

## 7 FIRE SAFETY

### 7.1 PURPOSE OF REVIEW

The purpose of this review is to determine with reasonable assurance that the applicant has designed a facility that provides adequate protection against fires and explosions that could affect the safety of licensed materials and thus present an increased radiological risk. The review should also establish that the application has considered radiological consequences of the fires and will institute suitable safety controls to protect workers, the public, and the environment.

### 7.2 RESPONSIBILITY FOR REVIEW

Primary: Fire Safety Specialist

Secondary: Criticality Safety Specialist  
Environmental Specialist  
Chemical Safety Specialist  
Physical Security Specialist

Supporting: Regional, Resident, and Fuel Cycle Inspection Staff

### 7.3 AREAS OF REVIEW

The regulation established in 10 CFR 70.62(a) requires an applicant to develop, implement, and maintain a safety program that will reasonably protect health and safety of the public and the environment from the fire and explosive hazards associated with processing, handling, and storing licensed materials during normal operations, anticipated operational occurrences, and credible accidents. The reviewers should first consult the ISA Summary (SRP Chapter 3) to identify analyzed operations that have the potential to result in fire or explosion, and should gain familiarity with the IROFS and complementary management measures that are proposed to prevent or mitigate any resulting chemical or radiological risks. The fire protection program must address these process-specific risks, as well as general fire prevention, protection, and management issues. Although 10 CFR Part 70 does not require a separate fire safety program, an applicant should provide commitments pertaining to fire safety in the following areas:

- Fire safety management includes safety organization, engineering review, fire prevention; inspection, testing, and maintenance; pre-fire plans; and personnel qualifications, drills, and training.
- Fire risk identification includes the Fire Hazards Analysis (FHA) and the ISA Summary.
- Facility design includes information on building construction, fire areas, life safety, ventilation, and electrical system design. The facility design should also consider competing requirements among fire safety and security, criticality, and environmental concerns.
- Process fire safety involves design considerations to prevent an accident or to mitigate the consequences of an accident resulting from using process chemicals, combustible metals,

flammable and combustible liquids and gases, high-temperature equipment, hot cells and glove boxes, and laboratories.

- Fire protection systems include fire detection, alarm, and suppression systems; portable extinguishers; water supplies; and emergency response organizations.

## **7.4 ACCEPTANCE CRITERIA**

An applicant that meets the acceptance criteria defined in this section, or has provided an acceptable alternative, should be considered to have an acceptable fire safety program.

### **7.4.1 Regulatory Requirements**

The regulatory basis for the fire safety review should be the general and additional contents of application as required by 10 CFR 70.22 and 70.65. In addition, the fire safety review should focus on providing reasonable assurance of compliance with 10 CFR 70.61, 70.62, and 70.64.

### **7.4.2 Regulatory Guidance**

The relevant regulatory guidance for fire safety includes the following NRC and industrial standards:

- National Fire Protection Association, "Standards for Facilities Handling Radioactive Material," NFPA Standard 801, latest edition.
- U.S. Nuclear Regulatory Commission, "Integrated Safety Analysis Guidance Document," NUREG-1513, 2001.
- U.S. Nuclear Regulatory Commission, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," NUREG/CR-6410, 1998.

### **7.4.3 Regulatory Acceptance Criteria**

Partial acceptability of the application and the ISA Summary will be contingent on the NRC staff's review of the applicant's commitments to control and mitigate fire hazards. The staff will focus on whether the application is risk-informed, addresses the applicant's procedures for maintaining an acceptable level of fire safety, and demonstrates that the applicant is prepared to react quickly and safely to extinguish fires. An applicant may use a graded approach to define fire safety, but must provide sufficient documentation and commitments to ensure that workers, the public, and the environment will be adequately protected from fire events.

These acceptance criteria may be incorporated in the information supplied to satisfy SRP Section 3 (ISA) or other SRP sections so long as clear references are provided (information need not be repeated). The staff's fire safety specialist will review the application, ISA Summary, and other documentation, as needed, regarding these acceptance criteria.

