending on the size and complexity of the process under consideration. For a large, complex, highly instrumented plant, it may be desirable to have team members with expertise in process engineering and design, process chemistry, instrumentation and computer controls, electrical hazards and classifications, safety and health disciplines, maintenance, emergency preparedness, warehousing or shipping, and process safety auditing. The team may use part-time members to provide for the depth of expertise required as well as for what is actually done or followed, compared to what is written.

An effective audit includes a review of the relevant documentation and process safety information, inspection of the physical facilities, and interviews with all levels of plant personnel. Utilizing the audit procedure and checklist developed in the preplanning stage, the audit team can systematically analyze compliance with the provisions of the standard and any other corporate policies that are relevant. For example, the audit team will review all aspects of the training program as part of the overall audit. The team will review the written training program for adequacy of content, frequency of training, effectiveness of training in terms of its goals and objectives as well as to how it fits into meeting the standard’s requirements, documentation, etc.

Through interviews, the team can determine the employee’s knowledge and awareness of the safety procedures, duties, rules, emergency response assignments, etc. During the inspection, the team can observe actual practices such as safety and health policies, procedures, and work authorization practices. This approach enables the team to identify deficiencies and determine where corrective actions or improvements are necessary. An audit is a technique used to gather sufficient facts and information, including statistical information, to verify
compliance with standards. Auditors should select, as part of their preplanning, a sample size sufficient to give a degree of confidence that the audit reflects the level of compliance with the standard. The audit team, through this systematic analysis, should document areas which require corrective action as well as those areas where the PSM system is effective and working in an effective manner. This provides a record of the audit procedures and findings, and serves as a baseline of operation data for future audits. It will assist future auditors in determining changes or trends from previous audits.

Corrective action is one of the most important parts of the audit. It includes not only addressing the identified deficiencies, but also planning, follow-up, and documentation. The corrective action process normally begins with a management review of the audit findings. The purpose of this review is to determine what actions are appropriate, and to establish priorities, timetables, resource allocations and requirements and responsibilities. In some cases, corrective action may involve a simple change in procedure or minor maintenance effort to remedy the concern. Management of change procedures need to be used, as appropriate, even for what may seem to be a minor change. Many of the deficiencies can be acted on promptly, while some may require engineering studies or in-depth review of actual procedures and practices. There may be instances where no action is necessary and this is a valid response to an audit finding. All actions taken, including an explanation where no action is taken on a finding, needs to be documented as to what was done and why.

c. **Discuss a contractor’s responsibilities to the Department regarding the operation of facilities containing highly hazardous chemicals.**

The following is taken from 29 CFR 1910.119.

Contract employees must perform their work safely. Considering that contractors often perform very specialized and potentially hazardous tasks such as confined space entry activities and nonroutine repair activities it is quite important that their activities be controlled while they are working on or near a covered process. A permit system or work authorization system for these activities would also be helpful to all affected employers. The use of a work authorization system keeps an employer informed of contract employee activities, and as a benefit the employer will have better coordination and more management control over the work being performed in the process area. A well-run and well-maintained process where employee safety is fully recognized will benefit all of those who work in the facility whether they are contract employees or employees of the owner.

d. **List the safety and health considerations associated with hazardous chemicals as outlined in 29 CFR 1910.119.**

The following is taken from 29 CFR 1910.119, appendix C.

The employer shall develop and implement written operating procedures that provide clear instructions for safely conducting activities involved in each covered process consistent with the process safety information. One of the elements that these procedures must address is safety and health considerations, which include
properties of, and hazards presented by, the chemicals used in the process
- precautions necessary to prevent exposure, including engineering controls, administrative controls, and PPE
- control measures to be taken if physical contact or airborne exposure occurs
- quality control for raw materials and control of hazardous chemical inventory levels
- any special or unique hazards

e. Discuss the non-mandatory compliance guidelines and recommendations for process safety management contained in 29 CFR 1910.119.

The following is taken from 29 CFR 1910.119, appendix C.

OSHA provided guidance in appendix C to the PSM rule to serve as a non-mandatory guideline to assist employers and employees in complying with the requirements of this section, as well as to provide other helpful recommendations and information. Examples presented in the appendix are not the only means of achieving the performance goals in the standard, and the appendix neither adds nor detracts from the requirements of the standard. Below is an abridged version of the appendix, highlighting the 14 elements of PSM discussed in the complete document.

**Employee Participation**
Ensure that workers and their representatives are consulted and have access to information regarding all PSM elements.

**Process Safety Information**
Maintain complete and accurate information on the process technology, process equipment, and hazardous characteristics and physical properties of all chemicals and intermediates for all covered processes.

**Process Hazard Analysis**
Identify and assess process hazards for each covered process, and take action to manage risk.

**Operating Procedures**
Provide clear written instructions for safely conducting activities at each covered process that address operating limits, safety and health considerations, and safety systems and their functions.

**Training**
Provide initial and refresher training with a means of verifying employee understanding for all employees involved in operating a covered process.

