Fire Protection for Fuel Cycle Facilities
Directed Self-Study Course
Trainee Guide

This self-study guide has been developed as a text and reference document for the Fuel Cycle Processes Course.

This self-study guide was compiled by the Oak Ridge Institute for Science and Education under an interagency agreement between the U.S. Department of Energy and the U.S. Nuclear Regulatory Commission, Associate Director for Training and Development, Specialized Technical Training (U.S. NRC Technical Training Center), Office of Human Resources.

This self-study guide was developed strictly for the use of NRC personnel for training and subsequent reference. It is not intended for distribution outside of the NRC without the approval of the USNRC Technical Training Center.

Any error detected in or any comments concerning the contents of this self-study guide should be forwarded to the address or faxed to the numbers listed below.

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INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) has made a commitment to ensure safe operations at NRC licensed facilities. It recognizes that NRC personnel share responsibility for safe operations with licensees. NRC staff assist licensees in recognizing potential problems and ensuring that effective solutions are implemented.

The role of the technical reviewer is to establish reasonable assurance that the design of a facility provides for adequate protection against fires and explosions [10 CRF 70.64(a)(3)] and is based on defense-in-depth practices [Part 70.64(b)]. The review should also establish that radiological consequences from fires are considered in determining how the facility will meet the performance requirements of Part 70.61.

Inspections are conducted at a facility to assess whether the licensee is using radioactive material safely and whether the facility is in compliance with established standards, regulations, license conditions, and the licensee commitments. The NRC performs both routine and reactive inspections. Routine inspections are typically comprehensive and unannounced, and are conducted on a set frequency. Reactive inspections are performed in response to an incident or special information obtained by the NRC.

Faced with ever-reducing budgets and yet an ever-constant need to provide training to NRC personnel, this directed Self-Study Guide for Fire Protection for Fuel Cycle Facilities has been developed to provide a basic understanding of fire protection at fuel cycle facilities. This Self-Study Guide contains procedures, requirements, and background information useful to those who are involved with fire protection inspections for the NRC.

Questions concerning the use of this Self-Study Guide, suggestions for improving the content or format, or corrections of any errors or inconsistencies should be documented on the "Evaluation Form" included at the end of this section of the Self-Study Guide and directed to the Technical Training Center, Chattanooga, Tennessee.

DIRECTED SELF-STUDY METHOD

The directed self-study method is a trainee controlled instructional process where you are responsible for the pace and sequence of learning and mastery of a particular subject matter. Self-study guides are designed to be used with little or no guidance from an instructor. They can be computer-based, paper-based, or a combination of the two. The method has advantages and limitations.

The advantages include:

- Meeting the needs of trainees with different entry-level skills, knowledge, and experience

- Providing flexibility of place and time
- Affording flexibility of pace and sequence
- Encouraging self evaluation and goal setting

There are also limitations that must be considered. These include:

- Trainee must be motivated and have initiative
- Goals of learning sessions must be clearly stated or understood
- Trainee's reading level and educational background must be compatible with the material presented
- Effectiveness of which variables the trainee controls may be based on the trainee's ability to make strategic decisions regarding educational support. Research has shown that new trainees may not know enough about the subject to make proper decisions as to how it is best learned.
- Social interaction is nonexistent

To help overcome some of these limitations, the Fire Protection for Fuel Cycle Facilities Directed Self-Study Guide has been designed to be used with an administrator. This is intended to provide you with personal instruction based on individual needs, periodic feedback, and regular progress reports. It also provides social interaction with the administrator while still allowing you to control the pace of the learning. Scheduled progress review meetings provide you with the opportunity to discuss specific topic areas and ask for clarification or additional information as needed.

ROLES AND RESPONSIBILITIES

The administrator should be a subject matter expert. The administrator should review all Self-Study Course materials and incorporate personal experiences where appropriate. Using recent experience establishes relevancy for you and contributes to the transfer of learning.

The responsibilities of the administrator are to:

- Provide an adequate learning environment for the trainee.
- Make specific assignments for learning.
- Monitor the trainee's progress.
- Provide assistance if problems arise.

TRAINEE RESPONSIBILITIES

The responsibilities of the trainee are to:

- Read each module and complete the supporting activities.

TRAINEE GUIDE

- Complete self-check review questions at the end of each module.
- Schedule progress review meetings.
- Interact with the administrator to enhance learning.

