National Nuclear Security Administration

Fire Protection Engineering

Qualification Standard

Reference Guide

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Acronyms	
AHJ	authority having jurisdiction
BNA	baseline needs assessment
CRD	contractor requirements document
DBA	design basis accident
DOE	U.S. Department of Energy
DSA	documented safety analysis
EFCOG	Energy Facility Contractors Group
ERO	emergency response organization
FAQS	functional area qualification standard
FHA	fire hazard analysis
FM	Factory Mutual
gpm	gallons per minute
HPR	highly protected risk
IC	incident command
ICS	incident command systems
ISM	integrated safety management
ITM	inspection, testing, and maintenance
KSA	knowledge, skills, and abilities
lbf	pound force
LCO	limiting condition for operation
LSC	Life Safety Code
MPFL	maximum possible fire loss
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NPH	natural phenomena hazard
NRP	National Response Plan
PPHF	Plutonium Processing and Handling Facilities
psi	pounds per square inch
SAR	safety analysis report
SCBA	self-contained breathing apparatus
SSC	structure, system, and component
TSR	technical safety requirement
UC	unified command
UL	Underwriters Laboratories

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 Fire Protection Engineering Functional Area Qualification Standard (FAQS). 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 addresses the competency statements in the December 2007 edition of DOE-STD-1137-2007, *Fire Protection Engineering Functional Area Qualification Standard*. The qualification standard contains 12 competency statements.

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

PREFACE

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

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

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

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

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

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

TECHNICAL COMPETENCIES

1. **Fire protection engineers shall demonstrate an expert level of knowledge of the fire protection related aspects of the following directives or their successor documents:**
   - **DOE O 151.1C, Comprehensive Emergency Management System**
   - **DOE G 151.1-1A, Emergency Management Fundamentals and the Operational Emergency Base Program**
   - **DOE O 420.1B, Facility Safety**
   - **DOE O 440.1B, Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees**
   - **DOE G 420.1-3, Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety**
   - **DOE-STD-1066-99, Fire Protection Design Criteria**
   - **DOE-STD-1088-95, Fire Protection for Relocatable Structures**
   - **10 CFR Part 851, Worker Safety and Health Program**
   - **DOE-HDBK-1081-94, Primer on Spontaneous Heating and Pyrophoricity**
   - **DOE-HDBK-1163-2003, Integration of Multiple Hazard Analysis Requirements and Activities**

   a. **Describe the essential fire safety principles, requirements, relationships, and importance of these Orders, Guides, and Standards with respect to fire protection issues.**

DOE O 151.1C, Comprehensive Emergency Management System

The Operational Emergency Base Program must provide for compliance with Federal property management regulations for fire prevention and with DOE O 420.1B, *Facility Safety,* which addresses requirements for fire protection programs. Some requirements must be incorporated into the facility emergency plan, including response by DOE/NNSA or local community fire departments.

DOE G 151.1-1A, Emergency Management Fundamentals and the Operational Emergency Base Program: Emergency Management Guide

Regarding exercises, at a minimum, the Order requires that each site/facility conduct building evacuation exercises consistent with the National Fire Protection Association (NFPA) standards.

Change in firefighting equipment and/or capacity may impact emergency planning and preparedness. Emergency planners should be particularly cognizant of possible changes in the effectiveness of emergency fire response on closure sites. Changes in site/facility hazards due to closure activities should be communicated to the fire department. Physical facility and site changes may impact timely fire response (e.g., location and access to fire hydrants; the need for high-angle rescue), as well as security. Facility/site changes could also impact the usability and reliability of prearranged fire preplans for facilities undergoing decontamination or decommissioning.

DOE O 420.1B, Facility Safety

DOE O 420.1B, *Facility Safety,* chapter II, establishes the primary requirement for a comprehensive fire protection program for DOE sites, facilities, and emergency service organizations to minimize the potential for

- occurrence of a fire or related event;
- fires that cause an unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment;
- unacceptable interruption of vital DOE programs as a result of fire and related hazards;
- property loss from fire exceeding the limits established by DOE;
- fire damage to critical process controls and safety-class systems, structures, and components (as documented by appropriate safety analyses).

Requirements

General. Fire protection for DOE facilities, sites, activities, design, and construction must

- provide a level of safety sufficient to fulfill requirements for highly protected risk (HPR);
- prevent loss of safety functions and safety systems as determined by safety analyses and provide defense in depth; and
- meet or exceed applicable building codes for the region and NFPA codes and standards.

Fire Protection Program. Acceptable, documented fire protection programs must be developed, implemented, and maintained that addresses 16 elements and requirements.

Fire Protection Design. A comprehensive fire protection design program for facilities and supporting systems must be developed, implemented, and maintained that addresses 12 elements.

DOE O 440.1B, Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees

The objective of DOE O 440.1B is to establish the framework for an effective worker protection program that will reduce or prevent injuries, illnesses, and accidental losses by providing DOE Federal workers with a safe and healthful workplace.

Requirements

- Establish and implement a written worker protection program, appropriate for the facility hazards, that:
  - provides a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to the employees; and,
  - integrates all requirements contained in DOE O 440.1B; program requirements contained in 29 CFR 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters"*;* applicable functional area requirements; and other related site-specific worker protection activities.

- 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.
- Implement procedures to allow workers to stop work when they discover employee exposures to imminent danger conditions or other serious hazards. The procedure must 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 Occupational Safety and Health Protection for DOE Employees 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.
- Develop and implement occupant emergency plans and procedures, conduct training, and emergency drills according to directives and guidance issued by DOE.
- Comply with the worker protection requirements that are applicable to the hazards at the facility.

DOE G 420.1-3, Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety

The following paragraphs describe in broad terms the approach to achieve the objectives of a DOE fire protection and emergency response program:

- Contractors can achieve a comprehensive, multi-faceted emergency response capability in a number of ways. They can rely on an onsite emergency services organization, such as what currently exists at many DOE sites; or they can rely completely on offsite fire departments to meet DOE determined response objectives. Contractors can also combine the capabilities of onsite and offsite emergencies services organizations so as to assure the timely and effective response to the spectrum of emergency conditions (fires, medical emergencies, technical rescue, hazardous material response, etc.) that they may encounter (e.g. mutual aid agreements).
    - If an onsite fire department will be relied on to provide complete emergency services, the full scope of its capabilities including: mission responsibilities, personnel, apparatus, equipment, facilities, programs, incident reporting, etc. should be delineated in a baseline needs assessment (BNA). The BNA should address compliance with the NFPA codes and standards and other requirements that define the character of its mission and responsibilities. The goal is to capture in one document information that will confirm that the fire department is fully capable of meeting emergency response requirements and needs.

- If a contractor will rely completely on (non-DOE) offsite emergency services organizations to satisfy the emergency response requirement, then the contractor should first define completely its emergency services needs against the services available by the offsite organization. This can be done via a BNA or comparable document, commensurate with the offsite organization's responsibilities. This document should delineate what is required (capability), why is it required (hazards, accident potential, code requirements, etc.), and how this capability is assured by the offsite emergency services organization.
- If a contractor will rely on a combination of onsite and offsite emergency services organizations, the contractor should comprehensively demonstrate that an adequate emergency response capability exists on the basis of some combination of the efforts described above.

DOE-STD-1066-99, Fire Protection Design Criteria

DOE-STD-1066-99 includes the following general criteria:

- When the maximum possible fire loss (MPFL) exceeds $50 million, a redundant fire protection system should be provided that, despite the failure of the primary fire protection system, will limit the loss to acceptable levels as determined by the authority having jurisdiction (AHJ).
- When the MPFL exceeds $150 million, a redundant fire protection system and a 3-hour fire barrier should be provided to limit the MPFL to acceptable levels as determined by the AHJ.
- Where a potential fire would represent an unacceptable risk to the health and safety of the public, workers, the environment, DOE programs or DOE property (as determined by a fire hazard analysis) fire protection should be provided for special structures, commensurate with the risk.
- All DOE sites and facilities should have access to a fully-staffed, completely equipped, and adequately-trained fire department that is capable and committed to respond to fires and related emergencies onsite in a timely and effective manner. If, on the basis of a needs assessment or operational basis document, it is determined that such a capability does not exist and that DOE is, consequently, subject to a higher loss potential, additional fire protection features should be provided to compensate for the deficiencies determined. The fire department capability to reduce loss due to a fire should be considered in terms of the following factors:
  - location of fire station(s) with respect to the facility to be protected
  - staffing of stations
  - ability to perform initial fire attack as outlined in NFPA 1410, *Standard for Training for Initial Emergency Scene Operations*
  - method(s) of fire department notification or alarm reception
  - familiarity of station staff with the DOE facility, and training in preparation for effective response to an alarm at the DOE facility

- New permanent structures in excess of 5,000 square feet floor area should be of noncombustible or fire resistive construction if no local building code is enforced. Interior fire barriers should be provided to isolate hazardous occupancies, to minimize the potential for fire spread (including products of combustion) and loss potential, and to help assure the orderly evacuation of facility occupants, consistent with the

conclusions of the Federal Housing Authority that is performed in conjunction with the design process. Openings in such barriers should be protected with appropriately fire-rated doors, windows, dampers, or penetration seals.

- To protect the integrity of the physical barriers associated with process confinement systems, fire protection features should include the following:
  - A fire-extinguishing system to rapidly remove heat produced by fire to prevent or minimize the pressurization of a process confinement and to rapidly extinguish a fire to minimize the loading of ventilation system filters with combustion products.
  - The introduction of the extinguishing agent in a way that does not result in over-pressurization of the confinement barriers.
- All facilities of significance, including facilities where a fire could cause unacceptable offsite consequences to health and safety, should be protected by an automatic fire suppression system. A decision to install another type of fire suppression system should be based on engineering analysis performed by a fire protection engineer. DOE has, historically, considered a facility with an MPFL in excess of $1 million as being significant from a property protection standpoint.
- In some circumstances, the need for automatic fire suppression systems should be considered, despite the absence of explicit requirements, such as when the MPFL is below $1 million or other limits imposed by DOE. Some examples of situations where automatic fire suppression systems may be warranted are
  - facilities that contain critical or long procurement time construction items;
  - a temporary-use trailer used as a control center for a vital one-time activity;
  - a facility with high public visibility or sensitivity (as defined by the AHJ);
  - electric power transformers with combustible contents that, if damaged, could result in an extended shut-down of the facilities they serve;
  - facilities in which a fire could result in the accidental release of significant quantities of toxic or hazardous materials or emissions (based on engineering analysis);
  - facilities that can be protected by extending automatic fire suppression systems from an adjacent protected facility or area at a low incremental cost;
  - facilities in which a fire could damage more important adjacent facilities;
  - facilities used to store hard to replace or irreplaceable records;
  - facilities that may warrant automatic fire suppression systems in the future; and
  - facilities where required for protection of human life.
- Where required by the DSA, the design of fire protection systems to withstand seismic events should be in accordance with the criteria developed by the NFPA, except as required by other DOE criteria, such as in section 7 of DOE-STD-1066-99.
- Fire protection systems or portions of them that must function to control effects of a design basis accident (DBA) event (as determined by safety analysis accident scenarios) should be designed to be functional for all conditions included in the accident scenario. This should include the event initial cause and its consequences.
- When the use of water sprinkler coverage is precluded because of nuclear criticality or other incompatibility reasons, nonaqueous extinguishing systems (e.g., inert gas, carbon dioxide, halon alternatives, etc.) should be used.
- Standpipes should be installed in all structures having three levels or more above or below grade. Standpipe systems should be provided in other structures, such as those

with extensive and complex interior layouts, where deemed necessary by the DOE fire protection AHJ. Standpipes should be designed and installed as class 1 systems.

DOE-STD-1088-95, Fire Protection for Relocatable Structures

DOE-STD-1088-95 provides fire protection criteria applicable to the design, construction, and location of relocatable structures as defined herein. It also addresses fire extinguishing methods and general safeguards. The provisions of this standard apply to the following:

- The purchase and lease, and the design and construction, of all relocatable structures acquired or initially installed after the effective date of DOE-STD-1088-95.
- Other temporary or non-permanent structures that are not encompassed by other DOE criteria. This includes relocatable structures that are fixed or anchored to a permanent or temporary foundation constructed in accordance with the International Building Code, applicable local building code, or industry standard as part of their siting.
- Existing relocatable structures (including structures repositioned from one site location to another) when a fire hazard analysis demonstrates conditions that represent a significant risk to the health and safety of the public or site personnel as determined by the DOE AHJ.
- Existing relocatable structures which, if lost due to fire, would result in an unacceptable program impact.

This standard does not apply to relocatable structures that will remain in place for no more than 180 days onsite and that do not contain significant fire hazards and have no programmatic importance or significant value, as determined by the cognizant fire protection engineer.

Modifications made to existing portable structures should be performed in accordance with this standard. Site-specific interpretations of the provisions of this standard should be the responsibility of the DOE AHJ.

10 CFR Part 851, Worker Safety and Health Program

Appendix A, parts a and b provide requirements for fire protection.

Contractors must implement a comprehensive fire safety and emergency response program to protect workers commensurate with the nature of the work that is performed. This includes appropriate facility and site-wide fire protection, fire alarm notification and egress features, and access to a fully staffed, trained, and equipped emergency response organization that is capable of responding in a timely and effective manner to site emergencies.

An acceptable fire protection program must include those fire protection criteria and procedures, analyses, hardware and systems, apparatus and equipment, and personnel that would comprehensively ensure that the objective in paragraph 2(a) of this appendix is met. This includes meeting applicable building codes and National Fire Protection Association codes and standards.

DOE-HDBK-1081-94, Primer on Spontaneous Heating and Pyrophoricity

The purpose of DOE-HDBK-1081-94 is to provide operations and maintenance personnel with the information necessary to identify and prevent potential spontaneous combustion

hazards. Throughout the history of industry and the DOE complex, fires caused by spontaneous heating and pyrophoric materials have occurred, sometimes causing personal injury and significant damage to facilities. By its very nature, spontaneous heating and pyrophoricity are among the most insidious types of fire hazards. Many times there is no outward evidence of the potential for fires caused by these phenomena. An understanding of the principles of spontaneous heating and pyrophoricity is necessary for instituting fire prevention measures

DOE-HDBK-1163-2003, Integration of Multiple Hazard Analysis Requirements and Activities

DOE-HDBK-1163-2003 is intended to provide DOE and contractor safety personnel with a resource to support the planning, technical review, or conduct of hazard analysis activities. Clarifications of requirements and discussions of best practices can be used to help improve cost effectiveness, clarify organizational roles and responsibilities, and provide a basis for enhancing the technical quality of hazard analysis activities.

This handbook can be applied to a broad set of activities conducted at DOE facilities, including nuclear or nonnuclear related processing, waste management, and laboratory and decommissioning operations. It is not intended to apply to DOE facilities engaged in developing, manufacturing, handling, storing, transporting, processing, or testing of explosives, pyrotechnics and propellants, or assemblies containing these materials. These activities represent a small sector of DOE's current missions and facilities, and are specifically covered by DOE M 440.1-1A, *DOE Explosives Safety Manual.*

b. Discuss the contractor's fire protection responsibilities associated with implementation of these directives.

DOE O 151.1C, Comprehensive Emergency Management System

Contractors must develop and implement a Comprehensive Emergency Management System designed to

- minimize the consequences of all emergencies involving or affecting Departmental facilities, and activities, including transportation operations/activities;
- protect the health and safety of all workers and the public from hazards associated with DOE/NNSA operations and those associated with decontamination, decommissioning, and environmental restoration;
- prevent damage to the environment; and
- promote effective and efficient integration of all applicable policies, recommendations, and requirements, including Federal interagency emergency plans.