**Subcontractor Safety**
Ensure that subcontractor operations do not compromise the level of safety on or in the vicinity of a process using HHCs.
**Pre-Startup Safety Review**
Perform safety reviews for new and modified facilities prior to operation when the modification is significant enough to require a change in the process safety information.

**Mechanical Integrity**
Ensure the integrity and safe operation of process equipment through inspection, testing, preventive maintenance, and QA.

**Non-Routine Work Authorizations**
Ensure that appropriate measures are taken any time non-routine operations are performed on or near covered process areas that might initiate or promote a release.

**Management of Change**
Establish and implement written procedures to manage changes (except for replacements in kind) to process chemicals, technology, equipment, and procedures, and to facilities that affect a covered process.

**Incident Investigation**
Using a written procedure, provide a team investigation of any incident which results in, or could reasonably result in, a catastrophic release of a highly hazardous chemical. Each investigation must be documented in a written report, and findings and recommendations must be resolved in a timely manner.

**Emergency Planning and Response**

**Compliance Audit**
Ensure that the PSM program is operating in an integrated and effective manner in compliance with PSM requirements.

**Trade Secrets**
Ensure all information is available to support the PSM Rule. When necessary, confidentiality or nondisclosure agreements may be used.

**46. Waste management personnel must demonstrate a familiarity level knowledge of Inter-Agency Agreements (IAG), Agreements in Principle, and Department Consent and Compliance Orders that are applicable to waste management programs.**

- Discuss how Interagency Agreements and Agreements in Principle apply to and impact Department waste management programs.

**Interagency Agreements**
The following is taken from the U.S. General Accountability Office, GAO-02-567.
Under section 120 of CERCLA, EPA must, where appropriate, evaluate hazardous waste sites at DOE’s facilities to determine whether the waste sites qualify for inclusion on the NPL, EPA’s list of the nation’s most serious hazardous waste sites. For each facility listed on the NPL, section 120(e)(2) of CERCLA requires DOE to enter into an IAG with EPA for the completion of all necessary remedial actions at the facility. The IAG must include, among other things, the selection of and schedule for the completion of the remedial action. Interagency agreements are revised, as necessary, to incorporate new information, adjust schedules, and address changing conditions. These agreements often include the affected states as parties to the agreements. These agreements may be known as Federal facility agreements or tri-party agreements. Under amendments to RCRA contained in section 105 of the FFCA of 1992, DOE generally must develop site treatment plans for its mixed-waste sites. These plans are submitted for approval to states authorized by EPA to perform regulatory responsibilities for RCRA within their borders or to EPA if the state does not have the required authority. Upon approval of the treatment plans, the state or EPA must issue an order requiring compliance with the approved plan. The agreements are generally known as Federal facility compliance orders.

Agreements in Principle

The following is taken from DOE Environmental Management, State Agreements in Principle Program Guidance Memorandum.

The parties to the agreement understand that the oversight activities authorized by the agreement are intended to supplement activities conducted under applicable environmental laws and regulations, but not to support specific state regulatory, permitting, and legally-required environmental oversight activities, such as issuance of regulatory permits, the review of DOE regulatory submissions when such review serves primarily as the basis for state action under regulatory programs, required regulatory inspections, required monitoring, issuance of regulatory notices of violation and other citations, nor to support the activities of the site-specific advisory board(s). Instead, the agreement is intended to support the non-regulatory activities of state in working with the DOE to evaluate the adequacy of DOE activities related to environmental monitoring and to support periodic state monitoring of discharges, emissions, or biological parameters as necessary to verify the effectiveness of the DOE programs. The agreement recognizes the continued need for state to have access to DOE facilities and to exchange relevant technical information with the DOE to support the state’s environmental monitoring efforts.

b. Describe how interagency agreements and agreements in principle are developed and entered into by the Department.

Interagency Agreements

The following is taken from the U.S. General Accountability Office, GAO-02-567.

In accordance with CERCLA, IAGs often include the affected states as parties to the agreements. These agreements may be known as Federal facility agreements or tri-party agreements. Under amendments to RCRA contained in section 105 of the Federal Facility Compliance Act of 1992, DOE generally must develop STPs for its mixed-waste sites. These
plans are submitted for approval to states authorized by EPA to perform regulatory responsibilities for RCRA within their borders or to EPA if the state does not have the required authority. Upon approval of the treatment plans, the state or EPA must issue an order requiring compliance with the approved plan. The agreements are generally known as Federal facility compliance orders.

Agreements in Principle

The following is taken from DOE Environmental Management, State Agreement-In-Principle (AIP) Program Guidance Memorandum from Thomas Grumbly (EM-1) to Operations Office Managers.

While the AIP grant instrument may be executed by the authorized field offices, the AIP itself must be approved by headquarters. Sites should forward a negotiated AIP proposal to the Office of Environmental Activities (EM-22). EM-22 will distribute the proposed AIP, for review and concurrence to the appropriate EM program (the Environmental Restoration Office Of Program Integration or the Waste Management Office Of Program Integration, EM-22 will consolidate the EM-22 and program comments and concurrences, and draft a recommendation from the assistant secretary authorizing the field element manager to sign the AIP. Once signed, this letter will be forwarded and constitute a delegation to sign the particular AIP. Three weeks should be allowed for the headquarters approval process. Once the AIP is signed, copies of the executed document should be provided to the program office(s) designated in the delegation memorandum and to EM-22.

c. Describe consent and compliance orders and discuss how they apply to and impact Department waste management programs.

