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U.S. NUCLEAR REGULATORY COMMISSION STANDARD REVIEW PLAN OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS

7.0 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 for 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 radiological consequences from fires have been considered and that suitable safety controls will be instituted to protect the 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, 10 CFR 70.62(a), requires a licensee to develop, implement, and maintain a safety program that will provide reasonable assurance of public health and safety and of the environment from the fire and explosive hazards of processing, handling, and storage of licensed material during normal operations, anticipated operational occurrences and credible accidents. The reviewer should first consult the "ISA Summary" (SRP Chapter 3) to identify those operations analyzed in the ISA that have a fire or explosion potential and 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:

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- Fire Safety Management: This includes safety organization; engineering review; fire prevention; inspection, testing, and maintenance; pre-fire plans; and personnel qualifications, drills, and training.
- Fire Risk Identification: This includes Fire Hazards Analysis (FHA) and ISA Summary.
- Facility Design: This includes information on building construction; fire areas; life safety; ventilation; and electrical system design. Consideration of competing requirements among fire safety and security, criticality, and environmental concerns should be included.
- Process Fire Safety: This involves design consideration to prevent an accident or mitigate the consequences from using process chemicals; combustible metals; flammable and combustible liquids and gasses; high-temperature equipment; hot cells and glove boxes; and laboratories.
- Fire Protection Systems: This includes fire detection, alarm, and suppression systems; portable extinguishers; water supply; and emergency response organizations.

7.4 ACCEPTANCE CRITERIA

An applicant that has met the following acceptance criteria, 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 review should be the general and additional contents of an application as required by 10 CFR 70.22 and 70.65. In addition, the fire safety review should be conducted to provide reasonable assurance of compliance with 10 CFR 70.61, 70.62, and 70.64.

7.4.2 Regulatory Guidance

Relevant regulatory guidance for fire safety includes:

National Fire Protection Association, NFPA Standard 801, "Standards for Facilities Handling Radioactive Material," latest edition.

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

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U.S. Nuclear Regulatory Commission, NUREG/CR-6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook," 1998.

7.4.3 Regulatory Acceptance Criteria

The acceptability of the application and the "ISA Summary" will be based on the NRC staff's review of the applicant's commitments to control and mitigate fire hazards. The staff will focus on an application that is risk-informed, has addressed maintaining an acceptable level of fire safety, and demonstrates that an applicant is prepared to react quickly and safely to extinguish fires. An applicant may use a graded approach for defining fire safety, but sufficient documentation and commitments must be made to assure the protection of workers, the public, and the environment from fire events.

These acceptance criteria may be incorporated in the information supplied to satisfy SRP Section 3.0 (ISA) or other SRP sections with references 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, wherever the information appears.

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 National Fire Protection Association (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 fire safety is administered and assured at the licensed facility. The application should reflect a commitment to assure that the IROFS, as identified in the "ISA Summary," are available and reliable; fire safety awareness among employees is maintained; transient ignition sources and combustibles are controlled; and the facility maintains a readiness to extinguish or limit the consequences of fire. These measures are unique to fire safety and are therefore 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 assure that fire safety receives appropriate priority. A Plant Safety Committee or Fire Safety Review Committee staffed by different discipline managers should integrate plant modifications. The Plant Safety Committee can do the work of a Fire Safety Review Committee. Day-to-day

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supervision of fire safety should be by an individual with sufficient practical fire safety experience (that is described in the application) in nuclear facilities.

The Standard for Fire Protection for Facilities Handling Radioactive Materials, NFPA 801, specifies the following fire safety management measures: 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. The licensee may use other nationally recognized codes and standards if appropriate. The staff's fire safety specialist will review the application's fire safety management measures for adequacy.

7.4.3.2 Fire Hazards Analysis

Knowing the fire risk allows a licensee to apply the appropriate level of fire protection to assure 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, then assess the consequences of an unmitigated fire. The staff recognizes NFPA 801 as one standard that provides guidance for conducting FHAs. The licensee 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 consequences, and a description of the mitigative controls.

The FHA is used to inform the ISA team of possible fire initiators and accident sequences leading to radiological consequences or toxic chemical consequences resulting from interaction with SNM. The ISA team, in developing accident sequences that will be reported in the ISA summary, 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 detailing how that fire hazard was considered and addressed (i.e., the management measures and/or IROFS) for each process such that the performance requirements in 10 CFR 70.61 are satisfied with respect to the fire hazards. Thus, while ultimate conclusions are based on the ISA Summary, the FHA is a fundamental tool in evaluating fire hazards as input to the ISA evaluation. The staff's fire safety specialist will review the fire safety aspects of the "ISA Summary" for adequacy.