DOE G 151.1-1A, Emergency Management Fundamentals and the Operational Emergency Base Program: Emergency Management Guide

The majority of specific requirements related to the release of hazardous materials promulgated in DOE O 151.1C are intentionally nonprescriptive due to the wide variety of operations and activities conducted by DOE/NNSA and its contractors, and the broad range of associated hazards. The Order requires that facility/site or activity emergency management programs be developed commensurate with the hazards at that particular facility/site or activity. To assist facilities/sites and activities in implementing the Order requirements,

DOE/NNSA has developed this comprehensive guidance document, the *Emergency Management Guide*. This guide is applicable to all DOE/NNSA facilities/sites and activities and generally applicable at DOE/NNSA organizational levels, including cognizant field elements and Headquarters offices.

DOE O 151.1C requires that emergency management programs are established and maintained at each organizational level to implement requirements pertaining to the comprehensive emergency management system. Because DOE and its contractors are involved in a variety of operations and activities incorporating a broad range of hazards that must be considered in effective emergency management, the Order requires that the emergency management program for a specific facility/site or activity be commensurate with the hazards present at that facility/site or activity.

DOE O 420.1B, Facility Safety

In the performance of this contract, the contractor is to develop, implement, and maintain a comprehensive fire protection program that is sufficient to meet DOE objectives for fire safety, as stated below.

DOE objectives are to establish requirements for a comprehensive fire and related hazards protection program for facilities sufficient to minimize the potential for (1) the occurrence of a fire or related event; (2) a fire that causes an unacceptable onsite or offsite release of hazardous or radiological material that will threaten the health and safety of employees, the public, or the environment; (3) vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards; (4) property losses from a fire and related events exceeding defined limits established by DOE; and (5) critical process controls and safety class systems being damaged as a result of a fire and related events.

DOE facilities, sites, and activities (including design and construction) shall be characterized by a level of fire protection that is sufficient to fulfill the requirements of the best protected class of industrial risks and shall be provided protection to achieve defense-in-depth. This includes meeting the applicable building code and NFPA codes and standards, or exceeding them (when necessary to meet safety objectives), unless explicit written relief has been granted by DOE.

The general requirements for contractors are identical to those listed in item a under DOE O 420.1B.

DOE O 440.1B, Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees

There are no contractor requirements for DOE O 440.1B.

DOE G 420.1-3, Implementation Guide for DOE Fire Protection and Emergency Services Programs for Use with DOE O 420.1B, Facility Safety

Contractors can achieve and maintain a comprehensive site and facility fire protection program through implementation of applicable industry codes and standards (principally from the NFPA), as modified by DOE fire safety criteria. Site and facility fire protection programs are characterized by defense-in-depth. This means that adequate safety is assured

by reliance on multiple levels of fire protection (fire safety policies, administrative procedures, active fire protection systems, passive fire safety features, trained people, and an adequate emergency response capability, among other possible facets). Additionally, the long-term adequacy of site and facility fire safety programs required routine self-assessments with a corrective action program that facilitates the timely remediation of significant fire protection and emergency response deficiencies. Such programs include appropriate notification, reporting, and tracking and trending of findings.

Subcontractors can achieve compliance with DOE fire safety objectives through an established and appropriately documented relationship with a prime contractor's fire protection and emergency response program.

DOE-STD-1066-99, Fire Protection Design Criteria

The provisions of DOE-STD-1066-99 apply as guidance to the following:

- All departmental elements as delineated in the scope of DOE O 420.1B, *Facility Safety,* and its contractor requirements document.
- The purchase and lease, as well as the design and construction, of all DOE facilities erected, modified, or renovated after the effective date of this standard.

Nothing in this standard is intended to limit the application of other fire protection methods when unique situations or hazards warrant an alternate approach. The alternate approach should provide a comparable level of safety to that achieved by conformance with this standard. Such alternate approaches should be approved by the AHJ, after consultation with a qualified fire protection engineer.

The development of this standard reflects the fact that national consensus standards and other design criteria do not comprehensively or, in some cases, adequately address fire protection issues at DOE facilities.

This standard provides supplemental fire protection guidance applicable to the design and construction of DOE facilities and site features (such as water distribution systems) that are also provided for fire protection. It is intended to be used in conjunction with the applicable building code, NFPA codes and standards, and any other applicable DOE construction criteria.

This standard constitutes the basic criteria for satisfying DOE fire and life safety objectives for the design and construction or renovation of DOE facilities.

DOE-STD-1088-95, Fire Protection for Relocatable Structures

Complete automatic sprinkler protection designed per the applicable NFPA standards should be provided for relocatable structures as follows:

- In all new structures over 5,000 square feet (465 square meters).
- In all structures having an MPFL in excess of $1 million.
- In all structures where the MPFL will affect a vital program for a period longer than that specified as acceptable by the Program Senior Official.
- In all structures where quantities of hazardous materials are used or stored in excess of the limits delineated in the Uniform Fire Code, or alternate model fire code as determined by the AHJ.

- In all structures used for sleeping quarters, including day care centers. (For such structures, quick-response sprinklers should be used.)

Exception 1: Limited supply suppression systems may be used where a reliable water supply is not available, or where the application of water would increase the overall hazard in the event of a fire.

Exception 2: Automatic sprinkler systems are not required in fabric or membrane type structures where alternate means of fire protection will provide an acceptable level of protection. Such means include, but are not limited to, fire detection systems combined with foam fire extinguishing systems and other special fire suppression systems.

Portable fire extinguishers, listed by a nationally recognized independent testing agency, should be provided for portable structures in accordance with NFPA 10, *Portable Fire Extinguishers.*

At least one fire hydrant supplied by an adequate and reliable water distribution system should be located so that it does not require more than 300 feet (91 meters) of fire hose to reach any exterior portion of a relocatable structure or a group of structures to be protected.

Exception 1: This requirement does not apply to those structures that are required to be mobile and are moved on a regular basis to support an operation, such as field monitoring and sampling trailers.

Exception 2: This requirement does not apply to structures under 5,000 square feet (465 square meters) in floor area, or when the MPFL is less than $1 million.

Exception 3: This requirement does not apply to remote structures as determined by the DOE AHJ.

All relocatable structures that are occupied by people should have access to a means to summon emergency assistance. Where a fire alarm or signaling system is not otherwise provided or required, this may take the form of a telephone, radio, or equivalent means.

Relocatable structures should be provided with fire alarm and notification systems as required by NFPA 101, *Life Safety Code,* and 29 CFR 1910.165, "Employee Alarm Systems," for the specific occupancy.

Relocatable structures equipped with an automatic fire suppression or detection system shall also be equipped with local alarm(s) that transmit separate and distinct signals for fire, trouble, and supervisory

- to the site fire department/emergency response center, or
- to a continuously occupied station for the purpose of initiating emergency response if a site fire department does not exist.

Provisions for emergency egress, including exits, emergency lighting, and exit signage should be in accordance with NFPA 101.

10 CFR Part 851, Worker Safety and Health Program

Contractors are responsible for the safety and health of their workforce and must ensure that contractor management at a covered workplace

- establish written policy, goals, and objectives for the worker safety and health program;
- use qualified worker safety and health staff (e.g., a certified industrial hygienist, or safety professional) to direct and manage the program;
- assign worker safety and health program responsibilities, evaluate personnel performance, and hold personnel accountable for worker safety and health performance;
- provide mechanisms to involve workers and their elected representatives in the development of the worker safety and health program goals, objectives, and performance measures and in the identification and control of hazards in the workplace;
- provide workers with access to information relevant to the worker safety and health program;
- establish procedures for workers to report without reprisal job-related fatalities, injuries, illnesses, incidents, and hazards and make recommendations about appropriate ways to control those hazards;
- provide for prompt response to such reports and recommendations;
- provide for regular communication with workers about workplace safety and health matters;
- establish procedures to permit workers to stop work or decline to perform an assigned task because of a reasonable belief that the task poses an imminent risk of death, serious physical harm, or other serious hazard to workers, in circumstances where the workers believe there is insufficient time to utilize normal hazard reporting and abatement procedures; and
- inform workers of their rights and responsibility by appropriate means, including posting the DOE-designated Worker Protection Poster in the workplace where it is accessible to all workers.

DOE-HDBK-1081-94, Primer on Spontaneous Heating and Pyrophoricity

DOE-HDBK-1081-94, *Primer on Spontaneous Heating and Pyrophoricity,* was prepared as an information resource for personnel who are responsible for operation of the Department's nuclear facilities. An understanding of spontaneous heating and pyrophoricity hazards is necessary for DOE facility personnel to operate and maintain facilities and facility support systems in a safe manner.

DOE-HDBK-1081-94 contains an introduction and sections on the following topics:

- Principles of combustion
- Spontaneous heating/ignition of hydrocarbons and organics
- Pyrophoric gases and liquids
- Pyrophoric nonmetallic solids
- Pyrophoric metals
- Accident case studies

The information contained in this primer is by no means all-encompassing. However, enough information is presented to provide the reader with a fundamental knowledge level sufficient to recognize most spontaneous combustion hazards and how to prevent ignition and widespread fires. This primer is provided as an information resource only, and is not intended to replace any fire protection or hazardous material training.

DOE-HDBK-1163-2003, Integration of Multiple Hazard Analysis Requirements and Activities

DOE contractors conduct multiple hazard analysis activities in accordance with integrated safety management (ISM) and various DOE Orders, rules, and Federal regulations. This handbook identifies numerous requirements having direct reference to hazard identification, hazard analysis, hazard evaluation, hazard assessment, accident analysis, and risk analysis or risk assessment.

c. Describe the role of the Department's fire protection engineers with respect to implementation of the fire protection requirements of these directives.

This element is covered in items a and b of this competency.

d. Describe the fundamental requirements that apply to a DOE fire department or brigade.

The following is taken from 29 CFR 1910.156.

The requirements of 29 CFR 1910.156, "Fire Brigades," apply to fire brigades, industrial fire departments and private or contractual type fire departments. Personal protective equipment requirements apply only to members of fire brigades performing interior structural fire fighting.

The employer shall prepare and maintain a statement or written policy that establishes the existence of a fire brigade; the basic organizational structure; the type, amount, and frequency of training to be provided to fire brigade members; the expected number of members in the fire brigade; and the functions that the fire brigade is to perform at the workplace. The organizational statement shall be available for inspection by the Assistant Secretary and by employees or their designated representatives.

The employer shall assure that employees who are expected to do interior structural fire fighting are physically capable of performing duties which may be assigned to them during emergencies. The employer shall not permit employees with known heart disease, epilepsy, or emphysema, to participate in fire brigade emergency activities unless a physician's certificate of the employees' fitness to participate in such activities is provided.

The employer shall provide training and education for all fire brigade members commensurate with those duties and functions that fire brigade members are expected to perform. Such training and education shall be provided to fire brigade members before they perform fire brigade emergency activities. Fire brigade leaders and training instructors shall be provided with training and education which is more comprehensive than that provided to the general membership of the fire brigade.

The employer shall assure that training and education is conducted frequently enough to assure that each member of the fire brigade is able to perform the member's assigned duties and functions satisfactorily and in a safe manner so as not to endanger fire brigade members or other employees. All fire brigade members shall be provided with training at least annually. In addition, fire brigade members who are expected to perform interior structural fire fighting shall be provided with an education session or training at least quarterly.

The quality of the training and education program for fire brigade members shall be similar to those conducted by such fire training schools as the Maryland Fire and Rescue Institute; Iowa Fire Service Extension; West Virginia Fire Service Extension; Georgia Fire Academy, New York State Department, Fire Prevention and Control; Louisiana State University Firemen Training Program, or Washington State's Fire Service Training Commission for Vocational Education.

The employer shall inform fire brigade members about special hazards such as storage and use of flammable liquids and gases, toxic chemicals, radioactive sources, and water reactive substances, to which they may be exposed during fire and other emergencies. The fire brigade members shall also be advised of any changes that occur in relation to the special hazards. The employer shall develop and make available for inspection by fire brigade members, written procedures that describe the actions to be taken in situations involving the special hazards and shall include these in the training and education program.

The employer shall maintain and inspect, at least annually, fire fighting equipment to assure the safe operational condition of the equipment. Portable fire extinguishers and respirators shall be inspected at least monthly. Fire fighting equipment that is in damaged or unserviceable condition shall be removed from service and replaced.

The following requirements apply to those employees who perform interior structural fire fighting. The requirements do not apply to employees who use fire extinguishers or standpipe systems to control or extinguish fires only in the incipient stage.

- The employer shall provide at no cost to the employee and assure the use of protective clothing which complies with the requirements of this paragraph. As the new equipment is provided, the employer shall assure that all fire brigade members wear the equipment when performing interior structural fire fighting.
- The employer shall assure that protective clothing protects the head, body, and extremities, and consists of at least the following components: foot and leg protection; hand protection; body protection; eye, face and head protection.
- Foot and leg protection shall meet the requirements of paragraphs (e)(2)(ii) and (e)(2)(iii) of 29 CFR 1910.156, and may be achieved by either of the following methods:
  - Fully extended boots which provide protection for the legs; or
  - Protective shoes or boots worn in combination with protective trousers that meet the requirements of 29 CFR 1910.156.

  Protective footwear shall meet the requirements of 29 CFR 1910.136, Foot Protection," for class 75 footwear. In addition, protective footwear shall be water-resistant for at least 5 inches above the bottom of the heel and shall be equipped with slip-resistant outer soles. Protective footwear shall be tested in accordance with

paragraph (1) of appendix E, and shall provide protection against penetration of the midsole by a size 8D common nail when at least 300 pounds of static force is applied to the nail.

- Body protection shall be coordinated with foot and leg protection to ensure full body protection for the wearer. This shall be achieved by one of the following methods:
  - Wearing of a fire-resistive coat meeting the requirements of 29 CFR 1910.156 in combination with fully extended boots meeting the requirements of paragraphs (e)(2)(ii) and (e)(2)(iii) of 29 CFR 1910.156.
  - Wearing of a fire-resistive coat in combination with protective trousers both of which meet the requirements of paragraph (e)(3)(ii) of 29 CFR 1910.156.

  The performance, construction, and testing of fire-resistive coats and protective trousers shall be at least equivalent to the requirements of the NFPA standard NFPA No. 1971, "Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting," which is incorporated by reference as specified in 29 CFR 1910.6, "Incorporation by Reference," with the following permissible variations from those requirements:
  - Tearing strength of the outer shell shall be a minimum of 8 pounds in any direction when tested in accordance with paragraph (2) of appendix E; and
  - The outer shell may discolor but shall not separate or melt when placed in a forced air laboratory oven at a temperature of 500 ºF (260 ºC) for a period of five minutes. After cooling to ambient temperature and using the test method specified in paragraph (3) of appendix E, char length shall not exceed 4.0 inches and after-flame shall not exceed 2.0 seconds.

- Hand protection shall consist of protective gloves or glove system which will provide protection against cut, puncture, and heat penetration. Gloves or glove system shall be tested in accordance with the test methods contained in the National Institute for Occupational Safety and Health (NIOSH) 1977 publication, *The Development Of Criteria For Firefighters' Gloves*, vol. II - Glove Criteria And Test Methods," which is incorporated by reference as specified in 29 CFR. 1910.6, and shall meet the following criteria for cut, puncture, and heat penetration:
  - Materials used for gloves shall resist surface cut by a blade with an edge having a 60º included angle and a .001 inch radius, under an applied force of 16 pound force (lbf)and at a slicing velocity of greater or equal to 60 in/min; Materials used for the palm and palm side of the fingers shall resist puncture by a penetrometer (simulating a 4d lath nail), under an applied force of 13.2 lbf , and at a velocity greater or equal to 20 in/min; and
  - The temperature inside the palm and gripping surface of the fingers of gloves shall not exceed 135 ºF (57 ºC) when gloves or glove system are exposed to 932 ºF (500 ºC) for five seconds at 4 psi pressure.

