National Nuclear Security Administration

Occupational Safety

Qualification Standard

Reference Guide

AUGUST 2006

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PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a National Nuclear Security Administration (NNSA) technical employee to successfully complete the Occupational Safety Qualification Standard. In some cases, information essential to meeting the qualification requirements is provided. Some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

SCOPE

This reference guide has been developed to address the competency statements in the March 2003 edition of DOE-STD-1160-2003, Occupational Safety Qualification Standard. Competency statements and supporting knowledge and/or skill statements from the qualification standard are shown in contrasting bold type, while the corresponding information associated with each statement is provided below it. The qualification standard for the Occupational Safety Study guide contains 21 competency statements. This reference guide will address all 21 statements.

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

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

TECHNICAL COMPETENCIES

1. Occupational safety personnel shall demonstrate a working-level knowledge of occupational safety-related requirements of DOE O 440.1A, technical standards, Occupational Safety and Health Administration regulations, and 29 CFR 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters."

a) Describe the purpose, responsibilities, and requirements of Department of Energy (DOE) orders with respect to occupational safety.

The purpose, responsibilities, and requirements of DOE Orders in regard to occupational safety are listed below:

- Implement a written worker protection program.
- Establish written policy, goals, and objectives for the worker protection program.
- Use qualified worker protection staff to direct and manage the worker protection program.
- Assign worker protection responsibilities, evaluate personnel performance, and hold personnel accountable for worker protection performance.
- Encourage the involvement of employees in the development of program goals, objectives, and performance measures, and in the identification and control of hazards in the workplace.
- Provide workers the right, without reprisal, to
  - accompany DOE worker protection personnel during workplace inspections;
  - participate in activities provided for in this Order on official time;
  - express concerns related to worker protection;
  - decline to perform an assigned task because of a reasonable belief that, under the circumstances, the task poses an imminent risk of death or serious bodily harm to that individual, coupled with a reasonable belief that there is insufficient time to seek effective redress through the normal hazard reporting and abatement procedures established in accordance with DOE orders;
  - have access to DOE worker protection publications, DOE-prescribed standards, and the organization's own worker protection standards or procedures applicable to the workplace;
  - observe monitoring or measuring of hazardous agents and have access to the results of exposure monitoring;
  - be notified when monitoring results indicate they were overexposed to hazardous materials;
  - receive results of inspections and accident investigations upon request.
- Implement procedures to allow workers, through their supervisors, to stop work when they discover employee exposures to imminent danger conditions or other serious hazards. The procedure shall ensure that any stop work authority is exercised in a justifiable and responsible manner.
- Inform workers of their rights and responsibilities by appropriate means, including posting the appropriate DOE Worker Protection Poster in the workplace where it is accessible to all workers.

- Identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness.
- Implement a hazard prevention/abatement process to ensure that all identified hazards are managed through final abatement or control.
- Provide workers, supervisors, managers, visitors, and worker protection professionals with worker protection training.

Additional requirements for specific functional areas are contained in the attachment to DOE-STD-1160.

b) Discuss compatibility between, and describe the respective applicability of, occupational safety requirements contained in DOE orders and applicable local, state, or Federal regulations.

Federal regulations from 29 CFR 1960 dictate the contents of DOE O 440.1. State and local laws are to be met through the implementation of appropriate Occupational Safety and Health Administration (OSHA) regulations for the given region. Title 29 CFR 1960 delineates the areas that must be covered and the requirements for federal employees and contractors.

c) Discuss relationship between DOE orders and OSHA standards and have a working knowledge of the applicability of OSHA requirements to DOE and contractors, including subcontractors.

The elements section of DOE O 440.1 describes each section to be covered and references applicable DOE and OSHA references for each individual element as necessary. The Code of Federal Regulations (CFR) drives the DOE documents that are required, and the OSHA documents are applicable to all workers.

d) Describe appropriate or required measures for obtaining interpretations of, or variances/exemptions from, occupational safety requirements in DOE orders.

Exemptions must be approved by the Assistant Secretary of Energy, and must not violate OSHA rules and regulations. The head of field elements will review exemptions each year to ensure that they are needed and do not violate any new OSHA requirements that may have been implemented.

e) Discuss the OSHA General Duty Clause of Public Law 91-596, Section 5 (a)(1) and its applicability.

The clause states, “Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.” This applies to all DOE facilities that are not exempt per the exemptions section in DOE O 440.1.

f) Discuss and have a working knowledge of Executive Order 12196 and OSHA 29 CFR 1960.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

g) Describe the organization of CFRs in terms of titles, chapters, parts, and sections.

The layout of the CFRs is found here: http://www.access.gpo.gov/nara/cfr/cfr-table-search.html#page1.

h) Describe the purpose, scope, and application of requirements in the following regulations as they apply to DOE facilities:

- **29 CFR 1904, "Recording and Reporting Occupational Injuries and Illnesses"**
- **29 CFR 1910, "Occupational Safety and Health Regulations"**
- **29 CFR 1926, "Safety and Health Regulations for Construction"**
- **29 CFR 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters."**

29 CFR 1904

The purpose of this rule is to require employers to record and report work-related fatalities, injuries, and illnesses. Recording or reporting a work-related injury, illness, or fatality does not mean that the employer or employee was at fault, that an OSHA rule has been violated, or that the employee is eligible for workers' compensation or other benefits.

All employers covered by the Occupational Safety and Health Act (OSH Act) are covered by the Part 1904 regulations. However, most employers do not have to keep OSHA injury and illness records unless OSHA or the Bureau of Labor Statistics (BLS) informs them in writing that they must keep records. For example, employers with 10 or fewer employees and business establishments in certain industry classifications are partially exempt from keeping OSHA injury and illness records.

29 CFR 1910

The Williams-Steiger Occupational Safety and Health Act of 1970 provides that "without regard to chapter 5 of title 5, United States Code, or to the other subsections of this section, the Secretary shall, as soon as practicable during the period beginning with the effective date of this Act and ending 2 years after such date, by rule promulgate as an occupational safety or health standard any national consensus standard, and any established Federal standard, unless he determines that the promulgation of such a standard would not result in improved safety or health for specifically designated employees." The legislative purpose of this provision is to establish, as rapidly as possible and without regard to the rule-making provisions of the Administrative Procedure Act, standards with which industries are generally familiar, and on whose adoption interested and affected persons have already had an opportunity to express their views. Such standards are either (1) national consensus standards on whose adoption affected persons have reached substantial agreement, or (2) federal standards already established by federal statutes or regulations.

This part carries out the directive to the Secretary of Labor. It contains occupational safety and health standards which have been found to be national consensus standards or established federal standards.

The standards contained in this part shall apply with respect to employments performed in a workplace in a state, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, Trust Territory of the Pacific Islands, Wake Island, Outer

Continental Shelf lands defined in the Outer Continental Shelf Lands Act, Johnston Island, and the Canal Zone.

None of the standards in this part shall apply to working conditions of employees with respect to which federal agencies other than the Department of Labor, or state agencies acting under section 274 of the Atomic Energy Act of 1954, as amended (42 U.S.C. 2021), exercise statutory authority to prescribe or enforce standards or regulations affecting occupational safety or health.

If a particular standard is specifically applicable to a condition, practice, means, method, operation, or process, it shall prevail over any different general standard which might otherwise be applicable to the same condition, practice, means, method, operation, or process.

On the other hand, any standard shall apply according to its terms to any employment and place of employment in any industry, even though particular standards are also prescribed for the industry to the extent that none of such particular standards applies. In the event a standard protects on its face a class of persons larger than employees, the standard shall be applicable under this part only to employees and their employment and places of employment.

An employer who is in compliance with any standard in this part shall be deemed to be in compliance with the Act, but only to the extent of the condition, practice, means, method, operation, or process covered by the standard.

29 CFR 1926

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

29 CFR 1960

The Occupational Safety and Health Act contains special provisions to assure safe and healthful working conditions for federal employees. It is the responsibility of the head of each federal agency to establish and maintain an effective and comprehensive occupational safety and health program which is consistent with the standards promulgated under the Act. The Secretary of Labor is to report to the President certain evaluations and recommendations with respect to the programs of the various agencies, and the duties which section 24 of the Act imposes on the Secretary of Labor necessarily extend to the collection, compilation, and analysis of occupational safety and health statistics from the Federal Government.

Executive Order 12196, Occupational Safety and Health Programs for Federal Employees, issued February 26, 1980, prescribes additional responsibilities for the heads of agencies, the

Secretary, and the General Services Administrator. Among other duties, the Secretary is required to issue basic program elements in accordance with which the heads of agencies shall operate their safety and health programs. The purpose of this part is to issue these basic program elements. Although agency heads are required to operate a program in accordance with the basic program elements, those elements contain numerous provisions which, by their terms, permit agency heads the flexibility necessary to implement their programs in a manner consistent with their respective missions, sizes, and organizations. Moreover, an agency head, after consultation with agency employees or their representatives and with appropriate safety and health committees, may request the Secretary to consider approval of alternate program elements. The Secretary, after consultation with the Federal Advisory Council on Occupational Safety and Health, may approve such alternate program elements. Under Executive Order 12196, the Secretary is required to perform various services for the agencies, including consultation, training, recordkeeping, inspections, and evaluations.

Agencies are encouraged to seek such assistance from the Secretary, as well as advice on how to comply with the basic program elements and operate effective occupational safety and health programs. Upon the request of an agency, the Office of Federal Agency Safety and Health Programs will review proposed agency plans for the implementation of program elements. The Executive order requires specific opportunities for employee participation in the operation of agency safety and health programs. The manner of fulfilling these requirements is set forth in part in these program elements. These requirements are separate from, but consistent with, the Federal Service Labor Management Relations Statute and regulations dealing with labor-management relations within the Federal Government.

Executive Order 12196 and these basic program elements apply to all agencies of the executive branch. They apply to all federal employees. They apply to all working conditions of federal employees except those involving uniquely military equipment, systems, and operations.

No provision of the Executive order or this part shall be construed in any manner to relieve any private employer, including federal contractors, or their employees of any rights or responsibilities under the provisions of the Act, including compliance activities conducted by the Department of Labor or other appropriate authority.

Federal employees who work in establishments of private employers are covered by their agencies' occupational safety and health programs. Although an agency may not have the authority to require abatement of hazardous conditions in a private sector workplace, the agency head must assure safe and healthful working conditions for his/her employees. This shall be accomplished by administrative controls, personal protective equipment, or withdrawal of federal employees from the private sector facility to the extent necessary to assure that the employees are protected.

i) Discuss relationship between CFRs and the Federal Register in terms of determining the latest version of any rule.

The relationship between the Federal Register and the Code of Federal Regulations is analogous to that between session laws and a codification. The Register is a current chronological record; the Code is a subject arrangement. Together they comprise the Federal Register System that provides an up-to-date version of any agency regulation. Regulations are first published in the Federal Register and are incorporated annually into the CFR. Regulations issued after the publication date of a particular CFR title appear in the Federal Register.

j) Describe difference between Requests for Information, Advanced Notice of Proposed Rulemaking, Notice of Proposed Rulemaking, and a Final Rule as it relates to regulatory entries in the Federal Register.

Request for Information

A Request for Information is a notice sent out by an agency in preparation for updating or creating a rule.

Advanced Notice of Proposed Rulemaking

The Advanced Notice of Proposed Rulemaking (ANPR) is the first public airing of the draft text of a proposed rule published for public review and comment. Often, the sections of the ANPR identify the agency's approach for making the rule.

Notice of Proposed Rulemaking

The Notice of Proposed Rulemaking (NPR) is the first public airing of the exact text of a proposed rule, published in the Federal Register for public review and comment. Often, the sections of the NPR explaining the various components of the rule and the agency's approach are much longer than the regulatory text itself.

Final Rule

The Final Rule is the final regulation as published in the Federal Register. However, under the Congressional Review Act, Congress can nullify a rule before it takes effect.

k) Describe job safety analyses, hazard analyses, and other safety review techniques when implementing occupational safety requirements.

Job Safety Analysis

Job safety analysis is the systematic breakdown of a job into tasks/steps in order to identify hazards, assess risks, and select the best control.

Hazard Analysis

Hazard analysis is an analysis or identification of the hazards that could occur at each step in the process, and a description and implementation plan of the measures to be taken for their control.

Hazard Identification

Hazard identification is the physical identification of hazards that are present in a work location.

2. Occupational safety personnel shall demonstrate the ability to perform occupational safety trend analyses.

a) Discuss key processes used in operation trending, analysis, post-operation activity information, and their relationships to occupational safety activities.

The general methodology for trending and analyzing DOE and contractor performance data combines simple and descriptive statistical methods to organize the data with engineering management knowledge and insights concerning process operations. This approach entails the use of control charts, count charts, X-charts, U-charts, distribution charts, and standard data evaluation and analysis techniques. This allows the tracking of safety issues and occurrences.

The analysis is used to assess facility operating information for trends and indications of deteriorating or improving conditions, and to identify lessons learned and good practices in order to prevent problems and improve safety and operations. Similarly, DOE line management is required to trend and analyze operational information to provide feedback to the contractor.

b) Determine what type of assessment should be performed and in what areas using an actual list of performance indicators.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

c) Analyze incident/occurrence report data for a specified period for safety trends or compliance problems and communicate results to workers and management.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

d) Describe OSHA's injury and illness record keeping and the DOE Computerized Accident/Incident Reporting System (CAIRS) and subsequent uses in safety trending.

The data contained in CAIRS consists of DOE and DOE contractor reports of injury/illness, property damage, and vehicle accident events. It also includes exposure information such as hours worked, miles driven, property valuation, etc., that can be used to calculate accident rates.

Under current procedures, a hard copy of each new or revised CAIRS report is submitted by the reporting organizations to the CAIRS Data Coordinator for processing. The CAIRS Data Coordinator distributes reports to data entry personnel and verifies accurate data entry. In the near future, the system will allow direct field input of reports.

The information contained in CAIRS provides a centralized collection of DOE accident data for users to perform various analyses, including developing trends and identifying potential hazards. The results of these analyses can be used to evaluate safety and health performance, to analyze causes of inadequate performance, to define and prioritize means for improvement of safety and health performance, and to determine the need for modification of DOE safety and health requirements in order to reduce the probability of future accidents.

3. Occupational safety personnel shall demonstrate expert-level knowledge of safety considerations associated with industrial operations.

a) Describe common industrial operations (e.g., maintenance, production, testing, inspection, and setup [both facility and equipment]) and related activities (e.g., welding, material handling, machining, cleaning, and coating), including the safety interfaces necessary to protect workers and safely perform work.

A thorough discussion of OSHA requirements are discussed in: http://www.osha-slc.gov/.

DOE O 420 provides input for facility and equipment safety in the areas or nuclear safety and explosive safety. These requirements are spelled out in other documents within the DOE.

There are many general safety interfaces that are used to protect workers from common industrial and maintenance operations. Some are listed below.

Activity	Safety Interfaces
Welding	Fire protection, fire watches, personnel protection (i.e., railings, eye protection, protective clothing), health protection, ventilation, etc.
Material handling	Sufficient clearances when using mechanical handling equipment, good housekeeping practices, secure storage, clearance signs, derail and/or bumper blocks on spur railroad tracks, guarding over pits, tanks, vats, and ditches, etc.
Machining	Machine guarding, work rests, repairs and maintenance, engineering design, safety devices, etc.
Cleaning	Drains and traps, chip guarding, personal protective clothing, ventilation, solvent selection, fire protection, etc.
Coating	Ventilation, good housekeeping practices, personal protective clothing, fire protection, drying spaces, spray booths, etc.

b) Describe safety considerations associated with placement of operations and equipment (i.e., location of personnel in the proximity of moving equipment or parts, traffic patterns, and structural support for equipment).

The placement of operations activities and the location of equipment is an important safety concern. Sufficient clearances should be ensured when using mechanical handling equipment. Housekeeping must be maintained to ensure access and movement. Storage of material must be secure to maintain clear aisles and passageways. Signs must also be posted that indicate the amount of clearance provided. Structural support must also be adequate to hold necessary equipment and operations.

c) Outline point of operation hazards associated with workplace equipment and describe appropriate machine guarding principles.

Point of operation hazards exist in machinery at the point at which cutting, shaping, boring, or forming is accomplished on the stock. A machine guard is a barrier that prevents entry of the operator's hands or fingers into the point of operation. There are several OSHA requirements regarding machine guarding. 29 CFR Part 1910.212(a) states that "One or more methods of machine guarding shall be provided to protect the operator and other employees in the machine area from hazards such as those created by point of operation, ingoing nip points, rotating parts, flying chips, and sparks." For more information, refer to the Machinery and Machine Guarding Surveillance Guide, prepared by the Oak Ridge Operations Office for the DOE.

d) Describe common concerns and associated control measures that must be addressed in the workplace environment (e.g., noise, thermal burn hazards, heat stress, vibration, eye hazards, workplace illumination, and lasers).

The following matrix identifies possible effects and control measures related to several workplace environmental hazards.

Workplace Environmental Hazards and Control Measures	
Hazard	**Control Measures**
Noise	Exposure time limitations
	Hearing protection
	Noise reduction at the source
	Noise dampening
Thermal Burns	Engineering design
	Insulation
	Guards
	Personal protective clothing
Heat Stress	Acclimatization periods
	Work and rest regimens
	Distribution of work load with time
	Regular breaks
	Provision for water intake
	Protective clothing
	Application of engineering controls
Eye Hazards	Face shields
	Goggles and/or safety glasses
	Machine guards
	Hand shields
	Welding helmets
Illumination	Auxiliary lighting
	Engineering design
Lasers	Minimize exposure
	Eye protection

e) Address the following confined space hazard considerations for industrial operations:

- **Describe the characteristics of a confined space hazard**
- **Identify potential construction-related confined space locations**
- **Identify and discuss the application of confined space entry procedures**

Working in confined spaces presents challenges that require planning and management of these spaces. Confined spaces are typically difficult to enter and exit, especially in an emergency. They may also contain hazardous atmospheres and other safety hazards, as described below, that could cause serious physical injury or death. General safety hazards in confined spaces include communication problems, entry and exit limitations, fall hazards, physical and mechanical hazards, etc.

Hazardous Atmospheres

The internal atmospheres of confined spaces may be oxygen deficient, flammable or explosive, toxic, or oxygen enriched, which may result in the risk of suffocation, fire and explosion, or impaired physical capability for persons entering these spaces. A hazardous atmosphere is defined by its potential to disable and/or injure those exposed. It may be characterized by how much it differs from the normal air we breathe. Normal air is defined as approximately 21 percent oxygen, 73 percent nitrogen, a trace of carbon dioxide, and a very small trace of other gases such as argon. If levels of these constituents change, whether up or down in concentration, then the atmosphere is considered hazardous.

Asphyxiating atmospheres. Oxygen deficiency may be caused by oxidation reactions such as fire or rusting. It also can take place during combustion of flammable substances, as in welding, heating, cutting, and brazing. Other causes for oxygen deficiency include the dilution of air with an inert gas (e.g., nitrogen or argon) and absorption by grains, chemicals, or soils. Normal air contains 20.9 percent oxygen; once the level drops below 9.5 percent, the air becomes hazardous to breathe. As the level of oxygen is decreased in a space, the danger of asphyxiation for anyone entering that space increases. Oxygen deficiency provides minimal sensory warning. Symptoms may include ringing in the ears, dizziness, and impaired cognitive functions. The victim may initially feel giddy and be otherwise impaired in his/her ability to sense the onset of problems.

Toxic atmospheres. Toxic gases and vapors come from the evaporation of fuel and solvents, or may be formed in the process of fermentation, or during decomposition of both animal and vegetable material. Welding or brazing with metals such as mild steel, high-strength steel, and stainless steel, produces toxic metal fumes and hazardous gaseous byproducts. Recirculation of diesel exhaust emissions will also create a toxic atmosphere.

Flammable and explosive atmospheres. This condition generally arises from vaporization of flammable liquids (fuels or solvents); byproducts of work, such as spray painting and welding; chemical reactions; concentrations of combustible dusts; and desorption of chemicals from inner surfaces of the confined space. Welding or other hot work may liberate flammable vapors from combustible liquids previously stored in a compartment. Gas-free procedures must evaluate not only the present material stored in an area, but also the contents of previous cargoes and adjacent spaces.

Other Common Confined Space Challenges

Communication problems. If a worker in a confined space should suddenly feel distressed and is not be able to summon help, an injury could become a fatality. Frequently, the body positions that are assumed in a confined space make it difficult for the standby person to detect an unconscious worker. Visual monitoring of the worker is often not possible because of the design of the confined space or location of the entry hatch. Effective process management and supporting OSHA regulations require provision for communication between worker and monitor and the means for emergency rescue, which must be identified before confined space entry.

Entry and exit limitations. The time it takes to enter and exit confined spaces may increase the hazards of exposure to the confined space atmosphere.

Other physical hazards. While working in a confined space, workers can become fatigued or be exposed to extreme heat and cold, hazardous noise levels, vibration, or radiation. Drowning hazards include engulfment in sludge and other liquids. Additional physical hazards include inadvertent contact with electrical, rotating, or mechanical equipment, steam or other sources of burning heat, and moving parts.

Monitoring and display of fluid levels inside tanks. Traditionally, tanks installed in a facility used float-type tank level indicators to monitor and display fluid levels in the tanks. These indicators consisted of a series of floats that were wired together inside of the tanks. The floats contained many internal electronic components to determine the tank fluid level. Whenever the floats needed maintenance, the tanks would have to be drained, opened, and freed of harmful gases before workers could enter them.

Fall hazards in confined spaces. Confined spaces also present the risk of slips, trips, and falls, especially where corrosion has caused rust, which damages ladders, walking surfaces, and anchor points for personal fall arrest systems. Many tanks have no proper fall protection equipment, anchors, or ladders inside. Tanks can be as deep as 60 feet, requiring scaffolding to be set up to perform maintenance. Scaffolding can present another fall hazard.

Recommendations

The first goal should be to eliminate the need to enter confined spaces for maintenance, repairs, or other purposes. Where confined space entry is unavoidable, it is best to minimize the hazards involved in working in a confined space at the ship design stage and during the initial installation of ship equipment.

Provide remote monitoring and inspection systems. Remote monitoring/inspection systems and automated cleaning systems eliminate or minimize the need for confined space entry. For example, the float-type tank level indicators can be replaced with non-intrusive radar tank level indicators. The radar indicators are mounted externally to the tank. The radar indicator sends a pulse down the tank that is reflected off the fluid level and the indicator measures the time it takes for the signal to return. The shorter the return time, the higher the fluid level is inside the tank. This signal is then converted into depth in inches to determine tank height. Existing sounding tables can be used to convert the reading from inches into gallons.

Radar indicators are more accurate than the existing float-type tank level indicators. Radar indicators can measure fluid level to within one inch and are virtually maintenance free. If a unit fails, it can be replaced with a new one and reprogrammed in about one hour because everything is external to the tank. It would take days to replace the old float-type indicators. Tanks would have to be drained, opened, and freed of harmful gases before personnel could enter the confined space. Replacement of float-type level indicators with non-intrusive radar indicators helps to eliminate the need for confined space entry inspection.

Other examples of remote monitoring/inspection systems and automated cleaning systems include

- the use of filters and external pumps to mix the water in tanks, or an automated self-cleaning system to avoid the build-up of sludge in tanks;
- the use of self-propelled video inspection units (some rated for use in hazardous locations), telescopic video inspection units, or telescopic valve stems to eliminate the need for confined space draining, purging, and entry during inspections.

Provide access for inspection. Not all spaces and tanks will have remote sensing/monitoring, and for these spaces or tanks, safe access must be provided. Condition-based maintenance may require more frequent inspections. Designers should provide for ventilation, isolation of supply and drain lines, control of hazardous energy, and provision of ladders, anchorage, and walkways where possible.

Use materials that reduce the need for maintenance. Designing and selecting equipment should be done on the basis of reducing, and if possible, eliminating, worker exposure in confined spaces. Coating systems should be used that have longer service lives so workers do not need to enter confined spaces often.

Provide adequate ventilation. Ventilation is one of the most effective means of controlling hazardous atmospheres in confined spaces. Providing adequate ventilation in confined spaces avoids build-up of contaminants or combustible atmospheres. Consider designs that will facilitate ventilation of the space. Ventilation modeling, including finite element analysis, may support designs and configurations that reduce purging time, minimize “dead spots,” and facilitate more rapid availability. Factors to consider are listed below:

- Clean air replaces contaminated air by natural or forced (mechanical) ventilation.
- Supply fan intake has to be located away from flammable or toxic air.
- Exhaust fan outlets should be positioned to avoid re-circulation of contaminants.

Prevent invasion of contaminants to confined spaces. Diesel exhaust emissions or chemical exhaust should be prevented from re-circulating into confined spaces.

Design adequate means of entry and exit. Design adequate and convenient means of entry and exit for persons who may be required to wear personal protective equipment, a breathing apparatus, and protective clothing. A good example is to have a “butterworth opening” or separate entry hole for all support equipment so personnel are not required to enter through this same access point. Designers should recognize the need for two hatches for spaces into which workers must enter along with the “butterworth hole” for ventilation. Ventilation ducts or hoses should not impede personnel access or exit through hatches. To avoid costly retrofits, include “butterworth hole” and additional hatch designs before loading is calculated

and the overall design structure is frozen. The same is true for design of lightening holes in tank baffles and girders. These should be positioned so workers can move from section to section of the tank without undue climbing.

Provide fall hazard protection. To prevent fall hazards in confined spaces, provide fixed ladders, platforms, guardrails, and anchor points for personal fall arrest systems. These devices provide a certified anchor point for attachment of scaffolding or anchorages for personal fall arrest systems.

Plan for emergency rescue. Confined spaces that will be entered by ship's crew and shipyard workers should be configured for the removal of injured or unconscious personnel. This means that hatches and trunks should be able to handle various stretchers (Stokes baskets, Oregon spine splint, Reeves sleeve, or stretcher) and be configured to accommodate high-angle rescue. Pad eyes and anchor points should be available for high-angle rescue and hoisting stretchers. Adequate hoisting points should also be provided for movement of materials and equipment.

Consider other design modifications. Confined space hazards can be further reduced by the following measures:

- Provide suitable illumination that will be sufficient for safe entry, conducting work, and exiting.
- Provide sufficient room for persons to work in other than stooped or cramped positions.
- Use catalytic converters and ventilation to prevent buildup of carbon monoxide levels in confined spaces.
- Provide a voice or alarm-activated explosion-proof type of communication system if visual monitoring of the worker is not available because of the design of the confined space or location of the entry hatch.

Make improvements in personal protective equipment. In situations where DOE or contractor personnel find it necessary to enter a confined space, proper personal protective equipment must be used. This may include breathing devices, such as the supplied-air respirator, with a backup self-contained breathing apparatus (SCBA). For ventilating confined spaces, facilities typically use a fire main, pressure-driven exhaust fan with elephant trunks. Protective clothing, such as chemically resistant coveralls and rubber gloves, can protect personnel entering confined spaces from developing occupational dermatitis or from absorbing toxic hazards through their skin.

f) Describe industrial-related electrical considerations (e.g., temporary wiring, grounding, and exposed electrical wires, equipment, or parts).

Title 29 CFR 1926 covers each of the following areas in detail.