The following is taken from DOE EGS 00-04.

Consent Order

A consent order is an agreement signed by DOE and a contractor. It acknowledges in summary form the breadth of a contractor’s investigation of the subject violation, as well as the comprehensive corrective actions developed and implemented as a result of the findings set forth in the investigation. It reflects DOE’s conclusion that the contractor’s investigation was appropriately aggressive and comprehensive and was focused on finding site-wide solutions to the subject nuclear safety problems, including those associated with radioactive waste management. It also reflects the DOE conclusion that the corrective actions proposed were appropriate and timely and, when fully implemented, would resolve the nuclear safety problem. Finally, it reflects DOE’s conclusion that there is a management commitment at the highest levels of the contractor organization that nuclear safety issues will be anticipated and addressed before the health and safety of workers and the public are compromised.

Compliance Order

The factual circumstances that justify the issuance of a consent order may be contrasted with those supporting issuance of a compliance order. As set forth in 10 CFR 820.41,
“Compliance Order,” the Secretary of Energy may issue a compliance order in any circumstance involving a nuclear activity. The order
- identifies a situation that violates or potentially violates, or otherwise is inconsistent with the Act, a nuclear statute, or a DOE nuclear safety requirement;
- mandates a remedy or other action;
- states the reasons for the remedy or other action.

Thus, issuance of a consent order is a reflection of DOE’s confidence in the ability of a contractor to anticipate, identify, and resolve nuclear safety problems in a timely manner, while issuance of a compliance order reflects a conclusion at the highest levels of DOE that a contractor has failed to anticipate, identify, and resolve such problems.

d. Given a list of consent and compliance orders, identify those that are applicable to waste management programs.

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

e. Identify the requirements contained in consent and compliance orders that form the basis of the authority for waste management personnel in the oversight and management of Department facilities.

Consent Orders
The following is taken from DOE EGS 03-01.

The Office of Price-Anderson Act Enforcement has recognized that even a contractor with a history of strong, proactive nuclear safety performance may have an occasional event or other noncompliance issue that would justify consideration of potential enforcement action. In such cases, this history of strong performance, coupled with an aggressive investigation of the subject issues and comprehensive corrective actions, forms the basis for the use of a consent order. In this regard, a contractor’s performance history over an extended period, which is about two years in most cases, must demonstrate a consistent proactive approach to the anticipation, comprehensive investigation, and resolution of nuclear safety issues or be reflective of a consistent improving trend in performance.

Compliance Orders
The following is taken from DOE EGS 00-04.

Compliance orders issued pursuant to 10 CFR 820, will be considered in circumstances where a safety problem is of such immediate magnitude that it requires undiluted, focused attention by the contractor, or in circumstances where repeated efforts by DOE to ensure completion of appropriate corrective actions by the contractor to resolve safety problems have failed.

f. Discuss how the requirements of site-specific consent and compliance orders are addressed by appropriate programs.

The following is taken from U.S. Environmental Protection Agency, EPA 315-B-98-011.
Orders (unilateral and consensual) and compliance agreements are the primary mechanisms EPA uses to address violations at Federal facilities. The specific type, scope, and effect of the administrative enforcement tool used for a particular violation will depend on the specific statutory authority that is available to EPA for enforcing compliance at a Federal facility. Orders will be used as EPA’s principal formal enforcement response unless EPA lacks the statutory authority to issue them. Otherwise, EPA will use a consent agreement to resolve violations. As a general rule, prior to an order going final, the Federal agency will be provided an opportunity to meet with EPA to discuss key issues prior to it becoming final and effective.

When EPA and the Federal agency settle a matter, EPA will prepare orders or compliance agreements for joint signature by the affected facility and EPA. At a minimum, all orders or compliance agreements should provide that the violating facility take specified steps to achieve full compliance with the underlying statute. As appropriate, the agreement or order should provide for further enforcement or penalties if the facility fails to meet the established schedules for compliance.

EPA may apply consent or compliance orders through the regulatory provisions of RCRA, CERCLA, the FFCA, and other laws. For example, under RCRA section 7003, EPA may order or seek a court order requiring long-term cleanup, including the design, construction, and implementation of any measures necessary to abate the conditions that may present an endangerment.