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DIRECTED SELF-STUDY COURSE PROCESS

The following steps are recommended for course completion.

- Directed self-study courses consist of a Trainee Guide and an Administrator Guide. You will receive a personal copy of the Trainee Guide.
- Directed self-study guide materials will be stored and made available at the Technical Training Center (TTC) in Chattanooga, Tennessee.
- Final examinations and answer keys will be kept at the TTC until requested by the training coordinator.

A. When a need is identified for an individual to take a self-study course, the supervisor identifies an administrator. The supervisor is responsible for providing you with an adequate learning environment and the necessary time and resources to complete the course.

   Note: As provided for in Inspection Manual, Chapter 1246, Section 1246-11, Exceptions, management has the option to allow you to challenge the examination (complete an equivalency examination) or waive you from the course if you are deemed to be already qualified by prior experience and education.

B. The trainee goes to the NRC online training catalog to register for a self-study course. Supervisor approval will be automatically required.

C. The TTC will then send the self-study manuals to you and the administrator. If required, the TTC will send the materials to the supervisor or designee for distribution to you and the administrator.

D. You then proceed with the self-paced study program, directed by the administrator. Each course will have a specified time period for completion, generally four to six months. Your progress will be noted by you and the administrator on appropriate areas of the tracking sheet located in the Trainee Guide. Your supervisor initials the completed tracking sheet and acknowledges sign-off by the administrator.

E. You will complete the Notice of Course Completion located in the Trainee Guide and give it to your supervisor. The supervisor or designee will then contact the TCC when you are ready to take the examination.

F. The TTC will send the examination to the supervisor/designee who will arrange for proctoring of the exam.

G. The supervisor/designee will administer the examination at a mutually agreed upon time with you and the proctor. Both the proctor and you will sign the exam cover sheet.

Note: A course evaluation form is contained in the Trainee Guide. You should complete this form and give it to your supervisor or designee who should return it to the TCC along with the examination.

H. The supervisor or designee will send the completed examination with the completed cover sheet to the TTC for grading. Minimum passing score on the examination is 70 percent. At the same time, the supervisor or designee will also forward the completed trainee evaluation form to the TTC.

I. The TTC will grade the examination and return it with a course certificate by memorandum to your division director, with a copy to you.

PURPOSE AND FORMAT OF THE DIRECTED SELF-STUDY GUIDE

Purpose of the Directed Self-Study Guide

The purpose of this NRC Fire Protection at Fuel Cycle Facilities Self-Study Guide is to provide a detailed understanding of fire protection principles and practices at fuel cycle facilities. Discussion includes:

- Regulations governing fire protection
- Fire protection equipment
- Fire detection and suppression systems
- Fire hazards and concerns associated with the processes used at fuel cycle facilities
- NRC fire inspection procedure and requirements

Directed Self-Study Guide Format

The following sections provide basic fire protection terms and concepts:

- Abbreviation/Acronyms
- Glossary
- Background

Information on selected topics and a copy of the NRC Inspection Procedure 88054 (Triennial) and 88055 (Annual), Fire Protection are provided in the appendices.

This directed self-study guide is designed to assist you in accomplishing the learning objectives listed at the beginning of each module. Each module has activities and self-check review questions to enhance the concepts and to provide practice in applying the information to real life situations. This directed self-study guide has the following topics and their objectives arranged as separate learning modules.

MODULES	LEARNING OBJECTIVE
1.0 NRC Guidance on Fire Protection for Fuel Cycle Facilities	Relate NRC guidance documents to recognized good industry practices in the area of fire protection.
2.0 Fire Protection Features and Systems	Identify fire protection features and systems used in fuel cycle facilities and review them for adequacy.

3.0 Fire Hazards and Fire Protection Concerns at Fuel Cycle Facilities	Identify fire hazards and fire protection concerns associated with the processes conducted at fuel cycle facilities.
4.0 Inspection Requirements for Fire Protection Programs	Identify the inspection requirements for a fire protection program at fuel cycle facilities.

SYMBOLS

Throughout this Directed Self-Study Guide, the following symbols have been used to provide instructions.

Symbol	Denotes
	**Learning Objectives**
	**Self-Check Questions**
You have completed this section. Please check off your progress on the tracking form. **It's time to schedule a progress meeting with your administrator. Review the progress meeting form on the next page. In Part III, as a Regulator, write your specific questions to discuss with the administrator.** 	**Transitional Statements** **or** **Time To Schedule A Progress Review Meeting**
	**Activity**

	**Progress Review Meeting**

MATERIALS LIST

The table below lists by module the materials you will need to complete this Directed Self-Study Guide for Fire Protection at Fuel Cycle Facilities.