Temporary wiring. Title 29 CFR 1926.405 addresses temporary wiring. General requirements exist related to the following:

- Origination of feeders and branch circuits
- Location of branch-circuit conductors
- Types of receptacles
- Disconnect switches

- Lamp guards
- Temporary light suspension
- Portable electric lighting
- Cable and raceway systems
- Protection of flexible cords and cable
- Extension cords

Grounding. Title 29 CFR 1926.404 covers grounding and includes the following general requirements:

- Use of ground fault circuit interrupters or an assured equipment grounding conductor program
- Identification of conductors
- Polarity of connections
- Use of grounding terminals and devices

Exposed wires, equipment, or parts. Title 29 CFR 1926.403 covers guarding. General requirements state that guarding shall be provided to prevent access of other than authorized and qualified personnel.

g) Define the following hazards and appropriate controls use associated with hoisting and rigging equipment and operations:

- **Crane load tests and inspection requirements**
- **Effects of boom angle and length on load limits**
- **Major signs of stress, strain, or other deterioration that must be evaluated when inspecting rigging equipment**
- **Overhead power lines**
- **Appropriate lifting techniques and limitations including the relationship between the crane operator and the guide**
- **Potential hazards associated with the use of suspect counterfeit parts.**

Operating practices listed in 29 CFR 1926.251, 1926.550, and 1926.554 discuss the hoisting and rigging rules. Dealing with suspect counterfeit parts is discussed in http://www.eh.doe.gov/docs/bull/bull0082.html.

h) Identify sources of potential fall hazards and recommend appropriate controls.

There are a large number of possible fall hazards. The following table illustrates some examples.

Potential Fall Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Tripping	Housekeeping
	Proper illumination
	Guardrails and handrails
Slipping	Housekeeping
	Safety shoes with nonskid soles
	Level walking surfaces

Potential Fall Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Working at elevations	Safety lines, harnesses, and lanyards
	Ladder and scaffold inspections
	Safety nets
Faulty ladders, scaffolds, or guardrails	Ladder, scaffold, and guardrail inspections
	Written safety policy to never step on top platform of ladder
	Safety cage or rail

i) Identify general personal protective equipment (PPE) requirements and effects of PPE on safety and worker performance for industrial operations.

Application. Protective equipment, including personal protective equipment (PPE), shall be provided, used, and maintained in a sanitary and reliable condition whenever necessary to prevent injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.

Employee-owned equipment. Where employees provide their own protective equipment, the employer shall be responsible to ensure its adequacy, including proper maintenance and sanitation of such equipment.

Design. All PPE shall be of safe design and construction appropriate for the work to be performed.

j) Describe and have a working knowledge of the Hazardous Waste Operations and Emergency Response Regulations (HAZWOPER) activities at a waste site.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

k) Outline the elements of an effective decontamination and decommissioning program, including HAZWOPER activities.

There are a number of considerations associated with decontamination and decommissioning operations. Some of them are detailed below.

Structural Support Considerations

Prior to starting all demolition operations, OSHA standard 1926.850(a) requires that an engineering survey of the structure be conducted by a competent person. The purpose of this survey is to determine the condition of the framing, floors, and walls so that measures can be taken, if necessary, to prevent the premature collapse of any portion of the structure. When indicated as advisable, any adjacent structure(s) or improvements should also be similarly checked. If the structure to be demolished has been damaged by fire, flood, explosion, or

some other cause, appropriate measures, including bracing and shoring of walls and floors, shall be taken to protect workers and any adjacent structures.

Need for Project Planning and Activity Hazard Analysis

Before the start of every demolition job, the demolition contractor should take a number of steps to safeguard the health and safety of workers at the job site. These preparatory operations involve the overall planning of the demolition job, including the methods to be used to bring the structure down, the equipment necessary to do the job, and the measures to be taken to perform the work safely. Planning for a demolition job is as important as actually doing the work.

Hazards Associated with Debris Removal and Appropriate Removal Techniques

Various hazards are associated with the removal of debris. Several OSHA requirements relate to the removal of debris. General precautions include the following:

- When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades.
- Signs to warn of the hazard of falling materials shall be posted at each level.
- Sign removal shall not be permitted in the lower area until debris handling ceases above.
- Any chute opening into which workmen dump debris shall be protected by a substantial guardrail.
- Walls that are to serve as retaining walls against which debris will be piled shall not be so used unless capable of safely supporting the imposed load.
- Before demolishing any floor arch, debris and other material shall be removed from such arch and other adjacent floor areas.
- The storage of waste material and debris on any floor shall not exceed the allowable floor loads.

Hazards Associated with Remaining Energy Sources, Equipment, and Materials

One of the most important elements of the prejob planning is the location of all utility services. All electric, gas, water, steam, sewer, and other service lines should be shut off, purged (if necessary), capped, or otherwise controlled at or outside the building before demolition work is started. In each case, any utility company that is involved should be notified in advance, and its approval or services, if necessary, shall be obtained.

If it is necessary to maintain power, water, or other utilities during demolition, such lines shall be temporarily relocated as necessary and/or protected. The location of all overhead power sources should also be determined, as they can prove especially hazardous during any machine demolition. All workers should be informed of the location of any existing or relocated utility service.

It shall also be determined if any type of hazardous chemicals, gases, explosives, flammable material, or similar dangerous substances have been used or stored on the site. If the nature of a substance cannot be easily determined, samples should be taken and analyzed by a qualified person prior to demolition. The hazardous materials may have to be removed prior to the start of demolition.

l) Discuss elements of hazard communications within industrial operation involving special programs (e.g., nonsmoking work environment program, vehicle safety, violence in the workplace, asbestos, silica, lead, beryllium, blood-borne pathogens, and infectious diseases).

Purpose

Evaluating the potential hazards of chemicals, and communicating information concerning hazards and appropriate protective measures to employees, may include, for example, but is not limited to, provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of material safety data sheets to employees and downstream employers; and development and implementation of employee training programs regarding hazards of chemicals and protective measures.

According to 29 CFR 1910.1200, under section 18 of the Occupational Safety and Health Act (OSH Act), no state or political subdivision of a state may adopt or enforce, through any court or agency, any requirement relating to the issue addressed by this federal standard, except pursuant to a federally approved state plan.

Scope and Application

The OSH Act requires chemical manufacturers or importers to assess the hazards of chemicals they produce or import, and all employers to provide information to their employees about the hazardous chemicals to which they are exposed, by means of a hazard communication program, labels and other forms of warning, material safety data sheets, and information and training. In addition, this section requires distributors to transmit the required information to employers.

This section applies to any chemical which is known to be present in the workplace in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency.

This applies to laboratories only as follows:

- Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
- Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible during each work shift to laboratory employees when they are in their work areas.
- Employers shall ensure that laboratory employees are provided information and training in accordance with the training requirements.
- Laboratory employers that ship hazardous chemicals are considered to be either a chemical manufacturer or a distributor under this rule, and thus must ensure that any containers of hazardous chemicals leaving the laboratory are labeled correctly in accordance with the material safety data sheet.

In work operations where employees only handle chemicals in sealed containers that are not opened under normal conditions of use, this section applies only as follows:

- Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.
- Employers shall maintain copies of any material safety data sheets that are received with incoming shipments of the sealed containers of hazardous chemicals, shall obtain a material safety data sheet as soon as possible for sealed containers of hazardous chemicals received without a material safety data sheet if an employee requests the material safety data sheet, and shall ensure that the material safety data sheets are readily accessible during each work shift to employees when they are in their work area(s).
- Employers shall ensure that employees are provided with information and training on hazards.

m) Describe non-ionizing radiation hazards and appropriate control measures.

The following matrix identifies control measures related to non-ionizing radiation hazards.

Non-Ionizing Radiation Hazards and Control Measures		
Radiation Form	**Possible Effects**	**Control Measures**
Ultraviolet Radiation	Suntan	Minimize exposure
	Sunburn	Eye protection
	Eye injury	Skin creams
	Cataracts	
	Decreased skin elasticity	
	Skin cancer	
Visible Energy	Headaches	Vary amount or type of lighting
	Eye fatigue	Reduce glare
Infrared Radiation	Increased tissue temperature	Minimize exposure
	Burns	Protective eyewear
	Eye injury	Face shields
Microwaves and Radio Waves	Increased tissue temperature	Minimize exposure
	Burns	Shielding
	Cataracts	Door interlocks
Power Transmission	Circadian rhythm disruption	Minimize exposure
	Diminished field perception	Shielding

Non-Ionizing Radiation Hazards and Control Measures		
Radiation Form	**Possible Effects**	**Control Measures**
Radar	Effects of x-ray radiation (if high voltage)	Minimize exposure
	Increased tissue temperature	Periodic medical examinations
	N/A	Use of microwave absorber
Lasers	Eye injury	Minimize exposure
	Skin injury	Eye protection

4. Occupational safety personnel shall demonstrate an expert-level knowledge of electricity and electrical hazards and controls to enable them to develop, implement, and evaluate an electrical safety program.

a) Describe general terminology associated with electricity and electrical hazards.

Conductors

Conductors are materials with electrons that are loosely bound to their atoms, or materials that permit free motion of a large number of electrons. Atoms with only one valence electron, such as copper, silver, and gold, are examples of good conductors. Most metals are good conductors.

Insulators

Insulators, or nonconductors, are materials with electrons that are tightly bound to their atoms and require large amounts of energy to free them from the influence of the nucleus. The atoms of good insulators have their valence shells filled with eight electrons, which means they are more than half filled. Any energy applied to such an atom will be distributed among a relatively large number of electrons. Examples of insulators are rubber, plastics, glass, and dry wood.

Resistors

Resistors are made of materials that conduct electricity, but offer opposition to current flow. These types of materials are also called semiconductors because they are neither good conductors nor good insulators. Semiconductors have more than one or two electrons in their valence shells, but less than seven or eight. Examples of semiconductors are carbon, silicon, germanium, tin, and lead. Each has four valence electrons.

Voltage

The basic unit of measure for potential difference is the volt (symbol V), and because the volt unit is used, potential difference is called voltage. An object's electrical charge is determined by the number of electrons that the object has gained or lost. Because such a large number of electrons move, a unit called the "coulomb" is used to indicate the charge. One coulomb is equal to 6.28 x 1018 (billion, billion) electrons. For example, if an object gains one coulomb

of negative charge, it has gained 6,280,000,000,000,000,000 extra electrons. A volt is defined as a difference of potential causing one coulomb of current to do one joule of work. A volt is also defined as that amount of force required to force one ampere of current through one ohm of resistance.

Current

The density of the atoms in copper wire is such that the valence orbits of the individual atoms overlap, causing the electrons to move easily from one atom to the next. Free electrons can drift from one orbit to another in a random direction. When a potential difference is applied, the direction of their movement is controlled. The strength of the potential difference applied at each end of the wire determines how many electrons change from a random motion to a more directional path through the wire. The movement or flow of these electrons is called electron current flow, or just current.

To produce current, the electrons must be moved by a potential difference. The symbol for current is (I). The basic measurement for current is the ampere (A). One ampere of current is defined as the movement of one coulomb of charge past any given point of a conductor during one second of time. If a copper wire is placed between two charged objects that have a potential difference, all of the negatively-charged free electrons will feel a force pushing them from the negative charge to the positive charge.

Real and Ideal Sources

An ideal source is a theoretical concept of an electric current or voltage supply (such as a battery) that has no losses and is a perfect voltage or current supply. Ideal sources are used for analytical purposes only since they cannot occur in nature. A real source is a real life current or voltage supply that has some losses associated with it.

Schematic Diagram

Schematic diagrams are the standard means by which we communicate information in electrical and electronics circuits. On schematic diagrams, the component parts are represented by graphic symbols. Because graphic symbols are small, it is possible to have diagrams in a compact form. The symbols and associated lines show how circuit components are connected and the relationship of those components with one another.

One-Line Diagram

The one-line, or single-line, diagram shows the components of a circuit by means of single lines and the appropriate graphic symbols. One-line diagrams show two or more conductors that are connected between components in the actual circuit. The one-line diagram shows all pertinent information about the sequence of the circuit, but does not give as much detail as a schematic diagram. Normally, the one-line diagram is used to show highly complex systems without showing the actual physical connections between components and individual conductors.

Block Diagram

A block diagram is used to show the relationship between component groups, or stages in a circuit. In block form, it shows the path through a circuit from input to output. The blocks are drawn in the form of squares or rectangles connected by single lines with arrowheads at

the terminal end, showing the direction of the signal path from input to output. Normally, the necessary information to describe the stages of components is contained in the blocks.

Wiring Diagram

A wiring diagram is a very simple way to show wiring connections in an easy-to-follow manner. These types of diagrams are normally found with home appliances and automobile electrical systems. Wiring diagrams show the component parts in pictorial form, and the components are identified by name. Most wiring diagrams also show the relative location of component parts and color coding of conductors or leads.

Resistivity

Resistivity is defined as the measure of the resistance a material imposes on current flow. The resistance of a given length of conductor depends upon the resistivity of that material, the length of the conductor, and the cross-sectional area of the conductor. The resistivity (r) allows different materials to be compared for resistance, according to their nature, without regard to length or area. The higher the value of r, the higher the resistance will be.

Temperature Coefficient of Resistance

Temperature coefficient of resistance, a (alpha), is defined as the amount of change of the resistance of a material for a given change in temperature. A positive value of "a" indicates that "R" increases with temperature; a negative value of "a" indicates "R" decreases; and zero "a" indicates that "R" is constant.

Electric Circuit

Each electrical circuit has at least four basic parts: (1) a source of electromotive force, (2) conductors, (3) load or loads, and (4) some means of control. A closed circuit is an uninterrupted, or unbroken, path for current from the source through the load, and back to the source. An open circuit, or incomplete circuit, exists if a break in the circuit occurs; this prevents a complete path for current flow.

Short Circuit

A short circuit is a circuit which offers very little resistance to current flow and can cause dangerously high current flow through a circuit. Short circuits are usually caused by an inadvertent connection between two points in a circuit which offers little or no resistance to current flow.

Series Circuit

A series circuit is a circuit where there is only one path for current flow. In a series circuit, the current will be the same throughout the circuit.

Parallel Circuit

Parallel circuits are those circuits which have two or more components connected across the same voltage source. Each parallel path is a branch with its own individual current.

Equivalent Resistance

In a parallel circuit, the total resistance of the resistors in parallel is referred to as equivalent resistance. This can be described as the total circuit resistance as seen by the voltage source.

In all cases, the equivalent resistance will be less than any of the individual parallel circuit resistors. Using Ohm's Law, equivalent resistance (REQ) can be found by dividing the source voltage (V) by the total circuit current (IT).

b) Define specific terminology applicable to the following:

- **Measurement of electricity**
- **Power systems**
- **Electrical distribution systems**
- **Protective devices**
- **Control measures**

Measurement of Electricity

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Real and ideal sources. An ideal source is a theoretical concept of an electric current or voltage supply (such as a battery) that has no losses and is a perfect voltage or current supply. Ideal sources are used for analytical purposes only since they cannot occur in nature. A real source is a real life current or voltage supply that has some losses associated with it.

Power Systems

Power triangle. In AC circuits, current and voltage are normally out of phase and, as a result, not all the power produced by the generator can be used to accomplish work. By the same token, power cannot be calculated in AC circuits in the same manner as in DC circuits. The power triangle equates AC power to DC power by showing the relationship between generator output in volt-amperes (VA), usable power in watts, and wasted or stored power volt-amperes-reactive (VAR).

Apparent power. Apparent power (S) is the power delivered to an electrical circuit. The measurement of apparent power is in volt-amperes (VA).

True power. True power (P) is the power consumed by the resistive loads in an electrical circuit. The measurement of true power is in watts.

Reactive power. Reactive power (Q) is the power consumed in an AC circuit because of the expansion and collapse of magnetic (inductive) and electrostatic (capacitive) fields. Reactive power is expressed in volt-amperes-reactive (VAR). Unlike true power, reactive power is not useful power because it is stored in the circuit itself. This power is stored by inductors, because they expand and collapse their magnetic fields in an attempt to keep current constant, and by capacitors, because they charge and discharge in an attempt to keep voltage constant. Circuit inductance and capacitance consume and give back reactive power. Reactive power is a function of a system's amperage.

Total power. The total power delivered by the source is the apparent power. Part of this apparent power, called true power, is dissipated by the circuit resistance in the form of heat. The rest of the apparent power is returned to the source by the circuit inductance and capacitance.

Power factor (pf) is the ratio between true power and apparent power. True power is the power consumed by an AC circuit, and reactive power is the power that is stored in an AC circuit.

Electrical Distribution Systems

Ampacity. Ampacity is the current in amperes that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Bond. The bond is the permanent joining of metallic parts or circuits, assuring electrical continuity and capacity to safely conduct any current likely to be imposed.

Conductor. A conductor is any wire, cable, or substance capable of carrying an electrical current.

Ground. A ground is a conducting connection, whether intentional or accidental, between a circuit or piece of equipment and the earth, or some body serving as earth; a place of zero electrical potential.

Ground voltage. Ground voltage is the voltage between any given conductor and any point at ground potential.

Leg. A leg is a current-carrying conductor intended to deliver power to or from a load normally at an electrical potential other than ground.

Neutral. The neutral is a current-carrying conductor normally tied to ground so that the electrical potential is zero.

Phase voltage. Phase voltage is the greatest root mean square (effective) difference of potential between any two legs of the circuit.

Protective Devices

Protective relays. Protective relays are designed to cause the prompt removal of any part of a power system that might cause damage or interfere with the effective and continuous operation of the rest of the system. Protective relays are aided in this task by circuit breakers that are capable of disconnecting faulty components or subsystems. Protective relays can be used for types of protection other than short circuit or over current. The relays can be designed to protect generating equipment and electrical circuits from any undesirable condition, such as under voltage, under frequency, or interlocking system lineups. There are only two operating principles for protective relays: (1) electromagnetic attraction, and (2) electromagnetic induction. Electromagnetic attraction relays operate by a plunger being drawn up into a solenoid or an armature that is attracted to the poles of an electromagnet. This type of relay can be actuated by either DC or AC systems. Electromagnetic induction relays operate on the induction motor principle whereby torque is developed by induction in a rotor. This type of relay can be used only in AC circuits.

Overlapping protective zones. A separate zone of protection is provided around each system element. Any failure that may occur within a given zone will cause the tripping or opening of all circuit breakers within that zone. For failures that occur within a region where two protective zones overlap, more breakers will be tripped than are necessary to disconnect the faulty component; however, if there were no overlap of protective zones, a fault in a region between the two zones would result in no protective action at all. Therefore, it is desirable for protective zones to overlap to ensure the maximum system protection.

Fuses. A fuse is a device that protects a circuit from an over current condition only. It has a fusible link directly heated and destroyed by the current passing through it. A fuse contains a current-carrying element sized so that the heat generated by the flow of normal current

through it does not cause it to melt the element; however, when an over current or short-circuit current flows through the fuse, the fusible link will melt and open the circuit. There are several types of fuses in use.

The plug fuse is a fuse that consists of a zinc or alloy strip, a fusible element enclosed in porcelain or Pyrex housing, and a screw base. This type of fuse is normally used on circuits rated at 125 V or less to ground and has a maximum continuous current-carrying capacity of 30 amps. The cartridge fuse is constructed with a zinc or alloy fusible element enclosed in a cylindrical fiber tube with the element ends attached to a metallic contact piece at the ends of the tube. This type of fuse is normally used on circuits rated at either 250 volts or 600 volts, and has a maximum continuous current-carrying capacity of 600 amps.

Control Measures

A control measure is a system or device used, or action taken, to control or prevent the introduction of physical hazards into a confined space. Control measures include isolation and lockout-tagout.

Isolation is the process by which an energy source is removed from service and completely protected against the release of energy and material into the space by such means as: blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; a double block and bleed system; lockout or tagout of all sources of energy; or blocking or disconnecting all mechanical linkages.

Lockout-tagout means placing locks or tags on the energy isolating device (e.g. breaker boxes, control switches, valves, etc.) to prevent the unauthorized re-energization of the device or circuit while work is being performed by personnel. Tags shall indicate that the energy isolated device must not be operated until the tag is removed by the individual(s) that installed the tag.

c) Describe major safety concerns and appropriate control measures for working on or near live electrical equipment (e.g., proper use of lockout/tagout procedures).

The major safety concern for working on electrical equipment is the possibility of being shocked. This can happen by direct contact or indirect contact with equipment, or by arcing if a large enough potential exists.

To protect employees from some of the electrical hazards at industrial sites, federal regulations limit the performance of electrical work to qualified and competent personnel. Specifically, the law requires that only a qualified person, or someone working under the direct supervision of a qualified person, may perform any repair, installation, or testing of electrical equipment. One of the best ways to prevent electrical accidents at industrial sites is to be aware of electrical dangers in the workplace. Once hazards have been identified, they must be pointed out and proper steps taken by a qualified person.

The following will improve the safety of the workplace:

- Maintain good housekeeping and cleanliness.
- Identify and diminish potential hazards.
- Anticipate problems.
- Resist pressure to "hurry up."
- Plan and analyze for safety in each step of a project.
- Document work.
- Use properly rated test equipment and verify its condition and operation before and after use.
- Know and practice applicable emergency procedures.
- Become qualified in cardiopulmonary resuscitation (CPR) and first aid, and maintain current certifications.
- Wear appropriate personal protective equipment (PPE).
- Refer to system drawings and perform system walkdowns.
- Maintain electrical equipment in accordance with the manufactures instructions.

d) Describe the use, function, and appropriate application of PPE designed to protect workers from identified electrical hazards.

Personal protective equipment ranges from rubber gloves, insulation, mats, and blankets to the specialized tools used. All this equipment must be considered when analyzing an electrical safety program. The standards of the American National Standards Institute (ANSI) direct PPE use and application.

e) Identify necessary training required for employees who face a risk of electric shock.

Below is a summary of training requirements found in 29 CFR 1910.332, Training, of subpart S, Electrical:

- The training requirements apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.
- Employees who face such a risk are required to be trained. The CFR targets occupations requiring training in Table S-4. Other employees who also may reasonably be expected to face a comparable risk of injury due to electric shock or other electrical hazards must also be trained.
- Qualified persons (i.e., those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:
  - The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment
  - The skills and techniques necessary to determine the nominal voltage of exposed live parts
  - The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed

The degree of training provided depends on the risk to the employee.

f) Identify specific safety-related work practices for a work place scenario, consistent with the nature and extent of associated electrical hazards.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

g) Describe first aid procedures for electrical shock.

If the victim is still in contact with or is close to a high-voltage electric current, do not attempt to rescue the victim. Insulating material, like rubber or dry wood, will not protect you against such high voltages. Get medical and police aid immediately. Stay at least 60 feet or 18 meters away from the victim, and wait until being informed that it is safe to give any first aid. It is usually safe to attempt to rescue a victim in contact with low-voltage current from a domestic power supply. Make sure you take the correct precautions during a rescue. Call for emergency medical help even if you decide to attempt a rescue. Examine the victim for injuries and give appropriate first-aid treatment. Only attempt a rescue if the victim is in contact with a low-voltage electric current. Cut off the current. If this is not possible, stand on some dry insulating material (wood or newspaper). Break the victim from electrical contact using dry wood, rubber, plastic, or newspaper (a wooden broom handle would work). Carefully observe the victim's breathing and heartbeat. If the victim is not breathing, give artificial respiration. If the victim's heart has stopped, give cardiopulmonary resuscitation immediately. If the victim has also stopped breathing and no help is available, alternate between CPR and giving artificial respiration. If both the victim's heart and breathing has stopped, but you have help available, one person should kneel at the victim's left shoulder to give a cardiac massage, while the other kneels at the right side to give mouth-to-mouth resuscitation. The person giving a cardiac massage should press the victim's chest over the area of the heart at a rate slightly quicker than once a second. The person giving artificial respiration should breathe into the victim once every five seconds.

h) Identify and discuss the application and function of major safety requirements and protective devices associated with electrical equipment and wiring in locations that are classified as hazardous.

DOE Order 5480.19, Attachment I, discusses the major safety concerns and appropriate control measures for working on or near electrical equipment.

i) Identify potential electrical hazards for a given process, operation, or piece of equipment; locate, interpret, and apply requisite requirements and/or standards; and recommend suitable or mandated control measures.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

j) Discuss the need for, selection, use, and performance of electrical tools and equipment with their uses and limitations.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

5. Occupational safety personnel shall demonstrate an expert-level knowledge of hazard analysis techniques and the application of hazard control methods and abatement activities.

a) Describe the preferred hierarchy of hazard control methods.

The preferred hierarchy of hazard control methods is to use engineering controls first, then administrative controls, with personal protective equipment as the last choice. This approach minimizes human intervention with the hazard.

b) Identify common types of engineering and administrative controls and discuss the applicability of each.

Engineering controls eliminate or reduce exposure to a chemical or physical hazard through the use or substitution of engineered machinery or equipment. Examples include self-capping syringe needles, ventilation systems such as a fume hood, sound-dampening materials to reduce noise levels, safety interlocks, and radiation shielding.

Administrative controls will not eliminate hazards, but they can reduce worker exposure to them. Some examples are listed below:

- Reschedule work to a time when fewer workers will be exposed.
- Rotate jobs so that each person is exposed for a shorter time.
- Extend rest periods. (This can be useful in preventing and reducing repetitive motion injury.)
- Increase the number of workers assigned to a task.

c) Outline appropriate actions when responding to the report or discovery of an imminent danger situation.

The following outline identifies information and procedures required to be able to respond to an imminent danger situation.

- Facility identification and general information
  - Name of facility
  - Address of facility
  - Name, title, home address, and telephone number (office and home) of primary emergency coordinator
  - Type of facility
  - Site plan
  - Description of generator, TSDF activities
- Emergency coordinator
  - Primary coordinator
  - Alternate coordinators
  - Duties and authority to commit resources
- Implementation of the contingency plan
  - Spills
  - Fires
  - Explosions

- Emergency response procedures for spills, fires, and explosions
  - Immediately upon discovery of an emergency (Notification)
  - During the emergency control phase (Control and Containment)
  - Following attainment of control (Follow-up)
- Emergency equipment
  - Emergency equipment inventory
  - Location of emergency equipment (facility diagram)
  - Equipment capabilities
  - Emergency equipment available from other sources
- Coordination agreements and telephone numbers
  - Police
  - Fire
  - Hospital
  - Other emergency response units
  - Spill contractors
- Evaluation plan
  - When to evacuate
  - Signals to begin evacuation
  - Primary evacuation routes
  - Alternate evacuation routes
- Required reports
  - Incident report
  - Notification of compliance before resuming operations
- Amendment of contingency plan
  - Revised regulations
  - Facility change
  - Emergency coordinator change
  - Emergency equipment change

d) Define the elements and appropriate application of a hazard abatement program.

Title 40 CFR 52 contains the requirements of an abatement program.

e) Outline benefits of applying hazard analysis techniques during the design phase of a facility, operation, process, or piece of equipment.

Non-reactor nuclear facilities shall be designed with the objective of providing multiple layers of protection to prevent or mitigate the unintended release of radioactive materials to the environment. Identifying the processes during the design phase will allow for identification of potential hazards prior to building a facility. This process will help minimize construction issues that may affect the safety envelope of a city.

f) Analyze a given identified hazard and recommend acceptable control measures, including informing, posting, and abatement.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

g) Discuss the importance of informing affected workers of hazard(s), abatement activities, and other related activities.