EPA or a court can thus require extensive work under section 7003. For example, EPA may seek, administratively or judicially, to require the responsible persons to
- identify and evaluate potential remedies
- design, construct, and implement a chosen remedy
- provide an alternative safe drinking water supply to an impacted area, including connecting affected areas to a municipal water supply
- install or restore clay covers and containment walls over and around certain areas of contaminated soils
- install and operate a wastewater treatment system as an alternative to impoundments contaminated with historical wastes
- close contaminated impoundments
- remove all wastes from the site or facility
- implement a groundwater recovery system
- provide access to state and Federal agencies
- monitor the effectiveness of the remedy
- provide samples from monitoring wells to EPA and the state for analysis
- provide periodic reports to EPA
- provide resources and information that will allow a local community to develop the capacity to monitor and enforce compliance with an order issued by EPA or a court
47. Waste management personnel must demonstrate a familiarity level knowledge of Department notice of violations (NOVs) that are applicable to waste management programs.

a. Describe notice of violations and discuss how they apply to and impact Department waste management programs.

The following is taken from EPA 315-B-98-011.

Generally, EPA bases its initial response to a violation on the following three factors:

- Type of violation
- Potential risk posed by the violation
- Ability of the facility to address the violation

Media-specific or program-specific guidance governs the type of initial response EPA may take.

When EPA determines that a violation warrants only an informal notification, the Federal facility coordinator or media program staff may provide informal notification to the facility prior to formal written notification in cases where formal notification is also warranted. Informal notification affords the Federal facility an opportunity to correct the identified violation. Formal notification may be in the form of an NOV—the initial written notice EPA provides to require a Federal facility to address a minor, identified violation. An NOV issued to a Federal facility is similar to one issued to a private facility, except that it does not include the possibility of an EPA-initiated civil judicial action. The NOV is tailored to address the specific circumstances presented by the situation, the violation, and applicable program-specific requirements. Formal notification also may include, depending upon the statute, an order or request to negotiate a compliance agreement or consent order.

b. Given a list of notice of violations, identify those that are applicable to waste management programs.

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

c. Given several notice of violations that are applicable to waste management programs, identify the violations, describe the corrective actions to be taken, and determine the status of implementation of the corrective actions.

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

d. 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 information for this KSA is covered under competency statement 28d and will not be repeated here.
48. Waste management personnel must demonstrate a familiarity level knowledge of the Pollution Prevention Act of 1990 (PPA).

a. Define the following terms:
   - Pollution/pollutants
   - Recycling
   - Waste minimization
   - Pollution prevention

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

*Pollution/Pollutants*

The EPA’s definition of pollution is as follows:

The presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and health effects. Under the CWA for example, the term has been defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Pollutants are defined as follows:

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

*Recycling*

Recycling (or reuse) is minimizing waste generation by recovering and reprocessing usable products that might otherwise become waste (e.g., recycling of aluminum cans, paper, and bottles).

*Waste Minimization*

Waste minimization encompasses the measures or techniques that reduce the amount of wastes generated during industrial production processes. The term is also applied to recycling and other efforts to reduce the amount of waste going into the waste stream.

*Pollution Prevention*

Pollution prevention includes using techniques that eliminate waste prior to treatment by identifying areas, processes, and activities that create excessive waste products or pollutants in order to reduce or prevent them through alteration or elimination of a process. The EPA has initiated a number of voluntary programs in which industrial or commercial “partners” join with the EPA in promoting activities that conserve energy, conserve and protect the water supply, reduce emissions or find ways of utilizing them as energy resources, and reduce the waste stream.
b. Discuss the Department’s policy pertaining to pollution prevention.

The following is taken from DOE G 450.1-1A.

Pollution prevention is not a stand-alone program; rather it is incorporated into the day-to-day operations at DOE sites. DOE O 450.1 Sec. 4 a.(1)(b) requires that all DOE elements ensure that site ISMSs include an EMS that provides for the systematic planning, integrated execution, and evaluation of programs for pollution prevention. DOE O 450.1 Sec. 4.b.(3) requires that as part of integrating EMSs into site ISMSs, DOE elements must reduce or eliminate the generation of waste, the release of pollutants to the environment, and the use of class I ODSs through source reduction, reuse, segregation, and recycling and by procuring recycled-content materials and environmentally preferable products and services.

DOE O 450.1 Sec. 5.d. (6) requires sites to conduct pollution prevention opportunity assessments (PPOA’s) and implement cost-effective pollution prevention solutions. A PPOA is an appraisal of a process, activity, or operation to identify and evaluate potential pollution prevention opportunities (see appendix D, glossary). Pollution prevention opportunities should be considered before setting the site’s objective and targets. For example, specific pollution prevention goals were set forth in a Secretary of Energy memorandum issued in 1999. Site-specific goals that contribute to these existing pollution prevention goals can be a site’s environmental objective for reducing or eliminating a certain impact (i.e., waste generation or discharge). A target could be a schedule for conducting a PPOA to identify pollution prevention solutions for achieving the objective.

Each site implementing an ISMS/EMS should develop an ES&H policy statement. The policy statement should reflect the nature and scale of the organization’s activities, products, and services and embody the organization’s commitment to

- compliance with laws and applicable requirements
- pollution prevention
- continual improvement of the management system and of ES&H performance
- integration of environmental accountability into decision-making processes

The site ES&H policy statement should express management’s commitment to identifying and addressing potential ES&H risks from site activities, and should serve as a framework for setting and reviewing a facility’s environmental goals, objectives, and targets. The following is an example of language that can be used in policy statements to address pollution prevention.