Before beginning Module 1.0, it is recommended, as a minimum, that you review the fire protection terms provided in the "Abbreviation/Acronyms" and the "Background" section located in the end of this Self-Study Guide.

Prior to beginning a module, you should review the materials list to ensure that the materials needed to complete the module are available. If an item is missing, contact the training coordinator.

	MODULES	WHAT YOU WILL NEED
1.0	NRC Guidance on Fire Protection for Fuel Cycle Facilities	◙ Directed Self-Study Course ◙ Materials listed in Module 1.0 Introduction ◙ Appendices
2.0	Fire Protection Features and Systems	◙ Directed Self-Study Course ◙ Materials listed in Module 2.0 Introduction
3.0	Fire Hazards and Fire Protection Concerns at Fuel Cycle Facilities	◙ Directed Self-Study Course ◙ Materials listed in Module 3.0 Introduction ◙ Appendices
4.0	Inspection Requirements for Fire Protection Programs	◙ Directed Self-Study Course ◙ Materials listed in Module 4.0 Introduction

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TRACKING FORM

The Tracking Form is included to allow you to check off and date completion of the modules and activities. It also notes where progress review meetings should be scheduled with the administrator.

PLEASE PRINT THE FOLLOWING INFORMATION:

Course Title: Fire Protection for Fuel Cycle Facilities Directed Self-Study Course	
Name: (As it appears on certificate)	Job Title:
Social Security Number:	Phone Number
Mailing Address:	

MODULE 1.0 NRC GUIDANCE ON FIRE PROTECTION FOR FUEL CYCLE FACILITIES

Objective: Relate NRC guidance documents to recognized good industry practices in the area of fire protection.

Activity 1: NRC Guidance Documents	Date Completed:	
Self-Check Questions 1-1	Date Completed:	
Progress Review 1	Date:	Date:
	Trainee's Initials:	Administrator's Initials:

MODULE 2.0 FIRE PROTECTION FEATURES AND SYSTEMS

Objective: Identify fire protection features and systems used in fuel facilities and review them for adequacy.

Self-Check Questions 2-1	Date Completed:	
Activity 1: Detectors	Date Completed:	
Self-Check Questions 2-2	Date Completed:	
Activity 2: Alarm System Fundamentals	Date Completed:	
Self-Check Questions 2-3	Date Completed:	
Activity 3: Identifying Sprinkler Systems	Date Completed:	
Self-Check Questions 2-4	Date Completed:	
Activity 4: Type of Extinguishers	Date Completed:	
Self-Check Questions 2-5	Date Completed:	
Self-Check Questions 2-6	Date Completed:	
Self-Check Questions 2-7	Date Completed:	
Self-Check Questions 2-8	Date Completed:	
Self-Check Questions 2-9	Date Completed:	
Progress Review 2	Date:	Date:
	Trainee's Initials:	Administrator's Initials:

MODULE 3.0 FIRE HAZARDS AND FIRE PROTECTION CONCERNS AT FUEL CYCLE FACILITIES

Objective: Identify fire hazards and fire protection concerns associated with processes conducted at fuel cycle facilities.

Activity 1: NRC Regulatory and Guidance Documents	Date Completed:	
Activity 2: Fire Hazards	Date Completed:	
Self-Check Questions 3-1	Date Completed:	
Progress Review 3	Date:	Date:
	Trainee's Initials:	Administrator's Initials:

MODULE 4.0 INSPECTION REQUIREMENTS FOR FIRE PROTECTION PROGRAMS

Objective: Identify the inspection requirements for a fire protection program at fuel cycle facilities.

Self-Check Questions 4-1	Date Completed:	
Self-Check Questions 4-2	Date Completed:	
Self-Check Questions 4-3	Date Completed:	
Progress Review 4	Date:	Date:
	Trainee's Initials:	Administrator's Initials:

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PROGRESS REVIEW MEETINGS

The purpose of these meetings is to discuss major issues, exchange questions and answers, assure that the subject matter is well understood, and provide encouragement and positive feedback to you.

The following table illustrates an example of preparation and conduct of a typical meeting. Actual Progress Review Meeting forms are located at the end of each course module.