The law requires that employees be alerted to all workplace hazards. This includes providing employees with access to applicable material safety data sheets (MSDS) that identify any new hazards that may be introduced to a work area. This is done to protect the worker and the employer. The employee is shown the hazards of the work area, while the employer tries to minimize any injuries or lost work time.

h) Identify circumstances and trade-offs warranting PPE use as a hazard-control method.

PPE may be used for hazard control whenever it is necessary to protect against hazards of processes or environment, chemical hazards, or mechanical irritants that are capable of causing injury or impairment to the function of any part of the body through absorption, inhalation, or physical contact.

i) Describe various types and intended functions of PPE.

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part	**PPE**	**Purpose**
Eyes and face	Face shield	Protects against chemical splashes
	Splash hood	Protects against chemical splashes
	Safety glasses	Protect eyes against large particles and projectiles
	Goggles	Can protect against vaporized chemicals, splashes, large particles, and projectiles
	Sweat bands	Prevent sweat-induced eye irritation and vision impairment
Respiratory system	Self-contained respirators	Provide the highest available level of breathing protection against airborne contaminants and apparatus oxygen deficiency
	Supplied-air respirators	Protect against most airborne contaminants and permitted for use in oxygen-deficient atmospheres
	Air-purifying respirators	Protect against specific chemicals and particulates up to specific concentrations
Hands and arms	Gloves and sleeves	Protect hands and arms from chemical contact
Feet	Safety boots	Protect feet from contact with chemicals and from compression, crushing, or puncture by falling, moving, or sharp objects
	Disposable shoes or boot covers	Protect safety shoes or boots from contamination
Head	Safety helmet	Protects head from blows
	Hood	Protects against chemical splashes, particulates, and rain

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part	**PPE**	**Purpose**
	Protective hair covering	Protects hair against chemical contamination or entanglement in machinery or equipment, and prevents hair from interfering with vision or with the functioning of respiratory devices
Full body	Fully encapsulating suit	Protects against splashes, dust, gases, and vapors
	Nonencapsulating suit	Protects against splashes, dust, and other materials, but not against gases and vapors
	Aprons, leggings, and sleeve protectors	Provide additional splash protection for chest, forearms, and legs

j) Describe an effective non-electrical lockout/tagout program and application.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

k) Discuss effective use and application of a job safety analysis system.

Job safety analysis (JSA) is a method that can be used to identify, analyze, and record the steps involved in performing a specific job, and the existing or potential safety and health hazards associated with each step. It also includes the recommended action(s)/procedure(s) that will eliminate or reduce these hazards and the risk of a workplace injury or illness.

The following hazards should be considered when completing a JSA:

- The existing or potential safety and health hazards associated with each step, including
  - impact with a falling or flying object;
  - penetration by sharp objects;
  - being caught in or between a stationary/moving object;
  - falls from an elevated work platform, ladders, or stairs;
  - the need to perform excessive lifting, twisting, pushing, pulling, reaching, or bending;
  - exposure to vibrating power tools, excessive noise, cold or heat, or harmful levels of gases, vapors, liquids, fumes, or dusts;
  - repetitive motion;
  - exposure to electrical hazards;
  - exposure to light (optical) radiation (i.e., welding operations, laser surveying, etc.);
  - exposure to water (potential for drowning or fungal infections caused by wetness).

When conducting analysis

- select jobs with the highest risk for a workplace injury or illness;
- select an experienced employee who is willing to be observed, and involve the employee and his/her immediate supervisor in the process.

l) Describe applicability and purpose of nuclear and non-nuclear hazard analysis techniques required during the life cycle of a DOE facility.

The various hazard analysis techniques may lend themselves to more efficient application at various times during the facility life cycle. The analyst generally will determine which technique to use to analyze hazards/risks according to four primary variables:

- Cost
- Scope, including the scope of hazards as well as those initiators to be analyzed
- Complexity of the facility, structure, system, or component
- Public or political interest

These factors may often be interrelated and may require analyses and iteration to arrive at an acceptable method that will satisfy/address all issues.

m) Discuss the need for, and the selection and performance of, the applicable qualitative and quantitative techniques of system safety analysis, such as the following:

- **Preliminary hazard analysis**
- **Fault tree analysis**
- **Failure modes and effects analysis**
- **Energy trace and barrier analysis**
- **Operating and support hazard analysis**
- **System/subsystem hazard analysis**
- **Process hazard analysis**

Preliminary Hazard Analysis (PHA)

PHA techniques are frequently used when it is desired to include the analysis of event sequences that transform hazards into accidents. The PHA considers corrective measures and consequences of an accident. In general, PHAs attempt to identify the system events and hardware that can lead to hazards. This step is normally performed during the initial design phase so that insights may be incorporated into designs.

Fault Tree Analysis (FTA)

The FTA process is a deductive technique used to identify combinations of equipment failures, other structures or phenomenological events, or external event failures that can result in the transformation of a hazard into an event of concern or an accident. The results are quantitative in nature, which allows relative risk ranking for individual or combinations of failures that may lead to the event of concern and generally unacceptable risk.

Failure Modes and Effects Analysis (FMEA)

The FMEA process is an inductive logic approach to the identification of all possible failure modes and their effects for all equipment on a component-by-component basis. This process identifies single failure modes only in accordance with the requirements of IEEE 279-1971, 10 CFR Appendix K, and Regulatory Guide 1.7. An FMEA is more detailed than a fault tree analysis since all failure modes are considered rather than only considering dominant ones as is typical in a fault tree analysis. As a consequence of the analysis, a qualitative, systematic list of equipment, failure modes, and associated effects is developed. The worst case consequences of a single failure are also given with recommendations for improving safety for individual failures. The end result is the generation of recommendations for increasing equipment reliability, thus improving safety.

Energy Trace and Barrier Analysis

The energy trace and barrier analysis method is a systematic process used to identify physical, administrative, and procedural barriers or controls that should have prevented an occurrence. This technique should be used to determine why these barriers or controls failed and what is needed to prevent recurrence.

Operating and Support Hazard Analysis

Operating and support hazard analysis is a subset of the hazard evaluation process discussed in the next paragraph.

The hazard evaluation process has been performed by the chemical process industry in excess of 35 years. Historically, the process has been known by several different names including process hazard analysis, process hazard review, process safety review, process risk review, predictive hazard evaluation, hazard assessment, process risk survey, and hazard study. To perform a hazard evaluation, all hazards associated with a facility or process to be studied must first be identified. Upon completion of this phase, the hazard evaluation process focuses on the potential causes and consequences associated with those hazards that are created from episodic or catastrophic events. An example would be an accidental release of gas from a storage cylinder. This is opposed to those hazards that routinely exist at a facility or may occasionally occur. An example of these would be slips from ladders, injury from the use of industrial tools such as drills or saws, continuous releases of exhaust gases from internal combustion engines, or intentional process exhaust from a stack. The latter hazards are normally addressed by design considerations and good housekeeping practices. Hazard evaluation, however, attempts to focus on the facility internal SSC failures, external events, and human influenced performance events that may lead to catastrophic releases of energy, toxic, radiological, and biologically harmful materials that may harm the surrounding environment.

System/Subsystem Hazard Analysis

See the hazard evaluation paragraph, above.

Process Hazard Analysis

Process hazard analysis is the application of one or more analytical methods to identify and evaluate process hazards to determine the adequacy of, or need for, control measures.

n) Describe and demonstrate understanding of the Integrated Safety Management approach. Discuss objectives, core functions, and the guiding principles approach to systematically integrate safety into management and work practices at all levels.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

6. Occupational safety personnel shall demonstrate a working-level knowledge of safety in construction operations.

a) Discuss the role of safety and health during project planning and analysis.

As with any project, construction activities are safer and more efficient when an appropriate amount of planning is done. This is particularly important to personnel safety. Construction contractors are required by DOE to evaluate the work associated with each project phase and to identify specific hazards to which worksite employees and other worksite personnel may potentially be exposed. This analysis also provides the data needed to identify appropriate control measures.

b) Describe safety program considerations at multi-employer construction sites.

Multi-employer construction sites offer unique problems for safety programs. Each subcontractor firm is responsible for some form of a safety program, as is the primary contracting organization. This situation creates natural problem areas at the responsibility interfaces. The solution to this problem is to identify one person who has total responsibility for the overall safety program. Another issue that occasionally occurs on multi-employer sites is that existing safety programs within the subcontractor organizations may not be compatible with each other or with the primary contractor's program. These concerns should be resolved in the contract establishment process.

c) Discuss requirements for, and purpose and application of, appropriate preliminary and activity hazard analysis.

Hazard Analyses Information		
	Preliminary Hazard Analysis	**Activity Hazard Analysis**
Requirements	DOE Order 440.1A	DOE Order 440.1A
Purpose	To reduce the likelihood of exposure of worksite employees and other worksite personnel by reviewing the planned work prior to start of the project	To reduce the likelihood of exposure of worksite employees and other worksite personnel during individual phases of construction by reviewing the planned work prior to the start of each phase
Application	▪ Identify the anticipated construction phases ▪ Identify the types of hazards associated with each anticipated phase of the project ▪ Identify potential control measures and programs necessary to protect employees and others at the worksite ▪ Identify the phases for which requirements for the protective measures must exist	▪ Identify the specific hazards associated with each activity to be performed in that phase of construction ▪ Identify the actual corrective measures planned to control the hazards ▪ Develop drawings and/or other documentation for all protective measures ▪ Designate and identify the qualifications of the person that will conduct inspections where required

d) Demonstrate the ability to perform the following:
- **Evaluate construction operations and identify construction-related hazards**
- **Identify, interpret, and apply appropriate construction-safety requirements**
- **Identify and implement appropriate control measures.**

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

e) Identify excavation and trenching hazards and control considerations including the following:
- **Factors affecting soil stability in a trench**
- **Application of different types of shoring, sloping, and shielding systems**
- **Excavation and trenching inspection considerations**
- **Soil types and test for determining same**

There are a number of factors that affect soil stability in a trench. Some of the more common factors include the following:
- Nearby traffic
- Nearness of structures
- Condition of nearby structures
- Soil type
- Surface water and groundwater
- The water table
- Overhead and underground utilities
- Weather

OSHA requires that, in all excavations, employees exposed to potential cave-ins must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area. Details regarding sloping and shoring can be found in 29 CFR 1926, subpart P, Excavation.

Title 29 CFR 1926, subpart P, requires that a competent person inspect, on a daily basis, excavations and the adjacent areas for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. If these conditions are encountered, exposed employees must be removed from the hazardous area until the necessary safety precautions have been taken. Inspections are also required after natural (e.g., heavy rains) or man-made (e.g., blasting) events, that may increase the potential for hazards.

Soil types are categorized as soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

f) Discuss the following hazard control considerations associated with demolition operations:
- **Structural support considerations**
- **Project planning and activity hazard analyses**
- **Hazards associated with debris and appropriate removal techniques**
- **Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)**

Structural Support Considerations

Prior to starting all demolition operations, OSHA Standard 1926.850(a) requires that an engineering survey of the structure must be conducted by a competent person. The purpose of this survey is to determine the condition of the framing, floors, and walls so that measures can be taken, if necessary, to prevent the premature collapse of any portion of the structure. When indicated as advisable, any adjacent structure(s) or improvements should also be similarly checked.

If the structure to be demolished has been damaged by fire, flood, explosion, or some other cause, appropriate measures, including bracing and shoring of walls and floors, shall be taken to protect workers and any adjacent structures.

Project Planning and Activity Hazard Analyses

Before the start of every demolition job, the demolition contractor should take a number of steps to safeguard the health and safety of workers at the job site. These preparatory operations involve the overall planning of the demolition job, including the methods to be used to bring the structure down, the equipment necessary to do the job, and the measures to be taken to perform the work safely. Planning for a demolition job is as important as actually doing the work.

Debris Hazards and Appropriate Removal Techniques

Various hazards are associated with the removal of debris. Several OSHA requirements exist that relate to the removal of debris. General precautions include the following:

- When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades.
- Signs warning of the hazard of falling materials shall be posted at each level. Removal shall not be permitted in this lower area until debris handling ceases above.
- Any chute opening, into which workmen dump debris, shall be protected by a substantial guardrail.
- Walls, which are to serve as retaining walls against which debris will be piled, shall not be so used unless capable of safely supporting the imposed load.
- Before demolishing any floor arch, debris and other material shall be removed from such arch and other adjacent floor area.
- Demolition of floor arches shall not be started until they have been cleared of debris and any other unnecessary materials.
- The storage of waste material and debris on any floor shall not exceed the allowable floor loads.

Hazards Associated with Remaining Energy Sources, Equipment, and Materials (Hazardous Chemicals/Wastes)

One of the most important elements of prejob planning is the location of all utility services. All electric, gas, water, steam, sewer, and other service lines should be shut off, capped, or otherwise controlled at or outside the building before demolition work is started. In each case, any utility company that is involved shall be notified in advance, and its approval or services, if necessary, should be obtained.

If it is necessary to maintain any power, water, or other utilities during demolition, such lines shall be temporarily relocated as necessary and/or protected. The location of all overhead power sources should also be determined, as they can prove especially hazardous during any machine demolition. All workers should be informed of the location of any existing or relocated utility service

It shall also be determined if any type of hazardous chemicals, gases, explosives, flammable material, or similar dangerous substances have been used or stored on the site. If the nature of a substance cannot be easily determined, samples should be taken and analyzed by a qualified person prior to demolition.

g) Describe construction-related heat and cold stress hazards and identify appropriate control measures.

The construction environment, by its very nature, requires workers to endure extremes of weather and other environmental conditions. Two of these are heat and cold stress. The following table describes each and provides several possible control measures.

Hazards Related to Heat Stress or Cold Stress		
Type	**Factors**	**Control Measures**
Heat	▪ Common problem ▪ Evaluation of heat stress is not simple ▪ People function efficiently only in a very narrow body temperature range ▪ Can cause: o Heat stroke o Heat exhaustion o Heat cramps	▪ Acclimatization periods ▪ Work and rest regimes ▪ Distribution of work load over time ▪ Regular breaks ▪ Provision for water intake ▪ Application of engineering control ▪ Protective clothing
Cold	▪ Also a common problem ▪ Physical activity increases loss of body heat in a cold environment ▪ Can cause: o Hypothermia o Frostbite	▪ Work and rest regimes ▪ Distribution of work load over time ▪ Regular breaks ▪ Provision for water intake ▪ Protective clothing ▪ Application of engineering control

h) Discuss hazards and identify appropriate controls associated with construction equipment and operations including, but not limited to, the following:
- **Scaffolding and other elevated work structures or platforms**
- **Tools, hand and power**
- **Heavy equipment (e.g., earth-moving equipment) and traffic**
- **Placement and temporary support of walls, floors, and other structures**

The following table describes construction equipment and operations related hazards and provides several possible control measures.

Construction Equipment and Operations-Related Hazards		
Type	**Hazard Description**	**Control Measures**
Scaffolding	▪ Falls from scaffolding ▪ Collapse of scaffolding	▪ Sound footing ▪ Ensure scaffolding is capable of carrying at least four times the maximum intended load ▪ Guardrails and toeboards must be installed ▪ Planking must be scaffold grade or equivalent
Powder-Actuated Tools	▪ Accidental firing causing injury ▪ Powder burns ▪ Misfire ▪ Flying dirt, scale, etc. ▪ Ignition of explosive or combustible atmosphere	▪ Only trained employees shall be allowed to operate powder-actuated tools ▪ All power-actuated tools shall be tested daily before use and all defects discovered before or during use shall be corrected ▪ Tools shall not be loaded until immediately before use and loaded tools shall not be left unattended ▪ Wear eye/face protection ▪ Wear hearing protection
Heavy Equipment	▪ Hearing Damage ▪ Injury from being struck by vehicle ▪ Injury from flying objects ▪ Operating accidents ▪ Combustion by-products	▪ Wear hearing protection ▪ Maintain awareness of equipment ▪ Avoid heavy traffic areas ▪ Post warning signs ▪ Wear hard hats ▪ Ensure adequate ventilation ▪ Ensure adequate guarding ▪ Perform frequent equipment inspections ▪ Ensure proper equipment maintenance ▪ Ensure use of audible reverse warning

i) Identify hazards related to new construction (e.g., steel erection, masonry work, fall protection, wood framing, and shoring).

Excavation and Trenching Hazards

There are a number of factors that affect soil stability in a trench. Some of the more common factors include the following:

- Nearby traffic
- Nearness of structures
- Condition of nearby structures
- Soil type
- Surface water and groundwater
- The water table
- Overhead and underground utilities
- Weather

OSHA requires that, in all excavations, employees exposed to potential cave-ins must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area.

Title 29 CFR 1926, subpart P, requires that a competent person inspect, on a daily basis, excavations and the adjacent areas for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. If these conditions are encountered, exposed employees must be removed from the hazardous area until the necessary safety precautions have been taken. Inspections are also required after natural (e.g., heavy rains) or man-made (e.g., blasting) events that may increase the potential for hazards.

Confined Space Hazards

A permit-required confined space has one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section
- Contains any other recognized serious safety or health hazard

There are numerous potential construction-related confined space locations. These include, but are not limited to, the following:

- Manholes
- Stacks
- Storage tanks
- Trailers
- Tank cars
- Vats
- Vessels
- Pits
- Sumps
- Hoppers

- Bins
- Trenches
- Rooms
- Tunnels
- Pipes

The following requirements apply to entry into a confined space. They are generic and, therefore, apply to many confined space entries. However, they may be altered by site or facility procedures.

- Complete the initial portions of a confined space entry permit.
- Confirm or perform training to establish personnel proficiency in the duties required.
- Test the atmosphere.
- Set up atmospheric monitoring to be performed throughout the entry.
- If a hazardous atmosphere is detected, evaluate to determine the cause.
- Take measures to protect employees before entry is made.
- Require proper respiratory equipment, if needed.
- Complete the confined space entry permit.
- Allow entry only after all requirements of the permit are met and the permit is reviewed and signed by the entry supervisor or job leader.

Construction-Related Electrical Hazards

Temporary wiring. General requirements exist related to the following:

- Origination of feeders and branch circuits
- Location of branch-circuit conductors
- Types of receptacles
- Disconnect switches
- Lamp guards
- Temporary light suspension
- Portable electric lighting
- Cable and raceway systems
- Protection of flexible cords and cable
- Extension cords

Grounding includes the following general requirements:

- Use of ground fault circuit interrupters or an assured equipment grounding conductor program
- Identification of conductors
- Polarity of connections
- Use of grounding terminals and devices

Exposed wires, equipment, or parts. General requirements state that guarding shall be provided to prevent access of other than authorized and qualified personnel.

Hoisting and rigging. The following is a simple list of basic load test and inspection requirements for cranes:

- Prior to initial use, all new, extensively repaired, or altered cranes shall be tested by or under the direction of a qualified inspector. A functional test of the crane under a normal operating load should be made prior to putting the crane back in service.
- Equipment shall be inspected by a competent person before each use and during use, and all deficiencies shall be corrected before further use.
- An annual inspection of the hoisting machinery shall be made by a competent person or by a government or private agency recognized by the U.S. Department of Labor. Records shall be kept of the dates and results of each inspection.

There are several effects that boom angle and length have on load limits:

- A safe load depends upon boom length, boom angle, and working radius.
- Always operate within the rated capacity of the machine.
- Always use the shortest boom possible.
- Never operate the boom at a higher angle than shown on the capacity charts.

Major signs of stress, strain, or other deterioration must be evaluated when inspecting rigging equipment. The following is a partial list of items to be inspected:

- Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, gross shimmy, or irregularity.
- There shall be no apparent damage, excessive wear, or deformation of any part of the equipment.
- All safety devices, load indicators, boom angle and radius indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.
- Any defects shall be corrected or repaired before the equipment is put into service.
- Parts found to be defective as a result of any inspection or nondestructive examination shall be replaced or repaired as directed by the cognizant line manager or a designated alternate.

There are also possible hazards associated with the use of cranes near electrical wires. Extreme caution must be used when traveling or working a crane near electrical wires. Special procedures are required except where the electrical distribution and transmission lines have been de-energized and are visibly grounded at the point of work.

- If cage-type boom guards, insulating links, or proximity-warning devices are used, they cannot replace having the electrical distribution and transmission lines de-energized and visibly grounded at the point of work.
- Communicate with the owners of the lines prior to commencement of the work and request their cooperation.
- Consider all overhead conductors to be energized unless and until the person owning the conductor or the electric utility verifies that it is not energized.
- Observe the minimum clearance requirements that are based on voltage.
- Observe the signs at the operator’s station and on the outside of the crane warning of possible electrocution.

Appropriate lifting techniques and limitations are important in the operation of a crane.

The relationship between the crane operator and the guide is also very important for safe operation.

- All personnel acting as signalers during crane operations shall be clearly identified to the crane operator by the use of one or more of the following: orange hardhat, gloves, and/or vest.
- In those cases where the crane operator cannot see the signaler, a second person (relay signaler) shall be stationed where he/she can see both the signaler and the crane operator and relay signals to the operator.
- Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator, not through a third person.
- The operator shall recognize signals only from the designated signaler, except that a STOP signal shall be obeyed no matter who gives it.
- The standard signals for DOE use of the particular type of crane or hoist being used shall be as specified in the latest edition of the American National Standards Institute (ANSI) B30 chapters.

Potential fall hazards. There are a large number of possible fall hazards. The following table illustrates some examples.

Potential Fall Hazards and Preventive Measures	
Hazard	**Preventive Measures**
Tripping	Good housekeeping practices Proper illumination Guardrails and handrails
Slipping	Good housekeeping practices Safety shoes with nonskid soles Level walking surfaces
Working at elevations	Safety lines, harnesses, and lanyards Ladder and scaffold inspections Safety nets
Faulty ladders, scaffolding, and guard rails	Ladder, scaffold, and guardrail inspections Written safety policy to never step on top platform of ladder Safety cage or rail

Heat stress or cold stress. The construction environment, by its very nature, requires workers to endure extremes of weather and other environmental conditions. Two of these are heat and cold stress. The following table describes each and provides several possible control measures.

Hazards Related to Heat Stress or Cold Stress		
Type	**Factors**	**Control Measures**
Heat	▪ Common problem ▪ Evaluation of heat stress is not simple ▪ People function efficiently only in a very narrow body temperature range ▪ Protective clothing o Can cause heat stroke, heat exhaustion, and heat cramps	▪ Acclimatization periods ▪ Work and rest regimes ▪ Distribution of work load with time ▪ Regular breaks ▪ Provision for water intake ▪ Application of engineering controls

Hazards Related to Heat Stress or Cold Stress		
Cold	▪ A common problem ▪ Physical activity increases loss of body heat in a cold environment o Can cause hypothermia and frostbite	▪ Work and rest regimes ▪ Distribution of work load with time ▪ Regular breaks ▪ Provision for water intake ▪ Protective clothing ▪ Application of engineering controls

7. Occupational safety personnel shall demonstrate a working-level knowledge of accident/incident investigation, analysis, and reporting as it is practiced within DOE.

a) Describe the purpose of accident/incident investigations within DOE.

According to DOE O 225.1, the purpose of accident investigation is to improve the environment, safety, and health for DOE employees, contractors, and the public. A second purpose is to prevent recurrence of accidents.

Accident Investigation

The DOE accident investigation process contains four main steps:

- Categorize the accident
- Conduct the investigation
- Report investigation results
- Close-out the investigation

Categorize the Accident

DOE accidents are categorized as warranting either a Type A or Type B investigation. The algorithm for determining the type of investigation is found under objective 2.A of DOE 0 225.1. The categorization algorithm is also found as Attachment 2 to DOE O 225.1.

Conduct the Investigation

The first step in a DOE accident investigation is the appointment of the Accident Investigation Board. The investigation time frame and board participants are outlined in DOE O 225.1. The Board's composition is mandated based upon the type of investigation; this information is found in the Order. The second step is the actual accident investigation which is detailed under objective 2.B. The main objective of the investigation is to analyze the facts and identify causal factors and judgments of need for corrective actions.

Report Investigation Results

After the Board has prepared the report, it is submitted to the Appointing Official who then accepts the report and its findings. The investigative phase is complete at this point. The investigation report's purpose and content is handled in detail under objective 2.E of DOE 0 225.1.

Close Out the Investigation

The Appointing Official ensures that the DOE and contractor line management organizations affected by the investigation have had an opportunity to conduct a factual accuracy review of

the draft report and present comments to the Board. The Board Chairperson and the senior manager of the site conduct a formal briefing on the outcome of the investigation. The final report is given to senior managers with a request for their organizations to prepare corrective action plans. The lessons learned from the accident investigation are disseminated DOE-wide. Last, the action plans are completed, and corrective actions are implemented to satisfy the judgments of need identified in the final investigation report.

b) Discuss and demonstrate the ability to apply criteria for determining the need for a particular type of accident/incident investigation.

DOE O 225.1 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. A table representation of the algorithm is found as Table 6.3. It breaks the criteria into four different categories of effects: Human, Environmental, Property, and Other.

Type A Investigation	Type B Investigation
Human Effects	
Any fatal, or likely to be fatal, injury, or chemical or biological exposure to an employee or a member of the public	Any one or series of injuries, chemical exposures, or biological exposures that results in hospitalization of one or more employees or members of the public for more than five continuous days
Any one accident that requires the hospitalization for treatment of three or more individuals	Any one or series of injuries, chemical exposures, or biological exposures that results in permanent partial disability of one or more employees or members of the public
Any one accident that has a high probability of resulting in the permanent total disability due to injuries, chemical exposures, or biological exposures of DOE, contractor, or subcontractor employees or members of the public	Any one accident or series of accidents within a one-year time period, resulting in five or more lost-workday cases, or any series of similar or related accidents involving five or more persons, one or more of which is a lost-workday case
A single individual radiation exposure resulting in: a. A total effective dose equivalent >25 rem b. A dose equivalent to the lens of the eye >75 rem c. A shallow dose equivalent to an extremity of skin >250 rem d. The sum of the deep dose equivalent for external exposure and the committed dose equivalent to any organ or tissue other than the lens of the eye >250 rem e. A dose equivalent to the embryo or fetus of a declared pregnant worker >2.5 rem	A single radiation exposure to an individual that results in: a. A total effective dose equivalent >10 but <25 rem b. A dose equivalent to the lens of the eye >30 but <75 rem c. A shallow dose equivalent to an extremity of skin >100 but <250 rem d. The sum of the deep dose equivalent for external exposure and the committed dose equivalent to any organ or tissue other than the lens of the eye >00 rem but <250 rem e. A dose equivalent to the embryo or fetus of a declared pregnant worker >1.0 but <2.5 rem

Type A Investigation	Type B Investigation
Environmental Effects	
Release of a hazardous substance, material, waste, or radionuclide from a DOE facility (onsite or offsite) in an amount greater than five times the reportable quantities specified in 40 CFR Part 302 that results in serious environmental damage	Release of a hazardous substance, material, waste, or radionuclide from a DOE facility (onsite or offsite) in an amount greater than or equal to two times but less than five times the reportable quantities specified in 40 CFR Part 302 that results in serious environmental damage
Property Effects	
Estimated loss of, or damage to, DOE or other property, including aircraft damage, greater than or equal to $2.5 million or requiring estimated costs greater than or equal to $2.5 million for cleaning, decontaminating, renovating, replacing, or rehabilitating structures, equipment, or property	Estimated loss of, or damage to, DOE or other property, greater than or equal to $1 million but less than $2.5 million, including aircraft damage, and costs of cleaning, decontaminating, renovating, replacing, or rehabilitating structures, equipment, or property
Any apparent loss, explosion, or theft involving radioactive or hazardous material under the control of DOE, contractors, or subcontractors in such quantities and under such circumstances to constitute a hazard to human health and safety or private property	The operation of a nuclear facility beyond its authorized limits
Any unplanned nuclear criticality	
Other Effects	
Any accident or series of accidents for which a Type A investigation is deemed appropriate by the Secretary or the Assistant Secretary of Environment, Safety, and Health	Any accident or series of accidents for which Type B investigation is deemed appropriate by the Secretary, or the Assistant Secretary of Environment, Safety, and Health; the associate deputy secretary for field management; the cognizant Secretarial Officer; or the head of the field element. This includes departmental cross-cutting issues and issues warranting the attention of local news or interest groups.

c) Describe accident causation models, emphasizing the importance of human reliability and effective management systems.