  Exterior materials of gloves shall be flame resistant and shall be tested in accordance with paragraph (3) of appendix E. Maximum allowable afterflame shall be 2.0 seconds, and the maximum char length shall be 4.0 inches.

When design of the fire-resistive coat does not otherwise provide protection for the wrists, protective gloves shall have wristlets of at least 4.0 inches in length to protect the wrist area when the arms are extended upward and outward from the body.

- Head protection shall consist of a protective head device with ear flaps and chin strap which meet the performance, construction, and testing requirements of the National Fire Safety and Research Office of the National Fire Prevention and Control Administration, U.S. Department of Commerce (now known as the U.S. Fire Administration), which are contained in *Model Performance Criteria for Structural Firefighters' Helmets*.

  Protective eye and face devices which comply with 29 CFR 1910.133, "Eye and Face Protection," shall be used by fire brigade members when performing operations where the hazards of flying or falling materials which may cause eye and face injuries are present. Protective eye and face devices provided as accessories to protective head devices (face shields) are permitted when such devices meet the requirements of 29 CFR 1910.133.

  Full facepieces, helmets, or hoods of breathing apparatus which meet the requirements of 29 CFR 1910.134 and paragraph (f) of 29 CFR 1910.156, shall be acceptable as meeting the eye and face protection requirements of paragraph (e)(5)(ii) of 29 CFR 1910.156.

- The employer must ensure that respirators are provided to, and used by, fire brigade members, and that the respirators meet the requirements of 29 CFR 1910.134 and this paragraph.

  Approved self-contained breathing apparatus with full-facepiece, or with approved helmet or hood configuration, shall be provided to and worn by fire brigade members while working inside buildings or confined spaces where toxic products of combustion or an oxygen deficiency may be present. Such apparatus shall also be worn during emergency situations involving toxic substances.

  Approved self-contained breathing apparatus may be equipped with either a buddy-breathing device or a quick disconnect valve, even if these devices are not certified by NIOSH. If these accessories are used, they shall not cause damage to the apparatus, or restrict the air flow of the apparatus, or obstruct the normal operation of the apparatus.

  Approved self-contained compressed air breathing apparatus may be used with approved cylinders from other approved self-contained compressed air breathing apparatus provided that such cylinders are of the same capacity and pressure rating. All compressed air cylinders used with self-contained breathing apparatus shall meet U.S. Department of Transportation and NIOSH criteria.

  Self-contained breathing apparatuses must have a minimum service-life rating of 30 minutes in accordance with the methods and requirements specified by NIOSH under

42 CFR 84, "Approval of Respiratory Protective Devices," except for escape self-contained breathing apparatus used only for emergency escape purposes.

Self-contained breathing apparatus shall be provided with an indicator which automatically sounds an audible alarm when the remaining service life of the apparatus is reduced to within a range of 20 to 25 percent of its rated service time.

- The employer shall assure that self-contained breathing apparatus for use by fire brigade members performing interior structural fire fighting operations, are of the pressure-demand or other positive-pressure type.

  This paragraph does not prohibit the use of a self-contained breathing apparatus where the apparatus can be switched from a demand to a positive-pressure mode. However, such apparatus shall be in the positive-pressure mode when fire brigade members are performing interior structural fire fighting operations.

e. Describe the relationship between fire and life safety provision of these documents with other safety and security elements (e.g., security, nuclear safety, including the documented safety analysis, criticality safety, etc.).

The following is taken from DOE G 420.1-3.

A fire hazard analysis (FHA) is required for all hazard category 1, 2 and 3 nuclear facilities, high-hazard facilities, significant new facilities, and facilities that store or process significant quantities of hazardous materials in excess of the allowances described in NFPA 1, *Uniform Fire Code*. These examples include planned facilities and significant renovations to existing facilities as determined necessary by the AHJ. NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials,* also requires a graded FHA for radiological facilities that exceed the thresholds in 10 CFR 830.

The purpose of an FHA is to conduct a comprehensive, qualitative assessment of the risk from fire within individual fire areas in a DOE facility to ascertain whether the DOE fire safety objectives of DOE O 420.1B, *Facility Safety,* are met. This should include an assessment of the risk from fire and related hazards (wildland fire exposure, direct flame impingement, hot gases, smoke migration, firefighting water damage, etc.) in relation to existing or proposed fire safety features to ensure that the facility can be safely controlled and stabilized during and after a fire. In accordance with the graded approach concept, the level of detail necessary for an acceptable FHA is directly related to the complexity of the facility and the potential risk to the public and facility operators. The scope and content of an FHA should be limited to only those issues that are significant and relevant to the facility. To facilitate the development of graded fire hazards analyses, model FHAs have been developed.

Analysis of significant planned facilities included in the FHA process should begin early in the design phase to ensure that an acceptable level of protection is being incorporated in the evolving design. This project or preliminary FHA should be updated whenever significant changes occur within an individual fire area and should form the basis for post-construction FHA included in the review and revision schedule per chapter II, section 3b(5)(b) and 3b(5)(c) of DOE O 420.1B. The analysis shall also support the conclusions of a preliminary

documented safety analysis (DSA) where required. In situations where the AHJ has determined that an FHA is necessary for a significant new facility that is not considered hazardous, post-construction FHA reviews and revisions are not required.

In accordance with DOE O 420.1B, and as referenced in DOE-STD-1066-99, *Fire Protection Design Criteria*, the FHA must be performed under the direction of a qualified fire protection engineer. This should include directing all of the technical aspects of an FHA's development including support from emergency services, systems, electrical, and mechanical engineers, as well as operations staff as needed.

An FHA should contain, but not be limited to, a conservative assessment of the following fire safety issues:

- Description of construction
- Description of critical process equipment
- Description of high-value property
- Description of fire hazards
- Description of operations
- Potential for a toxic, biological and/or radiological incident due to a fire
- Natural hazards (earthquake, flood, wind, lightning, and wildland fire) impact on fire safety
- Damage potential: Include the MPFL as defined in DOE-STD-1066-99 and the DSA of the design basis fire scenario
- Fire protection features
- Protection of essential safety class systems
- Life safety considerations
- Emergency planning
- Fire department/brigade response
- Recovery potential
- Security and safeguards considerations related to fire protection
- Exposure fire potential and the potential for fire spread between two fire areas
- Effect of significant fire safety deficiencies on fire risk
- Environmental impacts from a fire including suppression system run-off considerations

The FHA should evaluate the consequences of a single, worst-case automatic fire protection system malfunction; i.e., a detection system that also activates a pre-action type sprinkler system, but fails to transmit an alarm to the site emergency response force. This FHA evaluation may also include the failure of a valve in the underground main that could impair multiple systems, either in the same building or in adjacent buildings evaluated as an exposure.

In determining the value of the MPFL, which is used in part to assess the need for fire protection systems, the basic assumption should be that there is no automatic or manual fire suppression. This loss determination should include all direct and indirect costs associated with the fire and clean-up operations. In addition, there may be intangible costs such as mission interruption, erosion of public support, and local economic impact. All of these may need to be considered to ensure that appropriate levels of fire protection are included in a facility. The following direct and indirect costs should be considered:

- Replacement cost of building and building systems or contents within the fire area
- Replacement cost of contents
- Cost of lost time (considered mission interruption costs)
- Cost of environmental clean-up
- Exposure damage to other buildings, structures and property
- Costs for re-establishing operations; e.g., redesign approval and start-up

If redundant automatic fire protection systems are provided in the area, only the system that causes the most vulnerable condition is assumed to fail. Passive fire protection features, such as blank fire-rated walls or continuous fire-rated cable wraps, are assumed to remain viable for their rated fire endurance period to the extent that they are properly constructed and maintained.

The focus of the FHA should be the individual fire areas that comprise the facility. A fire area is defined as a location bounded by fire-rated construction, having a minimum fire resistance rating of two hours, with openings protected by equivalently rated fire doors, dampers, or penetration seals. The boundaries of exterior fire areas (yard areas) should be as determined by the AHJ or delegated authority. Where a facility is not subdivided by fire-rated construction, the fire area should be defined by the exterior walls and roof of the facility.

An important element of an acceptable FHA for nuclear facilities is an inventory of all safety class and safety significant systems within the fire area that are susceptible to fire damage. This includes those primary and supporting mechanical and electrical systems that must function effectively during and after a fire event to ensure safety. For example, loss of the building ventilation system in a fire (due to damage of power cables) may result in an ambient air temperature rise, which may cause the failure of sensitive electrical components, such as relays. Such safety systems may include, but are not limited to, process monitoring instrumentation, instrument air, hydraulic systems, and emergency lighting systems.

All credible fire-related failure modes of safety systems should be considered. For example, it is insufficient to assume that fire will merely cause the loss of function of safety equipment when power cables to that equipment are within the fire area. It is also necessary to consider the potential for spurious signals that may cause the inadvertent operation of such equipment. Similarly, fire-induced electrical faults may trip upstream electrical disconnect devices in such a way as to render inoperable other safety systems that may not even be located within the fire area. In addition, the effects of combustion products, manual firefighting efforts, and the activation of automatic fire suppression systems should be assessed.

Fire propagation and the potential for fire-induced radiological dispersal through the facility should be considered. These effects should be considered for the normal operating mode of the air distribution system as well as alternate modes, such as shutdown, that may result from the fire.

A tool that may be used in the development of an FHA is a fire model, such as those developed by the National Institute of Standards and Technology, as applied by qualified fire protection engineers, and approved for DOE use as a Toolbox code.

All assumptions used in a model should be listed in the FHA and limiting conditions of operation or specific administrative controls established to assure that these assumptions produce reasonably conservative results compared to applicable codes and standards. Small variations in an assumption can have a major impact on the outcome. (For example, assuming a door is closed can reduce fire intensity by half, but there is no assurance that the door will remain closed throughout the life of the facility.) Because of their potential errors, model results should be approved by a qualified fire protection engineer who is knowledgeable on the use of the model.

Additionally, FHA analysis may include reliance on actual fire testing or historical data on fire events inside and outside the DOE complex, provided that adequate documentation of such information is available for the AHJ's review. Alternately, an assumption can be made that all potentially vulnerable systems will be damaged within the fire area. Acceptable exceptions to this assumption are water-filled steel pipes, tanks, and similar components of adequate structural integrity with welded fittings and adequate pressure relief.

The quantity and associated hazards of flammable and combustible materials that are often found within the fire area should be factored into the analyses. Consideration should also be given to the presence of transient combustibles associated with storage and maintenance activities. Where a facility is fully protected as required by directives and prescriptive codes and standards, combustibles can usually be characterized in general terms and limited through normal housekeeping programs. However, when conditions prevent employment of normal fire protection features such as automatic sprinklers, noncombustible construction, and fire resistant boundaries, the FHA should quantify fixed combustibles and their locations and determine limits and locations of transient combustibles. These limits are usually enforced through formal combustible loading programs with permits for each combustible material brought into the area. Averaging combustible loading as a means to characterize the fire severity is not considered an acceptable technique over localized combustible loading.

FHAs for high-bay locations should consider the effects of smoke/hot gas stratification that may occur at some intermediate point below the roof or ceiling as well as the potential for delayed sprinkler response. Similarly, the effect of smoke movement through doors and dampers held open by fusible links should be addressed.

2. Fire protection engineers shall demonstrate an expert level of knowledge of the requirements for fire protection and life safety related design control processes identified in DOE directives.

a. Describe the key elements of the design, construction and acceptance process as practiced on site.

This is a site-specific KSA. The local Qualifying Official will evaluate its completion.

b. Identify who may conduct fire protection system and/or component design verifications.

The provisions of 10 CFR 830.122, "Quality Assurance Criteria," require the contractor to use individuals or groups other than those who performed the work to verify or validate the

adequacy of any changes to design products. Documentation of the independent design verification must be included in the change control package.

c. Describe the conditions to be considered when inspecting and testing fire protection and life safety systems so as to be able to verify or validate design features.

The following is taken from DOE G 420.1-3.

The inspection, testing and maintenance (ITM) program for fire protection features, apparatus and equipment should be based on industry standards, such as those established by the NFPA unless an alternative has been approved by the AHJ. The organizations responsible for ITM of fire protection features should maintain system inspection and test records for a minimum of three review cycles. In addition, responsible authorities should retain records of all ITM procedures for as long as such equipment remains in service.

d. Describe the key elements of facility design that are important to effective emergency response.

The following is taken from DOE-STD-1066-99.

New permanent structures in excess of 5,000 square feet floor area should be of noncombustible or fire resistive construction if no local building code is enforced.

Interior fire barriers should be provided to isolate hazardous occupancies, to minimize the potential for fire spread (including products of combustion) and loss potential, and to help assure the orderly evacuation of facility occupants, consistent with the conclusions of the FHA that is performed in conjunction with the design process. Openings in such barriers should be protected with appropriately fire-rated doors, windows, dampers or penetration seals.

To protect the integrity of the physical barriers associated with process confinement systems, fire protection features should include the following:

- A fire-extinguishing system to rapidly remove heat produced by fire to prevent or minimize the pressurization of a process confinement and to rapidly extinguish a fire to minimize the loading of ventilation system filters with combustion products.
- The introduction of the extinguishing agent in a way that does not result in over-pressurization of the confinement barriers.

Fire Suppression Systems

All facilities of significance, including facilities where a fire could cause unacceptable off-site consequences to health and safety, should be protected by an automatic fire suppression system. A decision to install another type of fire suppression system should be based on engineering analysis performed by a fire protection engineer. DOE has, historically, considered a facility with an MPFL in excess of $1 million as being significant from a property protection standpoint.

In some circumstances, the need for automatic fire suppression systems should be considered, despite the absence of explicit requirements, such as when the MPFL is below $1

million or other limits imposed by DOE. Some examples of situations where automatic fire suppression systems may be warranted are

- facilities that contain critical or long procurement time construction items;
- a temporary-use trailer used as a control center for a vital one-time activity;
- a facility with high public visibility or sensitivity;
- electric power transformers with combustible contents that, of damaged, could result in an extended shut-down of the facilities they serve;
- facilities in which a fire could result in the accidental release of significant quantities of toxic or hazardous materials or emissions;
- facilities that can be protected by extending automatic fire suppression systems from an adjacent protected facility or area at a low incremental cost;
- facilities in which a fire could damage more important adjacent facilities;
- facilities used to store hard to replace or irreplaceable records;
- facilities that may warrant automatic fire suppression systems in the future; and
- facilities where required for protection of human life.

Where required by the DSA, the design of fire protection systems to withstand seismic events should be in accordance the criteria developed by the NFAP except as required by other DOE criteria.

Fire protection systems, or portions of them, that must function to control effects of a design basis accident event should be designed to be functional for all conditions included in the accident scenario. This should include both the event initial cause and its consequences.

When the use of water sprinkler coverage is precluded because of nuclear criticality or other incompatibility reasons, nonaqueous extinguishing systems should be used.

Standpipes should be installed in all structures having three levels or more above or below grade. Standpipe systems should be provided in other structures, such as those with extensive and complex interior layouts, where deemed necessary by the DOE fire protection AHJ. Standpipes should be designed and installed as class 1 systems.

e. Describe the issues and concerns to be considered with respect to integration with other safety and security elements.

The following is taken from DOE O 420.1B.

DOE and contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of 48 CFR 970.5223-1, “Integration of Environment, Safety, and Health into Work Planning and Execution,” and the quality assurance requirements of either subpart A of 10 CFR 830, “Nuclear Safety Management,” or DOE O 414.1C, *Quality Assurance,* or successor document, as applicable. All work done must also comply with 10 CFR 851, “Worker Safety and Health Program.” All new construction, as a minimum, must comply with national consensus industry standards and the model building codes applicable for the state or region, supplemented in a graded manner with additional safety requirements for the associated hazards in the facility that are not addressed by the codes.

f. Describe activities, key characteristics, and requirements of a performance based design/evaluation process, including application of fire modeling.