Step	Administrator	Trainee
1	◙ Agree on a meeting place, date, and time.	◙ Request a Progress Review Meeting. ◙ Arrange for a place and time.
2	◙ Review the module(s) and the discussion questions for the meeting. ◙ Add questions. ◙ Note personal experiences that can enhance the lesson. ◙ Review assignments from the previous meeting. ◙ Identify additional materials that can help clarify concepts should these be needed.	◙ Review the module(s). ◙ List questions for the administrator. ◙ Identify areas needing clarification. ◙ Complete assignments from the previous meeting.
3	◙ Arrive on time for the meeting. ◙ Review assignments from the previous meeting. ◙ Answer questions from the trainee. ◙ Use discussion questions to evaluate trainee's comprehension of the subject matter. ◙ Review additional materials to clarify concepts as needed. ◙ Make assignments as appropriate. ◙ Set a date and time for a follow-up meeting for the module(s) under discussion if needed.	◙ Arrive on time for the meeting. ◙ Provide completed assignments from the previous meeting. ◙ Ask questions. ◙ Answer questions.
4	◙ Date and initial tracking form.	◙ Date and initial tracking form.

Progress Review Meeting 1

I. The following suggested items should be discussed with the administrator as to how they pertain to your current position:

- NRC Branch Technical Position 57 FR 35607, "Guidance on Fire Protection for Fuel Cycle Facilities"
- NUREG-1513, "Integrated Safety Analysis Guidance Document"
- NUREG 1520, Standard Review Plan for the Review of a License Application for a Fuel Cycle Facility, Section 7.0, "Fire Safety"
- Inspection Procedure 88054 and 88055, Fire Protection
- OSHA Regulation, Process Safety Management of Highly Hazardous Chemicals, 1992
- EPA Regulation, Risk Management Programs for Chemical Accidental Release Prevention, 1993

II. Use the space below to take notes or to write your specific questions.

III. Further assignments? If yes, please note and complete. If no, initial completion of progress meeting on tracking form.

The following readings are recommended:

- Standard Review Plan for the Recertification of the Gaseous Diffusion Plants, Section 11.0, "Fire Safety"
- Standard Review Plan for the Review of a License Application for the Tank

- Waste Remediation System Privatization (TWRS-P) Project, Section 7.0, “Fire Protection”
- Standard Review Plan for the Review of an Application for a Mixed Oxide (MOX) Fuel Fabrication Facility, Section 7.0, “Fire Protection“

Progress Review Meeting 2

I. The following suggested items should be discussed with the administrator as to how they pertain to your current position:

- Active versus passive fire protection systems
- Fire suppression and detection systems
- Alarm systems
- Automatic sprinkler systems
- Considerations for sprinkler systems
- Lessons learned
- NFPA Fire Protection Handbook
- Building standpipe systems
- Identification and proper use of portable fire extinguishers
- Machining operations of combustible materials
- Processes involving flammable and combustible liquids and gases
- Hydrogen systems
- Boiling Liquid Expanding Vapor Explosion (BLEVE)
- Lightning protection, NFPA 780
- Boilers, ovens, and furnaces
- Structural fire protection criteria
- Ventilation systems
- Life safety criteria, NFPA 101

Progress Review Meeting 2 (Continued)

II. Use the space below to take notes or to write your specific questions.

III. Further assignments? If yes, please note and complete. If no, initial completion of progress meeting on tracking form.

Progress Review Meeting 3

I. The following suggested items should be discussed with the administrator as to how they pertain to your current position:

- Fire Hazards at Fuel Cycle Facilities
  - □ Uranium mills
  - □ Conversion facilities
  - □ Gaseous diffusion facilities
  - □ Fuel fabrication facilities
- 1998 Portsmouth fire
- 1969 Rocky Flats fire (DOE facility)
- Uranium oxide fires
- Preventive measures and lessons learned
- Zircalloy fire hazards
- Glovebox fire hazards
- Common fire protection features

II. Use the space below to take notes or to write your specific questions.

III. Further assignments? If yes, please note and complete. If no, initial completion of progress meeting on tracking form.

Progress Review Meeting 4

I. The following suggested items should be discussed with the administrator as to how they pertain to your current position:

- ◙ Inspection requirements
  - □ Management involvement
  - □ Fire protection program
  - □ Fire safety review committee
  - □ Fire safe design and construction of facilities
  - □ Fire safe manufacturing processes, equipment, and storage
  - □ Fire protection systems
  - □ Fire hazards analysis
  - □ Pre-fire planning
  - □ Fire brigade
  - □ Training
  - □ Drills
- ◙ Good industry practices

II. Use the space below to take notes or to write your specific questions.

III. Further assignments? If yes, please note and complete. If no, initial completion of progress meeting on tracking form.