The discussion for the above requirements may be found in http://www.orau.gov/tdd/QualPrgm/learningmaterials/OccSafety/os1-04.pdf.

d) Discuss and apply necessary techniques for gathering facts applicable to an investigation and interviewing witnesses.

DOE O 225.1 lists the information that should be gathered by the Accident Investigation Board during an investigation.

The Board shall be responsible for conducting a thorough investigation of all individuals, organizations, and facilities having a stake in the accident. The Board shall determine the facts of the accident by examining the accident scene, examining DOE and contractor documentation, interviewing witnesses, and performing engineering analyses. The Board shall also examine policies, standards, and requirements that are applicable to the accident being investigated as well as management and safety systems at Headquarters (HQ) and field offices that could have contributed to or prevented the accident.

The purpose of an accident investigation is to determine the causes of the accident. Once the causes are determined, this information will then be fed back to the management, who will then take corrective actions by training the workers or installing new controls to prevent similar accidents.

All accident investigation should be for the sake of fact finding and not fault finding. Investigation should be conducted using the who, what, where, when, how, and why questions. For example:

- Who are the victims?
- What events lead up to the accident?
- Where were equipment and/or machinery?
- When did the incident occur?
- How did the victims and witnesses react in given situations?
- Why did the incident take place, in your opinion?

Interviews and document reviews will be the main source of information. However, observations of the place of the accident and the surrounding areas will be invaluable in determining the setting and the environment leading to the accident. All these factors are important to finding the cause as discussed through the use of the various accident theories.

e) Discuss and apply necessary analysis techniques used in accident investigations, such as management oversight and risk tree; change analysis; events and causal factor analysis; energy trace and barrier analysis; and basic tree analysis.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

f) Describe the purpose and content of an accident investigation report.

DOE O 225.1 outlines the purpose and content of an accident investigation report. The purpose of the report is to document the investigation board's judgment on the need for corrective actions based upon objective analysis of the facts, root and contributing causes, and DOE or contractor management systems that could have prevented the accident. The report will not contain statements that determine individual fault or that propose punitive measures.

The facts section of the draft investigation report should be offered to the affected DOE and contractor line management for their review of the report's factual accuracy. Prior to completing the investigation, the accident investigation board will review the report to ensure its technical accuracy, completeness, and internal consistency. They will also include an analysis of management control and safety systems that may have contributed to the accident.

If a board member wishes to offer an opinion different from that of the investigation board, a minority report section can be added to the report.

g) Discuss the importance of providing feedback on accident investigations, and describe the management systems necessary to ensure this feedback is communicated to DOE.

Since DOE operates numerous sites across the country, it is of paramount importance that information learned in the course of an accident investigation be shared with DOE and its contractors. All sites benefit from the communication and dissemination of accident information, which includes lessons learned and corrective actions. In addition, other sites may analyze their facilities for similar problems and implement needed changes in order to avoid a similar accident or occurrence. When practiced, this process saves lives and money by preventing repeated accidents.

One of the main tools used to accomplish the communication of accident and occurrence information is the Occurrence Reporting and Processing System (ORPS). This system serves as a historical database for all accident and occurrence report information within DOE and its contractor organizations. Once the information is stored in ORPS, the DOE Office of Environment, Safety, and Health, in conjunction with the Office of Nuclear Facility Safety, publishes the Operating Experience Weekly Summary. The process is intended to disseminate lessons-learned information as described in DOE-STD-7501-95. In addition to ORPS, the Office of Operating Experience Analysis and Feedback compiles information from daily operations reports, notification reports, and conversations with DOE field office and facility staffs for inclusion in the Weekly Summary. This effort is intended to augment ORPS, but should not substitute for a thorough review of interim and final occurrence reports.

h) Describe and understand the importance of securing the accident scene, preserving evidence, and rules of conduct.

Preserving the Accident Scene

Preserving an accident scene and evidence is important to the ensuing investigation. Important evidence must be collected quickly, or it may be lost or lose its value to the investigation. Site procedures should specify the DOE or contractor official who will control the scene and access to it. Generally, an accident scene should be isolated as soon as possible until it is turned over to the accident investigation board. This action prevents the scene from being disturbed or altered, prevents evidence from being removed from or relocated at the scene, and protects people from hazards that may remain after an accident. An accident scene can be protected in a number of ways, including: cordoning off the area with rope, tape, or barricades; locking doors and gates; posting warning signs; using a log to document who enters the area and their justification for entry; and posting guards to control and limit access. Special controls and coordination with local security operations are necessary if the accident scene or evidence contains classified or unclassified controlled nuclear information material. The accident investigation board may require that the same or different preservation and control procedures be kept in place until it has concluded the examination and documentation of the scene.

There may be circumstances where an accident scene must be preserved for investigation by an agency other than DOE. This could include the National Transportation Safety Board (e.g., for aircraft or railway accidents), OSHA, law enforcement agencies, or other agencies that may exercise jurisdiction to conduct investigations. In the event that an accident scene must be preserved to satisfy the investigative needs of these agencies, the scene should be cordoned off, access to it controlled, and otherwise secured, as indicated above, until the agency having jurisdiction arrives and takes control of the scene.

Collecting and Controlling Evidence

There are three types of evidence: physical, human (given through witness statements or interviews), and documentary (including photographic media). The collection and control of physical evidence is an important element of preserving the accident scene and an important role of readiness teams. Some physical evidence can safely be left intact at a protected accident scene. However, other evidence may be located remotely from the scene, may have been removed during emergency response or casualty evacuation activities, or may be too perishable to safely remain at the scene. Such evidence should be protected from damage or contamination and safely stored for delivery and transfer to the board. It may not be apparent whether some items are evidence — that is, whether they are significant to the investigation. When in doubt, it is best to be conservative in treating items as evidence. It is easy to discard items later that are not needed, but difficult or impossible to recover needed items that were not preserved.

Physical and documentary evidence should be preserved and secured as it is collected. These steps are necessary to prevent alteration and to establish the accuracy and validity of collected evidence. Evidence should be stored in a secured area and access to the evidence limited to those who have a need to examine and use it during the accident investigation. No evidence should be released without the authorization of the board chairperson.

Obtaining Initial Witness Statements

Statements from witnesses should be taken as soon as possible, preferably before they leave the accident scene. Quickly identifying witnesses and taking witness statements are important, because the first statements of witnesses are more accurate and have greater credibility than those made later. Other persons, such as emergency response personnel, persons who arrived at the scene shortly after the accident, and anyone else who would be expected to provide material information about the accident should be identified, located, and asked to provide a statement. While the board will conduct formal interviews later, initial statements help preserve early impressions and observations and help the board focus its efforts. A standardized witness statement form should be used to obtain initial statements. Use of a form provides necessary information about the witnesses and where they can be contacted later, ensures that a consistent set of questions is presented to all witnesses, and provides an opportunity for persons who have just witnessed or been associated with an accident to record what they know in a structured manner.

Documenting the Accident

Documenting the accident means making a record of the accident scene and collecting records of conditions before, during, and after the accident. Since the accident investigation board may not arrive at the accident site until 2 or 3 calendar days after the accident, it is

important for readiness or other personnel to document thoroughly the condition and status of the accident scene just after the accident has occurred.

i) Describe and understand the importance of reporting between contractors and Federal workers and have a working knowledge of various reporting systems, requirements, and investigations.

In the performance of a contract, contractors shall support Type A and Type B investigations of accidents at sites under their cognizance. Type A and Type B investigations are conducted by formally appointed DOE Accident Investigation Boards comprised of DOE employees, supplemented by advisors and consultants.

Contractors shall establish and maintain readiness to respond to accidents, mitigate the consequences, assist in collecting and preserving evidence, and assist with the conduct of the investigation. This shall include preserving the accident scene to the extent that it is under the control of the contractor, documenting the accident scene through photography and other means, providing office space and equipment for the Accident Investigation Board, meeting regularly with the Board for discussions of issues surrounding the accident, and providing general administrative assistance.

Contractors shall also prepare, implement, and track to completion approved corrective action plans that satisfy judgments of need identified by the Accident Investigation Board.

Reporting will be in accordance with attachment 2 of DOE 0 225.1A, Accident Investigations, at http://www.directives.doe.gov/pdfs/doe/doetext/neword/225/o2251a.pdf.

8. Occupational safety personnel shall demonstrate a working-level knowledge of the purpose, general content, development, and performance of worker occupational safety training.

a) Identify safety-training requirements addressed in applicable regulations or DOE Orders.

Key DOE & OSHA Worker Safety Regulations	Sample Worker Safety Training Requirements
DOE O 360.1, Training	"1. OBJECTIVES. a. Assign responsibilities and provide requirements for establishing, implementing, documenting and evaluating training programs for Federal employees. b. Commit to the continuing development of employees to ensure quality performance from a technically competent, versatile, and diverse work force. c. Establish the requirements for the training and qualification of technical employees and managers whose position requires them to provide management direction or oversight that could impact the safe operation of a defense nuclear facility."

Key DOE & OSHA Worker Safety Regulations	Sample Worker Safety Training Requirements
DOE O 440.1, Worker Protection Management for DOE Federal and Contractor Employees	"DOE Elements shall: . . . k. Provide workers, supervisors, managers, visitors, and worker protection professionals with worker protection training."
29 CFR 1910, Occupational Safety and Health Standards for General Industry	"(4) Management and supervisor training. On-site management and supervisors directly responsible for, or who supervise employees engaged in, hazardous waste operations shall receive 40 hours initial training, and three days of supervised field experience (the training may be reduced to 24 hours and one day if the only area of their responsibility is employees covered by paragraphs (e)(3)(ii) and (e)(3)(iii)) and at least eight additional hours of specialized training at the time of job assignment on such topics as, but not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedure and techniques."
29 CFR 1926, Safety and Health Regulations for Construction	"9) Employee Information and Training. (i) The employer shall, at no cost to the employee, institute a training program for all employees who are likely to be exposed in excess of a PEL and for all employees who perform Class I through IV asbestos operations, and shall ensure their participation in the program. (ii)Training shall be provided prior to or at the time of initial assignment and at least annually thereafter. (iii) Training for Class I operations shall be the equivalent in curriculum, training method and length to the EPA Model Accreditation Plan (MAP) asbestos abatement workers training (40 CFR part 763, subpart E, appendix C)."
29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters	"SUBPART H - TRAINING 1960.54 Training of top management officials. 1960.55 Training of supervisors. 1960.56 Training of safety and health specialists. 1960.57 Training of safety and health inspectors. 1960.58 Training of collateral duty safety and health personnel and committee members. 1960.59 Training of employees and employee representatives. 1960.60 Training assistance."

b) Discuss the basics of training development techniques, emphasizing the importance of using behavioral objectives.

ELEMENTS OF THE SYSTEMATIC APPROACH TO TRAINING	
Element	**Description**
Analysis	Ensures training activities are oriented to job requirements by identifying the specific tasks involved in a given job. Training requirements are determined by analyzing the job and its component tasks. Organizational needs are also assessed to determine the resources required to support identified training requirements.
Design	Begins with developing terminal and enabling learning objectives (also referred to as behavioral objectives because the objective is designed to change the learner's behavior in a particular way) based on information gathered from the analysis phase. Skills and knowledge associated with performing a task well are translated into enabling objectives. The objectives are then organized into instructional units and sequenced to aid the learning process. The objectives become the guides for the development of learning strategies, course content, and training materials. Additional design activities include identifying the appropriate training setting, developing test items and examinations (also done in the next phase), and documenting key components of this phase.
Development	The actual preparation of lesson plans, instructor guides, training aids, and training materials. Formulation of additional enabling objectives and revisions of test items and objectives may also occur. Both technical and instructional reviews of the products are conducted, and changes are made as necessary to ensure the content is both technically and educationally correct and relevant.
Implementation	Consists of resource allocation, planning, and scheduling, as well as the actual conduct of training. Resource allocation includes assigning instructors and support staff and scheduling training in facilities.
Evaluation	The critical feedback loop to ensure that the training meets its objectives. Feedback from instructors, trainees, evaluators, and supervisors is reviewed for its potential refinement of future training. Evaluation is a continuing action that occurs throughout the entire process and beyond. Evaluation results are translated into change actions or recommendations based on different criteria such as adequacy of content, tests, presentation, or documentation, and post-training job performance.

From the time that learning (or behavioral) objectives are prepared, virtually all the training processes and products are based on or specifically relate to these learning objectives. Because the learning objectives are derived from job performance requirements, the resulting training programs are considered job-based.

c) Discuss considerations that must be addressed in the development of a training course. Describe the various types (and uses) of training material and techniques.

In addition to instructor materials (e.g., instructor guides, overhead transparencies, slides, etc.), it is important to develop useful trainee materials that supplement the training and support the learning objectives. The trainee materials should provide organizers (e.g., agendas, objectives), reinforcements for concepts, communication of expected activities, and references for additional information. Handouts and job aids are the most common trainee materials used in training. Handouts can be used to: provide a summary of the presentation, replace or facilitate note taking, serve as a discussion guide, reference background material, or provide sample forms, drawings, etc. Job aids are any device, chart, or other reference that reduce the amount of information the worker must recall or retain in order to successfully carry out a task. Job aids are often used in place of a training course or are provided during training to serve as a performance aid on the job. After deciding what must be taught, the best way to teach it must be determined. This is the instructional method. There is no one best instructional method. The choice of methods is often based on several selection criteria. In addition to the scope and content of the learning objectives, the following should be considered:

- Background and ability of the trainees
- Stage of learning (e.g., new, refresher, or remedial)
- Level of learning required by the objective (i.e., simple to complex)
- Special needs of the trainees
- Time allotted to delivery and application of the lesson
- Time allotted to developing the lesson using that particular method
- Available facilities

Instructional methods are the strategies that are used during the course of instruction to convey information and to practice job skills. Some of the more common methods are listed below:

- Lecture
- Discussion
- Case studies
- Demonstration
- Laboratory or workshop exercises

There are many other methods and techniques that can be used. Whatever method is selected, there are two very important factors to be considered: the nature of the objective and the target audience.

d) Discuss the basics of evaluating a training course or program and the importance of, and methods for, evaluating occupational safety training effectiveness.

Tasks and associated skills and knowledge are translated into performance and learning objectives. The learning objectives in turn are used to create the course outline, which becomes the road map for the course developers in preparing lesson plans, test items and examinations, student materials, and training aids and equipment. This material is used by the trainers to conduct or present the training. All of this information is used to assess the

effectiveness of the training program, which should be job- or performance-based as a result of the application of the systematic approach to training. The evaluation results, which become source data for the needs analysis process, are used to modify the training program. The facility's training organization and programs should be evaluated periodically to determine whether they are achieving the established goals and objectives. The effectiveness of training programs to produce qualified personnel should also be evaluated periodically. This should be accomplished by reviewing operating occurrences, interviewing job incumbents and first-line supervisors, observing operations, etc. The results of these evaluations, if used correctly, will help ensure a facility of safe, efficient, and reliable operations. The following objectives should be emphasized when evaluating training and qualification programs:

- The responsibility for monitoring indicators, analyzing data, and approving revisions is clearly defined.
- The training department is alerted to facility operating, maintenance, and industrial safety experiences.
- Communication on training effectiveness occurs between plant supervisors and the training department.
- Employee opinion of the equality and effectiveness of training is collected periodically.
- The training department is alerted to employee performance errors.
- The training department meets with maintenance and operations supervisors and engineers to determine potential training problems.
- The training department uses facility inspection and evaluation reports to guide program revisions.
- Facility modifications and procedure changes are monitored for training consequences.
- The training department monitors industry operating and maintenance experiences for program impacts.
- Regulatory changes are reviewed for training consequences.
- Program performance data are analyzed.
- Proposed changes are reviewed by appropriate facility and training personnel.
- Training changes are tracked.

e) Describe the role and limitations of worker training in a comprehensive safety program.

A site safety plan, which is one aspect of a comprehensive safety program, establishes policies and procedures to protect the safety and health of workers and the public from potential hazards and mishaps. Worker training is a key element in the successful implementation of a site safety plan or safety program. The safety training program makes workers aware of the potential hazards they may encounter, provides the skills and knowledge necessary to perform the work with minimal risk to worker health and safety, makes the workers aware of the purpose and limitations of safety equipment, and assures that workers can safely avoid or escape from emergencies. The level of training should be consistent with the worker's job function and responsibilities. The training program should involve both classroom instruction and hands-on practice, which can be as simple as a laboratory or shop exercise or an area drill conducted in the field or simulated in a classroom. Training typically consists of safe work policies, procedures and practices; the nature of the

anticipated hazards; handling of emergent conditions and situations; safe use of safety equipment; handling, storage, and transportation of hazardous materials; worker rights and responsibilities; use, care, and limitations of personal protective clothing and equipment; changes and modifications; lessons learned; and legal and regulatory issues.

Factors that can limit the conduct and application of worker training (and which therefore affect the success and effectiveness of the training) include:

- availability of subject matter experts during the development and conduct of the training
- amount of time provided to develop and conduct the training
- pace of the training
- amount of time available or permitted to practice the learned skills and knowledge
- amount and difficulty of material covered
- clarity of material
- terminology used in material
- structure and sequence of material
- quantity and quality of exercises
- relevance of training to job performance

f) Discuss methods to conduct workplace evaluations and communicate results to workers.

What-If Checklist

The what-if checklist is a broadly based hazard assessment technique that combines the creative thinking of a selected team of specialists with the methodical focus of a prepared checklist. The result is a comprehensive process hazards analysis that is extremely useful in training operating personnel on the hazards of the particular operation.

The review team is selected to represent a wide range of disciplines (production, mechanical, technical, safety). The team is then provided with basic information on hazards of materials, process technology, procedures, equipment design, instrumentation control, incident experience, previous hazard reviews, and so on. A field tour of the process is also conducted at this time, assuming the process is in operation.

The review team methodically examines the process from receipt of raw materials to delivery of the finished product to the customer's site. At each step, the group collectively generates a listing of what-if questions regarding the hazards and safety of the operation. When the review team has completed listing its spontaneously generated questions, it systematically goes through a prepared checklist to stimulate additional questions.

Subsequently, answers are developed for each question. The review team then works to achieve a consensus on each question and answer. From these answers, a listing of recommendations is developed specifying the need for additional action or study. The recommendations, along with the list of questions and answers, become the key elements of the hazard assessment report.

Hazard and Operability Study (HAZOP)

HAZOP is a formally structured method of systematically investigating each element of a system for all of the ways in which important parameters can deviate from the intended design conditions to create hazards and operability problems. The hazard and operability problems are typically determined by a study of the piping and instrument diagrams (or plant model) by a team of personnel who critically analyze the effects of potential problems arising in each pipeline and each vessel of the operation.

Pertinent parameters are selected, for example, flow, temperature, pressure, and time. Then the effect of deviations from design conditions of each parameter is examined. A list of key words such as more of, less of, none of, part of, are selected for use in describing each potential deviation.

The system is evaluated as designed and with deviations noted. All causes of failure are identified. Existing safeguards and protection are identified. An assessment is made weighing the consequences, causes, and protection requirements involved.

Failure Mode and Effect Analysis (FMEA)

The failure mode and effect analysis is a methodical study of component failures. This review starts with a diagram of the process that includes all components which could fail and conceivably affect the safety of the process. Typical examples are instrument transmitters, controllers, valves, pumps, and rotometers. These components are listed on a data tabulation sheet and individually analyzed for the following:

- Potential mode of failure (open, closed, on, off, leaks, etc.)
- Consequence of the failure
- Effect on other components
- Effect on whole system
- Hazards class (high, moderate, low)
- Probability of failure
- Detection methods
- Compensating provision/remarks

Multiple concurrent failures are also included in the analysis. The last step is analysis of the data for each component or multiple component failure, and development of a series of recommendations appropriate to risk management.

Fault Tree Analysis

A fault tree analysis is a quantitative assessment of all of the undesirable outcomes, such as a toxic gas release or explosion, which could result from a specific initiating event. It begins with a graphic representation (using logic symbols) of all possible sequences of events that could result in an incident. The resulting diagram looks like a tree with many branches, each branch listing the sequential events (failures) for different independent paths to the top event. Probabilities (using failure rate data) are assigned to each event and then used to calculate the probability of occurrence of the undesired event. This technique is particularly useful in evaluating the effect of alternative actions on reducing the probability of occurrence of the undesired event.

Other Hazard Evaluation Procedures

Additional information on the hazard evaluation procedures outlined above and descriptions of other hazard evaluation procedures, as well as information concerning the selection of an appropriate procedure, are contained in Guidelines for Hazard Evaluation Procedures, prepared by The Center for Chemical Process Safety of the American Institute of Chemical Engineers.

g) Describe the role and value of a Job Safety Analysis as a training tool.

Supervisors can use the findings of a job safety analysis to eliminate and prevent hazards in their workplaces. This is likely to result in fewer worker injuries and illnesses; safer, more effective work methods; reduced workers' compensation costs; and increased worker productivity. The analysis also can be a valuable tool for training new employees in the steps required to perform their jobs safely.

h) Identify the key elements of HAZWOPER training as defined in 29 CFR 1910.120, Appendix E.

The following are the key criteria:

Training Facility

The training facility should have available sufficient resources, equipment, and site locations to perform didactic and hands-on training when appropriate. Training facilities should have sufficient organization, support staff, and services to conduct training in each of the courses offered.

Training Director

Each training program should be under the direction of a training director who is responsible for the program. The training director should have a minimum of two years of employee education experience.

Instructors

Instructors should be deemed competent on the basis of previous documented experience in their area of instruction, successful completion of a "train-the trainer" program specific to the topics they will teach, and an evaluation of instructional competence by the training director. Instructors should be required to maintain professional competency by participating in continuing education or professional development programs or by successfully completing an annual refresher course and having an annual review by the training director. The annual review by the training director should include observation of an instructor's delivery, a review of those observations with the trainer, and an analysis of any instructor or class evaluations completed by the students during the previous year.

Course Materials

The training director should approve all course materials to be used by the training provider. Course materials should be reviewed and updated at least annually. Materials and equipment should be in good working order and maintained properly. All written and audio-visual materials in training curricula should be peer reviewed by technically competent outside reviewers or by a

standing advisory committee. Reviewers should possess expertise in the following disciplines were applicable: occupational health, industrial hygiene and safety, chemical/environmental engineering, employee education, or emergency response. One or more of the peer reviewers should be an employee experienced in the work activities to which the training is directed.

Students

The program for accepting students should include

- assurances that the student is or will be involved in work where chemical exposures are likely, and that the student possesses the skills necessary to perform the work;
- a policy on the necessary medical clearance.

Ratios

Student-instructor ratios should not exceed 30 students per instructor. Hands-on activity requiring the use of personal protective equipment should have the following student-instructor ratios: for Level C or Level D personal protective equipment, the ratio should be 10 students per instructor; for Level A or Level B personal protective equipment, the ratio should be 5 students per instructor.

Proficiency Assessment

Proficiency should be evaluated and documented through the use of a written assessment and a skill demonstration selected and developed by the training director and training staff. The assessment and demonstration should evaluate the knowledge and individual skills developed in the course of training. The level of minimum achievement necessary for proficiency shall be specified in writing by the training director. If a written test is used, there should be a minimum of 50 questions. If a written test is used in combination with a skills demonstration, a minimum of 25 questions should be used. If a skills demonstration is used, the tasks chosen and the means to rate successful completion should be fully documented by the training director. The content of the written test or of the skill demonstration shall be relevant to the objectives of the course. The written test and skill demonstration should be updated as necessary to reflect changes in the curriculum, and any updates should be approved by the training director. The proficiency assessment methods, regardless of the approach or combination of approaches used, should be justified, documented, and approved by the training director.

9. Occupational safety personnel shall demonstrate a working-level knowledge of the Vehicle Safety Program.

a) Identify safe driving and defensive-driving techniques.

Alert Driving

A driver must concentrate on the road and drive defensively.

- Concentration. Operating a vehicle safely demands that the driver concentrate on driving. The person should be rested, calm, and not under the influence of alcohol or other drugs.
- Combating drowsiness. One of the greatest hazards of roadway driving is drowsiness or "highway hypnosis." Lack of sleep or fatigue impact your ability to safely drive your vehicle. When taking a long trip, avoid drowsiness by stopping frequently to drink coffee, exercise, or nap. Exercise your eyes by reading road signs or shifting the focus of your eyes to different parts of the roadway. Make sure you are properly rested.

- Defensive driving. Plan ahead for the unexpected. Always be prepared to react to the other driver. Do not expect the other driver to do what you think he or she should do. Do not think you know what he or she is going to do. If you cannot avoid a crash, remain calm and try to choose the least dangerous situation. For example, running into a ditch is less dangerous than a head-on collision. Also, your chances of survival are greater if your vehicle is in good mechanical condition.

Vehicle Following Distances

Following a vehicle too closely is called "tailgating." Use the two-second rule to determine a safe following distance. Select a fixed object on the road ahead, such as a sign, tree, or overpass. When the vehicle ahead of you passes the object, count "one-thousand-one, one-thousand-two." You should not reach the object before you count to one-thousand-two. If you do, you are following too closely. Most rear-end collisions are caused by the vehicle in back following too closely. The two-second rule also applies to your speed when you are on a good road and during good weather conditions. If the road and/or weather conditions are not good, increase your distance to a four- or five-second count. If you are being tailgated, move to another lane or slowly pull off the road and allow the vehicle to pass.

Vehicle Speed

Minimum and maximum speeds. A driver should use common sense when driving. Driving too fast or too slowly may create a dangerous situation. Regardless of the posted speed limit, weather and traffic conditions may make it necessary to drive more slowly. However, driving too slowly can also be dangerous. Your speed should be adjusted for the conditions and should match the flow of traffic, as long as it does not surpass the maximum posted speed.

Stopping. The ability to stop your car safely should be considered when deciding your speed. You should consider

- how quickly you can react physically and mentally;
- the type and condition of the roadway, since it will be more difficult and take longer to stop on wet asphalt;
- the kind of tires you are using and the condition of their tread (large, wide tires with good tread will stop a vehicle faster than small, narrow tires with little tread);
- the type, condition, and adjustment of your brakes;
- the direction and speed of the wind (a strong tail wind can make it very difficult to stop);
- vehicle design, weight distribution, suspension, and shock absorbers.

Vehicles and Trains

Crashes between vehicles and trains can be prevented. Approaching and crossing railroad tracks requires drivers to take extreme caution. Following are important laws and safety tips:

- Warning signs. Railroad crossings are marked with one or more of the following signs:
  - A round railroad advance warning sign means a crossing is ahead. In rural areas, this sign is posted 750 ft. before the tracks. It warns you to look, listen, and slow down.
  - In front of the railroad crossing, the pavement is marked with a large X and two Rs.