The following is taken from DOE G 420.1-3.

A tool that may be used in the development of an FHA is a fire model, such as those developed by the National Institute of Standards and Technology, as applied by qualified fire protection engineers, and approved for DOE use as a Toolbox code. This includes the CFAST Fire Model and other models. All assumptions used in a model should be listed in the FHA. Limiting conditions of operation or specific administrative controls should be established to assure that these assumptions produce reasonably conservative results. Also note that small variations in an assumption can have a major impact on the outcome. For example, assuming a door is closed can reduce fire intensity by half, but there is no assurance that the door will remain closed throughout the life of the facility. Because of their potential errors, model results should be approved by a qualified fire protection engineer who is knowledgeable on the use of the model.

g. Describe the purpose, content, and key attributes of a comprehensive fire hazard analysis (FHA), including when an FHA is required to be written, the level of personnel qualified to write an FHA, and how often an FHA is required to be revised.

The following is taken from DOE G 420.1-3.

Information in this section pertains to section 3b (5) of chapter II in DOE O 420.1B (and the corresponding CRD section in attachment 2 of DOE O 420.1B).

An FHA is required for all hazard category 1, 2 and 3 nuclear facilities (as defined in DOE Standard 1027), high-hazard facilities (as determined by the AHJ), significant new facilities and facilities that store or process significant quantities of hazardous materials in excess of the allowances described in NFPA 1, Uniform Fire Code. These examples include planned facilities as well as significant renovations to existing facilities as determined necessary by the AHJ. NFPA 801 also requires a graded FHA for radiological facilities that exceed the thresholds in 10 CFR 30. Examples of facilities not generally requiring an FHA include small utility buildings, trailers, and office buildings.

The purpose of an FHA is to conduct a comprehensive, qualitative assessment of the risk from fire within individual fire areas in a DOE facility to ascertain whether the DOE fire safety objectives of DOE O 420.1B are met. This should include an assessment of the risk from fire and related hazards (wildland fire exposure, direct flame impingement, hot gases, smoke migration, firefighting water damage, etc.) in relation to existing or proposed fire safety features to ensure that the facility can be safely controlled and stabilized during and after a fire. In accordance with the “graded approach” concept, the level of detail necessary for an acceptable FHA is directly related to the complexity of the facility and the potential risk to the public and facility operators. The scope and content of an FHA should be limited to only those issues that are significant and relevant to the facility. To facilitate the development of graded fire hazards analyses, “model” FHAs have been developed. Analysis of significant planned facilities included in the FHA process should begin early in the design phase to ensure that an acceptable level of protection is being incorporated in the evolving

design. This project or preliminary FHA should be updated whenever significant changes occur within an individual fire area and should form the basis for post-construction FHA included in the review and revision schedule per chapter II, section 3b(5)(b) and 3b(5)(c) of DOE O 420.1B. The analysis shall also support the conclusions of a preliminary Documented Safety Analysis (DSA) where required. In situations where the AHJ has determined that an FHA is necessary for a significant new facility that is not considered hazardous; then post-construction FHA reviews and revisions are not required.

In accordance with DOE O 420.1B, the FHA must be performed under the direction of a qualified fire protection engineer. This should include directing all of the technical aspects of an FHA's development including support from emergency services, systems, electrical, and mechanical engineers, as well as operations staff as needed.

An FHA should contain, but not be limited to, a conservative assessment of the following fire safety issues:

- Description of construction
- Description of critical process equipment
- Description of high-value property
- Description of fire hazards
- Description of operations
- Potential for a toxic, biological and/or radiological incident due to a fire
- Natural hazards (earthquake, flood, wind, lightning, and wildland fire) impact on fire safety
- Damage potential: Include both the Maximum Possible Fire Loss (MPFL) as defined in DOE-STD-1066-99 and the DSA of the design basis fire scenario Fire protection features
- Protection of essential safety class systems
- Life safety considerations
- Emergency planning
- Fire department/brigade response
- Recovery potential
- Security and Safeguards considerations related to fire protection
- Exposure fire potential and the potential for fire spread between two fire areas
- Effect of significant fire safety deficiencies on fire risk
- Environmental impacts from a fire including suppression system run-off considerations

The FHA should evaluate the consequences of a single, worst-case automatic fire protection system malfunction; i.e., a detection system that also activates a preaction type sprinkler system, but fails to transmit an alarm to the site emergency response force. This FHA evaluation may also include the failure of a valve in the underground main that could impair multiple systems, either in the same building or in adjacent buildings evaluated as an exposure.

In determining the value of the MPFL, which is used in part to assess the need for fire protection systems, the basic assumption should be that there is no automatic or manual fire suppression. This loss determination should include all direct and indirect costs associated with the fire and clean-up operations. In addition, there may be intangible costs such as

mission interruption, erosion of public support, and local economic impact. All of these may need to be considered to ensure that appropriate levels of fire protection are included in a facility. The following are direct and indirect costs that should be included:

- Replacement cost of building and building systems or contents within the fire area
- Replacement cost of contents
- Cost of lost time (considered mission interruption costs)
- Cost of environmental clean-up
- Exposure damage to other buildings, structures and property
- Costs for re-establishing operations; e.g., redesign approval and start-up

If redundant automatic fire protection systems are provided in the area, only the system that causes the most vulnerable condition is assumed to fail. Passive fire protection features, such as blank fire-rated walls or continuous fire-rated cable wraps, are assumed to remain viable for their rated fire endurance period to the extent that they are properly constructed and maintained.

The focus of the FHA should be the individual fire areas that comprise the facility. A fire area is defined as a location bounded by fire-rated construction, having a minimum fire resistance rating of two hours, with openings protected by equivalently-rated fire doors, dampers or penetration seals. The boundaries of exterior fire areas (yard areas) should be as determined by the AHJ or delegated authority. Where a facility is not subdivided by fire-rated construction, the fire area should be defined by the exterior walls and roof of the facility.

An important element of an acceptable FHA for nuclear facilities is an inventory of all safety class and safety significant systems within the fire area that are susceptible to fire damage. This includes those primary and supporting mechanical and electrical systems that must function effectively during and after a fire event to ensure safety. For example, loss of the building ventilation system in a fire (due to damage of power cables) may result in an ambient air temperature rise, which may cause the failure of sensitive electrical components, such as relays. Such safety systems may include, but are not limited to, process monitoring instrumentation, instrument air, hydraulic systems, and emergency lighting systems.

All credible fire-related failure modes of safety systems should be considered. For example, it is insufficient to assume that fire will merely cause the loss of function of safety equipment when power cables to that equipment are within the fire area. It is also necessary to consider the potential for spurious signals that may cause the inadvertent operation of such equipment. Similarly, fire-induced electrical faults may trip upstream electrical disconnect devices in such a way as to render inoperable other safety systems that may not even be located within the fire area. In addition, the effects of combustion products, manual firefighting efforts, and the activation of automatic fire suppression systems should be assessed.

Fire propagation and the potential for fire-induced radiological dispersal through the facility should be considered. These effects should be considered for the normal operating mode of the air distribution system as well as alternate modes, such as shutdown, that may result from the fire.

Additionally, FHA analysis may include reliance on actual fire testing or historical data on fire events both inside and outside the DOE Complex, provided that adequate documentation of such information is available for the AHJ's review. Alternately, an assumption can be made that all potentially vulnerable systems will be damaged within the fire area. Acceptable exceptions to this assumption are water-filled steel pipes, tanks, and similar components of adequate structural integrity with welded fittings and adequate pressure relief.

The quantity and associated hazards of flammable and combustible materials that are often found within the fire area should be factored into the analyses. Consideration should also be given to the presence of transient combustibles associated with storage and maintenance activities. Where a facility is fully protected as required by directives and prescriptive codes and standards, combustibles can usually be characterized in general terms and limited through normal housekeeping programs. However, when conditions prevent employment of normal fire protection features such as automatic sprinklers, noncombustible construction, and fire resistant boundaries, the FHA should quantify fixed combustibles and their locations and determine limits and locations of transient combustibles. These limits are usually enforced through formal combustible loading programs with permits for each combustible material brought into the area. Averaging combustible loading as a means to characterize the fire severity is not considered an acceptable technique over localized combustible loading.

FHAs for high-bay locations should consider the effects of smoke/hot gas stratification that may occur at some intermediate point below the roof or ceiling as well as the potential for delayed sprinkler response. Similarly, the effect of smoke movement through doors and dampers held open by fusible links should be addressed.

3. Fire protection engineers shall demonstrate an expert level knowledge of typical fire suppression systems.

a. Identify the various types of fire protection systems and their suitability for protecting typical site fire hazards.

The following is taken from DOE-STD-1066-99.

Water Distribution Systems

Domestic water distribution systems that also serve fire protection requirements should be designed to satisfy the calculated fire hydrant demand and the peak domestic demand. Where no other requirements are applicable, the peak domestic demand should be based on 2.5 times the calculated average daily demand plus any special demands, such as industrial or processes that cannot be reduced during a fire. The distribution system should be capable of meeting this combined demand at a minimum residual pressure of 20 psi at ground elevation (or higher elevation if special conditions apply) for a period of not less than 2 hours. Municipal supplies having the same capability are acceptable.

Where reliance is placed on fire department response, either for protection of buildings without sprinkler systems or where the fire department will serve as redundant (backup) protection, the water supply available from hydrants should be capable of providing the flow rates established in the International Fire Code based on the most severe facility fire risk on

site. These values may be reduced by a maximum of 50 percent when the facility is provided with automatic sprinkler protection throughout, in accordance with the applicable NFPA standards.

Automatic Sprinkler Systems

NFPA 13, *Standard for the Installation of Sprinkler Systems,* should be used to determine the occupancy classification for any facility. For facilities where there is a potential for a change in occupancy, light hazard occupancy sprinkler system design criteria should not be used.

Hydraulically designed sprinkler systems should be designed for a supply pressure of at least 10 percent but not less than 10 psi below the supply curve.

Fire Alarm Systems

Fire alarm systems should comply with NFPA 72, *National Fire Alarm Code,* and have the following basic features:

- Transmission of signals to the responding DOE facility fire department alarm center and other constantly attended locations in accordance with NFPA 72.
- Local alarms for the building or zone in alarm.
- Visual alarms for the hearing impaired, where there are high noise levels, or where there are special process requirements as determined by the DOE fire protection AHJ.
- The fire alarm control panel located near the main entrance or a protected location as determined by the AHJ. For buildings with multiple alarm zones, a zone alarm panel or a graphic zone alarm panel at the main entrance to the facility.
- Supervisory devices for all critical functions except those (such as sprinkler system control valves) that are locked or sealed.

b. Identify the applicable National Fire Protection Association (NFPA) code or standard.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*

This standard covers the design, installation, operation, testing, and maintenance of low-, medium-, and high-expansion foam systems for fire protection. It is not the intent of this standard to specify where foam protection is required.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*

This standard contains minimum requirements for carbon dioxide fire-extinguishing systems. This standard includes only the necessary essentials to make it workable in the hands of those skilled in this field.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*

This standard contains minimum requirements for total flooding Halon 1301 fire extinguishing systems. It includes only the essentials necessary to make the standard workable in the hands of those skilled in this field. Only those skilled in this work are competent to design, install, maintain, decommission, and remove this equipment. It might be necessary for many of those charged with purchasing, inspecting, testing, approving, operating, and maintaining this equipment to consult with an experienced and competent fire protection engineer to effectively discharge their respective duties.

NFPA 13, *Standard for the Installation of Sprinkler Systems*

This standard shall provide the minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems covered within this standard.

NFPA 14, *Standard for the Installation of Standpipes and Hose Systems*

This standard covers the minimum requirements for the installation of standpipes and hose systems. This standard does not cover requirements for periodic inspection, testing, and maintenance of these systems.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*

This standard provides the minimum requirements for the design, installation, and system acceptance testing of water spray fixed systems for fire protection service and the minimum requirements for the periodic testing and maintenance of ultra high-speed water spray fixed systems. Water spray fixed systems shall be specifically designed to provide for effective fire control, extinguishment, prevention, or exposure protection. This standard shall not apply to water spray protection from portable nozzles, sprinkler systems, monitor nozzles, water mist suppression systems, explosion suppression, or other means of application covered by other standards of NFPA.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*

This standard contains minimum requirements for the design, installation, and maintenance of foam-water sprinkler and spray systems. These systems shall be designed with the required density for either foam or water application as the controlling factor, depending on the design purpose of the system. It is not the intent of this standard to specify where foam-water sprinkler and spray protection is required. The determination of where foam-water sprinkler and spray systems are required shall be made in accordance with such applicable standards as NFPA 30, *Flammable and Combustible Liquids Code,* and NFPA 409, *Standard on Aircraft Hangars.* This standard shall apply only to systems using low-expansion foam.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*

This standard includes minimum requirements for dry chemical fire-extinguishing systems that discharge dry chemical from fixed nozzles or hand hose lines by means of expellant gas.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*

The provisions of this standard apply to the design, installation, operation, testing, and maintenance of pre-engineered wet chemical fire extinguishing systems that discharge wet chemical from fixed nozzles and piping by means of expellant gas. It contains only the essential requirements and recommendations needed to make the standard workable in the hands of those skilled in this field.

c. Identify some of the fundamental design principles of each system, including interface to other systems (e.g., HVAC, air, electrical power, process interlocks, etc.).

The following is taken from DOE G 420.1-3.

DOE does not specify the design expectations of fire protection systems relied on in safety analysis documentation, except for (1) seismic requirements on sprinkler systems set forth in section 7.3 of DOE-STD-1066-99, *Fire Protection Design Criteria* (2) general infrastructural (Mechanical/Electrical) requirements in chapter 5 of DOE G 420.1-1, *Nonreactor Nuclear Safety Design Criteria and Explosive Safety Criteria Guide for use with DOE O 420.1 Facility Safety;* and (3) chapter II, section 3c(12) of DOE O 420.1B, *Facility Safety,* which states: "Fire protection systems designed such that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of vital safety functions or inoperability of safety class systems as determined by the DSA."

The fire protection engineer will need to assess the overall adequacy of the system to mitigate the fire scenarios of concern. For a new system, this effort may be minimal, such as verifying that the design basis performance characteristics match those described in the safety basis documents. For an existing system, this effort may be more extensive. DOE O 420.1B, chapter I, section 3b (7) requires structures, systems, and components (SSCs) to be "…designed, commensurate with the importance of the safety functions performed, to perform their safety functions when called upon and to meet the quality assurance program requirements of either 10 CFR 830, subpart A, or DOE O 414.1C, *Quality Assurance,* as applicable."

Useful guidance to perform this design adequacy review has been provided by the Energy Facility Contractors Group (EFCOG). For example, hydraulic calculations, in lieu of scheduled design, may be needed to demonstrate that an installed sprinkler system can deliver the water discharge density required by NFPA 13 and otherwise meets the code's criteria for spacing and obstructions to water discharge. Where the existing system cannot be shown adequate to meet the requirements of the safety analysis, design upgrades may be needed or the system's reliability adjusted downward to reflect the less than optimum design.

d. Identify some of the basic inspection, test and maintenance requirements for typical systems.

The following is taken from NFPA 25.

Inspection

System components shall be inspected at intervals specified in the appropriate chapters of NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

Testing

All components and systems shall be tested to verify that they function as intended.

The frequency of tests shall be in accordance with NFPA 25.

As an alternative means of compliance, subject to the AHJ, components and systems shall be permitted to be inspected, tested, and maintained under a performance-based program.

Fire protection system components shall be restored to full operational condition following testing, including reinstallation of plugs and caps for auxiliary drains and test valves.