“We will seek, first, to cost-effectively avoid the generation of pollution and waste from our processes and services and, second, to manage remaining waste through safe and responsible methods and vendors. We will also seek to avoid the release of hazardous substances into the environment by using environmentally preferable products in our processes and services whenever cost-effectively feasible.”
c. Define source reduction and provide a list of source reduction technologies.

The following is taken from DOE Office of Health, Safety, and Security, Pollution and Prevention Act.

Section 13102 of the PPA defines source reduction as any practice that reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. The term includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control. The term “source reduction” does not include any practice that alters the physical, chemical, or biological characteristics or the volume of a hazardous substance, pollutant, or contaminant through a process or activity which itself is not integral to, and necessary for the production of a product or the providing of a service.

The following is taken from DOE-STD-1128-98.

Source reduction should concentrate on minimizing or eliminating the sources of radiation exposure. Reducing the number of areas with radiological contamination and reducing dose rate are examples of source-reduction goals. Where the presence of non-radiological hazardous materials results in mixed waste, the removal of the hazardous material may have ALARA benefits by reducing the waste classification. Such changes may also reduce exposure at a later time by eliminating the need to store or further treat the waste. In these cases, eliminating the hazardous material may be an appropriate source-reduction ALARA goal.

d. Discuss the purpose of Executive Order 12856, Federal Compliance with Right-To-Know Laws And Pollution Prevention Requirements.

The following is taken from EO 12856.

The purpose of Executive Order 12856 is to

- ensure that all Federal agencies conduct their facility management and acquisition activities so that, to the maximum extent practicable, the quantity of toxic chemicals entering any waste stream, including any releases to the environment, is reduced as expeditiously as possible through source reduction; that waste that is generated is recycled to the maximum extent practicable; and that any wastes remaining are stored, treated or disposed of in a manner protective of public health and the environment;
- require Federal agencies to report in a public manner toxic chemicals entering any waste stream from their facilities, including any releases to the environment, and to improve local emergency planning, response, and accident notification; and
- help encourage markets for clean technologies and safe alternatives to EHSs or toxic chemicals through revisions to specifications and standards, the acquisition and
procurement process, and the testing of innovative pollution prevention technologies at Federal facilities or in acquisitions.

e. Discuss the purpose of Executive Order 13101, Greening Government through Waste Prevention, Recycling, and Federal Acquisition.

The following is taken from EO 13101.

The purpose of EO 13101 is to improve the Federal government’s use of recycled products and environmentally preferable products and services.

f. Discuss how the Pollution Prevention Act applies to and impacts Department waste management programs.

The following is taken from Lawrence Livermore National Laboratory, *ES&H Manual* Document 30.1.

The PPA places minimization requirements on private and governmental facilities that emit toxic chemicals and generate hazardous wastes. Facilities that manufacture, process, or otherwise use certain chemicals must report annual chemical releases under earlier legislation, section 313 of SARA, and EPCRA. The SARA 313 “Form R” report used in this process details annual estimates of wastes reduced through source reduction, recycling, and treatment. The forms require reporting on four consecutive years of waste minimization activities for each chemical involved to show success or failure in reducing chemical releases to the environment.

EPCRA reporting requirements and the PPA require facilities to submit chemical-specific information on waste reduction activities, including an estimate of the amount of hazardous waste eliminated through source reduction measures, onsite and offsite recycling, and treatment processes. This information must be summarized and submitted to the EPA annually, on or before July 1.

g. Identify the requirements contained in the Pollution Prevention Act that apply to waste management.

The following is taken from Lawrence Livermore National Laboratory, *ES&H Manual* Document 30.1.

It is the policy of EPA to first prevent or reduce pollution at the source, whenever feasible. Feasibility is determined by the requirements of applicable laws, the level of risk reduction that can be achieved, and cost-effectiveness. EPA’s policy has led to the development of Federal and state guidelines and regulations to ensure the proper handling, minimization, and disposal of solid waste. The DOE’s version of the EPA policy institutes pollution prevention programs that place specific evaluation, reduction, and reporting requirements on facilities that generate hazardous and mixed radioactive and nonhazardous solid waste.
49. Waste management personnel must demonstrate a working level knowledge of financial management necessary to integrate program resources and apply those resources to meet project commitments as described in Department of Energy (DOE) Guide 430.1-1, Life Cycle Asset Management.

a. Define the term “work breakdown structure” and discuss the process for developing one.

The following is taken from DOE G 430.1-1, appendix A.

Work breakdown structure (WBS) is defined as a breakdown of a project into those sub-elements that define the project. The WBS provides a consistent organization framework throughout the project.

The following is taken from DOE G 430.1-1, chapter 5.

A WBS shows the relationship of all elements of a project. This provides a sound basis for cost and schedule control.

During the period of a project’s life from its inception to completion, 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.