- A solid yellow line means you may not pass another vehicle as you near the tracks.
- Crossbuck signs are posted at most tracks. The sign will indicate if there is more than one track.
- Flashing lights always mean a train is near. Always stop when the lights begin to flash.
- Some crossings also have gates. Always stop when the gates begin to lower. It is against the law to drive through, around, or under these gates.

Drive carefully. When crossing a railroad track, be especially careful! Drive as though you expect a train on any track at any time.

Watch for a second train. More than one train may be on the tracks. After one train has passed, always look for a second train on another track before proceeding.

Never get trapped. Sometimes you may be moving with a stream of vehicles across a railroad track. Check carefully to make sure there is enough room for your vehicle on the other side of the track. If there is not enough room, do not cross the tracks.

Never shift gears. If your vehicle has a manual transmission, shift down before reaching the tracks. To avoid stalling, you should not change gears while crossing the track.

Never race a train. Trying to race a train may cost you your life and those of your passengers. Do not race a train to a crossing.

Some vehicles must stop. Some vehicles are required to stop at railroad crossings. These include commercial vehicles carrying people for hire, school buses, and vehicles carrying hazardous material. Be prepared to stop when you are behind these vehicles. Remember, crashes involving trains and vehicles are usually caused by carelessness. Always stop, look, and listen for trains. Extra safety may save your life.

Weather Conditions

Weather can create a driving hazard. Special care must be taken in fog, rain, high winds, and winter driving conditions.

Fog. It is best not to drive in fog. However, if you must drive in fog, take the following precautions:

- Slow down. If you see headlights or taillights, slow down even more. A driver may be driving in the center of the roadway or may be stopped or barely moving.
- Drive with your headlights set on dim, or use fog lights.
- Do not overdrive your headlights. Stay within the limits of your vision. You may have to stop suddenly. If the fog is too dense, pull off the roadway and stop. Do not drive at five or 10 miles per hour.
- Use your turn signal long before you turn, and brake early when you approach a stop in order to warn other drivers.

Rain. When rain begins to fall lightly, water, dust, oil, and leaves cause the roadway to become slippery. When this happens, increase your following distance. Take special care on

curves and turns, and while braking. Your headlights must be on when operating your wipers. Parking lights are not acceptable.

When rain begins to fall heavily, your tires may "hydroplane." This means the tires are riding on a layer of water and not on the roadway. Avoid hydroplaning by slowing down. If you skid while hydroplaning, try to regain control of the vehicle. Otherwise, release the accelerator and ride out the skid.

High winds. Wind can be a difficult problem for all drivers. Wind is especially difficult for drivers of trucks, recreational vehicles, campers, and trailers-in-tow. In high winds, you should reduce your speed and make steering corrections when you go from a protected area to an open area, and when meeting large vehicles such as trucks and buses. Heavy rain or sleet often accompanies high winds. You should be alert to wet or slippery areas and plan for those conditions.

Winter driving. Winter is the most difficult driving season for many reasons, including ice, snow, lower temperatures, and fewer daylight hours. When driving in winter conditions, take the following precautions:

- Drive slower and increase your following distance. Roadway conditions may vary depending upon the sun, shade, or roadway surface.
- Remove all snow and ice from your vehicle. Clear all windows, and do not start driving until your windshield is defrosted and clear. Be sure you have non-freezing windshield washer liquid, and that your headlights and taillights are visible.
- Be sure your vehicle is maintained properly. Lights, brakes, windshield wipers, defrosters, radiator, and other parts should be in good working order.
- Use snow tires and/or chains (where allowed). Snow tires give you extra traction, and chains increase safety on snow or ice packed roads. Neither tires nor chains allow you to drive on bad roads at normal speeds.
- Start slowly. Gentle braking in slow, steady strokes helps you find out how much traction you have. Begin braking early when you come to an intersection or a stop.
- Approach bridges, shaded spots, overpasses, and turns slowly. They may remain icy after the rest of the roadway is clear and dry.
- Plan your winter driving. Carry a blanket, food, and other survival equipment, such as a shovel, in your vehicle in case you become stranded. If you become stranded, remain in your vehicle. Run your engine only for brief times, and open your window to prevent carbon monoxide poisoning. Make sure your vehicle tailpipe is free of snow and debris.

Equipment Failure

Crashes often happen when equipment fails. Your most important aid is remaining calm. Equipment failures may include the following:

- Blowouts. A thumping sound may be a warning of a blowout. If this happens, ease your foot off the gas pedal and keep a firm grasp on the steering wheel. Do not brake suddenly. Pull safely off the roadway and check your tires.
- Loss of a wheel. React as you would with a blowout. Ease off the gas pedal and pull off the roadway.

- Steering failure. If you suddenly have no control of the steering wheel, ease your foot off the gas pedal. Turn on your emergency flashers and allow your vehicle to come to a slow stop. Brake very gently to prevent your vehicle from spinning.
- Brake failure. If your brake pedal suddenly sinks to the floor, pump it to build pressure. If that does not work, use your emergency or parking brake. To slow down, shift your vehicle into a lower gear.
- Headlight failure. If your headlights fail suddenly, try your emergency flashers, parking lights, and/or turn signals. Pull off the road. If your lights begin to dim, drive to a service station or pull off the road and seek help.
- Stuck gas pedal. If the gas pedal becomes stuck, hook your toe under it to free it. If it does not become free, shift your vehicle into neutral and brake gently to slow down. If you have power steering or a locking steering wheel, do not turn off the ignition because you will lose either your power steering or your ability to steer.
- Blocked vision. If for any reason your vision becomes blocked, roll down the side window to see. Turn on your emergency flashers and then pull your vehicle off the road.

Special Driving Situations

Just as weather and equipment affect your safety, other driving situations also require extra caution.

Expressway driving. Expressways, toll roads, turnpikes, and freeways are fast, multiple-lane roads. The maximum speed limit is 55 or 65 miles per hour. Here are some tips for safe driving on expressways:

- Getting on expressways. When entering an expressway, you will usually find a speed-change lane. This lane allows you to gain the speed necessary before merging. You should signal and look for an opening in the traffic, match traffic speed, and merge with traffic when safe.
- Getting off expressways. Exits may be on the right or left. Be sure to be in the correct exit and speed-change lanes. Signal your intent, and then slow down to make your exit in the speed-change lane.

b) Discuss pre- and post-driving vehicle inspections.

Inspections are discussed in 49 CFR 396.11 to 49 CFR 396.19.

c) Discuss how the application and use of control measures, equipment, road conditions, barriers, and non-communication devices are affected by environmental conditions.

As environmental conditions change, different control measures, equipment, etc., are affected depending on their use and how they work. For devices that are visual, snow storms render them ineffective. Measures should be used to minimize the impact of bad weather or other environmental conditions.

d) Identify the purpose and process of training in accident/incident investigation.

Federal employees acting as board chairpersons or members may be subject to the Department's Technical Qualification Program. It is a local decision whether federal staff at HQ or in the field who may be board chairpersons or members fall under this program. If so, the necessary competencies should be determined and added to the pertinent qualification standard in the employees' organizations. Board chairpersons or members should also demonstrate acceptable experience, education, and skills to meet qualification standards in accordance with local procedures, as applicable. The board members must be familiar with accident investigation techniques and must have sufficient skills and knowledge, either through board members or through advisors and consultants, to evaluate: (1) the effectiveness of management systems, as defined in DOE P 450.4, Safety Management System Policy (there should be requisite knowledge on the board of the Department's integrated safety management system and its components); (2) the adequacy of DOE policy and policy implementation; and (3) how line management oversight responsibilities are executed, all as related to the accident.

Board chairpersons must

- be senior DOE managers;
- have demonstrated managerial competence and preferably be a member of the Senior Executive Service or at a Senior General Service Grade level determined to be appropriate by the appointing official;
- be knowledgeable of DOE accident investigation techniques and experienced in conducting accident investigations through participation in at least one Type A or Type B investigation, or have equivalent accident investigation experience as determined and documented by the appointing official.

Accident investigation board chairpersons must have attended an accident investigation course of instruction that is based on current materials developed by the Office of the Deputy Assistant Secretary for Oversight. For additional information on this subject, contact the program manager.

Board members must be

- DOE employees
- subject matter experts in areas related to the accident

At least one board member must be a DOE accident investigator and must have participated in at least one Type A or Type B accident investigation. At least one board member or consultant/advisor must be knowledgeable in evaluating management systems. These skills may reside in a single board member. The program manager will keep the field and HQ points of contact apprised of the availability of appropriate training to support the accident investigation program. Training will be necessary in the following areas:

- Basic accident investigation techniques
- Board chairperson skills
- Analytical techniques
- Readiness team actions

The program manager, in coordination with field and program office points of contact, may schedule and offer training courses or distribute training materials, as required, or may identify courses available from universities, commercial sources, or other government agencies that meet the Department's needs. Therefore, points of contact should coordinate their program-related training needs with the program manager and provide feedback and recommendations to the program manager on training from these various sources. Field elements, through their points of contact, are responsible for providing training required to assure readiness to conduct accident investigations.

e) Discuss actions and procedures for reporting a vehicle accident or property damage.

It is DOE policy that environmental, safety, and health reports be complete and readily available for authorized dissemination outside the cleared community. When accidents or incidents occur in Unclassified Controlled Nuclear Information (UCNI) sensitive facilities and/or involve classified operations, the local classification officer will be consulted to ensure that such reports do not inadvertently disclose classified or unclassified controlled information (such as UCNI or Official Use Only information.) If classification concerns appear to inhibit completely forthright reporting, the DOE offices of Classified and Controlled Information Review and Information Classification and Control Policy will provide assistance in creating complete yet unclassified reports. If this cannot be accomplished, the reports will be annotated to indicate the existence, identification, and file location of any classified addendum.

10. Occupational safety personnel shall demonstrate a working-level knowledge of the requirements and methods to maintain communication with DOE-Headquarters, field elements (including contractors), other Federal agencies, and regulatory agencies.

a) Describe the DOE's organization and discuss DOE's procedures for communicating between DOE Headquarters and Field Elements.

The DOE complex operates on the basis of a "chain of command" with different levels of authority. Headquarters, operations or field offices, area offices, and contractors all have different responsibilities. Formal policy, requirements, assessments, responses, etc., should be passed up and down, with the different levels of the chain of command performing their assigned duties and being held accountable for their actions. In order for DOE to function effectively, each level of the organization is responsible for formally acting upon and initiating actions only from its appropriate level of authority within the DOE chain of command. Pressures to violate the chain of command should be resisted, and all formal actions must be transmitted through proper channels to ensure review and approval before decisions are made or actions are taken. Similarly, only authorized personnel may represent, make commitments for, or communicate in the name of DOE with other federal agencies. The Office of Environment, Health, and Safety (EH) has responsibility for developing and coordinating Departmental policy for nuclear reactor and nonreactor nuclear facility safety. In this connection, reactor and nonreactor nuclear facility safety encompasses all systems and activities that can influence the potential for uncontrolled release of fission products, or for nuclear criticality. Certainty of nuclear safety involves not only verification that nuclear reactor and nonreactor nuclear facility designs comply with applicable standards, but also

verification that plant modifications, operations, maintenance, and plant material conditions meet nuclear safety requirements, and that human performance facets that could potentially affect nuclear safety are receiving appropriate attention. The Office of Defense Programs (DP) continues to be fully responsible within the Department for all elements of nuclear weapons safety. EH also directs the development of environmental, safety, and health policy in areas other than those designated above. In addition, EH is responsible for (and conducts) independent assessments to assure compliance with applicable laws related to environmental protection, worker safety and health (excepting radiation safety), and public health and safety related to DOE operations. On matters involving the independent oversight role, EH has direct access to the Secretary. In addition, EH is responsible for inspecting and assessing the effectiveness of the Department's safeguards, security policies, and programs, and for their implementation in the field, as well as for the safety certification of packaging containers for shipment of DOE radioactive materials, excluding nuclear weapons. In the area of radiological protection, EH is responsible for promulgating and maintaining the definitive policies, standards, and guidance for the Department's radiological protection program. These responsibilities include ensuring that the policies and standards are effective and capable of implementation by line management. In order to provide the Department with the framework for effective radiological control practices that are consistent with respect to requirements and standards, EH has prepared a comprehensive and definitive Radiological Control Manual to be the basis by which site-specific manuals can be generated. The Director of the Office of Nuclear Safety has the responsibilities of independent monitoring and assessment of the effectiveness of the Department's radiological protection performance, including independent oversight of on-site operational performance. The Department's line managers are fully responsible for the performance of radiological controls within their programs and the field activities and sites assigned to them.

b) Describe DOE's procedures and policies (including form Memorandums of Understanding) for communicating with OSHA, the Bureau of Labor Statistics, the National Institute for Occupational Safety and Health, and other regulatory agencies.

DOE is required to follow OSHA standards by DOE O 440.1, as well as by Executive Order 12196, "which establishes policies and responsibilities within Federal departments and agencies for implementation of the Occupational Safety and Health Act of 1970." Accordingly, knowledge of DOE's responsibilities, the purpose of the OSHA Code of Federal Regulations, 29 CFR 1910, and the regulatory interfaces between OSHA and DOE is needed. In accordance with regulations, mandatory guidance, good practice, and common sense, it is vital that critical occupational safety data and information be maintained and be retrievable. Critical data includes the following: (1) what is needed to make decisions at the moment, and (2) what is needed to document and defend decisions made in the past. This data would include exposure assessments, recommendations for and actual controls and medical surveillance, and past sampling data retrievable by employee, time, location, department, operation, and agent. Copies of past operating procedures and manuals should probably also be retained for future reference.

c) Define the respective jurisdictions of DOE and OSHA concerning occupational safety and health matters on DOE work sites.

The Occupational Safety and Health Act of 1970 exempted federal agencies from the authority of OSHA to the extent that those agencies exercised independent authority over worker safety and health. DOE, granted such authority under the auspices of the Atomic Energy Act, is the only federal agency that claims such an exemption. In 1993, DOE O 5483.1A (now DOE O 440.1) required DOE contractors to obey and implement all OSHA standards. However, OSHA does not have right-of-entry or inspection at DOE weapons facilities, nor can it issue citations at DOE facilities or impose financial or criminal penalties if DOE contractors fail to comply with these standards. DOE O 440.1, Worker Protection Management for DOE Federal and Contractor Employees, requires DOE elements to implement a written worker protection program that integrates all requirements contained in paragraphs 4a through 4l of the order, and program requirements contained in 29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters. Senior DOE HQ and field line officials are directed to ensure that their facilities conform to applicable operational, environmental, safety, health, and security standards established by law, regulation, or Departmental policy while at the same time ensuring that they meet their production and research missions. Based on the agreement with OSHA, the Department exercises full and independent statutory authority to prescribe and enforce standards fully compatible with OSHA regulations in its facilities. Furthermore, OSHA has established and codified a process in 29 CFR 3960, subpart B, for affirming that senior federal managers assume responsibility for federal worker safety and health programs. The regulation provides for a Designated Agency Occupational Safety Official identified as the senior federal manager responsible for the safety and health of workers at the agency (the Director of Administration and Human Resource Management). DOE has adopted the OSHA approach and emphasizes that the respective Program Senior Officials (PSOs) are designated as the assigned program officials responsible for the safety and health of contractor workers under their purview. Accordingly, they are responsible for administering occupational safety and health compliance programs; establishing programmatic goals, objectives, and priorities; and identifying and applying necessary resources to mitigate hazards and comply with requirements relevant to contractor workers. The PSOs' Self-Assessment Offices evaluate DOE and contractor line management accountability for the implementation of these workplace safety and health requirements; they are charged to regularly report the status of compliance to the PSOs. The self-assessment organizations in the field serve a similar purpose for their answerable line officials. The Office of Environment, Safety and Health (EH) is responsible for developing Departmental policies, requirements, and guidance upon which the Department exercises its authority under OSHA. In addition, EH assesses and reports to the Secretary and to the PSOs on the status and adequacy of line management performance of its occupational safety and health responsibility at DOE facilities.

d) Describe the importance of requiring the proper skill levels of knowledge for each of the occupational safety work areas listed in the Occupational Safety Qualification Standard.

Proper skill levels are required to be able to provide adequate knowledge, skills, and abilities to address any applicable safety issue that may be present or may present itself in any given

work environment. This knowledge would allow the mitigation of any potential injury within the workplace.

11. Occupational safety personnel shall demonstrate a working-level knowledge of the development and management of both the technical and programmatic elements of an occupational safety program.

a) Discuss the function of a safety program.

There are five basic policy statements on the function of a DOE safety program.

- Provide places and conditions of employment that are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm.
- Ensure that employees and employee representatives shall have the opportunity to participate in the Federal Employee Occupational Safety and Health Program.
- Establish programs in safety and health tracking for all levels of federal employees.
- Ensure that no federal employee is subject to restraint, interference, coercion, discrimination, or reprisal for filing a report of an unsafe or unhealthful working condition, or other participation regarding the safety and health of federal employees.
- Consider all OSHA and 29 CFR 1960 requirements to be minimum standards for federal employees.

b) Discuss general principles of management applicable to the organization of the safety function, safety program planning, safety program evaluation, and `, management, and the public.

General principles of management applicable to safety-related elements are listed below:

- Ensure through the Contracting Officer that contractors implement effective worker protection programs.
- Review contractor worker protection program budgets and provide recommendations to the funding official on the appropriateness of the budget request.
- Provide contractors with technical direction on and criteria for the development of contractor goals, objectives, and performance measures.
- Hold DOE line personnel accountable for providing technical direction to contractors that is consistent with the requirements contained in DOE O 231.1A.
- Evaluate the need for and direct the development of formal written agreements between organizations on their sites. These agreements shall outline the respective roles, responsibilities, and authorities of each organization as they relate to compliance with DOE worker protection requirements and the resolution of cross-cutting worker protection-related issues.
- Review and forward to DOE HQ all exemptions, exceptions, and variances to mandatory worker protection requirements contained in DOE O 231.1A. Conduct an annual review of the status of all exemptions to the requirements contained in this Order to ensure that circumstances requiring the need for relief have not changed and that instituted controls are still implemented and appropriate.

c) Describe the role and significance of the following major elements in a successful safety program:

- **Positive management leadership**
- **Assignment of safety management roles, authorities, accountabilities, and responsibilities**
- **Formal statement of policy**
- **Maintenance of safe working conditions**
- **Establishment of control and prevention programs**
- **Worksite analysis**
- **Training**
- **Employee involvement**
- **Program and work area assessments**

Descriptions of the above programs may be found at
http://www.directives.doe.gov/pdfs/doe/doetext/oldord/5483/o54831a.pdf.

d) Describe the importance of and methods for establishing, updating, and measuring program performance against safety program goals and objectives.

The key to a successful occupational safety and health (OSH) program is continuous improvement through regular feedback and program revision. Setting safety program goals and objectives gives all employees a clear understanding, initially, of the desired performance and results, but regular assessment of program progress and corrective actions to address identified problems are critical to maintaining the employees' commitment to the program.

The satisfactory control of occupational health hazards must be given continuing attention even though control measures are in place. Documented periodic monitoring is essential to assess maintenance and the continuing adequacy of controls, to determine the need for additional measures, or to review recommendations for maintenance or reemphasis of administrative controls. Employees should be given the opportunity to observe the monitoring for toxic materials or harmful physical agents and be given access to the results.

A well-designed OSH program follows the standard good management practices for any program. Typical program management activities include the following:

- An analysis of the work, environment, staff, and hazards is performed.
- The goals and objectives are clearly determined and communicated.
- The processes and methods for achieving the goals and objectives are determined.
- Milestones and checkpoints toward the goals and objectives are set.
- Period measurements are taken of the progress at the milestones and checkpoints and the data are evaluated.
- Necessary corrections are made in the processes and methods based on the evaluation of the performance.

e) Identify common safety program performance indicators.

Performance indicators such as lost work time, accident reports, accident severity, and personnel injury are statistics that are tracked and monitored to review the overall effectiveness of a program and to help improve the program as well.

f) Discuss safety program funding and human resource issues that must be considered in both short- and long-term plans and budgets.

Health and safety programs must compete for the available funding in any organization's budget. It is important to realize, however, that their funding is not optional at any DOE facility.

According to DOE Order 3790.1B, the Director of Administration and Management, "shall: Designate an official with sufficient authority and responsibility to plan for and assure funds for necessary safety and health staff, equipment, materials, and training required. . . ."

"Heads of Field Elements with Delegated Personnel Authority must . . . :

- Designate an official with sufficient authority and responsibility to plan for and assure funds for necessary safety and health staff, equipment, materials, and training required. . . ."
- "Ensure that funds sufficient to conduct the program are identified in the budget planning process."

g) Describe role, contents, and significance of a written safety program document.

The role of the safety program is to implement a philosophy of improving safety. This is done by delineating the following:

- A clear chain of command for safety and health activities
- Accountability for safety and health performance
- Well-defined Headquarters expectations regarding safety and health
- Well-defined task and operational hazards/risks
- Comprehensive hazard prevention and control methods
- Record-keeping requirements to track program progress

h) Discuss the importance of employee participation in the implementation of the safety programs and identify potential methods to ensure or encourage involvement.

Employee "ownership" of health and safety programs helps to secure cooperation and participation in the program. Participation may be enhanced by using motivational programs, incentive programs, recognition programs, giveaways, and similar means of providing incentives.

i) Identify and discuss the application of criteria in the Environment, Safety and Health Management Plan for occupational safety.

Guidance for a safety and health management plan is provided by 29 CFR 1910.120. Additionally, the EM-40 Health and Safety Plan (HASP) Guidelines and elements are shown in the following matrix.

Application of Criteria for ES&H Plan for Occupational Safety	
Criteria	**Application**
General Requirements	
Organizational structure	The HASP Guidelines require specific identification of the names and organizational relationships among the DOE, contractor, and subcontractor key personnel onsite. The document provides an example of an organization chart and the appropriate information for, and use of, the chart.
Comprehensive work plan	This is used in conjunction with hazard assessment. It should detail the selection of the operation or job, and the breakdown of the operation or job into constituent tasks. The hazards and hazard controls are then determined for the tasks.
Site-specific safety and health plan	This refers to the more detailed plan for multi-site facilities.
Safety and health training program	Each site is required to have a safety and health training program. Specific requirements for individuals are contained in a variety of OSHA and DOE Orders, CFR and federal, state, and local codes and standards.
Medical surveillance program	Medical surveillance of workers is necessary to protect the health of the worker, establish fitness for duty, and ensure documentation of exposure to hazardous materials.
Standard operating procedures for safety and health	Standard operating procedures for safety and health address two issues. The first is demonstration of management's commitment to safety and health in the form of detailed procedures to address the major concerns. The second is that workers who use general safe work practices are less likely to be injured or harmed than those who do not use these practices.
General and site-specific program interfaces	In order to ensure adequate coverage of all significant safety and health issues, it is necessary to compare the general and site-specific programs to identify gaps and duplication. Of particular concern are the areas where the two programs interface and the opportunity for errors and omissions is greatest.
Safety and health risk/hazard analysis	A safety and health risk/hazard analysis is required for each site task and operation found in the work plan.
Employee training assignments	All employees working onsite are required to receive appropriate safety and health training before beginning their duties. Because the level and content of the training varies depending upon the workers' assignments, it is important that all workers' training requirements be clearly documented and tracked throughout their assignments and updated as necessary.

Application of Criteria for ES&H Plan for Occupational Safety	
Criteria	**Application**
General Requirements	
Personal protective equipment	An effective personal protective equipment program is a significant factor in safe-guarding employee health and safety.
Medical surveillance documents	The records generated by this program form a foundation for dealing with long-term health and safety issues and for intermediate adjustments to the site safety and health plan. It is vital that these documents cover the appropriate personnel, are accurate, and are maintained in a timely and efficient manner.
Monitoring instrumentation and techniques	This portion of the plan must be based upon all chemical, physical, and radiological hazards identified in the site characterization. At a minimum, it must contain the following: ▪ Sampling strategy and schedule for personal monitoring, air monitoring, and environmental sampling ▪ Instrumentation and equipment used ▪ Calibration and maintenance of instruments and equipment ▪ Quality assurance/ quality control procedures and analytical methods

j) Identify methods to evaluate and develop health and safety programs and plans, including the Voluntary Protection Program (VPP) and Integrated Safety Management.

The ideology behind developing a health and safety program includes

- management leadership and employee involvement
- worksite analysis
- hazard prevention and control
- safety and health training

The evaluation process contains some or all of the following elements.

Voluntary Participation

Participation in VPP is strictly voluntary. The applying organization that wishes to participate in VPP freely submits information to OSHA on its safety and health management system and opens itself to agency review.

Cooperation

OSHA has long recognized that a balanced, multifaceted approach is the best way to accomplish the goals of the OSH Act. VPP's emphasis on trust and cooperation between OSHA, the employer, employees, and employees' representatives complements the agency's

enforcement activity, but does not take its place. VPP staff and participating sites work together to resolve any safety and health problems that may arise. This partnership enables the agency to remove participating sites from programmed inspection lists, allowing OSHA to focus its inspection resources on establishments in greater need of agency oversight and intervention. However, OSHA continues to investigate valid employee safety and health complaints, fatalities, catastrophes, and other significant events at VPP participant sites.

A Systems Approach.

Compliance with the OSH Act and all applicable OSHA requirements is only the starting point for VPP sites. VPP participants develop and implement systems to effectively identify, evaluate, prevent, and control occupational hazards so that injuries and illnesses to employees are prevented. Star sites, in particular, are often on the leading edge of hazard prevention methods and technology. As a result, VPP work sites serve as models of safety and health excellence, demonstrating the benefits of a systems approach to worker protection. Note: Federal agencies participating in VPP also must comply with Executive Order 12196 and 29 CFR 1960, in addition to Section 19 of the OSH Act.

Model Worksites for Safety and Health

OSHA selects VPP participants based on their written safety and health management system, the effective implementation of this system over time, and their performance in meeting VPP requirements. Not all work sites are appropriate candidates for VPP. At qualifying sites, all personnel are involved in the effort to maintain rigorous, detailed attention to safety and health. VPP participants often mentor other work sites interested in improving safety and health, participate in safety and health outreach and training initiatives, and provide OSHA with input on proposed policies and standards. They also share best practices and promote excellence in safety and health in their industries and communities.

Continuous Improvement.

VPP participants must demonstrate continuous improvement in the operation and impact of their safety and health management systems. Annual VPP self-evaluations help participants to measure success, identify areas needing improvement, and determine needed changes. OSHA on-site evaluation teams verify this improvement.

Employee and Employer Rights.

Participation in VPP does not diminish employee and employer rights and responsibilities under the OSH Act or, for Federal agencies, under 29 CFR 1960.

12. Occupational safety personnel shall demonstrate a working-level knowledge of assessment techniques applicable to occupational safety, reporting results, abatement of hazard, and following up on actions taken as the result of assessments.

a) Describe the roles and responsibility of occupational safety personnel with respect to oversight of Government-Owned Contractor-Operated facilities.

Each contractor shall assure that current copies of DOE prescribed OSHA standards, along with the contractor's own safety and health procedures applicable to the workplace, are

available in a place and form reasonably accessible to all employees and their authorized representatives.

b) Describe methods for, and the role and performance of, fact-finding interviews during an occurrence investigation.