During testing and maintenance, water supplies, including fire pumps, shall remain in service unless under constant attendance by qualified personnel or impairment procedures in chapter 15 of NFPA 25 are followed.

Test results shall be compared with those of the original acceptance test and with the most recent test results.

When a major component or subsystem is rebuilt or replaced, the subsystem shall be tested in accordance with the original acceptance test required for that subsystem.

Maintenance

Maintenance shall be performed to keep the system equipment operable or to make repairs.

4. Fire protection engineers shall demonstrate an expert level knowledge of fire barriers and their related appurtenances.

a. Define a fire barrier and describe typical devices which provide protection for openings therein.

The following is taken from NFPA 221.

A fire barrier is a fire-resistant-rated vertical or horizontal assembly of materials designed to restrict the spread of fire in which openings are protected. They can also be employed in air transfer openings in walls and partitions.

Wall, floor and ceiling, and roof and ceiling assemblies should be tested and rated for their fire resistance by Underwriters Laboratories (UL) or similar nationally recognized testing laboratories, or should be listed for their fire resistance as approved by Factory Mutual (FM) or similar organizations.

The development of an FHA and DSA should include consideration of conditions that may exist during normal operations and special situations (e.g., during periods of decontamination, renovation, modification, repair, and maintenance). Where required by the FHA or DSA, the structural shell surrounding critical areas and their supporting members should remain standing and continue to act as a confinement structure during anticipated fire conditions, including failure of any fire suppression system not designed as a safety class item. Fire resistance of this shell should be attained by an integral part of the structure (concrete slabs, walls, beams, and columns) and not by composite assembly (membrane fireproofing). In no event should the fire resistance rating be less than 2 hours under conditions of failure of any fire suppression system not designed as a safety class item.

Special facilities should be designed and constructed using building components of fire-resistant and noncombustible material, particularly in locations vital to the functioning of confinement systems. Combustible materials should not be used in the construction of process system confinement barriers.

b. Identify the applicable NFPA standards that apply to fire barriers, fire doors and fire dampers.

International Building Code, chapter 7, *Fire Resistance Rated Construction*, applies to fire walls and partitions.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* applies to fire barriers, fire doors, and fire dampers.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, applies to fire doors.

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, applies to fire dampers.

c. Identify some of the basic inspection, test, and maintenance requirements for fire barriers, fire doors, and fire dampers.

The following is taken from NFPA 80.

Testing

- Upon completion of installation, all fire door and fire window assemblies shall be tested to confirm operation of the automatic closing device and full closure.
- Resetting of the automatic closing device shall be in accordance with the manufacturer's written instructions.
- A written record shall be maintained and shall be made available to the AHJ.

Maintenance

- Where it is necessary to replace fire doors, shutters, windows or their frames, glazing materials, hardware, and closing mechanisms, replacements shall meet the requirements for fire protection and shall be installed as required by this standard for new installations.
- Repairs shall be made, and defects that could interfere with operation shall be corrected without delay.
- In cases where a field modification to a fire door assembly is desired, the laboratory whose label is on the assembly shall be contacted and a description of the modifications shall be presented to the laboratory.
- If the laboratory finds that the modifications will not compromise the integrity and fire resistance capabilities of the assembly, the modifications shall be permitted to be authorized by the laboratory without a field visit from the laboratory.
- Self-closing devices shall be kept in working condition at all times.
- Swinging doors normally held in the open position and equipped with automatic-closing devices shall be operated at frequent intervals to ensure operation.

- All horizontal or vertical sliding and rolling fire doors shall be inspected and tested annually to check for operation and full closure.
- Resetting of the release mechanism shall be done in accordance with the manufacturer's instructions.
- A written record shall be maintained and shall be made available to the AHJ.
- When conducting the annual test for operation and full closure, rolling steel fire doors shall be drop tested twice.
- The first test shall be to check for operation and full closure.
- A second test shall be done to verify that the automatic-closing device has been reset.
- Fusible links or other heat-actuated devices and release devices shall not be painted.
- Paint shall be prevented from accumulating on any movable part.

Inspections

- Fire door assemblies shall be inspected and tested not less than annually, and a written record of the inspection shall be signed and kept for inspection by the AHJ.

Functional Testing

- Functional testing of fire door and window assemblies shall be performed by individuals with knowledge and understanding of the operating components of the type of door being subject to testing.
- Before testing, a visual inspection shall be performed to identify any damaged or missing parts that can create a hazard during testing or affect operation or resetting.

5. Fire protection engineers shall demonstrate an expert level knowledge of a fire water distribution system.

a. Describe the various components of a fire water distribution system.

The following is taken from DOE-STD-1066-99.

Domestic water distribution systems that also serve fire protection requirements should be designed to satisfy the calculated fire hydrant demand and the peak domestic demand. Where no other requirements are applicable, the peak domestic demand should be based on 2.5 times the calculated average daily demand plus any special demands, such as industrial or processes that cannot be reduced during a fire. The distribution system should be capable of meeting this combined demand at a minimum residual pressure of 20 psi at ground elevation (or higher elevation if special conditions apply) for a period of not less than 2 hours. Municipal supplies having the same capability are acceptable.

Where reliance is placed on fire department response, either for protection of unsprinklered buildings or where the fire department will serve as redundant (backup) protection, the water supply available from hydrants should be capable of providing the flow rates established in the International Fire Code based on the most severe facility fire risk on site. These values may be reduced by a maximum of 50% when the facility is provided with automatic sprinkler protection throughout, in accordance with the applicable NFPA Standards.

Within a building or facility, domestic water should be supplied by a separate service line and not be a combined fire protection and potable water service or a combined process water and potable water system. Where combined fire and domestic-process water systems are used, distribution piping should be routed and provided with valves such that the domestic and process systems can be isolated without shutting off the fire system supply.

Facilities having a MPFL in excess of $100 million and significant nuclear facilities (category 1 hazard) should be provided with an additional, independent source of fire protection water.

Whenever feasible, all water distribution systems should be of the looped grid type providing two-way flow with sectional valving arranged to provide alternate water flow paths to any point in the system. In addition, sectional control valves should be provided to limit the number of hydrants and individual sprinkler systems made inoperative during a single line break to a total of five. Dead end runs utilized as a single supply to fire hydrants should not exceed 300 feet.

Listed and/or approved control valves should be installed at maximum intervals of not more than 5,000 feet on long supply lines and at maximum intervals of not more than 1200 feet on main distribution loops, feeders, and all primary branches connected to these lines. Such control valves should also be installed at selected points throughout the distribution system to provide system control over each service area. At intersections of distribution mains, one less control valve than the total number of intersecting mains may be provided. As an aid in determining the minimum number of sectional control valves, the critical nature of the building/facility should be considered as well as the number of fire and domestic systems affected in a potential line failure.

Sprinkler system water supply lead-ins should not run under buildings except for the minimum distance possible. Sprinkler system risers and alarm valves should be located as close as practical to a building entry point. Where a riser would otherwise be located in a potentially contaminated area, consideration should be given to locating the riser exterior to the building in a heated enclosure.

Hydrants should be provided so that hose runs from hydrants to all exterior portions of a protected building are no more than 300 feet. Hydrants should not be closer to than 40 feet to buildings.

b. Identify the applicable NFPA standards that apply to a fire water distribution system.

NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances

This standard shall cover the minimum requirements for the installation of private fire service mains and their appurtenances supplying the following: (1) automatic sprinkler systems (2) Open sprinkler systems (3) Water spray fixed systems (4) Foam systems (5) Private hydrants (6) Monitor nozzles or standpipe systems with reference to water supplies (7) Hose houses. This standard shall apply to combined service mains used to carry water for fire service and other uses.

NFPA 22, Standard for Water Tanks for Private Fire Protection

This standard provides the minimum requirements for the design, construction, installation, and maintenance of tanks and accessory equipment that supply water for private fire protection, including the following: (1) Gravity tanks, suction tanks, pressure tanks, and embankment-supported coated fabric suction tanks (2) Towers (3) Foundations (4) Pipe connections and fittings (5) Valve enclosures (6) Tank filling (7) Protection against freezing.

NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection

This standard deals with the selection and installation of pumps supplying liquid for private fire protection. The scope of this document shall include liquid supplies; suction, discharge, and auxiliary equipment; power supplies, including power supply arrangements; electric drive and control; diesel engine drive and control; steam turbine drive and control; and acceptance tests and operation. This standard does not cover system liquid supply capacity and pressure requirements, nor does it cover requirements for periodic inspection, testing, and maintenance of fire pump systems. This standard does not cover the requirements for installation wiring of fire pump units.

c. Identify some of the more fundamental design principles associated with a fire water distribution system, including interface to other systems (e.g., electrical and supervisory controls, process interlocks, etc.).

The following is taken from DOE-STD-1066-99.

Electrical Equipment

In addition to the applicable requirements of the National Electrical Code, NFPA 70, transformer installations should comply with FM Data Sheet 5-4/14-8.

Where there is no "listed" equipment or materials of the type, special one-of-a-kind equipment can be accepted if the AHJ can verify that all components meet high quality control standards.

Installation methods should be in accordance with the manufacturer's instructions, NFPA 70, and other applicable requirements.

Where multi-tiered cable trays are installed in configurations that represent a significant fire hazard (as determined by the FHA), they should be provided with fire protection/suppression as determined by the AHJ.

Where required by the SAR, critical facilities should be served by dedicated, redundant electric circuits. The two services should be separated by 4-hour fire-rated construction and should be served from separate sources. In lieu of providing two separate services, a single service supplied from a loop-type transmission or distribution system having sectionalizing features may be provided when the reliability of the single service proves adequate when considered in conformance with IEEE 399, *Recommended Practice for Power Systems Analysis* and IEEE 493, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems*. Locations where fire can damage both normal and emergency power should be protected by redundant fire protection systems.

General Process Hazards

Compressed gas cylinders that represent a significant fire hazard (as determined by the FHA) should be isolated outside of facilities or housed in a special hazardous materials storage room, exhausted gas cabinets, or similar types of containment.

When a process uses or produces combustible gases or vapors, the design should include features such as inert gas purging, premixing the gas to a nonflammable mixture with inert gas, or increasing the air flow within process confinement barriers to provide the dilution required to maintain the concentration of gases or vapors below the lower limit for flammability.

Lightning protection systems should comply with NFPA 780, *Standard for the Installation of Lightning Protection Systems*. Such systems should be considered for buildings containing facilities for the use, processing, and storage of radioactive, explosive and similarly hazardous materials; for buildings over 50 feet in height; and for buildings containing valuable equipment. A risk assessment using the guide in appendix I of NFPA 780 should be made of these buildings to determine the risk of loss due to lightning.

Special Hazards

Hazards unique to DOE and not addressed by mandatory codes and standards should be protected by isolation, segregation or use of special control systems such as: inert gas, explosion suppression, etc., as determined by the FHA and the AHJ. In addition, devices for limiting or controlling the effects of a fire (relief valves, filters, blast walls, emergency shutdown systems, scuppers, etc.) should be provided.

Plutonium Processing and Handling Facilities (PPHF)

Only hazardous gases or liquids that are necessary for a process should be used in PPHFs. No natural gas for heating purposes should be used unless the heating occurs in a separate building that is clearly isolated from the primary facility. Other flammable, explosive, corrosive, or toxic gases or liquids that are necessary to the process should be handled under special control and isolated to avoid releases or reactions that might cause injury to workers, the public, or the environment. Those flammable gases that are necessary for a process should be provided by a hard-piped system with the gas supply located outside of the facility in cylinders rather than from large capacity sources so as to limit the total quantity available in the event of a fire or explosion.

Process furnaces should be provided with a system for automatically shutting off the gas and purging with inert gas in the event of power failure, loss of coolant water, loss of exhaust ventilation, over temperature, or detection of hydrogen in the vicinity of the furnace.

d. Identify some of the basic inspection, test and maintenance requirements for a fire water distribution system.

Refer to element d of competency 3 for information regarding inspection, test, and maintenance requirements.

e. Discuss the methodologies and considerations when calculating fire flow demands for sprinklered and nonsprinklered facilities.

The following is taken from ISO Properties, Guide for Determination of Needed Fire Flow.

To estimate the amount of water needed to fight a fire in an individual, nonsprinklered building, ISO uses the formula:

$$NFF = (Ci)(Oi)[(1.0+(X+P)i]$$

where
NFF_i= the needed fire flow in gallons per minute (gpm)
C_i = a factor related to the type of construction
O_i a factor related to the type of occupancy
X = a factor related to the exposure buildings
P = a factor related to the communication between buildings

To calculate the needed fire flow of a building, you will need to determine the predominant type (class) of construction, size (effective area) of the building, predominant type (class) of occupancy, exposure from the property, and the factor for communication to another building.

Here is a summary of the step-by-step process:

- Step 1. Determine the predominant construction type and the associated factor (F).
- Step 2. Determine the effective area (Ai).
- Step 3. Substitute the values for F and A into the formula C_i=18F(Ai)0.5 and calculate the construction factor (C_i).
- Step 4. Round off the construction factor (C_ii) to the nearest 250 gpm.
- Step 5. Determine the predominant occupancy type and the associated factor (O_i).
- Step 6. Determine if there is an exposure charge by identifying the construction type and length-height value of the exposure building as well as the distance (in feet) to the exposure building. Also make note of any openings and protection of those openings in the wall facing the subject building (the building the needed fire flow is being calculated on). The factor related to the exposure building is (X).
- Step 7. Determine if there is a communication charge by identifying the combustibility of the passageway, whether the passageway is open or closed, the length, and a description of any protection provided in the passageway openings. The factor related to the communications between buildings is (P).
- Step 8. Substitute the values for the factors in the formula $NFF_i = (C_i)(O_i)[1.0+(X+P)_i]$ to determine the needed fire flow.

Note: ISO does not determine a needed fire flow for buildings rated and coded by ISO as protected by an automatic sprinkler system meeting applicable National Fire Protection Association standards.

6. Fire protection engineers shall demonstrate an expert level knowledge of a fire alarm and signaling system.

a. Describe the various components of a fire alarm and signaling system.

The following is taken from DOE-STD-1066-99.

Fire alarm systems should comply with NFPA 72 and have the following basic features:

- Transmission of signals to the responding DOE facility fire department alarm center and other constantly attended locations in accordance with NFPA 72.
- Local alarms for the building or zone in alarm.
- Visual alarms for the hearing impaired, where there are high noise levels, or where there are special process requirements as determined by the DOE Fire Protection AHJ.
- The fire alarm control panel located near the main entrance or a protected location as determined by the AHJ. For buildings with multiple alarm zones, a zone alarm panel or a graphic zone alarm panel at the main entrance to the facility.
- Supervisory devices for all critical functions except those (such as sprinkler system control valves) that are locked or sealed.

Alarm Actuating Devices

Alarms that respond to flow of water should be provided within a facility for occupant notification wherever a sprinkler system is installed.

A manual fire notification method, such as telephone, alarm, radio, or manual fire alarm boxes, should be provided at all facilities.

Alarm System Extensions

Extensions to existing fire alarm systems and all new systems in existing buildings or facilities should be compatible with existing fire alarm equipment at the location, including keys/locks, similarity of alarm signals and equipment as well as user operated devices, training requirements, and maintenance procedures.

b. Identify the applicable NFPA code that applies to a fire alarm and signaling system as well as other standards that are applied in conjunction with it.

The applicable NFPA code is NFPA 72, *National Fire Alarm Code* and NFPA 1, *International Fire Code*.

c. Identify some of the fundamental design principles associated with a fire alarm and signaling system, including interface to other systems (e.g., HVAC, air, electrical power, process interlocks, etc.).

The following is taken from DOE Order 6430.1A.