The initial WBS prepared for a project is the project summary work breakdown structure (PSWBS). Normally, the PSWBS contains the top three levels only. Lower-level elements may be included when necessary to clearly communicate all project requirements.

Understanding of the Scope
The first prerequisite to the preparation of the PSWBS is the clear understanding and statement of the project objective by the PSO. 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 PSO in structuring WBS levels and the contributing elements during WBS preparation.

Defining the Levels and Elements
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 it may limit the number of digits in the WBS numeric identifier.

**Use of the Work Breakdown Structure**

The PSWBS should be used to identify work for proposed supporting contractors. Subsequently, the PSWBS elements assigned to contractors are extended by the contractors to derive each contract work breakdown structure (CWBS). Together, the PSWBS and each CWBS constitute the project WBS, which then provides the framework for cost, schedule, and technical planning, and control through the life of the project.

**Updating the Work Breakdown Structure**

The PSO must maintain the WBS. Changes may occur when the work effort can be more accurately defined or if a revised approach (e.g., one that is technically different or more cost effective) is implemented to satisfy or meet the project objective. Also, contractors, while developing their CWBS, may propose to DOE alternative approaches to better accomplish the contract objectives. If the alternatives are accepted by DOE project management, the preliminary PSWBS will be revised accordingly. Thus, when establishing the numeric series for the WBS, it is advisable to leave some blocks of numbers for changes and additions to the scope. This makes the WBS revision process easier.

b. Define and compare the terms “cost estimate” and “budget.”

**Cost Estimate**

As found in DOE G 430.1-1, cost estimate is defined as 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.

**Budget**

As found in the GAO-05-734SP, *A Glossary of Terms Used in the Federal Budget Process*, budget is defined as “a detailed statement of anticipated revenues and expenditures during an account period.”

Comparing the two terms is a matter of understanding that cost estimates may exceed funds allocated to a given project, leading to revision of the scope of work to accommodate any possible shortfall, so that work performed aligns directly with funding available to accomplish the project.

c. Describe the process for preparing cost estimates and budgets.

The following is taken from DOE G 430.1-1, chapter 15.
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. Techniques suggested in DOE G 430.1-1, chapter 15 are described below.

**Bottom-Up Technique**
Generally, a work statement and set of drawings or specifications are used to “take off” material quantities required to perform each discrete task performed in accomplishing a given operation or producing 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 data based on similar systems or subsystems. Data is derived from the historical information or is developed from building a model scenario. 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 that can be used individually or grouped into more complex models. This technique is useful when the information available is not very detailed.

**Cost Review and Update Technique**
With the 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**
Using the 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**
When other techniques or data are not available, the expert opinion technique may be used, whereby several specialists can be consulted repeatedly until a consensus cost estimate is established.

d. **Describe and compare labor and non-labor costs.**

The following descriptions are taken from DOE G 430.1-1, chapter 9.
Labor Costs
Estimates of labor costs for environmental and waste management projects will be different than estimates for conventional projects because of job functions required by the project. For example, work at the facility may dictate the number of health and safety professionals working on the project, and additional technical support may be required for projects that involve new or experimental remediation technology. Labor salaries are usually higher because of additional certification and training requirements for personnel who work in the environmental remediation field.

Operating cost estimates should include provisions for salaries and labor burden, 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. Training costs may increase labor overhead for environmental projects. Labor overhead will be present regardless of the project operating schedule, but labor costs may be a function of the facility’s operating schedule, especially if shift work is involved. Labor scheduling should also contain an allowance for personnel decontamination time.

Non-Labor Costs
Non-labor costs include everything not directly related to salary (and benefits) and contractor costs. Some of these costs, like training and team-building expenses, are related to people. However, they are still considered non-labor since they are not related to employee salary or contractor hours. Each project manager must be aware of the accounting rules in his or her own company to make sure the labor and non-labor costs are allocated correctly. Generally, however, non-labor costs include the following:

- Hardware and software
- Equipment
- Material and supplies
- Travel expenses
- Training
- Team building
- Facilities

e. Describe and compare direct and indirect costs.

The following is taken from DOE G 430.1-1, chapter 7.

The American Association of Cost Engineers defines direct costs as “...costs of installed equipment, material, and labor directly involved in the physical construction of the permanent facility.”

The American Association of Cost Engineers defines indirect costs as “...all costs which do not become a final part of the installation, but which are required for its orderly completion. It includes (but is not limited to): field administration, direct supervision, capital tools, some start-up costs, contractor’s fees, insurance, taxes, etc.”
f. Discuss methods of reducing indirect costs.


Indirect costs are often referred to as overhead or burdened expenses.

There are several ways to reduce indirect costs, including the following:
- Understand the basis for allocation of cost pools.
- Question rate changes.
- Question cost changes.
- Look for inefficient/costly practices.
- Provide input to budget validations of indirect costs.
- Work with the Chief Financial Officer for a more effective process.