Some methods of gathering information include conducting interviews and collecting statements. Interviews must be factual. Preparing questions before the interview is essential to ensure that all necessary information is obtained. Interviews should be conducted, preferably in person, with those people who are most familiar with the system. Individual statements could be obtained if time or the number of personnel involved makes interviewing impractical. Interviews can be documented using any format desired by the interviewer. Consider conducting a walk-through of the system or facility as part of the interview if time permits.

c) Explain essential elements of a performance-based assessment including the areas of investigation, fact-finding, and reporting, including a follow-up closure of assessment.

Investigation

It is important to begin the investigation as soon as an assessment is called for to ensure that data is not lost. The information that should be collected consists of conditions before, during, and after operation of the facility; personnel involvement; environmental factors; and other information having relevance to the operation of the facility.

Fact Finding

Once all the data has been collected, the data should be verified to ensure accuracy. The investigation may be enhanced if some physical evidence is retained. Establishing a quarantine area, or the tagging and segregation of pieces and material, should be performed for failed equipment or components. The basic need is to determine the direct, contributing, and root causes so that effective corrective actions can be taken that will prevent recurrence. Some areas to be considered when determining what information is needed include

- activities related to the operations of the facility
- initial or recurring problems
- hardware (equipment) or software (programmatic-type issues) associated with the facility
- recent administrative program or equipment changes
- physical environment or circumstances

Some methods of gathering information include conducting interviews and collecting statements. Interviews must be factual. Preparing questions before the interview is essential to ensure that all necessary information is obtained. Interviews should be conducted, preferably in person, with those people who are most familiar with the system. Individual statements could be obtained if time or the number of personnel involved makes interviewing impractical. Interviews can be documented using any format desired by the interviewer. Consider conducting a walk-through of the system or facility as part of the interview if time permits.

Reporting

Review of reports and documents helps develop the foundation for identifying weaknesses and areas that are of concern to an auditor.

Review relevant documents or portions of documents as necessary, and reference their use in support of facility operation. Record appropriate dates and times associated with the occurrence on the documents reviewed. Examples of documents include the following:

- Operating logs
- Correspondence
- Inspection/surveillance records
- Maintenance records
- Meeting minutes
- Computer process data
- Procedures and instructions
- Vendor manuals
- Drawings and specifications
- Functional retest specification and results
- Equipment history records
- Design basis information
- Safety analysis report (SAR)/technical specifications
- Related quality control evaluation reports
- Operational safety requirements
- Safety performance measurement system/occurrence reporting and processing system (SPMS/ORPS) reports
- Radiological surveys
- Trend charts and graphs
- Facility parameter readings
- Sample analyses and results (chemistry, radiological, air, etc.)
- Work orders

Exit Interview

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

Follow-Up

After a reasonable period of time has elapsed, follow-up activities should be performed to verify the effectiveness of the corrective actions and how they were implemented. The verification should, at a minimum, sample the corrective actions to determine whether the problem/issue to be addressed has been resolved. The organization's reporting systems (e.g., noncompliance tracking system, occurrence reporting and processing system, external oversight reports and regulatory violations, performance indicators) should be reviewed for

evidence of the problem (or a similar problem) recurring. The same techniques used to conduct assessments may be used for verifying corrective actions; however, there are several common ways to verify the implementation of corrective actions, including the following:

- Reassessment of the deficient areas
- Review of new or revised quality-affecting documents such as manuals, procedures, and training records
- Verification during the next scheduled assessment
- Verification by conducting a surveillance covering the areas of concern

Closure

Contractors send a letter to the directives management group (DMG) requesting closure and stating that the corrective actions in the implementation plan have been completed. Any ongoing activities specified in the letter must be noted. The DMG coordinates approval of the closure with the appropriate division of primary interest and the contracting officer's representative.

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

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

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

d) Describe the necessary content and format of an assessment report addressing occupational safety.

An assessment report addressing occupational safety should include an executive summary, an observation section, a results section, and an attachment section, if applicable.

Executive Summary

This summary should be a brief, stand-alone document. It should describe the programs, systems, and processes assessed and the overall assessment results, including an evaluation of the effectiveness, efficiency, and adequacy of the area(s) assessed and the overall results. The executive summary should describe the strengths and weaknesses affecting the assessed organization, including barriers to performance, so that meaningful action can be taken for improvement.

Observation Section

Each part of the observation section should focus on the established assessment scope and the identified organization mission; otherwise, the recipient of the report will question why a

specific area or activity was assessed. The section should include general background on the assessment, including team members, scope of the assessment, methodology used, and a summary of the assessment basis and source documents. This section should also include a detailed discussion of each area assessed, including specific performance criteria used and summaries of interviews, documents reviewed, observations, and inspections. The summaries contained in this section should support the specific items discussed under the results section. Noteworthy practices identified during the assessment should also be documented so that the assessed organization and other organizations can learn and build upon them.

Results Section

The results section should list and discuss specific problem areas or deficiencies, areas needing improvement, or noteworthy practices identified during the assessment. In addition, this section should highlight any recurring problems as indicators of ineffective corrective action by the assessed organization. For each item listed, the report should include a discussion of the specific performance criteria used and the basis for the nonconformance in sufficient detail to enable further analysis and action by the responsible organization. The report should also include any required post-assessment actions by the assessed organization.

Attachments Section

Attachments provide supplementary information to validate the assessment and its methodology. They can be helpful in planning corrective actions and follow-up activities. Items frequently included as attachments to assessment reports are the assessment agenda, a list of persons contacted, a list of documents reviewed, performance criteria, and the tools used to perform the assessment.

13. Occupational safety personnel shall demonstrate a working-level knowledge of fire hazards and the principles and methods of fire prevention and protection.

a) Discuss fire chemistry (i.e., four required elements) and role of this chemistry in fire prevention and protection efforts.

Generally, there are four items necessary to support combustion:

- An oxidizing agent
- Fuel
- A heat source
- A chemical reaction

These are commonly called the Fire Tetrahedron. The Fire Tetrahedron shows that for combustion to occur, fuel, an oxidizing agent, a heat source, and a chemical reaction must all be present in the same place at the same time. If any one of the tetrahedron's legs is removed, the fire will be extinguished.

b) Describe workplace and facility inspection procedures necessary to identify fire hazards and assess the status of compliance with applicable regulations.

Section 9 of DOE Order 5480.7A, Fire Protection, lists the assessment and inspection requirements for the Fire Protection Program.

c) Describe fire protection considerations that must be addressed in the review of proposed or existing processes and operations, and identify appropriate control measures.

According to DOE Order 5480.7A, section 9, DOE Fire Protection Program Requirements: "A DOE facility shall be characterized by a level of fire protection sufficient to fulfill the requirements for the best protected class of industrial risks (Highly Protected Risk/Improved Risk). This program is characterized by the inclusion of a continuing, sincere interest on the part of management and employees in minimizing losses from fire and related perils and the inclusion of preventive features necessary to ensure the satisfaction of objectives related to safety."

d) Discuss the need to develop, maintain, and implement work procedures that focus on the prevention of fires and explosions, such as hot-work permits, fire watches, and proper handling and storage of flammable materials.

In accordance with DOE Order 5480.7A, section 9, DOE Fire Protection Program Requirements, c. Administrative Features of the Program, "Facilities shall have procedures governing the use and storage of combustible, flammable, radioactive and hazardous materials so as to minimize the risk from fire. Such procedures shall also exist for activities, such as smoking limitations, isolation of hot work, and other fire prevention measures, which contribute to the decrease in fire risk."

e) Discuss and assess the applicability of fire detection system requirements.

A fire detection system is "any system designed to detect, extinguish, and limit the extent of fire damage or enhance life safety." Redundant systems include any two of the following:

- Automatic suppression systems, such as fire sprinklers, foam, and gaseous, explosion suppression, or other specialized extinguishing systems, plus appropriate alarms
- Automatic fire detection, occupant warning, manual fire alarm, and fire alarm reporting systems combined with properly equipped and adequately trained fire departments or brigades
- Fire barrier systems or combinations of physical separation and barriers for outdoor locations
- Other systems, such as alternate process control systems

f) Discuss and assess applicability of portable and fixed-fire suppression equipment requirements.

For portable extinguishers, refer to 29 CFR 1910.157(c)(5)(d) Selection and Distribution. (1) Portable fire extinguishers shall be provided for employee use and selected and distributed based on the classes of anticipated workplace fires and on the size and degree of hazard that would affect their use.

For fixed-extinguisher systems, refer to 29 CFR 1910.160, Fixed Extinguishing Systems, General. (1) Scope and Application. This section contains the general requirements that are applicable to all fixed-extinguishing systems to meet OSHA standards.

g) Discuss and assess application of requirements related to basic design principles in the National Fire Protection Association (NFPA) 101, Life Safety Code, including emergency egress, evacuation, and other related program elements.

The requirements for following NFPA 101, Life Safety Code, are found at 29 CFR 1910.37.

h) Discuss the role and purpose of fire protection design considerations including fireproof and fire-resistant structures, firewalls, and fire curtains.

A special fire protection design analysis shall be made of each facility vital to DOE mission accomplishment. The analysis shall use time parameters established in accordance with DOE 5480.7. The analysis shall identify the special fire prevention and protection features and controls deemed by the cognizant DOE fire protection authority to achieve a level of fire protection for vital facilities and programs that meets or exceeds the "improved risk" level.

i) Discuss health and safety hazards of currently employed fire suppressant systems.

Reference 29 CFR 1926.156, Total Flooding Systems with Potential Health and Safety Hazards to Employees.

- "The employer shall provide an emergency action plan. . . ."
- "On all total flooding systems the employer shall provide a predischarge employee alarm. . . ."
- "The employer shall provide automatic actuation of total flooding systems by means of an approved fire detection device installed and interconnected with a pre-discharge employee alarm system to give employees time to safely exit from the discharge area prior to system activation."

Total flooding systems usually employ either carbon dioxide or Halon 1211 or 1301 (halogenated hydrocarbon). CO has the hazard of asphyxiation, and these systems must be used in conjunction with an alarm system to warn employees. The Halon systems are safe to humans in concentrations up to 10 percent by volume of air for exposures up to 20 minutes. Foam systems, too, have the possibility of asphyxiation in closed areas.

j) Discuss and have working knowledge of welding safety, including confined spaces.

The requirements are for welding safety are discussed in 29 CFR 1910.252

k) Discuss first aid treatment for various burn types (e.g., electrical, fire, heat, and chemical).

A discussion of various first aid treatments is located in
http://www.alpharubicon.com/med/burnspalehorse.htm.

l) Discuss the role of fire fighters and their required training.

Where the fire department, or other firefighting organization, is part of a larger organization that performs the research, development, implementation, and enforcement activities of an Occupational Safety and Health (OS&H) program, the fire department program's needs may be included within the larger program.

A Safety Officer shall be designated for each organization. Where safety services, monitoring, training, etc., are provided by another on-site organization, or the parent organization, the person designated as the Safety Officer shall be responsible for coordinating the services required by the department. Responsibility for safety at the first-response level shall be incorporated in the department's emergency procedures manual. The fire department Safety Officer can be anyone in the organization who can show up on the scene (not necessarily with the first response), but must be someone other than the incident commander, as the Safety Officer is intended to be an independent voice, advising the incident commander.

The Safety Committee may include representatives from other organizations when the department is part of a larger organization or is at a site where safety services are provided by others. The required safety meetings may be joint meetings.

The training records that are required may be maintained by a parent or service organization as long as they are auditable and are available to the department. The department shall have a procedure for reflecting possible exposures in the incident files and individual medical records.

The requirement for training and education is considered to require that all firefighters must be trained in the hazards to be encountered at the scene of an incident before they can participate in active operations requiring such training. The individuals providing the training and education need not be members of the fire department, but they should be knowledgeable in the area of instruction as it relates to the fire service. Training Officer qualifications may be met by either compliance with the stated NFPA 1041, or by obtaining local or state certification. All personnel assigned to structural firefighting positions shall receive training adequate to meet the Firefighter I qualification of NFPA 1001. Training programs for drivers/operators shall be designed to meet the intent of the referenced standard. It is understood that some licensing requirements will vary by state and/or type of equipment. All specialized training programs, i.e., fire officer, driver/operator, airport firefighter, shall be developed and implemented within each organization. Training in fire ground operations shall be based on accredited systems, such as those provided by the International Fire Service Training Association manuals, official state training manuals, etc.

Because of the specialized operations and hazards peculiar to most DOE sites, "special hazards" training requirements are of prime importance. Training should include not only the nature of the hazards, but familiarization with protective systems and monitoring and alarm systems peculiar to the operation, and the support services provided by other parts of the site organization in monitoring or alleviating an emergency situation. Drivers of fire department vehicles shall receive special training in the operation of the vehicle and must be certified and/or licensed, as appropriate, or as required by the state to operate fire department vehicles.

All present and future acquisitions of used apparatus shall be brought up to the minimum standards for safety seating requirements. For ladders, see the Interpretation Note on NFPA 1932. (All test conditions are required except that the annual test requirement may be changed to not less than every five years. All other conditions noted as requiring the test are unchanged.) As a clarification, all equipment must be available and donned before the individual participates in any activity requiring protective clothing use. It is not necessary for each member of a department or brigade to have a full set of all protective clothing, as long as supplies for the anticipated needs can be delivered to the point of use in adequate quantities and sizes without incurring undue delay in the emergency response.

In view of the limited number of responses and shorter travel distances at DOE facilities, as compared to operations by municipal fire departments, the mandatory continuous use of hearing protection is not required. However, the Safety Coordinator should ensure that a hearing protection program is in place that is compatible with site-wide programs.

Some of the requirements pertaining to emergency operations may be covered by a parent organization or be provided by other on-site organizations at DOE facilities. For responses requiring interior firefighting or other operations requiring the entrance of SCBA-equipped people, the minimum number of respondents shall be 5 persons. When fewer personnel are available, interior operations shall not be attempted.

14. Occupational safety personnel shall demonstrate a working-level knowledge of ergonomic hazards and elimination or control of them.

a) Discuss basic ergonomics terminology.

Terms Related to Ergonomics	
Term	**Definition**
Administrative controls	Any procedures that significantly limit daily exposure by control or modification of the work schedule or manner in which work is performed. Administrative controls include, but are not limited to, job rotation, use of rest breaks or alternative tasks, job enlargement to increase task variability, redesign of work methods, and adjustment of work pace to reduce the number of repetitions.
Awkward posture	A deviation from the neutral position of any articular joint. Examples include, but are not limited to, twisting, bending, kneeling, squatting, and stooping.
Control the job or controlled job	To implement control measures that reduce or prevent employee exposure to workplace risk factors.
Engineering controls	Physical changes to workstations, equipment, materials, production facilities, or any other relevant aspects of the work environment that reduce or prevent exposure to workplace risk factors.
Equipment	Tools, machines, vehicles, devices, furniture, installations, and other components in the work system.

Terms Related to Ergonomics	
Term	**Definition**
Ergonomics	The field of study that seeks to fit the job to the person, rather than the person to the job. This is achieved by the evaluation and design of workplaces, environments, jobs, tasks, equipment, and processes in relationship to human capabilities and interactions in the workplace.
Fixed postures	Prolonged muscle contraction without movement, such as maintaining an unsupported posture or prolonged gripping of a tool.
Incidence rate	The number of new work-related musculoskeletal disorders that occur during a year per 100 full-time equivalent workers. Incidence rates are calculated as follows: (number of new work-related musculoskeletal disorders) x (200,000 work hours or 100 full-time equivalent workers)/(work hours per year or total number of full-time equivalent workers).
Job	The performance of a series of tasks in order to reach a goal or defined end product, including a job assignment to complete specific tasks.
Lower extremity	The hip, thigh, knee, leg, ankle, and/or foot.
Package	Material(s) or object(s) in a container where the contents are not known and the weight cannot be ascertained by the handling employee, e.g., a cardboard box containing cans of paint or a suitcase in baggage handling.
Personnel protective equipment	Devices such as, but not limited to, gloves, corrective lenses for work with video display units, or padding, worn on or attached to the body, which are used for the purpose of controlling workplace risk factors.
Restrictions	Any limitation placed on the manner in which an employee performs a job or work tasks during the recovery period. Restrictions refer collectively to any of the following: alternative duty assignment, alternative work, light duty, job modifications, job restrictions, and modified duty.
Severity rate	The number of lost work days due to work-related musculoskeletal disorders occurring in a year per 100 full-time equivalent workers. Severity rates are calculated as follows: (number of lost workdays) x (200,000 hours or 100 full-time equivalent workers)/(work hours per year or number of full-time equivalent workers).
Task	A subunit of a job or the group of activities that must be performed to accomplish the work objective or the job.
Unassisted frequent or forceful manual handling	Lifting, lowering, carrying, handling or pushing/pulling animals, people, or heavy objects, equipment, or tools without assistance from mechanical manual devices.
Upper extremity	The hand, wrist, elbow, arm, shoulder and/or neck.

Terms Related to Ergonomics	
Term	**Definition**
Vibration	The oscillatory motion of a physical body. Localized (segmental) vibration, such as hand-arm vibration, is produced by contact with powered tools or equipment, or vibrating structures. Whole-body vibration exposure occurs while standing or seated in vibrating environments or objects, such as trucks or heavy machinery, or while using heavy equipment, such as jackhammers.
Work methods	The physical methods used to perform the tasks of a job, such as reaching, gripping, using tools and equipment, or discarding objects.
Workplace	An establishment, job site, or project at one geographical location.
Workplace risk factors	Actions in the workplace, workplace conditions, or a combination thereof, that may cause or aggravate a work-related musculoskeletal disorder. Workplace risk factors include, but are not limited to, repetitive, forceful, or prolonged exertions; frequent or heavy lifting; pushing, pulling, or carrying of heavy objects; a fixed or awkward work posture; contact stress; localized or whole-body vibration; cold temperatures; and poor lighting (leading to awkward postures). These workplace risk factors can be intensified by work organization characteristics, such as inadequate work-rest cycles, excessive work pace and/or duration, unaccustomed work, lack of task variability, machine-paced work, and piece rate.
Work-related musculoskeletal disorder	An injury or illness of the muscles, tendons, ligaments, peripheral nerves, joints, cartilage (including intervertebral discs), bones, and/or supporting blood vessels in either the upper or lower extremities, or back, which is associated with musculoskeletal disorder workplace risk factors and which is not the result of acute or instantaneous events (e.g., slips or falls). Classifications such as, but not limited to, cumulative trauma disorders, repetitive strain injuries or illnesses, repetitive motion injuries or illnesses, and repetitive stress injuries or illnesses are included in this definition.

b) Describe ergonomic considerations that must be addressed when evaluating new or existing jobs, processes, or operations, and identify appropriate methods for the elimination or control of ergonomic hazards.

Designers, suppliers, and manufacturers who provide assistance in identifying and applying ergonomic design principles should be consulted when evaluating new jobs in order to prevent new problems from being created. The use of workplace risk factor checklists should assist the occupational safety professional in assessing existing jobs or changes in existing jobs. Appropriate methods for elimination or control of ergonomic hazards will depend on the specific situation. Refer to an ergonomics specialist for assistance.

c) Explain the application of "single risk factors" for ergonomic hazards.

Single Risk Factors	
Single Risk Factor	**Description**
Performance of the same motion or motion pattern every few seconds	Frequent repetitions of the same motions stress the body parts involved. The repetition may be of a "pattern" where several motions get repeated every few seconds, e.g., completion of the task may involve three steps that get repeated in sequence every few seconds. Much assembly line work involves repetition for long periods of time. When this repetition occurs for more than two hours at a time during the work shift without a break, the body may not have time to sufficiently rest the body parts that are being repeatedly stressed.
A fixed or awkward work posture (for example, overhead work, twist or bent back, bent wrist, kneeling, stooping, or squatting)	Holding body parts in fixed or awkward postures for more than two hours during a work shift also creates excess stress that can cause or aggravate work-related musculoskeletal disorders.
Use of vibrating or impact tools or equipment	Stress on the body due to vibration or impact of tools or equipment has also been shown to cause work-related musculoskeletal disorders. These may be hand-held power tools, such as a power sander, or large pieces of equipment that are being driven, such as forklifts.
Unassisted frequent or forceful manual lifting	Many jobs require workers to lift, carry, or otherwise handle objects. Generally speaking, the heavier the object is, the greater risk to the employees handling it. However, frequency of lifting or handling is also a concern, as are the size and shape of the objects, the distance they have to be carried, and the height from which or to which they have to be lifted.

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d) Discuss the methodology for analyzing lifting tasks.

Low Back Spinal Force Analysis

The Low Back Spinal Force Analysis tool helps you evaluate the spinal forces acting on a virtual human's lower back under any posture and loading condition. Based on a complex biomechanical low back model incorporating the latest anatomical and physiological data, the tool enables you to

- determine whether newly defined or existing tasks conform to National Institute of Safety and Health (NIOSH) guidelines or expose workers to an increased risk of low back injuries;
- evaluate jobs in real-time, flagging the exact moments when the compression forces on a worker's low back exceed NIOSH recommended force limits.

Static Strength Prediction

The Static Strength Prediction tool helps you evaluate the percentage of a worker population that has the strength to perform a task based on posture, exertion requirements and anthropometry. Based on strength studies performed over 25 years at the University of Michigan Center for Ergonomics, the Static Strength Prediction tool

- aids in analyzing material handling tasks involving lifts, lowers, pushes, and pulls requiring complex hand forces, torso twists, and bends;
- predicts the percentage of men and women who have the static strength to perform the prescribed job;
- evaluates jobs in real-time, flagging postures where task requirements exceed NIOSH or user-specified strength capability limits.

NIOSH Lifting Analysis

The NIOSH Lifting Analysis tool helps you evaluate symmetrical and asymmetrical lifting tasks, including lifts with less than optimal couplings between the object and the worker's hands. Based on NIOSH lifting equations developed by a committee of experts, the tool

- tells you the expected weight or load, under given postural conditions, that most healthy workers could safely lift over a substantial period of time;
- gives a relative estimate of the level of physical stress associated with a manual lifting task or a job involving multiple lifting tasks.

Predetermined Time Analysis

The Predetermined Time Analysis tool helps you predict the time required to perform a job by subdividing a task into a set of motions which have been assigned times based on the methods-time measurement (MTM-1) system. With this tool you can

- design manual tasks for optimal cycle times;
- evaluate alternate work methods in planning manual tasks, as well as equipment needs for new facilities;
- identify the tasks in a job and the variables of the tasks that represent the best opportunities for reducing the overall time required to perform a job.

Rapid Upper Limb Assessment

The Rapid Upper Limb Assessment (RULA) tool helps you evaluate the exposure of workers to the risk of upper limb disorders. For a given manual task, RULA

- assesses the risk of upper limb disorders based on posture, muscle use, the weight of loads, task duration, and frequency;
- assigns the evaluated task a score that indicates the degree of intervention required to reduce the risk of an upper limb injury.

Metabolic Energy Expenditure

The Metabolic Energy Expenditure tool helps you predict the metabolic energy expenditure requirements of a job based on worker characteristics and a description of the simple tasks that comprise the job. Based on the research of Garg, Chaffin, and Herrin, this tool enables you to

- determine whether newly defined or existing jobs conform to NIOSH or user-specific guidelines for metabolic energy expenditure, or expose workers to an increased risk of fatigue and injury;

- identify the tasks in a job and the variables of the tasks that represent the best opportunities for reducing a job's overall energy expenditure requirements.

Manual Handling Limits

The Manual Handling Limits tool helps you evaluate and design manual handling tasks involving lifting, lowering, pushing, pulling, and carrying for reduced risk of low back pain. Based on 20 years of research conducted at the Liberty Mutual Research Center, the tool enables you to

- determine the maximum acceptable weight that men and women can handle when performing various lift, lower, push, pull, and carry tasks;
- run "what-if" scenarios, altering the task variables to arrive at a job design that meets your manual handling weight requirements. Variables include object width, vertical distance, task frequency, and duration.

Fatigue/Recovery Time Analysis

The Fatigue/Recovery Time Analysis tool helps you assess whether enough recovery time is available for a given job to avoid worker fatigue. Based on strength and fatigue studies undertaken by Walther Rohmert, the tool computes the recovery time required for a job and compares it to available rest time. If there is not enough rest time in a job cycle to accommodate recovery time, workers are assumed to be at risk of fatigue. With the Fatigue/Recovery Time Analysis tool, you can

- design manual tasks for minimal risk of worker fatigue;
- analyze worker fatigue in static postures, or continuously during a real-time simulation;
- identify the tasks in a job that require the most recovery time and the muscle groups that are under the most strain.

Working Posture Analysis

The OWAS tool provides you with a simple method for quickly checking the comfort of working postures and determining the urgency of taking corrective measures. Based on the Ovako Working Posture Analysis System (OWAS), the tool

- evaluates the relative discomfort of a working posture based on positioning of the back, arms, and legs, as well as load requirements;
- assigns the evaluated posture a score that indicates the urgency of taking corrective measures to reduce the posture's potential to expose workers to injury.

e) Discuss significance of repetitive motions and tasks.

Repetition refers to a task or series of motions that is performed over and over again, with little variation. If tasks or motions are repeated frequently (e.g., every few seconds), fatigue and muscle tendon strain can accumulate, which can result in permanent tissue damage. Tendons and muscles can often recover from the effects of stretching or forceful exertions if sufficient time is allotted between exertions. Frequent repetition of the same work activities can also exacerbate the effects of awkward postures and forceful exertions.

f) Discuss importance of worker interfaces with operational equipment.

Workers should understand the hazards that exist from using a piece of equipment. This includes such benign things as keyboards and use of writing instruments. Each piece of equipment has individual hazards that exist when using the equipment. Workers need to be familiar with the equipment that they are interfacing with to help minimize accidents that could lead to injury and damaged equipment.

g) Discuss the significance and definition of workplace tasks related to ergonomic consequences.

The questions below are examples of questions that are asked of employees that could lead to discovery of ergonomic issues as part of the performance of their work. Each task has its own set of ergonomic consequences and significance. The definition of a workplace task is any task that is performed as part of an employee's routine day-to-day work, or any work described in the qualification requirements for the employee's position.

Do you have frequent or reoccurring pain in your arms, wrists, neck or back?

Monitor and document arrangements:

- Does it seem that the monitor is positioned too high or too low?
- Are documents positioned too close or too far away?
- Is your keyboard, mouse, or monitor height adjustable?
- Is the monitor too difficult to see/read from?

Lighting/glare:

- Does it appear that ambient light is too bright or too dim?
- Do you use a desk lamp to light tasks?
- Is there glare visible on the monitor?
- Do you face an uncovered window/uncovered light source?

Workstations and accessories:

- Is your work surface crowded or too small?
- Is your keyboard or work surface too high or too low?
- Does your hand/wrist rest on a hard/sharp edge?
- Do you use a palm rest and mouse pad while keying?

h) Discuss methods to conduct workplace evaluations and communicate results to workers and management.

The following areas may be reviewed as part of the monitoring documents:

- Programmatic Review against 29 CFR 1960 Requirements
- Programmatic Review against DOE O 440.1 Requirements
- Management and Employee Surveys
- Walkthrough and Hazards Recognition
- Analysis and Documentation of Results

These results are shared with employees through several avenues. The method of sharing is determined by findings, lessons learned, and the impact on employees.