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ABBREVIATION/ACRONYMS

ACR	area control room
ADU	ammonium diuranate
AFFF	aqueous film forming foam
AIT	Augmented Inspection Team
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
BLEVE	Boiling Liquid Expanding Vapor Explosion
BTP	Branch Technical Position
°C	degrees centigrade
CCl4	carbon tetrachloride
CFR	Code of Federal Regulations
CO_2	carbon dioxide
CRT	cathode-ray tube
CV	control valve
DC	direct current
DOE	Department of Energy
DOP	dioctylphthalate
DU	depleted uranium
EOC	Emergency Operations Center
EPO	emergency power operation

°F	degrees fahrenheit
FHA	Fire Hazards Analysis
FLM	first line manager
FLMIT	first line manager in training
FM	Factory Mutual System
FR	Federal Register
FRP	fiberglass reinforced plastic
FS	flow switch
gpm	gallons per minute
HEPA	high efficiency particulate air
HF	hydrogen fluoride
HNO_3	nitric acid
HVAC	heating, ventilating, and air conditioning
IC	incident command
in	inch
IDR	integrated dry conversion
ISA	Integrated Safety Analysis
l	liter
IROFS	Items Relied On For Safety
lb	pound
LFL	lower flammable limit
MCFL	maximum credible fire loss

MIC microbiologically induced corrosion

min minute

mm millimeter

MOU memorandum of understanding

MPFL maximum possible fire loss

MSDS Material Safety Data Sheet

NaK sodium-potassium alloy

NFPA National Fire Protection Association

NFS Department of Energy's Office of Nuclear and Facility Safety

NRC Nuclear Regulatory Commission

NUREG Nuclear Regulatory Commission Report

ORGDP Oak Ridge Gaseous Diffusion Plant

OSHA Occupational Safety and Health Administration

OS&Y outside screw and yoke

PI pressure indicator

PIV post indicator valve

PEL permissible exposure limit

Psia pounds per square inch absolute

PuO_2 plutonium oxide

QA quality assurance

SAR Safety Analysis Report

SER Safety Evaluation Report

SRP Standard Review Plan

TBP tributyl phosphate

U uranium

UF_6 uranium hexafluoride

UFL upper flammable limit

UL Underwriters Laboratories, Inc.

UO_2 uranium dioxide

U_3O_8 triuranium octoxide (Yellowcake)

USEC United States Enrichment Corporation

GLOSSARY

Active Fire Protection System. A device or action that receives a stimulus before acting in a real or a perceived fire condition.

Administrative Controls. Policies and procedures established by management to ensure that fire safety principles are implemented effectively to maintain safe operating conditions. Requires manual actions to prevent fires, activate alarms, and maintain systems.

AFFF. Aqueous Film Forming Foam (AFFF) Concentrates. Liquid foam concentrates containing a fluorinated surfactant with suitable foam stabilizers and additives. Foams formed from these concentrates act as a barrier to exclude air or oxygen, and they develop aqueous films that are capable of suppressing the evolution of fuel vapors on most hydrocarbon fuel surfaces.

Alarm. A signal that warns or alerts.

Alarm Signal. A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

Alert Tone. An attention-getting signal to alert occupants of the pending transmission of a voice message.

Automatic Fire Detectors. A device designed to detect the presence of fire and initiate fire alarm and, in some cases, activate a suppression system.

Barrier. Any surface that will delay or prevent an ignition into an adjacent space.

BLEVE. An acronym for "boiling liquid expanding vapor explosion." Therefore, a BLEVE is a type of pressure release explosion.

Combustible Liquid. A liquid having a closed cup flash point at or above 100°F (37.8 °C).

- Combustible liquids shall be subdivided as follows:
  - Class II liquids shall include those having flash points at or above 100°F (37.8 °C) and below 140°F (60 °C).
  - Class IIIA liquids shall include those having flash points at or above 140°F (60 °C) and below 200°F (93 °C).
  - Class IIIB liquids shall include those having flash points at or above 200°F (93 °C).

Combustion. The burning of a gas, liquid, or solid in which the fuel is rapidly oxidized, producing heat and often light. Combustion falls into a class of chemical reactions called oxidation.