The reviewer(s) will use nationally recognized codes and standards are used by the reviewer to measure reasonable assurance of fire safety. These include, but are not limited to, the NFPA National Fire Codes, Factory Mutual (FM) Data Sheets and Approval Guide, Underwriters Laboratories (UL) Standards and Building Material Directory, ANSI Standards; and ASTM

Standards. Commitments to specified standards will normally be considered an acceptable means of meeting the acceptance criteria.

The NRC staff will review the application regarding the following acceptance criteria:

#### **7.4.3.1 Fire Safety Management Measures**

An adequate application documents how the applicant will administer and ensure fire safety at the licensed facility. The application should reflect a commitment to ensure that the IROFS, as identified in the ISA Summary, are available and reliable, and the facility maintains fire safety awareness among employees, controls transient ignition sources and combustibles, and maintains a readiness to extinguish or limit the consequences of fire. These measures are unique to fire safety and, therefore are not included in the acceptance criteria for SRP Section 11, "Management Measures."

An adequate application identifies a senior-level manager who has the authority and staff to ensure that fire safety receives appropriate priority. A facility safety committee or fire safety review committee staffed by managers of different disciplines should integrate facility modifications. (The facility safety committee can do the work of a fire safety review committee.) As described in the application, day-to-day fire safety should be supervised by an individual with sufficient practical fire safety experience in nuclear facilities.

The "Standard for Fire Protection for Facilities Handling Radioactive Materials," NFPA 801, specifies the following fire safety management measures, including fire prevention; inspection, testing, and maintenance of fire protection systems; emergency response organization qualifications, drills, and training; and pre-fire plans. An adequate application documents the fire safety management measures in sufficient detail to identify their relationship to, and functions for, normal operations; anticipated (off-normal) events; and accident safety (i.e., IROFS). The staff recognizes NFPA 801 as one acceptable standard for fire safety management measures, however the applicant may use other nationally recognized codes and standards if appropriate. The staff's fire safety specialist will review the adequacy of the fire safety management measures presented in the application.

#### **7.4.3.2 Fire Hazards Analysis**

Knowing the fire risk allows an applicant to apply the appropriate level of fire protection to ensure the safety of workers, the public and the environment from fire-induced radiological hazards. To be risk-informed, a licensee should conduct an FHA for each facility, or part thereof, that, if totally consumed by fire, could release SNM in quantity and form that could cause at least an intermediate consequence, as defined in 10 CFR 70.61. The FHA should develop bounding credible fire scenarios for each fire area containing significant fire loading, and then assess the consequences of an unmitigated fire. The staff recognizes NFPA 801 as one standard that provides guidance for conducting FHAs, however, the applicant may use other nationally recognized codes and standards if appropriate. The FHA should include a description, by fire area, of the fuel loading, fire scenarios, methods of consequence analysis, the potential consequences, and a description of the mitigative controls.

The FHA is used to identify possible fire initiators and accident sequences leading to radiological consequences or toxic chemical consequences resulting from interaction with SNM. In developing accident sequences that will be reported in the ISA Summary, the ISA team will consider the FHA results and assign likelihoods of the various events in the accident sequences. With respect to fire safety, the ISA Summary is acceptable if the credible fire

hazards (e.g., from the FHA) are identified for each process fire area, and information is provided to detail how each fire hazard was considered and addressed (i.e., the management measures and/or IROFS) for each process accident sequence whose consequence could exceed the performance requirements in 10 CFR 70.61. Thus, the FHA is a fundamental tool for evaluating fire hazards as input to the ISA evaluation. The staff's fire safety specialist will review the adequacy fire safety aspects of the ISA Summary.

#### **7.4.3.3 Facility Design**

Building construction, fire area determination, electrical installation, life safety, ventilation, drainage, and lightning protection are all facility design features that affect fire safety. An adequate application documents the fire safety considerations used in the general design of the facilities containing licensed material or facilities that impose an exposure threat to radiological facilities. The staff recognizes NFPA 801 as one standard that specifies acceptable facility fire safety design criteria; however the applicant may use other nationally recognized codes and standards if appropriate. The staff's fire safety specialist will review the adequacy facility's fire safety design.