7.4.3.3 Facility Design

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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 radiological 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. The licensee may use other nationally recognized codes and standards if appropriate. The staff's fire safety specialist will review the facility's fire safety design for adequacy.

The following are other specific areas of concern:

Criticality: 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. Consideration should be given to total flooding gaseous systems in water-exclusion areas with significant fire risks. An adequate application should address the methodology used for extinguishing fires in water-exclusion areas. The staff's fire safety and criticality specialist will review for adequacy.

Environmental Concerns: There is a potential for thousands of gallons of fire water to be contaminated with nuclear material during a fire event. 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 for control of fire water runoff. The staff's fire safety and environmental specialists will review for adequacy.

Physical Security Concerns: Buildings and facilities should be designed 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 off-site 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. The licensee may use other nationally recognized codes and standards if appropriate. The staff's fire safety and physical security specialists will review for adequacy.

Design of New Facilities: New facilities should be designed and constructed in accordance with: (a) the BDC specified in 10 CFR 70.64(a); (b) the defense-in-depth requirements of 10 CFR 70.64(b); and (c) 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 fire safety design of new facilities for adequacy.

7.4.3.4 Process Fire Safety

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Many hazardous chemicals and processes used by fuel cycle facilities contribute to the fire hazards affecting radiological areas. In fire areas that have fire hazards that may threaten radiological material, the application should identify the hazardous chemicals, processes, and design standards used to assure 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. The licensee may use other nationally recognized codes and standards if appropriate. The staff's fire safety and chemical safety specialists will review the application for adequacy.

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

Anhydrous Ammonia: Explosive, flammable, and toxic gas used to make hydrogen.

Fluorine: Reacts violently with organic material or metal powders and water vapor.

Hydrogen: Explosive and flammable gas used in reduction processes.

Hydrogen Peroxide: Off-gases hydrogen and oxygen, incompatible with some extinguishers.

Nitric Acid: Nitrates organic material, lowering the ignition temperature of combustibles.

Sulfuric Acid: Absorbs water from organic material in an exothermic reaction, causing ignition.

Zirconium: 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 Section 3.0) should identify the fire protection IROFS. An adequate application describes the fire protection provided for radiological areas and fire areas that may cause an exposure fire hazard to radiological areas. The application should describe which standards the fire protection systems and equipment meet. The staff recognizes NFPA National Fire Codes as acceptable standards for the design, installation, testing, and maintenance of the fire protection systems and equipment. The licensee 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." The licensee may use other nationally recognized codes and standards if appropriate. If off-site fire departments are needed for plant fire safety, periodic training with the fire departments is necessary to become familiar with facility access procedures, plant layout, and pre-fire plans. A memorandum of understanding (MOU) between the applicant and the fire departments may be necessary to define the protection required. The staff's fire safety specialist will review the fire protection and emergency response commitments for adequacy.

7.5 REVIEW PROCEDURES

7.5.1 Acceptance Review

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During the acceptance review, the primary reviewer evaluates the application for completeness as required by 10 CFR Part 70 and whether the criteria discussed in Section 7.3, "Areas of Review," have been addressed. If significant deficiencies in the application are identified, the application should be returned or additional information requested before the start of the safety evaluation.

7.5.2 Safety Evaluation

During the Safety Evaluation, the primary and secondary reviewers evaluate the adequacy of the application to comprehensively describe the fire safety of the licensed activity as covered in Section 7.3, "Areas of Review," and the commitments made 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. It is supported by management measures (training, quality assurance, procedures, etc.) that assure the action will be taken if needed. In NFPA 801, administrative controls are the training, qualifications, procedures, etc., behind the human action. These elements are "Management Measures" in 10 CFR Part 70, and in this SRP.

7.6 EVALUATION FINDINGS

The staff's review should verify: (a) that sufficient information has been provided, in the license application, to satisfy the intent of 10 CFR Part 70 requirements relating to the overall safety program; and (b) that it is consistent with the fire safety criteria in this SRP. On the basis of this information, the staff should be able to evaluate the application's ability to meet the appropriate criteria. As an example, the staff might document in an SER the fire safety review in the following manner:

The applicant has established a Fire Protection function meeting the acceptance criteria in the Fuel Cycle SRP, Chapter 7. The function includes a Plant 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 plant personnel are in accordance with applicable NFPA codes and standards. (Note: fire protection training requirements are described in SER Section 11.3)

The applicant has conducted risk analysis 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

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equipment within fire barriers; and a fire brigade meeting NFPA 600, "Industrial Fire Brigades." An MOU with the fire department documents the assistance required 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 and exceed 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.