Criticality Event. A nuclear event involving fissile materials where the number of neutrons produced is greater than the number of neutrons lost resulting in large amounts of radiation energy and heat being released. Careful consideration is required in the design, installation, and operation of water extinguishing systems where fissile materials are handled because water can be one of several factors that can initiate a criticality event.

Cubic Feet Per Minute (cfm). A standard measure of a substance flowing through air within a fixed period of time. Indoors, it is the amount of air measured in cubic feet that is delivered and exchanged in one minute.

Deflagration. An explosion in which the propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium.

Deluge Sprinkler System. A system employing open sprinklers installed in a water supply through a valve that is opened by the operation of a fire detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all attached sprinklers.

Detonation. Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium.

Dry Chemical. Various mixtures of finely divided solid particles additionally supplemented with special treatments to provide resistance to packing, moisture absorption (caking), and proper flow characteristics. These agents are designed for extinguishment of Class "A" and "B" fires. They are nonconductors and approved for use on energized electrical Class “C” fire situations.

Dry Pipe Sprinkler System. A system employing automatic sprinklers installed in a piping system containing air or nitrogen under pressure, the release of which, as from the opening of a sprinkler, permits the water pressure to open a valve known as a dry-pipe valve. The water then flows into the piping system and out the opened sprinklers.

Duct Entrance Filter. A duct entrance filter is a type of prefilter that is located at ventilation system exhaust duct entrances to prevent accumulation of flammable dust inside the ducts. This is a concern of particular interest to the nuclear industry because radioactive substances tend to deposit or "plate out" on ducts. Dust accumulation inside duct surfaces can create fires that are serious because they occur in the ventilation system leading directly to the final exhaust plenum filters.

Engineered Controls. Design and operating limits that effectively reduce the risks associated with fire, e.g. fire area boundaries, suppression and detection systems.

Enriched Uranium. Uranium in which the proportion of U-235 (to U-238) has been increased above the natural 0.7%. Reactor-grade uranium is usually enriched to about 3% U-235, weapons-grade uranium is usually more that 90% U-235.

Enrichment. Physical process of increasing the proportion of U-235 to U-238.

Evacuation. The withdrawal of occupants from a building or area.

Evacuation Signal. Distinctive signal intended to be recognized by the occupants as requiring evacuation of the building or area.

Exhaust Plenum Final Filter. The final filter unit assembly in a set of filters arranged in a series for ventilation and effluent discharge in a nuclear air cleaning system.

Explosion. An effect produced by the sudden violent production or expansion of gases. An explosion may vary from a deflagration (subsonic) to a detonation (supersonic) in combustion zone velocity.

Fire Area. A space or location bounded by fire-rated construction including fire-rated doors, dampers, or penetration seals as determined by the Fire Hazards Analysis.

Fire Barrier. Any surface that will delay or prevent an ignition into an adjacent space.

Fire Detection Equipment. Equipment which will automatically detect one or more components directly related to combustion such as heat, smoke, flame, and other fire phenomenon.

Fire Hazard Analysis. A thorough analysis of a fire potential, used to evaluate the possible consequences of a fire and define the appropriate level of protection.

Fire Protection. A broad term that encompasses all aspects of fire protection, including building construction and fixed building fire features; fire suppression and detection systems, fire water systems, emergency process safety control systems, emergency firefighting organizations (fire departments, fire brigades, etc.), Fire Protection Engineering, and fire prevention. Fire protection is concerned with preventing or minimizing the direct and indirect consequences of fire. It also includes aspects of the following perils as they relate to fire protection: explosion, earthquake, lightning, smoke, and water damage.

Fire Protection System. Any system designed to detect, extinguish, and limit the extent of fire damage or enhance life safety. These include:

a. Automatic fire suppression systems, such as sprinklers, foam, gaseous, explosion suppression, or other specialized extinguishing systems plus appropriate alarms. System should have an adequate water supply, storage, and distribution system.

b. Automatic fire alarm and detection systems, occupant warning, manual fire alarm, and fire alarm reporting systems combined with properly equipped and adequately trained fire departments or fire brigades.

c. Fire barrier systems, physical separation, or combination of fire barriers and separation for both indoor and outdoor locations.

d. Other systems as approved by the authority having jurisdiction.