DOE and its contractors have numerous efforts under way to reduce indirect and other support costs; however, in a September 2005 report, the GAO identified several efforts that could be strengthened to further reduce costs:
- DOE is including incentives in its contracts to encourage indirect cost reductions. DOE officials stated that one of these incentives, a pilot to award additional contract years for performance, had produced cost savings.
- DOE generally requires contractors to offer employee benefits that are similar in value to those of comparable organizations.
- DOE has begun requiring contractors to address a backlog of maintenance projects while they also manage current maintenance needs.

g. Discuss the importance of determining the measure for work performed before work starts.

The following is taken from DOE, Training Resources and Data Exchange Handbook, How to Measure Performance: A Handbook of Techniques and Tools.

Change might be inevitable, but all too often it occurs like an unguided missile seeking an elusive target at unpredictable speeds. For most activities, it is far better to manage change with a plan—one that includes clear goals and useful indications of progress toward a desired objective. Participants in an activity need to know what outcome is expected, where their work contributes to the overall goal, how well things are progressing, and what to do if results are not occurring as they should. This approach places performance measures right where they should be: integrated with the activity.

Such integration makes it possible for performance measures to be effective agents for change. If the measures quantify results of an activity, one only needs to compare the measured data with desired goals to know if actions are needed. In other words, the measures should carry the message.
h. Describe methods for measuring work performed.

The following is taken from Oak Ridge Associated Universities, Developing Metrics.

Performance metrics should be constructed to encourage performance improvement, effectiveness, efficiency, and appropriate levels of internal controls. They should incorporate “best practices” related to the performance being measured and cost/risk/benefit analysis, where appropriate.

The Department has promulgated a set of total quality management guidelines that indicate that performance metrics should lead to a quantitative assessment of gains in customer satisfaction, organizational performance and workforce excellence.

The key elements of the performance metrics to these guidelines should address
- alignment with organizational mission
- cost reduction and/or avoidance
- meeting DOE requirements
- quality of product
- cycle time reduction
- meeting commitments
- timely delivery
- customer satisfaction

The Process

The first step in developing performance metrics is to involve the people who are responsible for the work to be measured because they are the most knowledgeable about the work. Once these people are identified and involved, it is necessary to
- identify critical work processes and customer requirements
- identify critical results desired and align them to customer requirements
- develop measurements for the critical work processes or critical results
- establish performance goals, standards, or benchmarks

The establishment of performance goals can best be specified when they are defined within three primary levels:
- Objectives—Broad, general areas of review. These generally reflect the end goals based on the mission of a function.
- Criteria—Specific areas of accomplishment that satisfy major divisions of responsibility within a function.
- Measures—Metrics designed to drive improvement and characterize progress made under each criteria. These are specific quantifiable goals based on individual expected work outputs.

The SMART test is frequently used to provide a quick reference to determine the quality of a particular performance metric.
- S = Specific—Clear and focused to avoid misinterpretation. Should include measure assumptions and definitions and be easily interpreted.
- **M = Measurable**—Can be quantified and compared to other data. It should allow for meaningful statistical analysis. Avoid “yes/no” measures except in limited cases, such as start-up or systems-in-place situations.
  - **A = Attainable**—Achievable, reasonable, and credible under conditions expected.
  - **R = Realistic**—Fits into the organization’s constraints and is cost-effective.
  - **T = Timely**—Doable within the time frame given.

### Types of Metrics

Quality performance metrics allow for the collection of meaningful data for trending and analysis of rate-of-change over time. Examples include the following:

- Trending against known standards—The standards may come from either internal or external sources and may include benchmarks.
- Trending with standards to be established—Usually this type of metric is used in conjunction with establishing a baseline.
- Milestones achieved.

Yes/No metrics are used in certain situations usually involving establishing trends, baselines, or targets, or in start-up cases. Because there is no valid calibration of the level of performance for this type of measure, they should be used sparingly. Examples include the following:

- Establish/implement a system
- Reporting achieved (without analyses)
- System is in place (without regard to effectiveness)
- Threshold achieved (arbitrary standards)
- Analysis performed (without criteria)

### Determining the Quality of Metrics

The following questions serve as a checklist to determine the quality of the performance metrics that have been defined:

- Is the metric objectively measurable?
- Does the metric include a clear statement of the end results expected?
- Does the metric support customer requirements, including compliance issues where appropriate?
- Does the metric focus on effectiveness and/or efficiency of the system being measured?
- Does the metric allow for meaningful trend or statistical analysis?
- Have appropriate industry, or other external stands been applied?
- Does the metric include milestones and/or indicators to express qualitative criteria?
- Are the metrics challenging but at the same time attainable?
- Are assumptions and definitions specified for what constitutes satisfactory performance?
- Have those who are responsible for the performance being measured been fully involved in the development of this metric?
- Has the metric been mutually agreed upon by the supplier and the customers?
i. **Discuss schedule and cost variance.**

The following is taken from DOE M 413.3-1.

*Schedule Variance*

Schedule variance is a metric for the schedule performance on a program. It is the algebraic difference between earned value (EV) and the budget (Schedule Variance = Earned Value - Budget). A positive value is a favorable condition while a negative value is favorable. The SV is calculated in dollars or work units and is intended to compliment network analysis, not supersede or replace it.