15. Occupational safety personnel shall demonstrate a working-level knowledge of safety precautions and hazards associated with workplace chemicals and physical agents.

a) Discuss hazards associated with the following chemical types:

- **Corrosives**
- **Flammable, combustible, and explosive materials**
- **Oxidizers**
- **Cryogenic liquids**
- **Toxic chemicals**
- **Oxygen-displacing chemicals**

Corrosives

Corrosives can burn and destroy body tissues on contact. The stronger or more concentrated the corrosive material is, and the longer it touches the body, the worse the injuries will be. Some corrosives are toxic and can cause other health problems. Check the MSDS and label on the container for warnings of other possible health effects.

Corrosive materials can severely irritate, or in come cases, burn the eyes. This could result in scars or permanent blindness. The stronger or more concentrated the corrosive material is, and the longer it touches the eyes, the worse the injury will be.

Corrosives touching the skin can severely irritate or even badly burn and blister the skin. Severe corrosive burns over a large part of the body can cause death.

Breathing in corrosive vapors or particles irritates and burns the inner lining of the nose, throat, windpipe, and lungs. In serious cases, this results in pulmonary edema, a buildup of fluid in the lungs that can be fatal.

Swallowing corrosives burns the sensitive lining of the mouth, throat, esophagus, and stomach. In nonfatal cases, severe scarring of the throat may occur and could result in losing the ability to swallow.

Some corrosives are also flammable or combustible and can easily catch fire and burn or explode. Some corrosives are incompatible with other chemicals. They may undergo dangerous chemical reactions and give off toxic or explosive products if they contact each other. The MSDSs and the labels on the containers should explain all of the hazards for the corrosive materials used in the workplace.

Flammable, Combustible, and Explosive Materials

According to the Department of Transportation (DOT) and NFPA, combustible liquids are those having a flash point at or above 100°F, or liquids that will burn. They do not ignite as easily as flammable liquids. However, combustible liquids can be ignited under certain circumstances, and must be handled with caution. Such circumstances exist in industrial environments where processes involving high temperatures are performed.

Flammable liquids are those that catch on fire easily and burn rapidly. NFPA and the DOT define a flammable liquid as having a flash point below l00°F. Circumstances that could allow for a flammable liquid to reach its flash point can exist in any laboratory or work site within the DOE complex.

Oxidizers

Oxidizing materials may be toxic or corrosive. Depending on the material, route of exposure (inhalation, eye or skin contact, or swallowing), and dose, they could harm the body. Corrosive oxidizers can also attack and destroy metal. The MSDSs and the container labels should explain all of the hazards of the oxidizing materials that you use in the workplace.

An example of an oxidizer is ammonium perchlorate. This material is composed of white or colorless, odorless crystals. It is used in explosives and fireworks; as an oxidizing agent in solid rocket and missile propellants; as an adhesive; as an engraving agent; as a laboratory (analytical) reagent; as a chemical intermediate for alkali and alkaline metal perchlorates; as an animal feed supplement; and in oxygen-generating devices for life-support systems in submarines, spacecrafts, bomb shelters, and breathing apparatuses.

Ammonium perchlorate can decompose at high temperatures forming toxic gases, such as chlorine, hydrogen chloride, and nitrogen oxides. Closed containers or tanks may rupture and explode if heated. It does not burn, but is a powerful oxidizer and explosive when mixed with combustible materials. It is highly reactive, and impact or high temperatures can cause violent decomposition or explosion. It can form shock-sensitive mixtures with finely powdered metals, metal oxides, strong reducing agents, sulfur, and phosphorus. It may cause eye irritation.

Cryogenic Liquids

Cryogenic liquids and their associated cold vapors and gases can produce effects on the skin similar to a thermal burn. Brief exposures that would not affect skin on the face or hands can damage delicate tissues such as the eyes. Prolonged exposure of the skin or contact with cold surfaces can cause frostbite. The skin appears waxy yellow. There is no initial pain, but there is intense pain when frozen tissue thaws. Unprotected skin can stick to metal that is cooled by cryogenic liquids. The skin can then tear when pulled away. Even non-metallic materials are dangerous to touch at low temperatures. Prolonged breathing of extremely cold air may damage the lungs.

When cryogenic liquids form a gas, the gas is very cold and usually heavier than air. This cold, heavy gas does not disperse very well and can accumulate near the floor. Even if the gas is non-toxic, it displaces air. When there is not enough air or oxygen, asphyxiation and death can occur. Oxygen deficiency is a serious hazard in enclosed or confined spaces. Small amounts of liquid can evaporate into very large volumes of gas. For example, one liter of liquid nitrogen vaporizes to 695 liters of nitrogen gas when warmed to room temperature.

Each gas can cause specific health effects. For example, liquid carbon monoxide can release large quantities of carbon monoxide gas, which can cause death almost immediately. Refer to the MSDS for information about the toxic hazards of a particular cryogen.

Toxic Chemicals

When a toxic substance causes damage at the point where it first contacts the body, that damage is called a local effect. The most common points at which substances first contact the body are the skin, eyes, nose, throat, and lungs. Toxic substances can also enter the body and travel in the bloodstream to internal organs. Effects that are produced this way are called

systemic. The internal organs most commonly affected are the liver, kidneys, heart, nervous system, and reproductive system.

A toxic chemical may cause local effects, systemic effects, or both. For example, if ammonia gas is inhaled, it quickly irritates the lining of the respiratory tract (nose, throat, and lungs). Almost no ammonia passes from the lungs into the blood. Since damage is caused only at the point of initial contact, ammonia is said to exert a local effect. An epoxy resin is an example of a substance with local effects on the skin. On the other hand, if liquid phenol contacts the skin, it irritates the skin at the point of contact and can also be absorbed through the skin, and may damage the liver and kidneys.

Sometimes, as with phenols, the local effects caused by a chemical provide a warning that exposure is occurring. You are then warned that the chemical may be entering your body and producing systemic effects which you can't yet see or feel. Some chemicals, however, do not provide any warning at all and so they are particularly hazardous. For example, glycol ethers can pass through the skin and cause serious internal damage without producing any observable effect on the skin.

Oxygen-Displacing Chemicals

Oxygen-displacing chemicals, such as carbon monoxide, replace oxygen in your lungs. The effect is unconsciousness or death due to asphyxiation.

b) Discuss the terminology associated with toxic chemical effects.

Following are terms and definitions associated with toxic chemical effects.

Absorption: The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute: Occurring over a short time.

Acute exposure: Contact with a substance that occurs once or for only a short time (up to 14 days).

Additive effect: A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together.

Adverse health effect: A change in body function or cell structure that might lead to disease or health problems.

Aerobic: Requiring oxygen.

Ambient: Surrounding (for example, ambient air).

Anaerobic: Requiring the absence of oxygen.

Antagonistic effect: A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together.

Background level: An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation: Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic monitoring: Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biota: Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden: The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone, or because they leave the body very slowly.

Cancer: Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk: A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen: A substance that causes cancer.

Case study: A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study: A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number: A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system: The part of the nervous system that consists of the brain and the spinal cord.

Chronic: Occurring over a long time [compare with acute].

Chronic exposure: Contact with a substance that occurs over a long time (more than 1 year).

Cluster investigation: A review of an unusual number (real or perceived) of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports, determine whether they represent an unusual disease occurrence, and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP): A group of people from a community and from health and environmental agencies who work with the Agency for Toxic Substances and Disease Registry (ATSDR) to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): CERCLA, also known as Superfund, is the federal law that addresses the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration: The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant: A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect: A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal: Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact: Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology: The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit: The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease prevention: Measures used to prevent a disease or reduce its severity.

Disease registry: A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

Dose (for chemicals that are not radioactive): The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals): The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship: The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

EPA: United States Environmental Protection Agency.

Epidemiology: The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure: Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term, of intermediate duration, or long-term.

Exposure assessment: The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction: A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure pathway: The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry: A system of ongoing follow-up of people who have had documented environmental exposures.

Feasibility study: A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS): A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference, such as streets and homes.

Half-life (t½): The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time

necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25 percent of the original number of radioactive atoms remain.

Hazard: A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat): The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste: Potentially harmful substances that have been released or discarded into the environment.

Health education: Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation: The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure, and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Health statistics review: The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard: The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence: The number of new cases of disease in a defined population over a specific time period.

Ingestion: The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way.

Inhalation: The act of breathing. A hazardous substance can enter the body this way.

Lowest-observed-adverse-effect level (LOAEL): The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring: A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism: The conversion or breakdown of a substance from one form to another by a living organism.

Minimal risk level (MRL): An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects.

Morbidity: State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality: Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

Mutagen: A substance that causes mutations (genetic damage).

Mutation: A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Toxicology Program (NTP): Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No-observed-adverse-effect level (NOAEL): The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard: A category used in ATSDR's public health assessment documents for sites where people have never, and will never, come into contact with harmful amounts of site-related substances.

Physiologically based pharmacokinetic model (PBPK model): A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Plume: A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure: The place where someone can come into contact with a substance present in the environment.

Population: A group or number of people living within a specified area or sharing similar characteristics.

Potentially responsible party (PRP): A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

Prevalence: The number of existing disease cases in a defined population during a specific time period.

Prevalence survey: The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention: Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period: An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health advisory: A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA): An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health.

Public health hazard: A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories: Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are: no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement: The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance: The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Public meeting: A public forum with community members for communication about a site.

Radioisotope: An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide: Any radioactive isotope (form) of any element.

Reference dose (RfD): An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry: A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

Resource Conservation and Recovery Act (1976, 1984) (RCRA): This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

Risk: The probability that something will cause injury or harm.

Risk reduction: Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication: The exchange of information to increase understanding of health risks.

Sample: A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people, the sample is a number of people chosen from a larger population [see population]. An environmental sample, for example, a small amount of soil or water, might be collected to measure contamination in the environment at a specific location.

Sample size: The number of units chosen from a population or an environment.

Solvent: A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination: The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations: People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder: A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics: A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance: A chemical.

Survey: A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people.

Synergistic effect: A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves.

Teratogen: A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent: Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile: An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge of a substance and describes areas where further research is needed.

Toxicology: The study of the harmful effects of substances on humans or animals.

Tumor: An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancerous) or malignant (cancerous).

Uncertainty factor: Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard: A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs): Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

c) Describe general safety precautions that must be implemented or observed during the use, handling, storage, transportation, and disposal of each type of hazardous chemical listed above.

Title 29 CFR 1910 discusses all safety precautions that must be observed when using any chemical. Each of the areas mentioned in "15-a," above, are readily broken down for certain chemicals that form subcategories of the above-mentioned types. For each constituent of concern, 29 CFR 1910 has general precautions for use or specific precautions for certain types of chemicals.

d) Describe safety precautions specific to the use, handling, storage, and disposal of flammable and combustible liquids.

Title 29 CFR 1910.106 describes all precautions related to flammable and combustible liquids.

e) Describe the relationships and hazards associated with chemicals in a confined space entry and how their presence could dictate the confined space designation. Describe a proper confined space program including entry precautions and procedures.

Title 29 CFR 1910.146 discusses the requirements for designating a confined space and for controlling the space, as well as associated precautions.

f) Discuss hazards associated with chemical incompatibilities and the need for segregation and containment.

If chemicals that are not compatible are stored together, the reactions that may happen include fire, explosion, formation of toxic gases, and/or corrosion of storage containers. Storage of chemicals should be in accordance with http://www.lbl.gov/ehs/chsp/html/storage.shtml.

g) Discuss first aid and emergency response considerations for operations involving hazardous chemicals.

For operations involving hazardous chemicals, the employer shall develop an emergency response plan for emergencies which shall address, at a minimum, the following:

- Pre-emergency planning
- Personnel roles, lines of authority, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures which are not covered by the site safety and health plan
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- PPE and emergency equipment

First aid should be performed in accordance with the appropriate chemical MSDS.

h) Describe the methods by which toxic compounds may enter the body and the control mechanisms available to block these routes of entry.

Primary Methods of Entry	
Method	**Description**
Inhalation	Involves those airborne contaminants that can be inhaled directly into the lungs and can be physically classified as gases, vapors, and particulate matter such as dusts, fumes, smoke, aerosols, and mists.
Absorption	Chemicals can be absorbed through the skin, and more rapidly through cut or abraded skin than through intact or unbroken skin. Some substances are absorbed by way of the openings for hair follicles, while others dissolve in the fats and oils of the skin. Some organic chemicals can produce systemic poisoning by direct contact with the skin.
Ingestion	Toxic compounds are capable of being absorbed from the gastrointestinal tract into the blood.

The primary methods of blocking chemicals from entering the body are PPE, monitoring for the chemicals, and training of personnel using chemicals.

i) Analyze processes or operations to identify potential chemical hazards and appropriate control measures.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

j) Describe general considerations for the storage and use of different classes of explosives and blasting agents, including the construction, capacity, and placement of facilities or operations.

DOE M 440.1-1A, DOE Explosives Safety Manual, states that explosives shall be classified based on their reactions to specific initiating influences. The United Nations' (UN) recommended hazard classification system shall be used for DOE explosives classification. The UN system consists of nine classes for dangerous goods, with explosives included in Class 1. The explosives hazard class is further subdivided into divisions based on the character and predominance of the associated hazards and their potential for causing personnel casualties or property damage. The following table lists the six divisions of Class 1.

Hazard Class and Division Designators	Hazards
1.1	Mass detonating
1.2	Non-mass explosion, fragment producing
1.3	Mass fire, minor blast or fragment
1.4	Moderate fire, no significant blast or fragment
1.5	Explosive substance, very insensitive (with a mass explosion hazard)
1.6	Explosive article, extremely insensitive

DOE recognizes four classes of explosives operations consistent with the hazards to personnel based on the activity. The four hazard classes for explosives are defined below.

Class I consists of those explosives activities with high accident potential. Remote operations are required because any personnel exposure is unacceptable for Class I activities. In general, Class I includes activities where energies that may interface with explosives are approaching the upper safety limits, or the loss of control of the interfacing energy is likely to exceed the safety limits for the explosives involved.

Class II consists of explosives activities with moderate accident potential because of the explosives type, condition of the explosives, or nature of the operations involved. Class II activities have an accident potential greater than Class III activities, but personnel exposure in contact operations is acceptable. Class II includes activities where the energies that do or may interface with the explosives are normally well within the safety boundaries for the explosives involved, but where the loss of control of these energies could approach the safety limits.

Class III consists of explosives activities with low accident potential such as activities during storage and operations incidental to storage or removal from storage.

Class IV consists of those explosives activities with insensitive high explosives (IHE) or IHE subassemblies. Although mass detonating, this explosive type is so insensitive that the probability of accidental initiation or transition from burning to detonation is negligible.

Each bay (i.e., storage, handling, or processing building) that houses an explosives activity shall have a protection level based on the hazard class determined for the activity. The level of protection may be provided by equipment design, structural design, operation separation, or provision of operational shields. The levels of protection required for each hazard class are detailed in paragraph 4.2 of DOE M 440.1-1A, DOE Explosives Safety Manual, and shall be required for new facilities or redesign of any existing facilities when changes in activities will result in a more hazardous class.

Permanent explosives facilities shall comply fully with TM 5-1300, Structures to Resist the Effects of Accidental Explosions, and DOE/TIC-11268, A Manual for the Prediction of Blast and Fragment Loading on Structures. Portable magazines should be ventilated and resistant to water, fire, and theft. They can be made of any material that meets these guidelines. (Portable facilities that comply with 27 CFR 55.203 and 55.207 through 55.211, Bureau of Alcohol, Tobacco and Firearms [BATF], meet these criteria.) Portable magazines shall be sited per DoD 6055.9-STD as above ground magazines.

Each facility shall establish a program to review the explosive materials stored at that facility. Explosives shall not be stored with materials or items that increase the risk of initiation or decomposition. Different types of explosives may be stored in the same magazine if they are compatible. Each type of explosive shall be assigned to an appropriate storage compatibility group (A through G, L, and S) for the purpose of storage at DOE facilities.

DOE M 440.1-1A provides additional information for storage in buildings other than storage magazines:

- Packing and shipping buildings
- Service magazines
- Warehouses
- Pre-positioned storage of security response munitions

k) Discuss the use of and considerations regarding chemical monitoring and sampling techniques.

In situations where immediate decisions are required, direct-reading instruments may be the only sampling method available. Because the information they provide is limited, the proper interpretation of this data is dependent on the experience and imagination of the industrial hygienist. In general, when plans and time allow, integrated personal sampling covering the entire duration of a representative operation is preferred, but this may not always be possible. When personal sampling is not possible, integrated area sampling may provide adequate information if carefully interpreted. If sampling over the full shift is not possible, the performance of consecutive direct-reading or grab samples and their interpretation in accordance with standard methods may also yield useful information.

Instruments must be calibrated before and after sampling. Most instruments also require additional periodic calibration in a laboratory. In the field, personal sampling pumps should be constantly monitored to ensure their continued operation. The performance of direct-reading sampling in association with integrated sampling may provide corroborative or supplemental information detailing changing levels throughout the operation. All calibration and instrument monitoring information, as well as descriptive information of the operation that could influence the sampling results, should be recorded on the sampling sheet. Exposure to more than one hazardous agent may require the use of more than one sampling instrument by the same employee. More than one sampling instrument may also be required if substances of interest require the performance of incompatible laboratory analyses. The potential for chemical interferences may also require the use of more than one sampling method and create complications in the interpretation of results. In order for the sample to be of much value, the level of detection must be lower than the criterion level of interest, either the allowable limit (AL) or permissible exposure limit (PEL), but preferably much lower. In order to ensure that the level of detection is as low as possible, the sample must contain a minimum volume of air. This, in general, requires a minimum sample duration. Duration is also important when the sample is being related to specific criteria, e.g., short-term exposure limits (STELs), ceilings, etc. If possible, sampling should be performed for the entire duration of the operation being characterized. When sampling is performed for less than eight hours because the operation was completed in that time, this fact should be noted on the sampling sheet in order to justify the assumption that personal exposure for the remainder of the day was zero. The frequency of sampling may be listed in a few expanded OSHA regulations; however, normally this is dictated by professional judgment. In general, initial measurements should be taken whenever it is believed that significant exposure is possible. A second set of measurements taken sometime after the first set is also advisable as a check against possible variation in operations. If both sets of results show insignificant exposure, sampling may probably stop. Continued surveillance of work places is necessary in order to verify that new operations have not been initiated and that previously characterized operations have not changed so as to increase the potential for exposure. Environmental extremes may influence instrument operation. Extreme cold, for example, may affect pumps,

direct-reading instruments, and detector tube operation. High moisture or humidity resulting in condensation may also affect operation of dosimeter microphones and the reliability of sampling media. Wind may also affect noise measurement. In general, potential environmental limitations and interferences will be clearly described in the instrument operator's manual and in standardized sampling and analytical methods, and the industrial hygienist should take note of them.

If results of monitoring are significant, periodic sampling may be required, largely in order to verify the continuing adequacy of controls then in place. Probably, the higher the previous results and more dangerous the agent, the more frequent subsequent samples should be performed. Follow-up to initial sampling may also be required if modifications in a process of controls would indicate the possibility for increased exposure over earlier samples, and to verify that new engineering controls are performing as expected.

l) Discuss other aspects of physical agents (e.g., noise, lasers, hot/cold, and radio frequency waves) in the working environment, and associated procedures, precautions, and controls.

Procedures shall be developed to implement precautions and controls that may affect the overall safety of the employee. Precautions are developed from the control measures that are listed below. The precautions will implement such things as exposure limit times and engineering design. Potential controls for certain areas are listed below.

Workplace Environmental Hazards and Control Measures	
Hazard	**Control Measures**
Noise	Exposure time limitations Hearing protection Noise reduction at the source Noise dampening
Lasers	Face shields Goggles and/or safety glasses Machine guards Hand shields Welding helmets Guards
Thermal	Engineering design Insulation Guards Personal protective clothing
Heat Stress	Acclimatization periods Work and rest regimens Distribution of work load with time Regular breaks Provision for water intake Protective clothing Application of engineering controls
Radio frequency waves	Engineering design Shielding

m) Discuss major elements of a hazard communication program, laboratory safety program, and process safety management program.

Hazardous Communication Program

Employers shall develop, implement, and maintain at each workplace a written hazard communication program which, at a minimum, describes labels and other forms of warning, material safety data sheets, and methods for providing employee information and training. The following should also be included:

- A list of the hazardous chemicals known to be present using an identifier that is referenced on the appropriate material safety data sheet (the list may be compiled for the workplace as a whole or for individual work areas)
- The methods the employer will use to inform employees of the hazards of non-routine tasks (for example, the cleaning of reactor vessels), and the hazards associated with chemicals contained in unlabeled pipes in their work areas

Laboratory Safety Program

The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present, and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

Employees shall be informed of

- the contents of 29 CFR 1910.1450 and its appendices which shall be made available to employees;
- the location and availability of the employer's Chemical Hygiene Plan;
- the permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;
- signs and symptoms associated with exposures to hazardous chemicals used in the laboratory;
- the location and availability of known reference material on the hazards, safe handling, storage, and disposal of hazardous chemicals found in the laboratory including, but not limited to, material safety data sheets received from the chemical supplier.

Employee training shall include

- methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);
- instruction on the physical and health hazards of chemicals in the work area;
- the measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used;
- instruction on the applicable details of the employer's written Chemical Hygiene Plan.

Process Safety Management Program

The employer shall complete a compilation of written process safety information before conducting any process hazard analysis required by 29 CFR 1910.119. The compilation of written process safety information will enable the employer and the employees involved in operating the process to identify and understand the hazards posed by those processes involving highly hazardous chemicals. This process safety information shall include information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process.

Information pertaining to the hazards of the highly hazardous chemicals in the process. This information shall consist of at least the following:

- Toxicity information
- Permissible exposure limits
- Physical data
- Reactivity data
- Corrosivity data
- Thermal and chemical stability data
- The foreseeable hazardous effects of the inadvertent mixing of different materials

Information pertaining to the technology of the process. Information concerning the technology of the process shall include at least the following:

- A block flow diagram or simplified process flow diagram
- Process chemistry
- Maximum intended inventory
- Safe upper and lower limits for such items as temperatures, pressures, flows, or compositions
- An evaluation of the consequences of deviations, including those affecting the safety and health of employees

Where the original technical information no longer exists, such information may be developed in conjunction with the process hazard analysis in sufficient detail to support the analysis.

Information pertaining to the equipment in the process. Information pertaining to the equipment in the process shall include:

- Materials of construction
- Piping and instrument diagrams (P&IDs)
- Electrical classification
- Relief system design and design basis
- Ventilation system design
- Design codes and standards employed
- Material and energy balances for processes built after May 26, 1992
- Safety systems (e.g. interlocks and detection or suppression systems)

The employer shall document that equipment complies with recognized and generally accepted good engineering practices.

For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the employer shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

16. Occupational safety personnel shall demonstrate a working-level knowledge of the use and function of worker protection safety testing and measurement equipment.

a) Discuss the use, limitation, and function of worker protection safety testing equipment (e.g., oxygen meters, explosive atmosphere meters, electrical test equipment, illumination meters, and calipers).

Instrument	Purpose or Function	Calibration Interval or Requirement	Example of Use
Oxygen Meter	Measures the percentage of O_2 in the air	Must be calibrated prior to use to compensate for altitude and barometric pressure	To identify an oxygen-deficient environment or a flammable or explosive atmosphere
Explosive Atmosphere Meter	Measures the concentration of a combustible gas or vapor	Accuracy depends, in part, on the difference between the calibration and sampling temperatures; calibrate immediately before use	To assess or measure the formation of combustible gases (i.e., hydrogen-oxygen) as the result of a process
Electrical Test Equipment	Measures resistance, voltage, current, and impedance of electrical components	Calibrate as required by manufacturer's instructions	To troubleshoot electrical component failure or inadequate response of equipment
Illumination Meter	Measures three essential quantities: illumination, luminance, and reflectance	Instruments should be corrected (to account for light reflected from the light-detecting cell surface) and calibrated for accuracy, with scale ranges so that measurements are made below one-quarter full scale	To determine whether a work area is adequately lighted
Calipers	Can make quick, accurate inside and outside diameter measurements	Calibrate as required by manufacturer's instructions	To measure or verify the dimensions of a given component

b) Discuss need for proper equipment maintenance and calibration.

DOE relies upon the accuracy of equipment and instrument readings to provide a safety envelope for the public, workers, and the environment. Without proper maintenance and calibration, the instrument readings are unreliable and that envelope is compromised.

c) Describe circumstances requiring use of each type of equipment.

See the table in part "a" of this competency, above.

d) Describe the appropriate actions taken in response to various readings from each type of equipment.

Depending on the equipment, application, and use, the actions will vary. Refer to the appropriate operating procedures to determine the course of actions to follow based on given readings.

e) Describe the appropriate application and function of industrial hygiene monitoring and sampling equipment and discuss required safety interfaces.

The appropriate application and function of industrial hygiene monitoring and sampling equipment is dependent upon instruments in use at your facility or site. Review the appropriate procedures or operations manuals to determine your answer.

17. Occupational safety personnel shall demonstrate a familiarity-level knowledge of the following disciplines that interface with occupational safety:

- **Health physics**
- **Industrial hygiene**
- **Occupational medicine**
- **Safeguards and security**
- **Environmental protection**
- **Nuclear safety**

a) Discuss the applicability of occupational safety and health criteria in DOE Orders to nuclear safety.

All applicable occupational safety standards are required to be implemented when dealing with nuclear safety. Nuclear safety requirements usually develop a stricter safety envelope than what is typical for an occupational safety plan.

b) Describe the potential impact of nuclear safety requirements on occupational safety matters and discuss the need for coordination between occupational safety professionals and health physicists.

The impact of nuclear safety requirements works in conjunction with operational safety requirements. If for any reason the work to be performed or the requirements of the nuclear safety standard violate occupational safety, a review shall be conducted to identify all hazards and address the risk associated with them.

c) Discuss applicable "safety and analysis" and "review system criteria" for nuclear facilities.

"Safety and analysis" refers to the performance of systems-related safety evaluations of the implementation of DOE requirements and of applications for new facilities or designs. This includes the performance and evaluation of probabilistic safety assessments for nuclear power plants and the evaluation of Design Basis Accident (DBA) and severe accident issues as they relate to designs and operations.

"Review system criteria" outlines general and basic requirements for safety analysis, hazard classification, and approval.

d) Discuss industrial hygiene fundamentals in terms of the following:

- **Basic terminology**
- **Nature, recognition, evaluation, and control of hazards**
- **Necessary elements for implementing and maintaining an effective industrial hygiene program**

Basic terminology can be found in 29 CFR 1910.

Nature, recognition, evaluation, and control of hazards can be found in 29 CFR 1910 and 1926.

The necessary elements for implementing and maintaining an effective industrial hygiene program can be found at http://www.orau.gov/tdd/QualPrgm/learningmaterials/Industrial/ih01.pdf.

e) Discuss the relationship and need for coordination that exists between the disciplines of occupational safety, industrial safety, health physics, and occupational medicine.

The relationship between these four disciplines is one of mutual understanding and use. They need to interact and work together to develop a safety program for organizations for given tasks. They create the overall safety envelope for an organization. The areas these four groups cover need to address any issues that may contradict or conflict with each other. Operations and procedures need to be reviewed by all organizations to ensure that all four of the above mentioned disciplines interact to help create a safety envelope that does not diminish any single discipline mentioned above.

f) Discuss DOE's occupational medicine program requirements and their applicability/interface with occupational safety program requirements.