Fire Rating. A method of rating or ranking the fire endurance of building components or assemblies. The rating is not the actual time expected to withstand all fires, but the time an assembly can withstand the ASTM E-119 standard test fire.

Fire Resistance Rating. The time that the construction will withstand the standard fire exposure in hours as determined by ASTM E-119.

Fire Retardant. A material or product that, due to its inherent composition or as a result of chemical treatment during its manufacture, has or imparts low flammability or flame spread properties.

Fire Safety Functions. Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of harmful effects of fire.

Fire Screen. A screen across a flue or duct work that prohibits the propagation of flame or embers from a fire. Sometimes used to protect ventilation from flammable liquid lockers and the final stages of HEPA filters. Also known as spark arrestor.

Fire Suppression System. An automatic or manual system designed to control and/or extinguish fires.

Fire-Gas Detector. A device that detects gases produced by a fire.

Flame Detector. A device that detects radiant energy (such as ultraviolet, visible, or infrared) that is emitted as a product of combustion reaction and obeys the laws of optics.

Flame Spread Rating. Flame spread rating is a numerical classification determined by the ASTM E-84 test, which indexes the relative burning behavior of a material by quantifying the spread of flame (in a horizontal position) across the surface of building materials. The surface burning characteristic of a material is not a measure of resistance to fire exposure.

Flammable Liquid. A liquid having a closed cup flash point below 100°F (37.8 °C) and having a vapor pressure not exceeding 40 psia (2068 mm Hg) at 100°F (37.8 °C) shall be known as a Class I liquid.

- Class I liquids shall be subdivided as follows:
  - Class IA shall include those having flash points below 73°F (22.8 °C) and having a boiling point below 100°F (37.8 °C).
  - Class IB shall include those having flash points below 73°F (22.8 °C) and having a boiling point at or above 100°F (37.8 °C).
  - Class IC shall include those having flash points at or above 73°F (22.8 °C) and below 100°F (37.8 °C).

Flash Point. The minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitible mixture with air near the surface of the liquid (under controlled conditions).

Fuel. A material that reacts with the oxidizing agent during combustion. Examples include coal, wood, and gasoline.

Fuel Fabrication. Making reactor fuel elements, usually from UO_2.

Gallons per Minute (gpm). A standard measure of water flow in fire protection.

Gaseous Suppression. Non-water fire suppression utilizing a "clean agent" such as CO_2, Halon, or Halon alternative.

Glovebox. A sealed enclosure with viewing windows designed to separate the space in the box from its surroundings and in which all items in the box are handled using gloves that are sealed to the enclosure walls.

Halon. Halon 1301 (bromotrifluoromethane or $CBrF_3$) is a colorless, odorless, electrically nonconductive gas that is an effective medium for extinguishing fires.

Heat Detector. A device that detects abnormally high temperature or rate-of-temperature rise.

Heat Resistant. A material having the quality or capability of withstanding heat for a specified period at a maximum given temperature without decomposing or losing its integrity.

Heat Source. A flame or spark that ignites a mixture of an oxidizing agent and a fuel.

HEMF Filter. High efficiency metal fiber filter. A reusable metal filter composed of fine sintered stainless steel fibers together with a stainless steel wire and metal support housing and pleated to enhance strength, surface area, and dirt holding capacity.

HEPA Filter. High efficiency particulate air filter. A throwaway extended pleated medium dry type filter with a ridged housing having a minimum particle removal efficiency of at least 99.97% (maximum penetration of 0.03%) for particles of 0.3 micrometers or greater (by light scattering mean droplet diameter) when tested with monodisperse dioctylphthalate (DOP), emory 3004, or other acceptable smoke and maximum pressure drop of 1.0 inch of water when clean and operated at its rated airflow capacity. HEPA filters consist of a material that is a thin mat of fine intertwined glass fibers that are folded back and forth around thin separators and then enclosed by a plywood or metal frame. HEPA filters are easily damaged by very high temperatures and aerosols and can fail when subjected to excess wetting and/or structural loading.

Hydrophoric Materials. Materials that react violently with water or water vapor (such as lithium and lithium hydride).

Hypergolic Reaction. A material's ability to spontaneously ignite or explode upon contact with ANY oxidizing agent.

Initiating Device. An alarm system component that originates transmission of a change of state condition, such as a smoke detector, manual fire alarm box, supervisory switch, etc.

Ignition Temperature. The temperature at which an element or compound will catch fire in air (atmospheric oxygen).