Fire alarm systems shall have the following basic features:

- Transmission of signals to the DOE facility fire department alarm center and other constantly attended locations in accordance with the appropriate NFPA Signaling Systems Standard

- Local alarms for the building or zone in alarm
- Trouble signals as required by the appropriate NFPA Signaling Systems Standard
- Emergency battery backup for system operation
- Electric supervision of all circuits as required by the appropriate NFPA standard
- Supervisory devices for all critical functions (vale position switches, water level, temperature)
- Capability of annunciating at least three separate conditions: 1) a fire alarm, 2) a supervisory alarm, and 3) a trouble signal indicating a fault in either of the first two. Annunciation of each condition shall be separate and distinct from the other two.

Fire alarm systems for new DOE buildings shall be compatible with those for the DOE complex where the new building is to be located.

Alarm Actuating Devices

Alarms that respond to flow of water shall be provided wherever a sprinkler system is installed and shall comply with requirements of the NFPA standard for the type of signaling system used.

A manual fire notification method such as manual fire alarm boxes shall be provided and located in accordance with the appropriate NFPA standard

Combined watch reporting and fire alarm systems, if used, shall be in accordance with the appropriate NFPA standard

d. Identify some of the basic inspection, test and maintenance requirements for a fire alarm and signaling system.

The following is taken from Firewatch, The Importance of Proper Inspection and Maintenance of the Fire Alarm System.

Inspection of the System

Prior to any actual testing being conducted on the fire alarm system, a thorough inspection must be done. This may be done by visually looking for problems that should be fairly obvious, such as missing or damaged devices, improper device locations and the use of non-rated components, and any deficiencies found should be documented. Any original drawings of the system should be reviewed in order to ascertain where all of the equipment is located. Other documentation, such as specifications and any operational manuals should also be located so that a comprehensive analysis of the system may be made before any actual testing is conducted.

A recent trend in documentation, which is becoming increasingly popular with AHJ is the use of test and inspection software. This typically provides for less paperwork to sort through afterwards, and also allows the testing company to keep a database of their own records that is easily accessed in order to provide verification of a service performed for a customer.

Several software programs also feature signature capture capability, so there is even further proof of testing and inspection of the fire alarm system, which many AHJs prefer over a handwritten paper form.

System Testing

Prior to any test of a building's fire alarm system, all occupants should be notified, in accordance with NFPA 72 section 10.2.3.1. This ensures that everyone is aware of what is going on and the testing can be conducted that much more efficiently. Typically, a two–man team performs testing of a system, with one technician remaining at the panel to report what device or zone is activated. This allows for greater accuracy. Although with smaller systems, one technician may be sufficient.

While most system manufacturers recommend an annual test and inspection (after the initial acceptance test), other agencies and local authorities both recommend and even mandate testing intervals. NFPA 72, chapter 10, which specifically deals with inspection, testing, and maintenance, includes a table that provides the recommended testing intervals for the various components encompassing a fire alarm system, including, but not limited to, batteries, generators, initiating devices and interface equipment. Section 10.4.3 provides frequency requirements for periodic testing of all fire alarm system components. Frequency of testing varies depending on the system component; however records must be kept to ensure that testing was done within the required frequency.

Among the first components to be tested are usually the initiating devices and alarm sensors, such as smoke detectors and heat detectors. These should be tested in accordance with the manufacturer's requirements. When testing smoke detectors, it is imperative to perform a functional test to ensure that there is actual smoke entry into the sensing chamber. It is certainly not enough to perform a "magnet test," or an electrical stimulation of the detector. The synthetic aerosol smoke that is used should be approved by the manufacturer as well as listed with an accepted approval house. Ideally this smoke should also be of a non-flammable formulation due to concern over the possibility that certain operations/electronics within the detector and its base could cause ignition of a flammable aerosol test product. Additionally, care should be taken to avoid spraying directly into the sensing chamber, which can be a cause for detector malfunction later on.

Heat detectors should be tested according to NFPA 72, section 10.4.3.4.1 (if of the restorative type) with at least 2 per circuit being tested annually, with all heat detectors being tested at least once per five years. Nonrestorable heat detectors are never tested in the field; however a representative sample must be tested and replaced after fifteen (15) years. Whenever heat detectors are tested one should utilize an instrument that produces heat safely (not using a live flame or otherwise).

When a sensitivity test is required of a smoke detector there are several portable test devices that are available and approved by the major detector manufacturers. Detector sensitivity can and does drift. Over-sensitivity leads to false alarms, while under-sensitivity leads to late alarms or no alarms at all.

One often neglected area of system testing and inspection is duct detectors. Duct smoke detectors require tests to ensure smoke entry into the sensing chamber in the device. Often, these types of detectors are equipped with test switches that test the circuitry of the device, but this should not be accepted as a true functional, smoke-entry test.

Additionally, after all system inputs and annunciators are tested, the testing activities themselves must be coordinated with the system monitoring company or fire department in order to ensure proper communication between the building's fire alarm system and the monitoring company. Upon completion of the testing, the fire alarm system must be immediately restored, and building maintenance and supervisory personnel notified.

Maintenance and Documentation

Upon completion of system testing, there are often deficiencies that are found. While these must be corrected immediately, if possible, sometimes this cannot be done right away. However, it is incumbent on the building owner to ensure that the system is fully operational within a reasonable period of time. Most preventative maintenance is often easy to perform. Depending on the environment in which the equipment operates, it can consist of simply blowing the smoke detectors out with compressed air to more frequent and intensive cleanings based upon location. In the end however, the technician should always follow the manufacturer's recommendations in order to be completely sure that proper maintenance is being performed.

Upon completion of system testing and maintenance, the servicing organization must complete figure 10.6.2.3 of NFPA 72 and leave it on site with the building owner or his duly authorized representative. The AHJ may request a copy of all test, inspection and maintenance forms at any time. It is therefore imperative that the required documentation be kept available at all times. In addition, the owner must retain records of inspection, testing and maintenance for the life of the system.

7. Fire protection engineers shall demonstrate an expert level knowledge of the life safety concepts.

a. Describe the basic elements of a means of egress.

The following is taken from NFPA 101.

Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with section 8.3 of NFPA 101, unless otherwise permitted by the following:

- This requirement shall not apply to existing building, provided that the occupancy classification does not change.
- This requirement shall not apply where otherwise provided in chapter 12 through chapter 42 of NFPA 101.

Where NFPA 101 requires an exit to be separated from other parts of the building, the separating construction shall meet the requirements of section 8.2 of NFPA 101 and the following:

- The separation shall have not less than a 1-hour fire resistance rating where the exit connects three stories or less.
- The separation shall have not less than a 2-hour fire resistance rating where the exit connects four or more stories, unless one of the following conditions exists:

- In existing non-high-rise buildings, existing exit stair enclosures shall have not less than a 1-hour fire resistance rating.
- In existing buildings protected throughout by an approved, supervised automatic sprinkler system, existing exit stair enclosures shall have not less than a 1-hour fire resistance rating.
- One-hour enclosures in accordance with sections 28.2.2.2.1.2, 29.2.2.1.2, 30.2.2.1.2, and 31.2.2.1.2 of NFPA 101 shall be permitted as an alternative to section 7.1.2.2.1(2) of NFPA 101.

- The 2-hour fire resistance-rated separation shall be constructed of an assembly of non-combustible or limited-combustible materials and shall be supported by construction having not less than a 2-hour fire resistance rating. In Type III, Type IV, and Type V construction, fire-retardant-treated wood enclosed in noncombustible or limited-combustible materials shall be permitted.
- Openings in the separation shall be protected by fire door assemblies equipped with door closers.
- Openings in exit enclosures shall be limited to doors from normally occupied spaces and corridors and doors for egress from the enclosure, unless one of the following conditions exists:
  - Openings in exit passageways in mall buildings
  - In buildings of Type I or Type II construction, existing fire protection-rated doors to interstitial spaces shall be permitted, provided that such spaces meet all of the following criteria:
    - The space is used solely for distribution of pipes, ducts, and conduits.
    - The space contains no storage.
    - The space is separated from the exit enclosure.

  - Existing openings to mechanical equipment spaces protected by approved existing fire protection-rated doors shall be permitted, provided that the following criteria are met:
    - The space is used solely for non-fuel-fired mechanical equipment.
    - The space contains no storage of combustible materials.
    - The building is protected throughout by an approved, supervised automatic sprinkler system.

- Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:
  - Doors permitted by section 7.1.3.2.1(5) of NFPA 101
  - Electrical conduit serving the stairway
  - Required exit doors
  - Ductwork and equipment necessary for independent stair pressurization
  - Water or steam piping necessary for the heating or cooling of the exit enclosure
  - Sprinkler piping
  - Standpipes
  - Existing penetrations that are protected
  - Penetrations for fire alarm circuits, where the circuits are installed in metal conduit and the penetrations are protected

- Penetrations or communicating openings shall be prohibited between adjacent exit enclosures.

b. Describe how occupancy considerations influence emergency egress requirements.

The following is taken from NFPA 101.

The total capacity of the means of egress for any story, balcony, tier, or other occupied space shall be sufficient for the occupant load thereof.

The occupant load in any building or portion thereof shall be not less than the number of persons determined by dividing the floor area assigned to that use by the occupant load factor for that use. Where gross and net area figures are given for the same occupancy, calculations shall be made by applying the gross area figure to the gross area of the portion of the building devoted to the use for which the gross area figure is specified and by applying the net area figure to the net area of the portion of the building devoted to the use for which the net area figure is specified.

The occupant load in any building or portion thereof shall be permitted to be increased from the occupant load established for the given use.

The AHJ shall be permitted to require an approved aisle, seating, or fixed equipment diagram to substantiate any increase in occupant load and shall be permitted to require that such a diagram be posted in an approved location.

Where an exit serves more than one story, only the occupant load of each story considered individually shall be used in computing the required capacity of the exit at that story, provided that the required egress capacity of the exit is not decreased in the direction of egress travel.

Where means of egress from the story above and the story below converge at an intermediate story, the capacity of the means of egress from the point of convergence shall be not less than the cum of the capacity of the two means of egress.

c. Describe several emergency egress issues on site and how they have been resolved.

This is a site-specific KSA. The local Qualifying Official will evaluate its completion.

d. Define the "equivalency concept" and the "exemption process" as delineated in NFPA 101 and DOE directives.

The following is taken from DOE G 420.1-3.

Equivalency Concept

An equivalent method of protection provides an equal or greater level of safety. It is not a waiver or deletion of the code requirements.

The prescriptive provisions of NFPA 101 provide specific requirements for broad classifications of buildings and structures. These requirements are stated in terms of fixed values, such as maximum travel distance, minimum fire resistance ratings, and minimum features of required systems, such as detection, alarm, suppression, and ventilation, and not in terms of overall building or system performance.

However, the equivalency clause permits the use of alternative systems, methods, or devices to meet the intent of the prescribed code provisions where approved as being equivalent. Equivalency provides an opportunity for a performance-based design approach. Through the rigor of a performance-based design, it can be demonstrated whether or not a building design is satisfactory and complies with the implicit or explicit intent of the applicable code requirement.

When employing the equivalency clause, it is important to clearly identify the prescriptive-based code provision being addressed, to provide an interpretation of the intent of the provision, to provide an alternative approach, and to provide appropriate support for the suggested alternative.

Performance resulting from proposed designs can be compared to the performance of the design features required by NFPA 101. Using prescribed features as a baseline for comparison, it can then be demonstrated in the evaluation whether a proposed design offers the intended level of performance. A comparison of safety provided can be used as the basis for establishing equivalency.

Exemption Process

The DOE directives system and the requirements of 10 CFR 851, "Worker Safety and Health Program," impose a range of explicit direction in the development, review, and approval of exemptions, variances and equivalencies as delineated below. Contractors are advised to consult with the AHJ before proceeding with a request for relief. One goal is to avoid unnecessary duplication of effort and the generation of unnecessary paperwork.

DOE M 251.1-1B, *Departmental Directives Program Manual,* states: "If the Order, Notice, or Manual includes specific provisions for exemptions, equivalencies, or other forms of relief from the requirements in the document, then those provisions must be applied. If the document does not include specific provisions for relief, the process in DOE M 251.1-1B applies to granting permanent or temporary relief from the applicable requirements in those documents."

With respect to exemptions to the provisions of DOE O 420.1B, paragraph 6a of that Order states: "Exemptions to DOE O 420.1B must follow the process defined for exemptions in DOE M 251.1-1B, except for the approval authority defined in the responsibilities paragraphs of this Order."

DOE O 420.1B assigns the authority to grant exemptions to the provisions of DOE O 420.1B to the Secretarial Officer, unless delegated. Furthermore, a granted exemption to DOE O 420.1B is not considered an exemption from all other DOE directives or statutory requirements, such as 10 CFR 851 that may be affected by such relief. Please refer to the

DOE directive or statutory requirements for information on exemption processing of the affected document.

With respect to requests for relief from NFPA code provisions, paragraph 6b of DOE O 420.1B states: "Exemptions, exclusions, and equivalencies to standards or other documents referenced in this Order should follow the provisions explicitly set forth in those documents; for example: the equivalency, alternative, and modification provisions in the NFPA code."

Paragraph 5d (10) of DOE O 420.1B assigns the AHJ responsibility, and therefore the authority to approve equivalency decisions in accordance with those provisions, to the head of field elements with a notation to ensure that fire protection SME comments are addressed.

The process for requesting and approving variances from the provisions of 10 CFR 851 is delineated in the rule and in supplemental guidance promulgated by DOE.

Most codes and standards of the NFPA are silent on exemptions to their requirements but allow for an equivalent or alternate means of achieving compliance with the code or standard. Where no equivalent or alternate means for achieving compliance is provided, noncompliance to an applicable NFPA code or standard should be processed as an exemption to DOE O 420.1B. The exemption process should be in accordance with DOE O 420.1B exemption provisions and those in DOE M 251.1-1B, which DOE O 420.1B references.

Documented requests for relief should be developed by a qualified fire protection engineer or certified fire department officer and submitted through the AHJ to the appropriate reviewing authority. Documented approvals should be kept on file in an auditable form. Multiple conditions that can be resolved on the basis of such relief can be grouped by individual code or standard, provided that the specific conditions are explicitly identified.

The level of documentation necessary to support a request for relief will vary depending on the issue. As a minimum, each request should identify the specific site location or condition at issue and the paragraph/section of the code or standard which addresses the issue; discuss why the requirements of the code or standard that cannot or should not be met; and justify the conclusion that the alternate configuration is acceptable from a safety, environmental, property damage, or program continuity perspective to what is stipulated in the code or standard. All functions should also be addressed. For example, an automatic sprinkler system provides detection, local alarms, fire department notification, and fire suppression. The description of alternatives in an equivalency should address each of these functions. Additionally, relief under one source document is not considered relief from another. All codes and standards with similar requirements should be identified and any differences addressed accordingly. For example, sprinklers may be required for life safety by NFPA 101 and for nuclear safety by NFPA 801.

When a positive determination is made in support of relief, then documentation should include signatures of all those involved in the decision, including that of the cognizant DOE fire protection engineer.

A change in use or occupancy will require the re-evaluation and approval of all documented requests for relief within the structure to assure that these are valid under the building's new use or occupancy.

Regarding FHAs, all approved variances and exemptions to DOE directives and/or equivalencies should be provided or referenced within the FHA document itself along with all supporting information. Documentation related to approved relief should be reviewed during the FHA update to verify that conditions have not changed and the justifications are still valid.

Additionally, such considerations may have other conditions for review according to a specified schedule, which should also be documented in the FHA. If there is no FHA for the facility, appropriate reviews and documentation should be consolidated and maintained with the fire protection staff for review by the AHJ or representative.