DOE recognizes that healthy employees are more productive and, as a result, reduce costs to the Government. Accordingly, DOE is committed to providing work-related medical services for preventive, diagnostic, and treatment purposes to the extent such services can be provided cost effectively. The type and extent of occupational medical services for Federal employees varies depending on available resources such as funds, personnel, and equipment at or near the work site. Every effort should be made to provide or contract for quality comprehensive services. Medical support staffs are expected to

- know the work environment and organization served;

- demonstrate a caring attitude about employees;
- treat or refer for treatment (as determined by a qualified health services professional) employees who incur injuries or illnesses while on the job;
- monitor employees who undergo treatment or rehabilitation to ensure they receive appropriate care, actively participate in treatment or rehabilitation, and return to duty as soon as possible.

Priority should be given to

- assistance in identifying positions with hazardous exposures or the potential for such exposures;
- examinations and medical surveillance of employees exposed to hazardous conditions;
- fitness-for-duty examinations and emergency first aid.

Cases that need in-depth attention and should be managed include those involving hazardous exposure, employee relations, a medical issue, and workers' compensation.

Occupational medical services should be available within a reasonable time to respond to emergencies. "Reasonable time" is based on the work site location and resources available in that area, which affect the time required for medical assistance to arrive at the work site. Occupational medical services programs are to be evaluated periodically by medical professionals with thorough knowledge of occupational medicine and the work environment. Evaluation reports are to be provided to top managers in the DOE element being evaluated and to applicable HQ program managers. Managers at both levels should have sufficient authority to ensure that agreed-upon recommendations and required actions are implemented. The application of occupational medicine will improve upon occupational safety by making both the employee and the employer aware of hazards that exist, and by creating a line of communication about these hazards.

g) Discuss the general requirements of DOE's environmental protection program and describe how these requirements interface with the occupational safety program.

The general requirements of DOE's environmental protection program are to implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations, by which DOE cost effectively meets or exceeds compliance with applicable environmental, public health, and resource protection laws, regulations, and DOE requirements. This objective must be accomplished by implementing Environmental Management Systems (EMSs) at DOE sites. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. These EMSs must be part of Integrated Safety Management Systems. This continuous cycle allows for a continuous identification of potential occupational safety issues.

h) Discuss the interface with, and the general requirements for, DOE's Safeguards and Security Program.

Safeguards and security management systems provide a formal, organized process for planning, performing, assessing, and improving the secure conduct of work in accordance

with risk-based protection strategies. These systems are institutionalized through DOE directives and contracts. The purpose of this policy is to formalize an Integrated Safeguards and Security Management (ISSM) framework. The ISSM system framework encompasses all levels of activities and documentation related to safeguards and security management throughout the DOE complex. Throughout this policy statement, the term ISSM includes all topical areas of safeguards and security (e.g., personnel; physical, information, and nuclear safeguards; cyber security) and related cross-cutting areas (e.g., export control, classification, foreign visits and assignments, and foreign travel). ISSM will ensure the adequate protection of DOE assets (e.g., classified matter, unclassified sensitive matter, and Government property). The Department is committed to conducting work efficiently and securely. It is Department policy that the ISSM framework shall be used to systematically integrate safeguards and security into management and work practices at all levels so that missions are accomplished securely. Direct involvement of all personnel during the development and implementation of an ISSM framework is essential for success. The ISSM framework will be implemented through programmatic directives and other related directives. The ISSM framework establishes a hierarchy of components. To facilitate the orderly development and implementation of safeguards and security management throughout the DOE complex, the ISSM framework consists of six components:

- the objective
- guiding principles
- core functions
- mechanisms
- responsibilities
- implementation

The objective, guiding principles, and core functions of ISSM identified below must be used consistently throughout the DOE complex. The mechanisms, responsibilities, and implementation components are established by sites for all work. Any part of safeguards and security that may conflict with occupational safety will be addressed in the safety plan for a facility or operation. This will identify why the occupational safety regulations are not complied with and what is being done to maintain the safety envelope.

i) Discuss the existing interface between occupational safety personnel and safeguards and security personnel, including situations where security considerations conflict with personnel safety (e.g., locked fire exits, security barriers creating tripping hazards).

Personnel that are trained in security and safeguards implementation are also trained in occupational safety. Any deviation from the rules of occupational safety is done in accordance with the employees' training and written procedures approved by management. Operations that involve work for safeguards and security will be identified in the procedures or training requirements. All personnel will be trained and know how the deviations from occupational safety are performed. The deviations will be minimized as much as possible.

18. Occupational safety personnel shall demonstrate familiarity with the application of basic and applied sciences to safety considerations.

a) Discuss role of mathematical tools (e.g., algebra, trigonometry, calculus, statistics, and symbolic logic) in the safety field in analyzing quantities, magnitudes, and probabilities.

Review DOE-HDBK-1014-92, Fundamentals Handbook, "Mathematics," volumes 1 and 2.

b) Discuss physics laws associated with mechanics, heat, light, sound, electricity, magnetism, and radiation and application of these laws in the safety field.

Review DOE-HDBK-1010-92, Fundamentals Handbook, "Classical Physics."

c) Discuss basic chemistry concepts including atomic structure, bonding, states of matter, chemical energy and equilibrium, and chemical kinetics.

Review DOE-HDBK-1015-93, Fundamentals Handbook, "Chemistry," volumes 1 and 2.

d) Discuss biological sciences including heredity, diversity, reproduction, development, structure, and function of cells, organisms, and populations, with emphasis on human biology.

Review Fundamentals of Industrial Hygiene, 3rd Edition, National Safety Council, 1988 (parts 1 and 2).

Review Industrial Toxicology, Safety, and Health Applications in the Workplace, edited by Phillip L. Williams and James L. Burson, Van Nostrand Reinhold, New York, 1985.

e) Discuss behavioral sciences including individual differences, attitudes, learning, perception, and group behavior and application of these in the safety field.

Review DOE-HDBK-1202-97, DOE Guide to Good Practices for Teamwork Training and Diagnostic Skills Development.

f) Discuss general engineering and technology disciplines including applied mechanics, properties of materials, electrical circuits and machines, principles of engineering design and drawings, and computer science.

Review DOE-HDBK-1016-93, Fundamentals Handbook, "Engineering Symbology, Prints, and Drawings."

Review DOE-HDBK-1017-93, Fundamentals Handbook, "Material Science," volumes 1 and 2.

Review DOE-HDBK-1018-93, Fundamentals Handbook, "Mechanical Science," volumes 1 and 2.

Review DOE-HDBK-1012-93, Fundamentals Handbook, "Thermodynamics, Heat Transfer, and Fluid Flow," volumes 1–3.

Review DOE-HDBK-1011-93, Fundamentals Handbook, "Electrical Science," volumes 1–4.

19. Occupational safety personnel shall demonstrate familiarity with the knowledge of safety in the research and development, manufacture, use, transportation, testing, demilitarization, storage, and disposal of explosives.

a) Discuss major principles of personnel protection from explosive hazards and the application of each principle to explosives operations.

DOE M 440.1-1A states that the cardinal principle to be observed at any location or in any operation involving explosives, ammunition, severe fire hazards, or toxic materials is to limit, in a manner consistent with safe and efficient operation, the exposure to a minimum number of personnel, for a minimum time, and to a minimum amount of the hazardous material. This is known as the "3M Rule" or the "Cardinal Rule" for explosives safety. Following are the major principles of personnel protection from explosive hazards:

- Explosive limits
- Personnel limits
- Limit control
- IHE limits

Explosive Limits

The quantity of explosives at an operating location shall be the minimum necessary to carry out the operation safely and efficiently. When practical, this quantity shall be subdivided and separated to prevent propagation of detonation. Supplies exceeding this minimum quantity shall be removed from the operating area. In no case shall the quantity of explosives permitted in an operating building exceed the maximum permitted by quantity-distance criteria.

Personnel Limits

The number of personnel at an operating location shall be the minimum consistent with safe and efficient operation. In establishing personnel limits, the following principles shall be followed:

- Only jobs necessary to the performance of a hazardous explosives operation should be performed in the same location as the hazardous operation. Only personnel needed for the hazardous operations shall be allowed in hazardous locations.
- Personnel limits shall allow for necessary casuals. A casual is a person other than an operator who intermittently visits an explosives operation for the purpose of supervision, inspection, maintenance, etc. Casuals do not perform hands-on work with explosives but are otherwise involved with the explosives operation being performed. Casuals are accounted for in the established personnel limits for the area and are provided a level of protection consistent with the explosion hazard of operations in adjacent areas.
- Sufficient personnel shall be available to perform a hazardous operation safely and to obtain help and aid the injured if an accident occurs.
- No person shall perform explosives work with a high risk of serious injury alone. Prompt and easy communications with other employees shall be provided. Facility management shall specify explosives activities that may be performed alone.

Limit Control

All rooms, bays, and buildings containing explosives shall have posted in a conspicuous place a standardized placard stating the maximum amount of explosives and the maximum number of workers and casuals permitted in the control unit at any one time. Maximum

explosives and personnel limits for all buildings and bays for each explosives area shall be documented and maintained on file.

When the use of a location changes, personnel and explosives weight limits shall be reviewed and limits reestablished as required. Additionally, a procedure shall be established for the approval of temporary changes in explosives and personnel limits for an operating location.

A system shall be established to control the presence of personnel within explosive operating areas. The movement of transients in the vicinity of an explosives operating area should be controlled when their presence creates a congestion problem or other safety concern.

A verifiable system shall be established to control the amount of explosives present in an explosives facility.

IHE Limits

When no other explosives are present, IHE weight limitations shall be based on separation distances for Hazard Class 1.6 explosives or equivalent protection provided by facility design features.

b) Describe the types, purpose, and application of personal protective clothing and equipment for explosives operations.

DOE M 440.1-1A provides the following information concerning personal protective clothing and equipment.

Clothing

Each operation shall be analyzed to determine when personnel working with explosives and toxic materials must wear approved coveralls or laboratory coats to prevent contact with these materials and prevent contaminating personal apparel. Flame-retardant coveralls may be desired for explosives operations with the potential for flash fire. These coveralls shall not have cuffs and should not have metallic fasteners. Written procedures shall include protective clothing and equipment requirements. Cotton or other antistatic outer and undergarments, including socks, should be worn where generation of static electricity would create a hazard.

Footwear

Personnel working in areas where electrostatic-sensitive explosive powders or materials are handled shall wear conductive, non-sparking footwear. Exception: personnel working on electrical or electronic equipment shall not wear conductive footwear unless protected by insulated mats, ground fault circuit interrupters (GFCI), etc. Personnel working in other areas where explosives contamination may be present shall wear non-sparking footwear or bootie shoe coverings.

Respirators

Approved respiratory protection shall be worn when exhaust ventilation is unavailable or does not adequately control airborne particulate, gases, or vapors released during explosives operations. The employee shall have current approval to wear respiratory protection (medical exam, respirator fitting, and training).

Eye Protection

Personnel working in or visiting eye hazard areas shall wear suitable eye protection devices, particularly when electroexplosive devices (EEDs) are handled. Explosive operations shall be evaluated for eye hazard risks. Contact lenses shall not be considered appropriate eye protection.

Gloves

Skin contact with some explosives and associated materials can result in dermatitis or absorption across the skin barrier. Operations where these materials are present must be evaluated for skin contact hazards and the need for the proper gloves.

c) Discuss and demonstrate the ability to apply quantity-distance criteria to explosives operations.

DOE M 440.1-1A states that quantity-distance criteria must account for the types and severity of hazards each explosive material presents, the construction and orientation of facilities to which the criteria are applied, and the degree of protection desired for personnel and facilities adjacent to the explosives operations.

The hazard classification system recommended by the UN defines the types and severities of explosives hazards such as blast, fragment, mass fire, and moderate fire hazards. The guidelines presented in chapter 6 of DOE M 440.1-1A specify minimum degrees of protection for various facility categories and describe how quantity-distance tables are to be applied to facilities of various construction and orientation with respect to adjacent facilities.

The principles and tables presented in DoD 6055.9-STD, DoD Ammunition and Explosives Safety Standards, shall be used to determine the total quantities of explosives in adjacent magazines, operating buildings, or other explosives facilities that must be applied to quantity distance tables. The minimum separation distances required for the facilities are based on the desired level of protection and total quantities of explosives. The total quantity of explosives is determined by defining and examining the maximum credible event (MCE). If an explosives event occurs, the MCE is the largest credible amount of explosives that could be involved (not necessarily the total quantity of explosives present). When the levels of protection required by DOE M 440.1-1A, chapter 6, section 4.0, differ from the requirements of DoD 6055.9-STD, section 4.0 shall take precedence.

Throughout DoD 6055.9-STD, the net explosive weight (NEW) is used to calculate distance using the formula D = KW1/3, where D is the distance in feet, K is a factor based on the risk assumed or permitted, and W1/3 is the cube root of the NEW in pounds.

Note: The remainder of this competency is performance-based. The ability to complete this competency must be observed by a qualifying official.

d) Discuss hazards associated with uncontrolled electrical sources (e.g., static electricity and lightning) and application of required controls such as the following:

- **Lightning protection**
- **Nonsparking tools**
- **Conductive footwear and floors**
- **Equipment bonding and grounding**

Lightning Protection

DOE M 440.1-1A states that lightning presents a hazard to explosives in at least five ways:

1) The electrical current produced by a voltage gradient resulting from a lightning strike could initiate the explosives directly.
2) The surface flashover or arcing of the generated electrical current between conductive surfaces that are not at equilibrium could initiate the explosives directly by the heat, sparks, and molten metal generated by the arc.
3) This same arcing could cause damage or fires in electrical fixtures and equipment.
4) The lightning could initiate a fire involving combustible materials in the facility, including the containers around explosives.
5) The spalling generated by the heat of the current flowing through the structural components of the facility could initiate, by impact, unprotected explosives. In addition, lightning could affect support systems such as fire protection and security. Lightning can reach a structure not only by direct strike, but also indirectly by coupling to a conductor that penetrates the structure.

Protection from lightning-induced hazards can best be achieved by enclosing the explosives in an interconnected network of good conductors such that the exterior fields, currents, and voltages are reduced. A second method or layer of protection is achieved by providing a sufficiently large sideflash separation (standoff) distance between the explosives and any electrical conductor within the structure (including the walls and ceiling) to preclude the possibility of current flowing onto the explosives or arcing to them. A third method *involves* directing the current away from the structure and directly to ground by use of air terminals, masts or catenaries, and down conductors.

Nonsparking Tools

Positive steps must also be taken to control or eliminate static electricity in areas where materials ignitable by static spark discharge are processed or handled.

Nonsparking tools are tools made of metals such as brass, bronze, Monel metal (copper-nickel alloy), copper-aluminum alloys (aluminum bronze), copper-beryllium alloys (beryllium bronze), and titanium. Non-sparking metals have less tensile strength than steels usually used to make tools. This means the metal has less strength or resistance to tearing apart when stretched under test conditions. It also means that these tools are softer and wear down more quickly than ordinary steel tools.

Tools made from stainless steel also have a lower tendency to generate sparks than those made from steel. However, all metal tools can produce sparks. While nonsparking tools may lower the risk of a spark, they do not eliminate the possibility of sparks.

Conductive Footwear and Floors

Conductive floors and shoes should be used for grounding personnel in operations involving explosives (propellants, pyrotechnics, lead azide, lead styphnate, mercury fulminate, CP, etc.) that are sensitive to initiation by the electrostatic spark discharge from a person. Static discharge from a person may ignite many flammable liquids and air mixtures. In areas where personnel come into the proximity of (i.e., possible contact with) static-sensitive explosives or vapors, conductive floors shall be installed except where adequate housekeeping, dust

collection, ventilation, or solvent recovery methods eliminate the hazards of dust-air or flammable vapor-air mixtures. Conductive floors may also be required in areas where operations involve EEDs that contain a static-sensitive explosive.

Conductive floors are not required throughout an entire building or room if the hazard is localized. In such cases, conductive mats or runners may be used where required. These mats or runners shall meet all specifications and test requirements that apply to conductive floors. Conductive wristbands may be substituted for conductive mats and footwear at fixed, grounded, or bonded workstations or outdoor locations.

Conductive floors must be made of non-sparking material such as conductive rubber or conductive flooring composition and shall meet the following requirements:

- The flooring and its grounding system must provide for electrical resistance not to exceed 1,000,000 ohms.
- The surface of the installed floor must be free from cracks and reasonably smooth. The material must not slough off, wrinkle, or buckle under operating conditions. Conductive tiles are not recommended for use in areas where explosives dust can cause contamination.
- Where conductive floors and shoes are required, resistance between the ground and the wearer shall not exceed 1,000,000 ohms, (i.e., total resistance of conductive shoes on a person, plus the resistance of floor to ground). Where conductive floors and shoes are required, tabletops on which exposed explosives or dusts are encountered should be covered with a properly grounded or bonded conductive material that meets the same requirements as those for flooring.
- Conductive floors must be compatible with the explosive materials to be processed.
- Conductive wristbands shall not exceed a resistance between the wearer and ground or bonding point of 1,200,000 ohms. Wristbands shall be of a design that maintains electrical contact with the wearer when used.
- Table-top work surface mats that are not part of a total conductive system shall have a resistance not to exceed 1,200,000 ohms.

Equipment Bonding and Grounding

Bonding straps can be used to bridge locations where electrical continuity may be broken by the presence of oil on bearings, paint, or rust at any contact point. Pressure contact alone is not adequate grounding for permanent equipment in contact with conductive floors or tabletops. Static grounds shall not be made to gas, steam, or air lines; dry pipe sprinkler systems; or air terminals of lightning protection systems. Static grounds can be made to water pipes, ground cones, buried copper plates, or driven ground rods of lightning protection systems. If a structure is equipped with a lightning protection system, all grounds shall be interconnected. Wires used as static ground conductors should be at least No. 10 AWG or equivalent.

e) Discuss fire protection considerations for explosives operations.

DOE M 440.1-1A states that vegetation around storage magazines and explosives operating facilities should be controlled to minimize potential damage to the magazine or facility from erosion or grass, brush, or forest fires. A firebreak at least 50-ft (15-m) wide and free from combustible material should be maintained around each aboveground magazine or explosives operating facility. If an aboveground magazine or explosives facility exterior is fire resistant,

the firebreak can have vegetation, but the growth must be controlled to prevent rapid transmission of fire to the magazine or facility. Maintaining the firebreaks around earth-covered magazines and cutting grass covering these structures is only required around ventilators to prevent transmission of a fire into a structure.

The following fire protection criteria shall be required for all new facilities or redesign of existing facilities where changes in activities will result in a higher hazardous classification:

- Automatic fire suppression systems shall be installed in all buildings containing HE and plutonium, except storage magazines.
- For buildings containing explosives, but no plutonium, facility management shall determine the need for fire suppression systems based on maximum fire loss criteria and program mission interruptions and delays as outlined in the current versions of DOE O 420.1B, Facility Safety; DOE O 430.1B, Real Property Asset Management; and DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees.
- Where fire suppression is required, each explosives bay shall have an individual feed with its controls protected outside the bay and located to enable system operation if a detonation occurs in any bay.
- Transmitted fire alarms shall distinguish between explosives and nonexplosives areas through the use of annunciator panels at safe locations. Small non-HE areas do not need separately transmitted alarms.

f) Describe the role of hazard analysis and planning techniques for designing or evaluating explosives operations and storage.

Hazard analysis is used in conjunction with DOE M 440.1-1A for developing storage areas. The hazard analysis identifies the hazards and helps identify areas that may be located nearby to apply the formula for establishing the safe separation distance. The amount of required storage will be compared to the hazard analysis to determine if the storage facility is adequate for that amount of material.

DOE M 440.1-1A states that before starting any operation involving explosives, a hazard analysis shall be undertaken to identify any abnormal problems that will require special training, equipment, or procedures to safeguard personnel conducting the operation.

Also, DOE M 440.1-1A states that before beginning any explosives synthesis, formulation, manufacturing, testing, or disposal operation, a process hazard analysis shall be performed. A single process hazard analysis may be performed for similar processes performed in a single facility provided that the "worst-case" process is the basis for the hazard analysis. If required, a shield or other protective measure shall be employed. Selection criteria for the worst-case process are

- sensitivity of materials
- quantity of materials
- number of personnel potentially affected
- impact on other operations/activities

The process hazard analysis shall be formally documented. Employees and employee representatives shall be consulted on the process hazard analysis. The result of the process

hazard analysis shall be provided to employees involved in or affected by the operation. The process hazard analysis shall be updated and revalidated at least every five years. The facility manager shall be responsible for establishing a system to address the team's findings and recommendations promptly. Corrective actions, schedules for corrective actions, and completion of corrective actions shall be formally documented. Such documentation shall be filed with the process hazard analysis. Files containing process hazard analyses, updates, and corrective actions status shall be maintained for the life of the process.

g) Discuss the importance of development, implementation, and maintenance of safe work procedures for explosives operations and storage.

Before starting any operation involving explosives, operating procedures shall be written and approved. The requirements for procedures minimize the chances of an incident resulting from operations using outdated, inapplicable, or incomplete procedures, or from operations performed in violation of established practices.

DOE M 440.1-1A also states that procedures must be generated for all explosives operations because the step-by-step reasoning process that is used in developing the procedure will identify many safety-related problem areas that might be overlooked otherwise. In addition, the approval system for new or revised procedures also provides other viewpoints and knowledge that may not be available to the originator and which may need to be incorporated into the procedure.

20. Occupational safety personnel shall demonstrate familiarity with the knowledge of firearms safety.

a) Identify PPE necessary during firearms use.

DOE-STD-1091-96, Firearms Safety, 2.4(a), states, "While on the range, it is mandatory to use approved eye and sound barrier-type ear protection and other personal protective equipment as required by the range safety officer."

b) Discuss firing-range safety considerations including required procedures and controls.

DOE-STD-1091-96, Firearms Safety, 2.4, Range Operations and Procedures, states, "Specific-site range safety rules and regulations shall be developed and implemented by the organization designated to be responsible for operating a live-fire range. Such rules and regulations shall be formal, provide a disciplined approach to range operations, and include rules and regulations on prefiring and postfiring range activities."

c) Discuss principles of firearms safety and describe appropriate and mandated controls.

The principles of firearms safety are based on four general rules. They are

- all firearms are always loaded
- never point a firearm at anything you are not willing to destroy
- keep your finger off the trigger until your sights are on the target
- be sure of your target

Appropriate and mandated controls are contained in DOE 5480.16A, Firearms Safety.

d) Discuss industrial hazards (e.g., noise and lead exposures) associated with firing ranges and describe appropriate control measures.

Noise hazards are controlled through the use of hearing protection. Picking up brass is a part of shooting and you must remember that there is a health hazard involved: absorbing lead into the body. Lead is a toxic substance that you need to avoid as much as possible. Over time, the accumulation of lead can cause a variety of ailments:

- Loss of memory and difficulty concentrating
- Fatigue, irritability, and noticeable aggressiveness
- A possible loss of sexual interest
- Insomnia, depression, and headaches

If you take a few simple precautions, you can reduce or avoid any health problems caused by lead. Do **not** use your hat as a container for brass when cleaning up after shooting. Lead left behind can be absorbed directly through the pores on your head. Immediately upon leaving the range, blow your nose and wash your hands in cold soapy water.

e) Describe and apply firearms safety precautions associated with DOE safeguards and security operations and exercises.

DOE Order 5480.16A, Firearms Safety, chapter 1, "Exercise Hazard and Safety Rules," states

- "Exercise plans or standard operating procedures shall discuss exercise hazards and enumerate all applicable safety rules such as those dealing with vehicles, fence climbing, and hand-to-hand combat."
- "Participants in exercises shall wear eye protection and hearing-protective equipment unless exercise safety considerations indicate otherwise as determined by the senior controller and approved in the exercise plan."
- "Directives for force-on-force exercises shall include or cover the following:
  - The location of the exercise site and the identification of responsible personnel and organizations
  - A description of the equipment, firearms, ammunition, explosive devices, and materials involved
  - A description of the operation with appropriate diagrams
  - Details of the hazardous conditions
  - Procedures for the actions of personnel and/or the use and accountability of equipment
  - Procedures for tracking and controlling personnel with live ammunition
  - Procedures covering an accident, emergency, or unexpected occurrence
  - The assignment of responsibility to ensure compliance with safety procedures
  - Notification of appropriate management and of all personnel affected by the exercise"

21. Occupational safety personnel shall demonstrate a familiarity-level knowledge of DOE contract management and administration sufficient to appraise, assist, or direct contractor organizations in the area of occupational safety.

a) Discuss key elements of contractual relationships between DOE and contractors and the process for preparing cost estimates and budgets.

DOE personnel who use the contracting process to accomplish their programs must support the contracting officer in ensuring that

- competitive sources are solicited, evaluated, and selected;
- quality standards are prescribed and met;
- performance or delivery is timely;
- prices, estimated costs, and fees are reasonable.

Files are documented to substantiate the judgments, decisions, and actions taken.

Cost Estimate Technique	Description
Bottoms-Up	Uses a work statement and a set of drawings or Specifications to "takeoff" material quantities needed to accomplish an operation or to produce an equipment component. From these quantities, direct labor, equipment, and overhead costs are derived and added on.
Specific Analogy	Uses the known cost of an item used in a prior system to estimate the cost of a similar item in the new system. Adjustments are then made to account for recognized differences in the two systems (i.e., design, complexity of performance, etc.).
Parametric	Requires historical databases on similar systems and uses statistical analysis to find correlations between the cost drivers and other system parameters.
Cost Review and Update	Previous estimates of the same project are examined for internal logic, completeness of scope, etc.
Trend Analysis	Actual costs of work performed are compared to the original projected costs and a contractor efficiency index is derived. The index is then used to predict the cost of work not yet completed.
Expert Opinion	Specialists are consulted reiteratively until a consensus cost estimate is established. This is used in the absence of other data or techniques.

b) Describe the role of DOE's occupational safety professional with respect to the evaluation of contractor occupational safety programs for the cost-plus award fee process or other performance-rating processes.

Program personnel who use the contracting process to accomplish their programs must support the contracting officer in ensuring that

- competitive sources are solicited, evaluated, and selected;
- quality standards are prescribed and met;
- performance or delivery is timely;
- prices, estimated costs, and fees are reasonable;
- files are documented to substantiate the judgments, decisions, and actions taken.

c) Describe responsibilities of a DOE occupational safety professional associated with contractor compliance with the Price Anderson Amendments Act (PAAA).

A DOE occupational safety professional

- oversees and provides direction to the contractor for the preparation of implementation plans in response to the new rules;
- monitors the contractor's adherence to the rules;
- brings potential non-compliances to the attention of a supervisor or PAAA coordinator;
- assists DOE HQ in determining the contractor's liability and penalty, civil and/or criminal, for a violation.

d) Using actual or hypothetical data for an occupational safety program, discuss the program's budget, schedule, appropriateness, and impact on occupational health protection.

Note: This is a performance-based competency. The ability to complete this competency must be observed by a qualifying official.

e) Identify appropriate contract mechanisms and channels that must be employed or considered when communicating with or directing DOE contractors (e.g., describe appropriate procedures and considerations for issuing a stop work order to a DOE contractor).

According to chapter 9 of title 48 of CFRs, "With regard to the contractor's taking all reasonable precautions to protect the safety and health of employees and of members of the public, in the event that the contractor fails to comply with DOE health and safety regulations, the contracting officer may, without prejudice . . . , issue an order stopping all or any part of the work."

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