*Cost Variance*

Cost variance is the algebraic difference between EV and actual cost (Cost Variance = Earned Value - Actual Cost.) A positive value indicates a favorable position and a negative value indicates an unfavorable condition.

j. **Given actual project management documentation and data, identify budgeted cost of work scheduled, budgeted cost of work performed, 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 earned value (EV) and how they are measured.**

The following is taken from DOE M 413.3-1 and DOE Office of Engineering and Construction Management, *Earned Value Management Tutorial, Module 5—EVMS Concepts and Methods*.

Earned value management is a system that allows both government and contractor managers to have visibility into technical, cost, and schedule progress on their contracts. The implementation of an EV management system is widely recognized as a key component of program and project management. It ensures that cost, schedule and technical aspects of the contract are truly integrated.

Earned value is a method for measuring project performance. It compares the value of work performed (budgeted cost of work performed) with the value of work scheduled (budgeted cost of work scheduled) and the cost of performing the work (actual cost of work performed) for the reporting period and/or the cumulative total to date.

Cumulative EV is the sum of the budget for the activities accomplished to date.

Current EV is the sum of the budget for the activities accomplished in a given period.

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
In project management terms, a baseline is defined as 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, and 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 Office of Management, Budget, and Evaluation, Scheduling and Cost Estimating.

Cost estimates are prepared using appropriate estimating methodologies that are integrated with the WBS and the DOE cost structure as specified by DOE for all contract work.

Planning and scheduling is a process that is established and is in operation through the life of the project to identify programmatic, operational, legislative, institutional, and other requirements or constraints that may affect technical, cost, or schedule baselines and ensure that such baselines reflect such potential impacts.

Schedules are developed integrating the WBS and cost estimate, and represent all work scope regardless of funding source. Activity logic is used to depict all work scope, constraints, and decision points. Durations are estimated and assigned to activities that represent work accomplishments. The detail scheduled activities form the master and intermediate level schedules as required.

n. Define the term “life cycle cost estimate.”

The following is taken from DOE G 430.1-1, appendix A.

[Note: the term “life cycle cost estimate” does not exist in any DOE materials related to this competency statement. Therefore, “life cycle cost” has been defined in this regard.]

Life-cycle cost (LCC) is the sum total of the direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span. Where system or project planning anticipates use of existing sites or facilities, restoration and refurbishment costs should be included.

o. Given sample data, calculate “life cycle cost estimate.”

This is a performance-based KSA. The Qualifying Official will evaluate its completion. However, the following information may be helpful.

Life-cycle cost analysis consists of defining the LCC of each element and reducing each element cost to a common basis. In LCC analysis, escalation and discount rates must be considered. The most used method of LCC analysis uses the net present worth method. In this method, costs are estimated in current dollars, escalated to the time when they would be
spent, and then corrected to a present worth using a discount rate. When the inflation and discount rates are equal, LCC can be computed as current dollars, totaled for the project life, and compared. When the escalation and discount rate are different, the escalation and present worth calculations must be performed.

An example of a LCC analysis is available in DOE G 430.1-1, Chapter 23, *Life Cycle Cost Estimate*.

**p. Discuss the importance of formal change control with regard to project management.**

The following is taken from DOE O 413.3A.

Change control ensures that project changes are identified, evaluated, coordinated, controlled, reviewed, approved, and documented in a manner that best serves the project. Errors, problems, opportunities, new management, or the availability of new methods or tools can trigger project changes. Uncontrolled changes lead to chaos due to the far-reaching effects that even small changes can have on the project’s technical scope, schedule, and cost baseline, as well as effects on safety, risk, quality, and products.

An approved project performance baseline is the highest controlling element of a project. Controlling changes within the performance baseline should be an inherent element of project management that is directly related to the risks and uncertainties associated with a project. One key goal of change control is to ensure that performance baseline threshold values are not exceeded. Change control provides a system to approve and document project changes.

The goals of a change control process include the following:

- Anticipate, recognize, and predict changes
- Prevent performance baseline deviations
- Evaluate and understand the impacts of each change
- Identify, understand, and control the consequences of changes
- Prevent unauthorized or unintended deviations from approved baselines
- Ensure that each change is evaluated, reviewed, and dispositioned at the proper management level

**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/PO-0041.

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 the Department. 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
- helping to evaluate departmental performance

Strategic planning has been carried out and effectively used in many DOE programs and activities. Secretarial officers are encouraged to develop and maintain strategic plans in their line and staff organizations to facilitate the kind of strategic thinking and management needed to ensure departmental activities are carried out in a manner most supportive to overall administration and departmental strategies, goals, and objectives.

The departmental strategic plan is the foundation for all DOE planning, budgeting, execution, control, and evaluation activities by programs and support organizations. The departmental strategic plan is supplemented with headquarters programmatic and crosscutting strategic planning and by strategic planning at the field level. Strategic planning is the foundation for multi-year program and operational plans that can drive daily activities.

r. Establish the terms of contractor performance elements and monitor and assess contractor performance against those performance elements.

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