Regarding BNAs, those responsible for managing site fire protection emergency service programs may decide to request relief from the provisions of NFPA and similar industry standards, provided that the NFPA or industry standards allows the use of an alternative approach and the proposed alternative achieves an equivalent level of safety. Appropriate documentation that justifies the alternative should be submitted to the AHJ for review and approval prior to the implementation of the alternative.

e. Identify how life safety concepts integrate with concepts of other safety and security disciplines.

This element is covered in competency 2, element e.

8. Fire protection engineers shall demonstrate an expert level knowledge of a fire department/brigade operations and the "baseline needs assessment."

a. Describe the intent of a "baseline needs assessment."

The following is taken from DOE G 420.1-3.

A baseline needs assessment is required for each site that maintains a staffed fire department or fire brigade. A BNA or an evaluation in documented form of comparable scope is to be developed by contractors at sites where emergency response is achieved by a capability other than a site fire department or brigade. The intent is to define, for all sites, the minimum capability to achieve a timely and effective response to fires and related events.

The BNA should be based on conformance with applicable NFPA standards, promulgated by the NFPA, as well as supplementary requirements and guidance developed by DOE. It should include organizational responsibilities, collateral duties, facility hazards, response time requirements, personnel levels, and required apparatus and equipment. In addition, the document should describe the organization's various programs that support its personnel. This should include training, physical fitness, and medical programs relating to emergency responders.

b. Describe the fundamental responsibilities of a DOE fire department or brigade.

According to DOE G 420.1B-0/440.1/E-0, responsibilities of DOE firefighting forces include the following:

- Fire suppression
- HAZMAT response (where assigned)
- Training
- Search and rescue
- Inspection, testing and maintenance (where applicable)
- Emergency medical services (where assigned)
- Confined space entry
- Offsite assistance

c. Describe the activities that are typically performed by a fire department/brigade at the scene of a fire or other emergency.

The following is taken from NFPA 600.

The degree of potential exposure to a hazardous environment and the degree of training determine the limits of any fire brigade action. Written standard operating procedures at each site define these limits.

At facilities where fire brigade members are intended to function as the first responders to incipient fires, the fire brigade assumes command of the incident once the brigade arrives on the scene.

The degree of potential exposure to a hazardous environment and the degree of training shall determine the limits of any industrial fire brigade action and responsibility.

The written industrial fire brigade organizational statement and standard operating procedures shall define these limits.

Interior structure fires are considered appropriate for offensive action in the hot zone by fire brigade members who have been assigned advanced exterior firefighting response duties when the following occurs:

- The organizational statement lists it as a response duty of the fire brigade, and it is covered by the standard operating procedures at that site.
- The fire brigade has received training for that activity.
- SCBA and thermal protective clothing are not required.
- The fire brigade is able to perform defensive action effectively, using hand lines flowing up to 1,140 L/min, master streams, or similar devices for the manual application of specialized agents.

Exterior fires and interior structural fires are appropriate for offensive action in the hot zone for fire brigade members who have been assigned advanced exterior and interior firefighting response duties when the following occurs:

- The organizational statement lists it as a response duty of the fire brigade, and it is covered by the standard operating procedures at that site.
- The fire brigade has received training for that activity.

- SCBA and thermal protective clothing are not required.
- The fire brigade is able to perform defensive action effectively, using hand lines flowing up to 1,140 L/min, master streams, or similar devices for the manual application of specialized agents.

d. Identify some of the NFPA standards that are applicable to a DOE fire department/brigade.

As of this writing, current NFPA standards that are applicable to a DOE fire department or brigade include the following:

- NFPA 13E, *Recommended Practice for Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems*
- NFPA 1201, *Standard for Providing Emergency Services to the Public*
- NFPA 600, *Standard on Industrial Fire Brigades*
- NFPA 1081: *Standard for Industrial Fire Brigade Member Professional Qualifications*
- NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*
- NFPA 1710: *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*

e. Describe the integration of emergency service providers with other site emergency management in the Incident Command or Unified Command structure.

The following is taken from DOE G 151.1-4.

An incident command (IC) should be designated to manage and control all response activity at the event scene. The IC typically coordinates the activities of multiple response elements at the scene (e.g., fire, rescue, medical, spill containment, mutual aid) and makes on-the-spot decisions. The IC will utilize the incident command systems (ICS) to manage response operations at the event scene, in accordance with the National Response Plan (NRP) and the National Incident Management System (NIMS)/ICS. The NIMS/ICS is ideally tailored to deal with command, control, and coordination issues in advance. Some of these issues are command on-scene, transfer of command, authority to request offsite mutual aid, authority to declare the situation under control, integration of field response functions, and assignment of response activities. The facility/site ICS should be compatible and integrated with offsite agency ICS systems. This is important to the inter-relationship of the site emergency response organization (ERO) and offsite agencies when utilizing the NIMS/ICS structure.

When an incident involves more than one agency with incident jurisdiction or when incidents crossover political jurisdictions, an application of the ICS, known as unified command (UC), should be used. UC provides guidelines to enable agencies with different legal, geographic, and functional responsibilities to coordinate, plan, and interact effectively. Agencies work as a team to establish a common set of objectives and strategies, as well as a single incident action plan.

An area command is established to oversee management of multiple incidents that are each being handled by a separate ICS organization or to oversee the management of a very large

or complex incident that engages multiple incident management teams. Area command is generally used when there are a number of incidents in the same area and of the same type, which tend to compete for the same resources, such as public health emergencies. If the incidents under the authority of the area command span multiple jurisdictions, a unified area command should be established.

f. Discuss the principles and methodologies of fire investigation utilizing NFPA 921, Guide for Fire and Explosion Investigations.

A fire or explosion investigation is a complex endeavor involving skill, technology, knowledge, and science. The compilation of factual data and an analysis of those facts should be accomplished objectively and truthfully. The basic methodology of the fire investigation should rely on the use of a systematic approach and attention to all relevant details. The use of a systematic approach often will uncover new factual data for analysis that may require previous conclusions to be reevaluated. With few exceptions, the proper methodology for a fire or explosive investigation is to first determine and establish the origin, then investigate the cause, circumstances, conditions, or agencies that brought the ignition source, fuel, and oxidant together. Additional information related to basic methodology is available in chapter 4 of NFPA 921, *Guide for Fire and Explosion Investigations.*

9. Fire protection engineers shall demonstrate an expert level knowledge of the essential elements of a documented fire safety program.

a. Explain the importance of a comprehensive fire safety program.

The following is taken from DOE O 420.1B.

A fire safety program for DOE sites, facilities, and emergency service organizations is important to minimize the potential for

- occurrence of a fire or related event;
- fires that cause an unacceptable onsite or offsite release of hazardous or radiological material that could impact the health and safety of employees, the public, or the environment;
- unacceptable interruption of vital DOE programs as a result of fire and related hazards;
- property loss from fire exceeding limits established by DOE; and
- fire damage to critical process controls and safety class systems structures and components (as documented by appropriate safety analysis).

b. List some of the policies, practices and procedures that are encompassed by a fire protection program.

The following is taken from DOE O 420.1B.

Acceptable, documented fire protection programs must be developed, implemented, and maintained and must include the following elements and requirements:

- A policy statement that
  - incorporates fire protection requirements from DOE O 420.1B; related DOE directives; and other applicable Federal, state, and local requirements; and
  - affirms DOE's commitment to fire protection and fire suppression capabilities sufficient to minimize losses from fire and related hazards consistent with highly protected risk status in private industry.

- Comprehensive, written fire protection criteria or procedures that include
  - site-specific requirements;
  - staff organization, training, and responsibilities;
  - administrative responsibilities;
  - design, installation, operability, inspection, maintenance, and testing requirements;
  - use and storage of combustible, flammable, radioactive, and hazardous materials to minimize risk from fire;
  - fire protection system impairments;
  - smoking and hot work;
  - safe operation of process equipment; and
  - prevention measures that decrease fire risk.

- A system to ensure that fire protection program requirements are documented and incorporated in plans and specifications for new facilities and significant modifications to existing facilities.
- Documented review of plans, specifications, procedures, and acceptance tests by a qualified fire protection engineer.
- FHAs using a graded approach conducted for hazard category 1, 2 and 3 nuclear facilities, significant new facilities, and facilities that represent unique fire safety risks. The FHAs must be
  - performed under the direction of a qualified fire protection engineer;
  - reviewed every 3 years; and
  - revised when
    - changes to the annual DSA updates impact the contents in the FHA,
    - a modification to an associated facility or process adds a significant new fire safety risk, or
    - the 3-year review identifies the need for changes.

- FHA conclusions incorporated into the DSA and integrated into design basis and beyond design basis accident conditions.
- Access to qualified, trained fire protection staff that includes fire protection engineers, technicians, and firefighting personnel to implement the requirements of DOE O 420.1B.
- A BNA of the fire protection emergency response organization that
  - establishes the site firefighting capabilities to provide
    - effective response to suppress all fires;
    - emergency medical and hazardous materials response capabilities; and
    - staffing, apparatus, facilities, equipment, training, pre-plans, offsite assistance, and procedures;

- reflects applicable NFPA codes and standards; and
- is updated at least every 3 years and in accordance with applicable NFPA code provisions and whenever a significant new hazard is introduced that is not covered by the current BNA.

- Site emergency plans, FHAs, and DSAs that incorporate BNA information.
- Pre-fire strategies, plans, and standard operating procedures to enhance the effectiveness of site firefighting personnel.
- Procedures governing the use of firefighting water or other neutron moderating materials to suppress fire within or adjacent to moderation controlled areas.
- Where no alternative exists to criticality safety restrictions on the use of water for fire suppression, the need for such restrictions is fully documented with written technical justification.
- A documented comprehensive fire protection self assessment and an assessment of contractors' programs performed by DOE every 3 years.
- Processes to identify, prioritize, and monitor the status of fire protection assessment findings, recommendations, and corrective actions until final resolution.
- A process for reviewing and recommending approval of fire safety equivalencies to any fire protection code or standard requirements to the DOE organization AHJ for fire safety.
- Procedures governing firefighting techniques to be used during deactivation, decontamination, and demolition phases, when applicable.

10. Fire protection engineers shall demonstrate at the expert level the ability to conduct fire protection and emergency services assessments, develop corrective actions and recommendations, communicate assessment results verbally and in writing, and develop supporting results.

a. Describe the purpose of a comprehensive compliance-based and performance-based fire safety assessment.

According to DOE G 414.1-2A, compliance-based assessments focus on verification of adherence to established requirements. Performance-based assessments are conducted on activities and processes that relate directly to performance expectations and emphasize safety and reliability.

<u>Mandatory Performance Activities</u>:

a. Lead a program assessment of a site fire protection program.

This is a performance-based KSA. The Qualifying Official will evaluate the completion of this competency. The following information, extracted from DOE G 420.1-3, may be helpful.

The principal objective of a fire safety assessment is to identify deficiencies that would prevent the achievement of DOE's fire safety policy objectives.

Facility and programmatic assessments should be performed under the supervision of a qualified fire protection engineer as defined by DOE. Personnel conducting such assessments

should have an appropriate level of knowledge and experience in the application of fire safety codes and standards to diverse facilities. Assessments should, as a minimum, encompass the following elements of the fire protection program:

- Program related (performed by both DOE and contractors)
  - Comprehensiveness of the fire protection program
  - Procedures for engineering design and review
  - Procedures for maintenance, testing, and inspection of installed fire protection systems and features
  - Fire protection engineering staff (number, qualifications, training)
  - Emergency services organizations including the BNAs
  - Management support
  - Exemptions and documented equivalencies or deviations

- Facility related (principally, but not exclusively, contractor self-assessments and DOE operational readiness reviews)
  - Fire protection of safety class and safety significant equipment
  - Life safety considerations
  - Fire protection of vital programs
  - Fire protection of high-value property
    - Fire suppression equipment
    - Water runoff
    - Facility fire prevention planning documents (evacuation plan/fire wardens extinguisher training)
    - Fire apparatus accessibility
    - Completeness of fire hazards analyses
    - Fire barrier integrity
    - Completeness of fire loss potential (MPFL) determinations
    - Fire safety training
    - Potential for toxic, biological and /or radiological incident due to fire

- Combined Aspects (program and facility)
  - Conformance with applicable Orders, codes, and standards
  - Inspection, testing, and maintenance reports
  - Adequacy of facility appraisal reports
  - Tests, inspections, procedures, and records for maintaining fire protection systems and features
  - Administrative controls
  - Temporary protection and compensatory measures

The frequency of assessments should be as follows:

- Annual fire protection assessments should be made of facilities valued in excess of $100 million, facilities considered a high hazard, or those in which vital programs are involved as defined by DOE.
- Remaining facilities should be assessed at least every three years or at frequencies determined by the AHJ. (Note: Low and ordinary hazard facility assessments in adjacent areas may be combined.)

- Comprehensive assessments of fire protection program elements by DOE and by contractors should be made every three years. (These should be staggered in anticipation of contractor-initiated enhancements.)

Assessment reports should include a description of what was accomplished during the effort (areas toured, documents reviewed, and people interviewed). It should feature a baseline description of the facility, hazards and other occupancy considerations, and fire protection features. Additionally, the report should document changes of significance that have occurred within the facility since the last assessment that affect fire safety, and it should list all noted deficiencies, along with a recommendation for remediation and interim compensatory measures, if necessary, pending resolution.

DOE self-assessments and assessments of contractors are intended to confirm that comprehensive fire protection programs are in place site-wide. They should include a select review of facility and site fire protection features, fire safety policies and procedures, the qualifications of contractor fire safety professionals, the adequacy of self-assessments, fire hazards analyses, and program performance as detailed in DOE G 420.1-3 and other DOE Orders/ Manuals such as DOE O 226.1, *Implementation of DOE Oversight Policy*, and table F-2 (Program Performance Measures) of DOE M 231.1-1A, *Environment, Safety and Health Reporting Manual*.

Additionally, it is expected that DOE assessments include the capabilities to respond in a timely and effective manner to site fire emergencies and related events. This assessment responsibility extends to contractors where there is no site fire department or brigade and where effective emergency response is predicated on other resources, such as occupant emergency organizations and offsite fire departments. In other words, the heads of field elements should determine the adequacy of the emergency response capability at all of the sites for which they have responsibility.

b. Conduct a comprehensive compliance-based and performance-based fire safety assessment.

This is a performance-based KSA. The Qualifying Official will evaluate its completion. Helpful information is available in element b of this competency.

c. Formally document a comprehensive assessment report and orally communicate the results of the assessment to DOE and contractor management.

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

11. Engineers (including fire protection engineers and safety system oversight personnel) who are assigned safety system oversight for specific fire protection system(s) shall demonstrate a working level knowledge of the system(s) they have assigned oversight responsibility.

a. Discuss and characterize the role of fire protection systems within the content of technical safety basis documentation (e.g., documented safety analysis, technical safety requirements, safety evaluation report, and fire hazard analysis).

The following is taken from DOE G 423.1-1.

Fire poses the most significant risk in some DOE facilities. For those facilities, certain key fire protection limiting conditions for operation (LCOs) will need to be developed as dictated by the DSA accident analysis and the FHA required by DOE O 420.1B, or successor document. The technical safety requirement (TSR) document may need to include a reference to general safety controls provided by the fire protection program but it also needs to identify specific controls (usually LCOs) for any fire protection equipment that has been identified in the DSA as performing a safety function. Similarly, the heating, ventilating, and air-conditioning systems and their filters may require TSRs for those elements of the system that have been identified with a safety function in the DSA. The natural phenomena hazard (NPH) assessment required by DOE O 420.1B may also result in controls (mainly related to NPH detection and warning devices) that should be incorporated into the TSR document.

b. Describe the various components of the fire protection systems, including the necessary support systems (e.g., water supply, fire alarm, electrical supply, etc.).

The following is taken from DOE-STD-1066-99.