Line-Type Detector. A device in which detection is continuous along a path. Typical examples are rate-of-rise pneumatic tubing detectors, projected beam smoke detectors, and heat-sensitive cable.

Lower Flammable Limit (LFL). The lowest percent concentration (by volume) of a flammable vapor or gas mixed in air that will ignite and burn with a flame. Lower flammable limit percentages of flammable liquids and gases can be found in NFPA 325M.

Noncombustible Materials. Materials that, in the form in which they are to be used and under the conditions anticipated, will not aid combustion or add appreciable heat to an ambient fire.

Oxide Fuels. Enriched or natural uranium in the form of UO_2, used in many types of reactors.

Oxidation. The chemical combination of a substance with oxygen or, more generally, the removal of electrons from an atom or molecule. Oxidation reactions almost always release heat (exothermic).

Oxidizing Agent. A chemical substance that gives up oxygen easily, removes hydrogen from another substance, or attracts electrons.

Passive Fire Defense. Building components such as fire barriers and noncombustible construction that passively contain fire growth.

Permissible Exposure Limit (PEL). The permissible exposure limit of vapor expressed in parts of vapor per million parts of contaminated air.

Portable Fire Extinguisher. A portable device carried on wheels and operated by hand containing an extinguishing agent that can be expelled under pressure for the purpose of suppressing or extinguishing fire.

Pre-action Sprinkler System. A closed head sprinkler system that is activated by a fire detection system that in turn opens the water supply valve. This system may take longer to activate but is less likely to activate inadvertently.

Prefilter. A filter installed to remove large particles and dust from the flowstream and installed upstream of the final HEPA filter enclosure. Although final HEPA filters are excellent collectors of very small particles, they are likely to plug when subjected to high loads of dust and large smoke particles generated in a fire. Prefilters help remove the large particles and dust that would accumulate on the HEPA filters. Prefilters, often referred to as roughing filters, can generally be located at any point in the exhaust ventilation system prior to the final HEPA filters and sometimes are located in the final filter plenum enclosure.

Protection Factor. The ratio of the concentration of contaminant in the atmosphere to the concentration inside the facepiece or hood under conditions of use.

Pyrophoric. Capable of spontaneous combustion when exposed to air. Combustible metals such as plutonium, uranium, and zirconium are pyrophoric when in finely divided form.

Pyrophoricity. Pyrophoricity is a special case of a hypergolic reaction because the oxidizing agent is restricted to atmospheric oxygen.

Reprocessing. Separation of uranium and/or plutonium from used reactor fuel and the production of a much reduced quantity of high-level waste.

Smoke Detector. A device that detects visible or invisible particles of combustion.

Smoke Developed Rating. Smoke developed rating is a numerical classification determined by ASTM E-84, which indexes the smoke generation rate of a given material to those of two standard materials, inorganic reinforced cement board and select grade red oak.

Specific Area. A measure of the surface area of the materials exposed to an oxidizing atmosphere per gram of materials and is expressed in units of cm2/g.

Spontaneous Combustion. The ignition of a combustible material caused by the accumulation of heat from oxidation reactions.

Spontaneous Heating. The slow oxidation of an element or compound that causes the bulk temperature of the element or compound to rise without the addition of an external heat source.

Spot-Type Detector. A device whose detecting element is concentrated at a particular location.

Sprinkler Density. The rate of application of water to an area expressed in gallons per minute per square foot (gpm per sq. ft.).

Swarf. Finely divided metal particles produced by sawing and cutting operations.

Titanium. A nontoxic metallic element used principally in commercially pure and alloy forms.

Upper Flammable Limit (UFL). The highest concentration (expressed in percentage of vapor or gas in the air by volume) of a substance that will burn or explode, when an ignition source is present. Theoretically, above this limit, the mixture is said to be too "rich" to support combustion. The range between the LFL and the UFL constitutes the flammable range or explosive range of a substance.

Ventilation. The process of supplying or removing an atmosphere to or from any space by natural or mechanical means.

Wet Chemical. Normally a solution of water and potassium carbonate-based chemical, potassium acetate-based chemical, or a combination thereof that forms an extinguishing agent.

Wet Pipe Sprinkler System. A system employing automatic sprinklers installed in a piping system containing water and connected to a water supply. Water discharges immediately from sprinklers opened by a fire.

Wheeled Fire Extinguisher. A portable fire extinguisher equipped with a carriage and wheels intended to be transported to the fire by one person.