The following are other specific areas of concern:

- Criticality concerns may exclude water extinguishing systems from process areas. However, during major fire events, the fire may easily overcome the extinguishing capability of portable extinguishers, and hose lines may be needed to extinguish the fire. Consequently, applicants should consider using total flooding gaseous systems in water-exclusion areas with significant fire risks. An adequate application addresses the methodology for extinguishing fires in water-exclusion areas. The staff's fire safety and criticality specialist will review for adequacy.
- Environmental concerns include the potential for thousands of gallons of fire water to be contaminated with nuclear material during a fire event. Consequently, diked areas and drainage of process facilities may be needed. NFPA 801 provides guidance on how to calculate the potential amount of runoff to properly size drainage and containment systems. An adequate application documents any measures used to control fire water runoff. The staff's fire safety and environmental specialists will review the applicant's fire water retention system for adequacy.
- Physical Security Concerns include the need to design buildings and facilities to provide safe egress in case of fire or chemical events that could lead to radiological emergencies. Physical security requirements for SNM may inadvertently delay worker egress and fire fighter access. Physical security procedures should allow offsite fire departments quick and efficient access to fire emergencies. An adequate application documents the design criteria used for worker egress and procedures for firefighter access. The staff recognizes NFPA 801 as one standard that specifies acceptable worker egress design criteria; however, the applicant may use other nationally recognized codes and standards if appropriate. The staff's fire safety and physical security specialists will review for adequacy.
- Design and construction of new facilities should: (1) comply with the baseline design criteria (BDC) specified in 10 CFR 70.64(a), (2) comply with the defense-in-depth requirements of 10 CFR 70.64(b), and (3) be consistent with the guidance provided in NFPA 801 or other appropriate nationally recognized fire protection codes and standards.

The staff's fire safety specialist will review the adequacy of the fire safety design of new facilities.

#### **7.4.3.4 Process Fire Safety**

Many hazardous chemicals and processes used by fuel cycle facilities contribute to the fire hazards affecting radiological areas. In areas that have fire hazards that may threaten licensed material, the application should identify the hazardous chemicals, processes, and design standards used to ensure fire safety. The staff recognizes NFPA 801 as one standard that provides acceptable design criteria for radiological process areas that may contain: hazardous material, laboratories, high-temperature equipment, hot cells, and/or glove boxes. However, the applicant may use other nationally recognized codes and standards if appropriate. The staff's fire safety and chemical safety specialists will review the adequacy of application.

The following are a few of the more common hazardous materials used at fuel cycle facilities:

- Anhydrous ammonia is an explosive, flammable, and toxic gas used to make hydrogen.
- Fluorine reacts violently with organic material or metal powders and water vapor.
- Hydrogen is an explosive and flammable gas used in reduction processes.
- Hydrogen peroxide, off-gases hydrogen and oxygen, and is incompatible with some extinguishers.
- Nitric acid, nitrates organic material, which lowers the ignition temperature of combustibles.
- Sulfuric acid absorbs water from organic material in an exothermic reaction, thereby causing ignition.
- Zirconium is a combustible metal that burns at elevated temperatures.

#### **7.4.3.5 Fire Protection and Emergency Response**

The application should document the fire protection systems and fire emergency response organizations provided for licensed facilities. The ISA Summary (see SRP Chapter 3) should identify the fire protection IROFS. An adequate application describes the fire protection provided for areas in which licensed material is present. The application should describe which standards the fire protection systems and equipment meet. The staff recognizes the NFPA's national fire codes as acceptable standards for the design, installation, testing, and maintenance of the fire protection systems and equipment. However, the applicant may use other nationally recognized codes and standards if appropriate.