Domestic water distribution systems that also serve fire protection requirements should be designed to satisfy the calculated fire hydrant demand and the peak domestic demand. Where no other requirements are applicable, the peak domestic demand should be based on 2.5 times the calculated average daily demand plus any special demands, such as industrial or processes that cannot be reduced during a fire. The distribution system should be capable of meeting this combined demand at a minimum residual pressure equal to the sprinkler system demand at ground elevation (or higher elevation if special conditions apply) for a period of not less than 2 hours. Municipal supplies having the same capability are acceptable.

Fire Hydrant Demand—Where reliance is placed on fire department response, either for protection of buildings without sprinkler systems or where the fire department will serve as redundant protection, the water supply available from hydrants should be capable of providing the flow rates established in NFPA 1 based on the most severe facility fire risk on site.

Within a building or facility, domestic water should be supplied by a separate service line and not be a combined fire protection and potable water service or a combined process water and potable water system. Where combined fire and domestic-process water systems are used, distribution piping should be routed and provided with valves such that the domestic and process systems can be isolated without shutting off the fire system supply.

Facilities having a MPFL in excess of $100 million and significant nuclear facilities should be provided with an additional, independent source of fire protection water.

Whenever feasible, all water distribution systems should be of the looped grid-type providing two-way flow with sectional valving arranged to provide alternate water flow paths to any point in the system. In addition, sectional control valves should be provided to limit the number of hydrants and individual sprinkler systems made inoperative during a single line break to a total of five.

Sprinkler system water supply lead-ins should not run under buildings except for the minimum distance possible. Sprinkler system risers and alarm valves should be located as close as practical to a building entry point.

Hydrants should be provided so that hose runs from hydrants to all exterior portions of a protected building are no more than 300 feet. Hydrants should not be closer to than 40 feet to buildings.

Fire alarm systems should comply with NFPA 72 and have the following basic features:

- Transmission of signals to the responding DOE facility fire department alarm center and other constantly attended locations in accordance with NFPA 72.
- Local alarms for the building or zone in alarm.
- Visual alarms for the hearing impaired, where there are high noise levels, or where there are special process requirements as determined by the DOE Fire Protection AHJ.
- The fire alarm control panel located near the main entrance or a protected location as determined by the AHJ.
- Supervisory devices for all critical functions (such as sprinkler system control valves).

c. Identify some of the more fundamental design principles associated with a fire water distribution system.

The following is taken from NFPA 1.

The minimum fire flow and flow duration for buildings other than one-and two-family dwellings shall be as specified in table H.5.1 of NFPA 1.

A reduction in required fire flow of up to 74 percent, as approved, shall be permitted when the building is protected throughout by an approved automatic sprinkler system. The resulting fire flow shall not be less than 100 gpm.

A reduction in required fire flow of up to 75 percent, as approved, shall be permitted when the building is protected throughout by an approved automatic sprinkler system, which utilizes quick response sprinklers throughout. The resulting fire flow shall not be less than 600 gpm.

d. Identify some of the basic inspection, test and maintenance requirements for a fire water distribution system.

DOE O 420.1B and the corresponding contractor requirements document (CRD) require the development of site criteria for inspection, testing, and maintenance of fire protection systems.

The inspection, testing, and maintenance program for fire protection features, apparatus and equipment should be based on industry standards, such as those established by NFPA 25. To the extent that an adequate technical basis exists to justify deviations from the inspection and test frequencies delineated in these standards, DOE would accept well-documented alternatives, provided that operability was reasonably assured.

Data on fire protection system performance should be continually collected and maintained so as to be able to provide a sound technical basis for the fire protection inspection, testing, and maintenance program. Trends in system performance should be monitored so as to be able to determine if significant degradation of system performance is occurring over time. Such degradation would justify revising the inspection, testing, and maintenance program to feature more conservative frequencies.

e. Identify the applicable NFPA codes or standards that apply to the fire protection systems and water distribution systems.

The following NFPA codes or standards apply to fire protection systems and water distribution systems:

- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 14, *Standard for the Installation of Standpipes and Hose Systems*
- NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
- NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
- NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*
- NFPA 22, *Standard for Water Tanks for Private Fire Protection*
- NFPA 24, *Installation of Private Fire Service Mains and Their Appurtenances*
- NFPA 25, *Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*
- NFPA 750, *Standard on Water Mist Fire Protection Systems*

f. Identify some of the fundamental design principles associated with a fire alarm and signaling system and how the alarm system is considered a support system to a suppression system.

The following is taken from DOE-STD-1066-99.

Fire alarm systems should comply with NFPA 72 and have the following basic features:

- Transmission of signals to the responding DOE facility fire department alarm center and other constantly attended locations in accordance with NFPA 72.
- Local alarms for the building or zone in alarm.
- Visual alarms for the hearing impaired, where there are high noise levels, or where there are special process requirements.

- The fire alarm control panel located near the main entrance or a protected location.
- Supervisory devices for all critical functions (such as sprinkler system water flow and control valves).

g. Identify the fundamental design principles, including pertinent calculations for each system.

h. Identify the basic inspection, test and maintenance requirements for each system.

Elements g and h of this competency are performance-based KSAs. The Qualifying Official will evaluate their completion.

<u>Mandatory Performance Activities:</u>

a. Conduct a comprehensive in-plant assessment of assigned fire related system(s) addressing the operability, functionality, and reliability of each system and its necessary support system.

b. Formally document and communicate the results of the assessment to DOE and contractor management.

Mandatory performance activities are evaluated by the Qualifying Official.

12. Engineers who are assigned safety system oversight for specific fire protection system(s) but have no other fire protection responsibilities shall demonstrate a familiarity level knowledge of the DOE fire protection program.

a. Discuss the contractor's fire protection responsibilities associated with implementation of the DOE directives listed in competency 1 of this FAQS.

General requirements for a contractor's fire protection are listed below. Additional responsibilities and requirements are available in attachment 2 of DOE O 420.1B, *Facility Safety.*

Fire protection for DOE facilities, sites, activities, design, and construction must

- provide a level of safety sufficient to fulfill requirements for highly protected risk;
- prevent loss of safety functions and safety systems as determined by safety analysis and provide defense-in-depth; and
- meet or exceed applicable building codes for the region and NFPA codes and standards as follows:

b. Describe the fundamental requirements and system-related considerations that apply to a DOE fire department or brigade.

Fire Brigade

The following is taken from NFPA 600.

Corporate or local management shall be responsible for the following:

- Evaluating the site-specific conditions and hazards to determine site-specific response duties to be assigned to the industrial fire brigade
- Assigning the site-specific response duties of the industrial fire brigade
- Establishing, reviewing, and maintaining a written industrial fire brigade organizational statement
- Establishing lines of authority and assigning responsibilities to ensure that the components of the industrial fire brigade organizational statement are accomplished
- Establishing a written policy for the occupational safety and health of industrial fire brigade members
- Establishing a written policy for the medical and job-related physical performance requirements for industrial fire brigade members
- Developing or adopting performance-based standards that establish baseline levels of proficiency in skills, knowledge, and the safety measures necessary for industrial fire brigade members to accomplish the site-specific response duties described in the industrial fire brigade organizational statement
- Developing, reviewing, and maintaining written standard operating procedures for site-specific conditions and hazards
- Ensuring that a system exists to advise industrial fire brigade management of changes in an employee's eligibility for participation in an industrial fire brigade, resulting from changes in the employee's medical condition
- Establishing a policy to ensure that the records required in NFPA 600 are maintained
- Establishing a policy to ensure that annual funds are budgeted and available for equipment, vehicles, training and education, medical and job-related physical performance evaluations, and other necessary items to accomplish these objectives

Management shall establish, review, and maintain a written industrial fire brigade organizational statement.

This policy statement, which establishes the existence of the industrial fire brigade, shall include the following:

- Basic organizational structure
- The type, amount, and frequency of training and education to be provided
- The expected number of members in the brigade
- The response duties that the brigade is expected to perform in the workplace, which define the limits of industrial fire brigade responsibility
- The shifts during which the brigade members are available for response

Fire Department

The following is taken from NFPA 1710.

The AHJ shall maintain a written statement or policy that establishes the following:

- Existence of the fire department
- Services that the fire department is required to provide
- Basic organizational structure
- Expected number of fire department members
- Functions that fire department members are expected to perform

The fire department organizational statement shall provide service delivery objectives, including specific response time objectives for each major service component and objectives for the percentage of responses that meet the response time objectives.

The fire department shall establish the following time objectives:

- One minute for turnout time
- Four minutes or less for the arrival of the first arriving engine company at a fire suppression incident and/or 8 minutes or less for the deployment of a full first alarm assignment at a fire suppression incident
- Four minutes or less for the arrival of a unit with first responder or higher level capability at an emergency medical incident
- Eight minutes or less for the arrival of an advanced life support unit at an emergency medical incident, where this service is provided by the fire department

c. Describe the key elements of the design, construction, and acceptance process as practiced on site.

This is a site-specific KSA. The local Qualifying Official will evaluate its completion.

d. Identify who may conduct fire protection system and/or component design verifications, including inspection, testing, and maintenance of the system.

This is a site-specific KSA. The local Qualifying Official will evaluate its completion.

e. Describe the conditions to be considered when inspecting and testing fire protection systems so as to be able to verify or validate design features.

Refer to element c of competency 2 for a description of conditions to be considered when inspecting and testing fire protection systems.

f. Describe the key elements of facility design that are important to effective emergency response.

The following is taken from DOE G 420.1-3.

In accordance with DOE O 420.1B, DOE facilities, sites, and activities, including design and construction, must have a level of fire protection that is sufficient to fulfill the requirements of the best protected class of industrial risks (commonly referred to as “Highly Protected Risk” or “Improved Risk”) and should be provided protection to achieve defense-in-depth. This includes meeting the applicable building code and NFPA codes and standards, and exceeding them when necessary to meet safety objectives. The applicable codes and standards are those in effect when facility design commences (code of record). In accordance with DOE O 420.1B, when significant modifications to a facility occur, as determined by the AHJ, the current edition of the code or standard must apply to the modification.

g. Identify the various types of fire protection systems and their suitability for protecting typical site fire hazards.

Refer to element a of competency 3 for a discussion of the various types of fire protection systems.

h. Define a fire barrier and describe typical devices which provide protection for openings therein.

Fire Barrier

The following is taken from DOE-STD-1066-99.

Interior fire barriers isolate hazardous occupancies, to minimize the potential for fire spread, including products of combustion and loss potential, and to help assure the orderly evacuation of facility occupants, consistent with the conclusions of the FHA that is performed in conjunction with the design process. Openings in such barriers should be protected with appropriately fire-rated doors, windows, dampers, or penetration seals.

Wall, floor and ceiling, and roof and ceiling assemblies must be tested and rated for their fire resistance by UL or similar nationally recognized testing laboratories, or should be listed for their fire resistance as approved by FM or similar organizations.

Fire barrier walls shall meet the requirements of chapter 7 of NFPA 221.

The following is taken from NFPA 221.

Fire barrier walls shall be continuous from one of the following or a combination thereof:

- An exterior wall to an exterior wall
- A floor below to a floor or roof above
- One fire barrier wall to another fire barrier wall, fire wall, or a high challenge fire wall having a fire resistance rating of not less than that required for the fire barrier wall

Fire barrier walls shall be continuous through all concealed spaces, such as those found above a ceiling, including interstitial spaces.

A fire barrier wall required for an occupied space below an interstitial space shall not be required to extend through the interstitial space, provided that the construction assembly forming the bottom of the interstitial space has a fire resistance rating not less than that of the fire barrier wall.

The fire barrier wall shall be permitted to terminate at an individually protected structural member in the same plane provided the structural member has a fire resistance rating of not less than that required for the fire barrier wall.

Structural elements supporting fire barrier walls shall have a fire resistance rating of not less than required for the wall.

i. Describe the various components of a fire alarm and signaling system.

Refer to element f of competency 11 for a description of fire alarms and signaling systems.

j. Describe the basic elements of a means of egress and how a fire protection system may be considered relevant to life safety.

The following is taken from DOE-STD-1066-99.

Life safety provisions should be provided for all facilities in accordance with NFPA Standard 101, *Life Safety Code* (LSC). Compliance with the LSC is considered by DOE to satisfy the exit requirements of the applicable building code and 29 CFR 1910.

Any security, radiological control or other physical restrictions to prevent access to or egress from an area should not prevent emergency egress in the event of a fire or related condition. Where conflicting criteria exist, the most effective compromise should be implemented consistent with the objectives of DOE O 420.1, as determined by the AHJ.

In addition, for explosives environments, exits should reflect the criteria contained in DOE M 440.1-1A, *DOE Explosives Safety Manual.*

k. List some of the policies, practices and procedures that are encompassed by a fire protection program.

The following is taken from DOE O 420.1B.

An acceptable fire protection program must be developed, implemented, and maintained by the contractor, which includes the following elements and requirements:

- A policy statement that
  - incorporates fire protection requirements of this CRD, related DOE directives, and other applicable Federal, state, and local requirements; and
  - affirms the contractor's commitment to fire protection and fire suppression capabilities sufficient to minimize losses from fire and related hazards consistent with highly protected risk status in private industry.

- Comprehensive, written fire protection criteria or procedures that include
  - site-specific requirements;
  - staff organization, training, and responsibilities;
  - administrative responsibilities;
  - design, installation, operability, inspection, maintenance, and testing requirements;
  - use and storage of combustible, flammable, radioactive, and hazardous materials to minimize risk from fire;
  - fire protection system impairments;
  - smoking and hot work;
  - safe operation of process equipment; and
  - prevention measures that decrease fire risk.

- A system to ensure that fire protection program requirements are documented and incorporated in plans and specifications for new facilities and significant modifications to existing facilities.
- Documented review of plans, specifications, procedures, and acceptance tests by a qualified fire protection engineer.

- Fire hazard analyses using a graded approach for all hazard category 1, 2, and 3 nuclear facilities, significant new facilities, and facilities that represent unique fire safety risks. The FHAs must be
  - performed under the direction of a qualified fire protection engineer;
  - reviewed every 3 years; and
  - revised when
    - changes to the annual DSA updates impact the contents in the FHA,
    - a modification to an associated facility poses a significant new fire safety risk, or
    - the 3-year review identifies the need for changes.

- FHA conclusions incorporated into the DSA and integrated into design basis and beyond design basis accident conditions.
- Access to qualified, trained fire protection staff that includes fire protection engineers, technicians, and firefighting personnel to implement the requirements of this CRD.
- A baseline needs assessment of the fire protection emergency response organization that
  - establishes the site firefighting capabilities to provide
    - effective response to suppress all fires;
    - emergency medical and hazardous materials response capabilities; and
    - staffing, apparatus, facilities, equipment, training, pre-plans, offsite assistance, and procedures;
  - reflects applicable NFPA codes and standards; and
  - is updated at least every 3 years and in accordance with applicable NFPA code provisions and whenever a significant new hazard is introduced that is not covered by the current BNA.

- Site emergency plans, FHAs, and DSAs that incorporate BNA information.
- Pre-fire strategies, plans, and standard operating procedures to enhance the effectiveness of site firefighting personnel.
- Procedures governing the use of firefighting water or other neutron moderating materials to suppress fire within or adjacent to moderation controlled areas.
- Where no alternative exists to criticality safety restrictions on the use of water for fire suppression, the need for such restriction is fully documented and with written technical justification.
- A documented comprehensive fire protection self-assessment program performed every 3 years.
- Periodic facility assessments on a schedule as directed by DOE.
- Processes to prioritize and monitor the status of fire protection assessment findings, recommendations, and corrective actions until final resolution.
- A process for reviewing and recommending approval of fire safety equivalencies to any fire protection code or standard requirements to the DOE.
- Procedures governing firefighting techniques to be used during deactivation, decontamination, and demolition phases, when applicable.

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