Facilities with significant fire risks may need a fire emergency response team. One acceptable standard is NFPA 600, "Industrial Fire Brigades." However, the applicant may use other nationally recognized codes and standards if appropriate. If offsite fire departments are needed for facility fire safety, periodic training with the fire departments is necessary to enable them to become familiar with facility access procedures, facility layout, and pre-fire plans. A memorandum of understanding (MOU) between the applicant and the fire departments may be necessary to define the required protection. The staff's fire safety specialist will review the adequacy of the applicant's fire protection and emergency response commitments.

### **7.5 REVIEW PROCEDURES**

#### **7.5.1 Acceptance Review**

During the acceptance review, the primary reviewer evaluates the application for completeness as required by 10 CFR Part 70 and determines whether the application addresses the criteria

discussed in SRP Section 7.3, “Areas of Review.” If significant deficiencies in the application are identified, the primary reviewer should recommend the return of the application or requested additional information before the start of the safety evaluation.

## **7.5.2 Safety Evaluation**

During the safety evaluation, the primary and secondary reviewers evaluate whether the application is adequate to comprehensively describe the fire safety of the licensed activity as identified in Section 7.3, “Areas of Review,” and the commitments made in response to the criteria specified in Section 7.4, “Acceptance Criteria.” The staff may request the applicant or licensee to provide additional information or modify the submittal to meet the acceptance criteria.

Reviewers should note that NFPA 801 uses “administrative control” in a different sense than 10 CFR Part 70 and elsewhere in this SRP. In 10 CFR Part 70, an administrative control is an IROFS if it is the human action necessary to meet safety performance requirements, and it is supported by management measures (training, quality assurance, procedures, etc.) that ensure that the action will be taken if needed. In NFPA 801, “administrative controls” are the training, qualifications, procedures, etc., behind the human action; however these elements are referred to as “Management Measures” in 10 CFR Part 70, and in this SRP.

## **7.6 EVALUATION FINDINGS**

The staff’s review should verify that the applicant (1) provides sufficient information to satisfy the intent of 10 CFR Part 70 requirements related to the overall safety program, and (2) is consistent with the fire safety criteria in this SRP. On the basis of this information, the staff should be able to evaluate whether the application meets the appropriate criteria. As an example, the staff might document the fire safety review in an SER in the following manner:

The applicant has established a fire protection function meeting the acceptance criteria in Chapter 7 of the “SRP for the Review of a License Application for a Fuel Cycle Facility.” The function includes a facility safety review committee responsible for integrating modifications to the facility and a Fire Safety Manager responsible for day-to-day program implementation. Fire prevention, inspection, testing, and maintenance of fire protection systems, and the qualification, drills, and training of facility personnel are in accordance with applicable NFPA codes and standards. (Note that fire protection training requirements are described in SER Section 11.3.)

The applicant has conducted risk analyses in accordance with NFPA 801, “Standard for Fire Protection for Facilities Handling Radioactive Material.” The FHAs identified credible fire scenarios that bound the fire risk. The ISA used these scenarios and identified fire protection IROFS, (in particular, wet pipe sprinkling in the process areas, isolation of the high-temperature equipment within fire barriers, and a fire brigade meeting NFPA 600, “Industrial Fire Brigades”). An MOU with the fire department documents the required assistance and the annual exercises. Procedures are in place to allow the fire department efficient access to process areas during fire emergencies. Worker egress is designed and maintained in accordance with NFPA 101, “Life Safety Code.”

The staff concludes that the applicant’s capabilities meet the criteria in Chapter 7 of the SRP. The staff concludes that the applicant’s proposed equipment, facilities, and procedures provide a reasonable level of assurance that adequate fire protection will be

provided and maintained for those IROFS to meet the safety performance requirements and BDC of 10 CFR Part 70.

## **7.7 REFERENCES**

National Fire Protection Association, "National Fire Codes," latest edition.

U.S. Nuclear Regulatory Commission, Information Notice No. 92-14, "Uranium Oxide Fires at Fuel Cycle Facilities," February 21, 1992.

U.S. Nuclear Regulatory Commission, NUREG-1513, "Integrated Safety Analysis Guidance Document," 2001.

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